



# TECHNICAL MANUAL

**VERSION 13**

# WELCOME

The updated standards outlined in this Technical Manual apply to all homes quoted on or after 1st January 2026. At LABC Warranty, we remain committed to supporting the construction industry in its efforts to deliver high-quality homes.

This Technical Manual is designed to provide clear, practical guidance on meeting our Warranty requirements thereby enabling industry professionals to navigate the evolving landscape of building standards and best practices with confidence. The Technical Manual is intended to be a valuable resource for our developers, builders and designers alike, combining our extensive experience with industry insights, regulatory updates, claims analysis, and feedback from our partners.

This version of the Technical Manual has undergone a comprehensive review and features significant updates, including:

- A new portrait layout.
- Simplified Functional Requirements.
- The reintroduction of Performance Requirements to support the Functional Requirements, ensuring greater clarity around our Warranty expectations.

Additionally, we have introduced two new sections:

1. Section 21: MMC Systems, which provides guidance on Volumetric Systems, Closed Panel Systems, Structural Insulated Panels (SIPs), and Insulated Concrete Forms (ICF), as well as our system acceptance process.
2. Section 22: Conversions and Retained Elements, which offers more comprehensive information and has been expanded from an appendix to a full section.

Our primary objective is to promote quality construction and provide assurance to both industry professionals and future homeowners. We appreciate the opportunity to work with you and look forward to supporting you throughout your building projects.



David Swigciski  
Managing Director

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# ADDITIONAL RESOURCES AND SERVICES

## Technical Standards Online

This Technical Manual, along with our additional guidance documents can be accessed online by scanning the QR code.



## Site Quality Reviews

The Site Quality Review gives you an in-depth assessment of workmanship and site management practices at key stages of construction. Scan the QR code for more information.



## System Acceptance

As part of our Warranty application process, developers and builders must ensure that the systems they use on site are accepted by us in line with the requirements of our Technical Manual.

Our system acceptance has been developed to help manufacturers gain accreditation under our Warranty technical requirements, allowing them to be promoted as an accepted system provider, giving customers confidence in using their systems on sites registered with LABC Warranty. Scan the QR code for more information.



## Technical Training

Bring your staff up to speed on construction fundamentals with our training courses. Focused on building practical skills for jobs in construction, our training offers your staff short, accessible, information-rich courses. Whether they're onsite every day, just starting out in the industry, or pursuing an office-based role, your staff will benefit from a more robust understanding of the design, build, and inspection processes.

For more information on what training is available to you, scan the QR code.



## Early Engagement Consultancy

Our Early Engagement Consultancy offers a technical review led by our knowledgeable and highly skilled Major Projects Managers, to ensure your plans satisfy our Warranty requirements long before construction works start on site.

For more information, scan the QR code.



# Main Changes to this Version

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## Section 1 Ground Conditions

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- We have a new section titled 'Ground Conditions - Managing Ground Contaminants'. The guidance focuses site investigations and the assessment of ground contaminants, the remediation strategy report and the specification and installation of gas resistant membranes.

## Section 2 Waterproofing Below Ground Storeys and Structures (previously the 'Basements' section)

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- The 'Basements' section has been renamed to reflect the scope of what is covered. The section is now titled, 'Waterproofing Below Ground Storeys and Structures'.
- We now have guidance on waterproofing and its interface with above ground structures, to help ensure continuity of protection and reduce the risk of water ingress at junctions.
- We have introduced new guidance on dealing with penetrations through waterproofing protection, as these are common failure points if not correctly detailed and sealed.

## Section 3 Foundations

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- The 'Foundations - Piles' section has been rewritten with input from our Engineers to rationalise the guidance, make it more concise, and present it in a more logical order.
- We have introduced new guidance on hydraulically treated soils to ensure appropriate design measures are taken at an early stage.
- Our guidance on retaining walls has been moved to its own separate section within the 'Foundations' section, and we have introduced new guidance on reinforced earth retaining walls as they need careful design and detailing.

## Section 5 Drainage

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- The 'Drainage' section has been reworked to remove unnecessary repetition. As a result, the section now consists of three subsections instead of seven.
- We now provide guidance on rain gardens to support sustainable drainage systems due to their increased use onsite and the risks they pose when poorly located, detailed and maintained.

## Section 6 External Walls

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- The scope of the guidance in our 'External Walls - External Masonry Walls' section has increased, and we now also cover masonry external cladding to timber frame structures and light gauge steel frame structures.
- We now provide details for our requirements for cast stone masonry due to some of the issues we've come across in relation to their specification.
- We have introduced new guidance on separate lintels being used for both leaves of masonry due to some of the risks we have come across onsite.
- The 'External Walls - Render' section has been completely re-written to improve its flow, make it easier to understand, and follow a more logical order.
- The 'External Walls - Parapets' section now states that parapets should have at least three lines of defence due to their exposure.
- Within the 'External Walls - Parapets' section we now have detailed guidance on a parapet wall and external wall junction due to the risks associated with detailing at this junction.

## Section 7 Internal Walls

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- We previously had guidance on party wall spandrel panels within the 'Internal Walls – Masonry' section. We have moved this to its own section called 'Internal Walls – Spandrel Panels' within the 'Internal Walls' section to align with the changes we made to the 'External Walls' section and our guidance on gable spandrel panels.

## Section 11 Roofs

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- Within the 'Roofs - Pitched Roof Structures' section we have introduced guidance on dormer construction to highlight some of the risks associated with their inclusion in a pitched roof.
- Within the 'Roofs - Pitched Roof Structures' section, we now provide more extensive guidance on wall plates, particularly in relation to how they should be specified and resist wind uplift.
- Our bracing requirements within the 'Roofs - Pitched Roof Structures' section has been updated to align with latest industry standards.
- Within the 'Roofs - Pitched Roof Structures' section we have introduced new guidance which highlights some of the key risks associated with specifying items of plant, equipment or water storage tanks within cold roof voids.
- We now provide a list of our requirements for the designer to satisfy where a pitched roof structure incorporates steps and staggers within the 'Roofs - Pitched Roof Structures' section.
- We have rewritten our guidance on ventilation provisions to pitched roofs to provide more clarity, align it with the latest industry practices and ensure it follows a more logical order. The new guidance can be found within the 'Roofs - Pitched Roof Structures' section.



# Main Changes to this Version

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- The requirements for material characteristics and independent certification for flat roof waterproofing systems has been re-written to provide more clarity on what we need.
- Within the 'Roofs - Flat Roofs' section we have introduced new guidance on control of work post waterproofing completion and protection of completed waterproofing to emphasis some of the risks which may lead to a failure of the waterproofing system and water ingress.
- We now highlight some of the risks associated with using pedestals to support pedestrian surfaces when they're specified incorrectly within the 'Roofs – Flat Roofs' section.

## Section 15 Heating Systems

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- For our guidance on performance of space heating systems, we have updated the minimum internal room temperatures and air change rates to align them with latest industry standards. New guidance has also been added on external design temperatures for the performance of space heating systems.

## Section 17 Electrical Services

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- Our guidance on Photovoltaic (PV) Solar Panels has been moved to the 'Electrical Services' section and we now also provide guidance on integrated PV Solar Panels and the risks they pose.

## 19 Garages

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- We have introduced a requirement for attached/integral garages to have adequate protection against ground gases.
- We have also introduced a requirement for preventing dampness entering habitable parts of the home for attached and integral garages.
- We have updated our requirements for sub-floor ventilation requirements for suspended ground floors to better reflect the risks posed to us.
- We have updated our guidance on the structural stability of walls, piers and external door and window openings to provide more clarity and align with latest standards.
- We have introduced new guidance on retaining walls and below ground slabs due to increasing scenarios where garages are inadequately waterproofed where walls retain earth or where external ground levels are higher than internal garage floor levels.

## Section 21 MMC Systems

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- We have written new guidance which focuses on our requirements for category 1 (volumetric) and category 2 (panelised) forms of offsite construction.

## Section 22 Conversions and Retained Elements (previously Appendix D)

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- This new section offers more comprehensive information on conversions and retained elements and has been expanded from an appendix to a full section.

## Appendix C

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- In the service life table, we now have the following statement before the table: 'The following service life requirements are in relation to the function of the building components only (not in relation to discolouration for example)'.
- In addition, the service life table now lists more cladding types under cladding systems.
- We now offer new guidance on exposure classes related to environmental factors for concrete mixes.
- We now have guidance on concrete testing requirements and what we expect.

# Contents

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|                                                                                   |          |
|-----------------------------------------------------------------------------------|----------|
| <b>The Structure of this Technical Manual</b>                                     | <b>5</b> |
| <b>Functional Requirements</b>                                                    | <b>7</b> |
| <br>                                                                              |          |
| <b>1. Ground Conditions</b>                                                       |          |
| 1.1 Site Investigation                                                            | 12       |
| 1.2 Managing Ground Contaminants                                                  | 21       |
| <br>                                                                              |          |
| <b>2. Waterproofing Below Ground Storeys and Structures</b>                       |          |
| 2.1 General Requirements                                                          | 26       |
| <br>                                                                              |          |
| <b>3. Foundations</b>                                                             |          |
| 3.1 Mass Fill and Strip                                                           | 38       |
| 3.2 Piles                                                                         | 43       |
| 3.3 Raft                                                                          | 49       |
| 3.4 Engineered Fill                                                               | 52       |
| 3.5 Vibratory Ground Improvement                                                  | 58       |
| 3.6 Trees and Clay                                                                | 66       |
| 3.7 Retaining Walls                                                               | 74       |
| <br>                                                                              |          |
| <b>4. Ground Floors</b>                                                           |          |
| 4.1 Suspended Ground Floors                                                       | 78       |
| 4.2 Ground Supported Slab                                                         | 85       |
| 4.3 Stepped Floors, Screeds, and Underfloor Heating Requirements                  | 88       |
| <br>                                                                              |          |
| <b>5. Drainage</b>                                                                |          |
| 5.1 Above Ground Drainage                                                         | 94       |
| 5.2 Below Ground Drainage                                                         | 99       |
| <br>                                                                              |          |
| <b>6. External Walls</b>                                                          |          |
| 6.1 External Masonry Walls                                                        | 110      |
| 6.2 Timber Frame                                                                  | 135      |
| 6.3 Light Gauge Steel Frame                                                       | 155      |
| 6.4 Render                                                                        | 170      |
| 6.5 Claddings                                                                     | 176      |
| 6.6 Parapets                                                                      | 188      |
| 6.7 Gable Spandrel Panels                                                         | 196      |
| <br>                                                                              |          |
| <b>7. Internal Walls</b>                                                          |          |
| 7.1 Masonry                                                                       | 202      |
| 7.2 Timber Stud                                                                   | 206      |
| 7.3 Metal Stud                                                                    | 211      |
| 7.4 Spandrel Panels                                                               | 215      |
| 7.5 Fire Resistance, Cavity Barriers, and Fire Stopping                           | 219      |
| <br>                                                                              |          |
| <b>8. External Windows and Doors</b>                                              |          |
| 8.1 General Requirements                                                          | 224      |
| 8.2 Additional Requirements for External uPVC Window and Door Frames              | 232      |
| 8.3 Additional Requirements for External Timber Window and Door Frames            | 234      |
| 8.4 Additional Requirements for External Aluminium & Steel Window and Door Frames | 237      |
| 8.5 Additional Requirements for Vertically Stacked Coupled Window Assemblies      | 240      |
| 8.6 Additional Requirements for External Bi-fold Doors                            | 243      |
| <br>                                                                              |          |
| <b>9. Stairs</b>                                                                  |          |
| 9.1 General Requirements for all Stairs                                           | 246      |
| 9.2 Timber Stairs                                                                 | 250      |
| 9.3 Concrete and Steel Stairs                                                     | 252      |

# Contents

---

|            |                                                                      |     |
|------------|----------------------------------------------------------------------|-----|
| <b>10.</b> | <b>Upper Floors</b>                                                  |     |
| 10.1       | Timber Upper Floors                                                  | 254 |
| 10.2       | Concrete Upper Floors                                                | 272 |
| 10.3       | Fire Resistance, Cavity Barriers, and Fire Stopping                  | 282 |
| <b>11.</b> | <b>Roofs</b>                                                         |     |
| 11.1       | Pitched Roof Structures                                              | 286 |
| 11.2       | Panelised Roof Cassettes                                             | 307 |
| 11.3       | Pitched Roof Coverings (Tiles and Slates)                            | 309 |
| 11.4       | Flat Roofs                                                           | 325 |
| 11.5       | Green Roofs                                                          | 348 |
| 11.6       | Metal Deck Roofing                                                   | 354 |
| 11.7       | Blue Roofs                                                           | 365 |
| 11.8       | Podium Decks                                                         | 374 |
| <b>12.</b> | <b>Roof Terraces and Balconies</b>                                   |     |
| 12.1       | Roof Terraces                                                        | 384 |
| 12.2       | Balconies                                                            | 396 |
| <b>13.</b> | <b>Chimneys and Flues</b>                                            |     |
| 13.1       | Masonry                                                              | 406 |
| 13.2       | Gas Flue Outlets                                                     | 411 |
| 13.3       | False Chimney Stacks                                                 | 417 |
| <b>14.</b> | <b>Driveways and Paving</b>                                          |     |
| 14.1       | Driveways and Paving                                                 | 420 |
| <b>15.</b> | <b>Heating Systems</b>                                               |     |
| 15.1       | Services Entering the Building                                       | 430 |
| 15.2       | Space and Water Heating Systems                                      | 433 |
| 15.3       | Other Forms of Heating Systems Including Low and Zero Carbon Systems | 438 |
| <b>16.</b> | <b>Ventilation and Extraction</b>                                    |     |
| 16.1       | General Requirements                                                 | 446 |
| <b>17.</b> | <b>Electrical Services</b>                                           |     |
| 17.1       | Mains                                                                | 452 |
| 17.2       | Photovoltaic (PV) Solar Panels                                       | 458 |
| <b>18.</b> | <b>Cold Water Supply</b>                                             |     |
| 18.1       | Cold Water Supply to Plumbing, Boilers, and Appliances               | 464 |
| <b>19.</b> | <b>Garages</b>                                                       |     |
| 19.1       | Non-habitable Garages                                                | 468 |
| <b>20.</b> | <b>Tolerances</b>                                                    |     |
| 20.1       | Tolerances                                                           | 476 |
| <b>21.</b> | <b>MMC Systems</b>                                                   |     |
| 21.1       | General Requirements                                                 | 490 |
| 21.2       | Requirements for Volumetric MMC Systems                              | 497 |
| 21.3       | Requirements for Closed Panel Timber Frame Systems                   | 501 |
| 21.4       | Requirements for Closed Panel Light Gauge Steel Frame                | 504 |
| 21.5       | Requirements for Structural Insulated Panel Systems                  | 508 |
| 21.6       | Requirements for Insulated Concrete Formwork (ICF)                   | 512 |

# Contents

---

|              |                                                |     |
|--------------|------------------------------------------------|-----|
| <b>22.</b>   | <b>Conversions and Retained Elements</b>       |     |
| <b>22.1</b>  | General Requirements                           | 518 |
| <b>22.2</b>  | Retained Foundations                           | 520 |
| <b>22.3</b>  | Retained Basements and Below Ground Structures | 522 |
| <b>22.4</b>  | Retained Ground Floors                         | 524 |
| <b>22.5</b>  | Retained Drainage                              | 528 |
| <b>22.6</b>  | Retained External Walls                        | 530 |
| <b>22.7</b>  | Retained Framed Structures                     | 536 |
| <b>22.8</b>  | Retained Internal Walls                        | 538 |
| <b>22.9</b>  | Retained Intermediate Floors                   | 540 |
| <b>22.10</b> | Retained External Windows and Doors            | 542 |
| <b>22.11</b> | Retained Roofs                                 | 543 |
| <b>22.12</b> | Retained Chimneys and Flues                    | 545 |
| <br>         |                                                |     |
| <b>A.</b>    | <b>Appendix A</b>                              |     |
| <b>A.1</b>   | Finishes                                       | 548 |
| <br>         |                                                |     |
| <b>B.</b>    | <b>Appendix B</b>                              |     |
| <b>B.1</b>   | Coastal Locations                              | 552 |
| <br>         |                                                |     |
| <b>C.</b>    | <b>Appendix C</b>                              |     |
| <b>C.1</b>   | Materials, Products, and Building Systems      | 558 |



# The Structure of this Technical Manual

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## Contents

|                                                   |   |
|---------------------------------------------------|---|
| Our Warranty Requirements and Supporting Guidance | 6 |
| Limitations                                       | 6 |

# The Structure of this Technical Manual

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This Technical Manual is divided into 22 Sections, each addressing a specific build element, which follow a traditional build sequence. The Appendices serve to deal with general matters relating to finishes, coastal location risks, and materials and product requirements.

## Our Warranty Requirements and Supporting Guidance

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### Functional Requirements

Located at the front of this Technical Manual, the Functional Requirements define the core standards that must be met in all cases.

### Performance Requirements

Each Section and Appendix sets out Performance Requirements, identifiable by bold text and a shaded background, that help assist in achieving the Functional Requirements. Compliance with the Performance Requirements demonstrates that the associated Functional Requirements have been met.

### Supporting Guidance

Each Performance Requirement is accompanied by Supporting Guidance which offers acceptable solutions and best-practice details on satisfying the Performance Requirement. Alternative solutions may be acceptable provided they are approved in advance of construction.

### Limitations

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The Supporting Guidance within this Technical Manual is intended primarily for low rise construction (buildings of 5 storeys or lower – including the ground floor level). For projects being overseen by our Major Projects team, please liaise directly with your Major Projects Manager to confirm any project specific requirements.

We will accept work that meets relevant Building Regulations, except where our Warranty requires a higher standard to be met (e.g. durability / minimum service life).

This Technical Manual **is not** for the purpose of showing compliance with relevant Building Regulations or statutory regulations.

All illustrations are indicative of our Warranty requirements and best practise, they are not working construction details.

The Functional Requirements, Performance Requirements, and Supporting Guidance do not form a complete specification and are not contract specifications.

This Technical Manual does not apply to:

- Construction elements which are not covered by specific Sections or Appendices.
- Health and safety matters relating to building operations.
- Planning matters.
- Works not provided with Warranty cover.

# Functional Requirements

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## Contents

|                                                                      |   |
|----------------------------------------------------------------------|---|
| Functional Requirement 1 - Building Regulations                      | 8 |
| Functional Requirement 2 - Structural Design                         | 8 |
| Functional Requirement 3 - Workmanship                               | 9 |
| Functional Requirement 4 - Materials, Products, and Building Systems | 9 |
| Functional Requirement 5 - Design and Specifications                 | 9 |



# Functional Requirements

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## Functional Requirement 1 – Building Regulations

For the purposes of our Warranty, where there is a Performance Requirement within this Technical Manual, the completed construction works must comply with relevant Building Regulations.

Where we provide a Performance Requirement, we will generally accept works that satisfies the relevant Building Regulations except where we have a higher standard.

## Functional Requirement 2 – Structural Design

All buildings must be structurally sound and structural designs must be carried out by suitably qualified persons, in accordance with relevant British Standards and Codes of Practice.

In adherence to established technical standards, consideration must be given to the entirety of the following British Standards:

- Eurocodes and their respective National Annexes
- BS EN 1990: Eurocode 0 – 'Basis of structural design'
- BS EN 1991: Eurocode 1 – 'Actions on structures'
- BS EN 1992: Eurocode 2 – 'Design of concrete structures'
- BS EN 1993: Eurocode 3 – 'Design of steel structures'
- BS EN 1995: Eurocode 5 – 'Design of timber structures'
- BS EN 1996: Eurocode 6 – 'Design of masonry structures'
- BS EN 1997: Eurocode 7 – 'Geotechnical design'

As an alternative, designs in accordance with BS 8103 – 'Structural design of low rise buildings' shall be deemed acceptable.

The designs must show structural adequacy, ensuring the safe transfer of loads to the supporting structure or foundation without excessive movement.

Where we refer to British Standards and codes of practice, these are documents, the editions of which are referred to in Building Regulations that were current at the time of Building Regulation approval and are published by BSI in respect of Structural design. These include relevant BS, BS EN and PD standards that are accepted by us.

Throughout the Technical Manual, we will refer to the term 'Engineer'. For Warranty purposes this means a Chartered Civil or Structural Engineer whose status (including professional indemnity insurance) is accepted by us.

Subsequent sections of the Technical Manual will state where we require a Structural design from an Engineer. This will include:

- Foundations on hazardous ground.
- Foundations and superstructure\*.
- Retaining wall structures where they provide support to a building, drainage or the approach route to the principle entrance.
- A home constructed of non-traditional or MMC construction.
- Structural elements outside the parameters of Building Regulations.
- Specialist structural works.
- Reinforced concrete elements.
- Precast structural elements.
- Any engineered beams/posts manufactured off-site.

\*Please note: In all cases where a building is over three storeys in height, a Structural design by an Engineer must be provided for foundations and superstructures to ensure compliance with British Standards.

The Structural design must also take account of:

- The durability and service life requirements stated within this Technical Manual.
- Our Tolerances requirements.

# Functional Requirements

## Functional Requirement 3 - Workmanship

All buildings must be structurally sound and all work must be carried out by a technically competent person in a workmanlike manner.

All workmanship must be within the tolerance requirements set out in this Technical Manual.

Concreting, brick laying or rendering must not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

The builder/developer must ensure that:

- Workmanship satisfies the requirements of the design.
- The correct installation methods are utilised, adhering to Manufacturers installation requirements and any conditions stipulated as part of a third party product conformity certification.
- Suitable precautions against damage from follow on trades are in place.

The design team must provide specifications and detailing to demonstrate the durability, suitability and weather tightness of the construction as identified in this Technical Manual including coastal locations.

## Functional Requirement 4 – Materials, Product and Building Systems

All materials, products and building systems must be suitable for their intended purpose for where there is a Performance Requirement.

All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.

Non structural components, must achieve the service life requirements in this Technical Manual.

The following must be taken into account in the selection of all materials, products and building systems:

- The geographic location, exposure of the site and any other site specific conditions which may affect its required Durability and service life.
- Its position on site.
- Its position within the structure and surrounding building elements including compatibility with adjoining materials.
- Demonstrate the proposed materials, products and building systems meet relevant British Standards for its intended use or has a current third party product conformity certificate which is acceptable to us.
- Building systems and modern methods of construction will require to meet Section 21 and Appendix C of this Technical Manual and any other applicable parts of the Technical Manual.
- All materials must be stored, installed, and protected correctly in a manner that will not cause damage or deterioration of the product.

Timber must be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment must be in accordance with relevant British Standards and Codes of Practice.

Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.

Reclaimed materials may only be reused with the prior agreement with the Warranty surveyor. Independent certification and/or testing of the suitability may be required.

## Functional Requirement 5 – Design and Specifications

Designs and specifications must prove satisfactory performance, for where there is a Performance Requirement in this Technical Manual.

The design of the home must demonstrate it meets the Performance Requirement in each applicable Section of this Technical Manual.

The designs must include sufficient detail to enable accurate construction and inspection.

The designs and specification must meet or exceed the minimum performance Requirements within this Technical Manual.

Where multiple systems or products are used the design must clearly demonstrate compatibility.

The designs must take into consideration the ground conditions and any site specific hazards and consider the geographical position of the site in relation to exposure and topography.



# 1.

## Ground Conditions

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### Contents

|     |                              |    |
|-----|------------------------------|----|
| 1.1 | Site Investigation           | 12 |
| 1.2 | Managing Ground Contaminants | 21 |

## Introduction

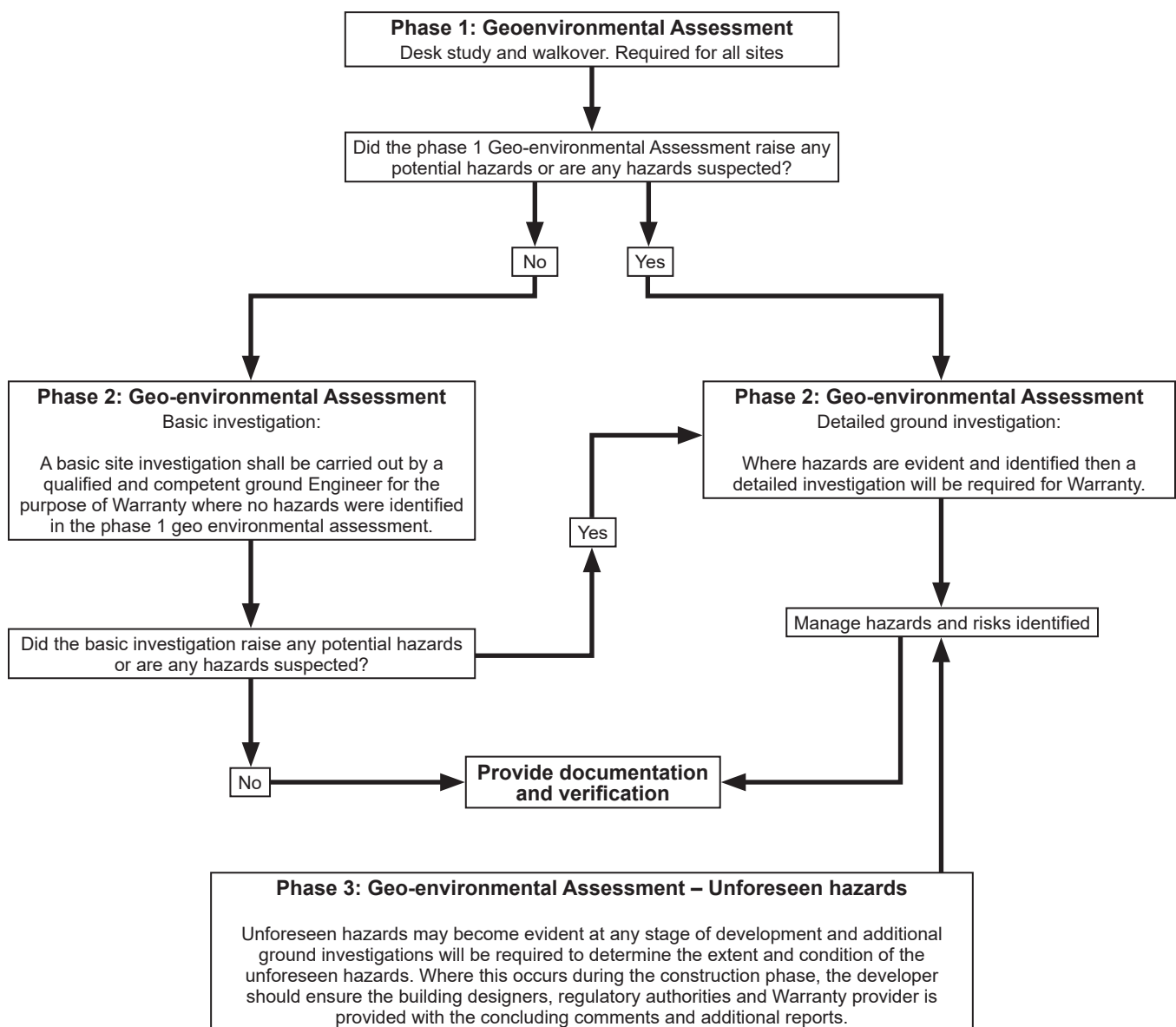
This section provides guidance on meeting the performance requirements for an acceptable site and ground investigation.

### 1.1.1 Compliance

All sites shall have an appropriate level of site investigation which accurately assesses and investigates potential hazards which may affect the development.

To ensure a consistently high standard, all stages of the work should be carried out by an Engineer or Geologist with at least five years' experience of ground and soil engineering. Specifying and using competent qualified personnel will considerably increase the overall industry standard.

#### Site investigation procedures flow chart



## 1.1.2 Information to be provided

The developer shall provide an appropriate level of site investigation for the specific site which accurately assesses and investigates potential hazards which may affect the development.

Please note, historical reports greater than 5 years may be used as a reference document for the desk study but investigative reports of ground conditions must be undertaken and dated within 5 years of construction starting on site.

A full set of site investigations should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This should include:

1. Phase 1: Geo-environmental Assessment – Desk study and walkover
2. Phase 2: Geo-environmental Assessment – Basic and detailed ground investigation
3. Phase 3: Geo-environmental Assessment – Unforeseen hazards (where applicable)

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

## 1.1.3 Phase 1 Geo-environmental Assessment – Desk study and walkover survey

A Phase 1: Geo-environmental Assessment shall be provided and shall consist of a desk study and walkover survey undertaken by a competent person who has experience with ground investigations.

The phase 1 assessment shall be sufficiently thorough as outlined within the guidance to highlight any potential hazards.

The collation of information from the phase one assessment shall be evaluated and recorded. The resulting initial assessment report shall include sufficient details appropriate to the site.

### Desk study

The desk study is essential for all sites. The contents of the report highlights the site location, the geology, hydrogeology (ground water), surface water and flooding, topographical features and past investigations undertaken on or close to the site.

It is an overall collection and examination of existing data brought together from a wide variety of sources. The purpose of the assessment is to indicate the potential hazards at the very early stage of the development and provide the guidance for more detailed exploratory investigations.

The following headings are what to expect within a Phase 1 - Geo-environmental assessment – Desk Study report. A listing of the contents of a Phase 1: Geo-environmental report along with their sources of the data can also be found in the checklists within this section.

### Site description

The description should outline the exact extent of the site, and should include the site address the grid reference and elevation above sea level. The boundaries topography of the site should be clearly defined.

### Geology and mining

The bedrock geology, any overlying superficial deposits and the effects of weathering should all be described, together with any geological faults that may affect the site. An explanation of the likely ground conditions should be given, together with reference to any other mapped geological features, particularly if there are likely to be any natural cavities or solution features.

In former coalfields, or other areas of mineral extraction, the maps may not always record the presence of old or active workings particularly shallow or surface workings. The likelihood of shallow coal workings affecting surface stability should be established in conjunction with a Coal Authority report. Such reports also record areas that have been affected by the extraction of brine, which is particularly prevalent in the Cheshire area of the UK. Other forms of mineral extraction will require site-specific research possibly requiring investigative or exploratory work.

### Solution (soluble) features

Solution features (such as pipes, swallow holes and solution cavities, sometimes loosely infilled with drift deposits) are commonly found in chalk, caused by water draining through the chalk and dissolving it. They can also be found in Limestone and other soluble rocks. The British Geological Survey categorises the five main soluble rocks found in the UK as Chalk, Limestone, Gypsum, Dolomite, and Salt.

The risk of solution features should be addressed in the Phase 1 Geo-environmental assessment (commonly from an Envirocheck or GroundSure report on geological hazards, both on-site and locally).

Hazard maps are available with different coloured areas representing different levels of risk. Where the risk is moderate or high, special precautions should be taken, which for strip foundations would include careful inspection of the excavation, probing and use of reinforcement to span potential voids.

### Ground gases and radon

Potential naturally occurring ground gases and where sites previously used for the industrial, commercial and social use will need to be identified for the purpose of building and environmental protection.

The need to incorporate radon protection measures should be determined by reference to risk maps produced by the Health Protection Agency. Such information is also usually included within commercially available datasets.

### Geo-environmental risk assessment and the conceptual site model

A quantitative health and environmental Risk Assessment should be carried out as part of the assessment. The process of a Risk Assessment is set out in Part IIA of the Environment Protection Act 1990, and amended in subsequent legislation.

This act introduces the concept of a pollution linkage, which consists of a pollution (contaminative) source or hazard and a receptor, together with an established pathway between the two. For land to be contaminated, a pollution linkage (hazard-pathway-receptor) must exist; this forms a so-called 'conceptual model' of the site.

### Hydrology and hydrogeology

A significant part of the desk study will consider an assessment of flooding risk to the site. The presence of surface water features and drainage should be described, and the overall risks of flooding to the site should be determined, primarily with reference to the Environment Agency flood map data and Local Authority-commissioned strategic flood risk assessments. Flood risk data is continually being updated by the Environment Agency and Local Authority.

The hydrogeology of the site provides an understanding of the transpiration of water below the surface of the ground. Sites where a principle or secondary aquifer and Source Protection Zones are identified are susceptible to pollution of the ground water.

Any ground water or surface water abstraction points 'downstream' of the site, particularly any potable (drinking water) abstraction points, should be recorded, as this may have liability implications should the development cause any pollution.

### Site history

The history of the site and the surrounding areas is extremely important when assessing the likelihood of contamination or geotechnical hazards.

The influence or impact of off-site past industrial use, (e.g. agricultural use, below ground mining, landfill and quarrying) will depend upon the type of industry, the underlying geology and the topography. However, consideration should normally be given to any such features within a 250m radius of the site (or further where appropriate) with the potential to affect it.

It should be remembered that historical maps only provide a snapshot in time, and care must be taken when interpreting what may have occurred in the intervening years.

### Environmental setting

The question as to whether a site poses an actual or potential environmental risk, or is at some external risk from pollution, will be determined by its environmental setting. This will in turn depend upon the site's topography, geology, hydrogeology and hydrology, amongst other site-specific considerations.

It is necessary to consider other potential sources of contamination, such as pollution control licenses, discharge consents, hazardous sites (COMAH, NIHHIS), pollution incidents, landfills, waste treatment sites and past and current industrial sites.

### Geotechnical assessment

Although no intrusive investigation may have been undertaken it should be possible to give preliminary indications in respect of the geotechnical matters.

## Desk study Checklist for Phase 1: Geo-environmental Assessment

### Site Description (and surrounding area of relevance)

- Location, O.S. grid reference and plans
- Topography, levels
- Site layout and main features
- Site infrastructure
- Site description and topography
- Made ground, erosion, cuttings or quarries
- Slope stability
- Evidence of faulting or mining
- Watercourses, seepages or sinks
- Marshy or waterlogged ground
- Type and health of vegetation
- Existing structures and condition
- Existing on-site processes
- Demolished structures/old foundations
- Visual evidence of contamination
- Existing site operations
- Underground and overhead services
- Trees
- Previous site conditions and current use
- Site proposals

### Mining

- Past, present and future mining
- Reference to geological sources
- Coal Authority Mining Report
- Register of abandoned mine plans and opencasts
- Shaft register
- Other mining, e.g. sand, sandstone, limestone, brine, etc.

### Geology

- Geological maps (1:50,000 and 1:10,000 scale)
- Memoirs
- Technical reports
- Previous site investigations
- Previous laboratory results – Soil sampling
- Engineering geological maps
- Existing trial pit or borehole logs and reports
- Subsidence features

## Hydrogeology and hydrology

- Ground water vulnerability
- Aquifer status
- Abstraction licences (within 1km)
- Flood risk, drainage and watercourses (within 1km)

## Local Authority consultation

- Building Control, Planning and Environmental Health/Contaminated Land Officer
- Petroleum Officer

## Archival research

- Past O.S. mapping and previous on-site and off-site usage possible contaminants associated with former use(s)
- Town plans
- Local history records, books and photographs (where relevant and practicable)
- Aerial photographs (where relevant)
- Archaeological register (where relevant)

## Contamination

- Likely contaminants based on past history
- Hazard-Pathway-Receptor scenario
- Preliminary Conceptual Site Model

## Environmental database

- Operational and former landfill sites, scrapyards and waste processing sites
- Radon protection measures

## Walkover survey

This survey is undertaken to identify and verify the potential hazards for construction based upon the findings of the desk study assessment of the site and surroundings.

The walkover should be always undertaken by a competent person who can interpret the desk study and relate it to the actual site conditions. Photographs are an essential means of recording the potential hazards.

Potential Hazards that will require further investigation include:

|                                           |                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Topography<br/>(physical features)</b> | Significant and abrupt changes in slope and site depressions<br>Overburden on slopes<br>Excavation at the bottom of slopes<br>Landslip and subsidence<br>Contamination – tipped or imported harmful material<br>Species, height and spread of trees hedges and scrub<br>Tree and vegetation condition |
| <b>Geology<br/>(soils and rocks)</b>      | Ground Conditions – basic soil types and classifications<br>Below surface compressible materials<br>Surface cracking<br>Sudden changes in soil types                                                                                                                                                  |
| <b>Hydrology<br/>(surface water)</b>      | Waterlogged ground<br>Signs of flooding<br>Aquatic plants and grasses<br>Ponds, water courses and springs<br>Discoloured water - source                                                                                                                                                               |
| <b>Hydrogeology<br/>(ground water)</b>    | Tree and vegetation – water demand on sub-surface soils<br>Hedgerow and scrub – Dying or sparse                                                                                                                                                                                                       |
| <b>Historic<br/>(local buildings)</b>     | Damage to buildings or structures - cracking<br>Building movement - tilting<br>Below ground services                                                                                                                                                                                                  |
| <b>Local Information</b>                  | Local knowledge – mining, landfill, localised flooding<br>Past uses – local history, place and street names                                                                                                                                                                                           |



### 1.1.4 Phase 2 Geo-Environmental assessment

Where no hazards are identified in the phase one geo environmental assessment, a basic ground investigation shall be carried out by a competent person who has experience with ground investigations.

A detailed ground investigation shall be provided where:

- The initial scope of the ground investigation reveals potential hazards.
- The basic investigation reveals anomalies not previously raised in any site investigation.
- There are any doubts about the condition of the ground.
- The basic investigation reveals potential hazards.

### Introduction

The outcome of the desk study and the walkover survey will provide the scope for the Phase 2 Geo-Environmental assessment and involves using a combination of various intrusive techniques depending on the risks identified.

The investigation must be designed to provide the appropriate level of information on ground and ground water conditions on the site, together with identifying potential areas of contamination. The investigation should be undertaken in accordance with the principles of:

- BS EN 1997-1: Eurocode 7 - Geotechnical design - Part 1: General rules.
- BS EN 1997-2: Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing.
- BS 5930 and BS 10175.

The dates of the investigation and the methods used should be stated, with the exploratory trial pit or borehole positions clearly being shown on a drawing.

### Basic ground investigation

A basic ground investigation should:

- Be carried out by a qualified and competent Engineer.
- Be carried out where no hazards were identified in the phase one geo environmental assessment.
- Include an assessment of observations specific to the site.
- Include ground material testing to provide assurance to the Warranty provider that sites are free from potential hazards that can influence the design of the building.

### Trial pitting

This method enables:

- Soil conditions to be closely examined at any specific point and samples to be taken.
- It gives useful information on the stability of excavations and water ingress.
- Material and any other required ground tests can easily be undertaken in the open trial pit.

The following should be considered where trial pits are proposed:

- They should be at least three times the anticipated foundation depth where possible, or sufficient to prove a founding formation material suitable to support the design loads of the developments structure.
- They should be excavated outside of the proposed foundation area where possible.
- The distance from the edge of the trial pit from a foundation should be at least the proposed foundation depth plus 250mm.
- On completion excavations are normally backfilled.

### Detailed ground investigation

Where hazards are evident, an intrusive investigation will be required. A detailed ground investigation will be required where hazards are evident and identified from:

- The initial scope of the ground investigation.
- Phase 1 Geo-environmental assessment (desk study and walkover survey).
- Basic ground investigation.

In addition, a detailed ground investigation will be required:

- Where the basic investigation reveals anomalies not previously raised in any site investigation.
- If there are any doubts about the condition of the ground.

The detailed Phase 2 Geo-environmental assessment should adopt a clearly defined structured and detailed approach to the investigation for gathering site information and testing and include:

- Basic ground investigation.
- Changing development proposals – Usage.
- Ground conditions – complexity of materials and stratum.
- Influence of foundations on the bearing strata.
- Presence of contaminants and ground gases.
- Surface and ground water.
- Geology, topography and site history.

On site intrusive investigation and soil sampling is required for foundation and basement designs which extend further into the ground. Investigations require the use of deeper boreholes and the use of rigs and different sampling will need to be specified.

In order for the development of the site to succeed the liabilities and site hazards will need to be managed and communicated in the detailed Phase 2 Geo-environmental ground investigation report. Further assessment of ground conditions through Investigation may be required to fully address the development objectives.

## Mining areas - Key requirements for foundations

Any foundations must be designed to clearly demonstrate that design loads are transferred to known soil strata capable of supporting those loads.

Foundations should not settle more than what is specified within the 'Foundations' section. For piled foundations, settlement should not be more than what is specified by the Engineers design.

The potential for mine workings and mine entries within an influencing distance of the proposed development should be addressed by an Engineer prior to commencement of works, and in accordance with CIRIA guidance (including CIRIA C758D Abandoned mine workings manual), Coal Authority Technical Guidance Notes (including TGN01/2019) and our "Mining - Structural Requirements" document.

Reference should be made to reports on geological hazards, such as Envirocheck or GroundSure reports, both on-site and locally.

For further guidance on foundation proposals in mining areas, please refer to the Warranty Good Practice Guide: 'Mining - Structural Requirements' available on the Warranty website.

The dates of the investigation and the methods used should be stated, with the exploratory trial pit or borehole positions clearly being shown on a drawing.

## Soluble geology - Key requirements for foundations

The foundation scheme should be designed to clearly demonstrate that the foundations are capable of supporting and transferring the design loads safely to known soil strata that can be demonstrated from the appropriate project Site Investigation report to be capable of carrying the load, using the appropriate soil properties obtained from geotechnical testing.

Where there is a moderate to high risk of voids being present, the foundations should be designed in the first instance to span across a void of at least 5 metres without settlement greater than what is specified within the 'Foundations' section. For piled foundations, settlement should not be more than what is specified by the Engineers design.

## Soakaways and soluble geology

The potential effects of soakaways, leaking drains, run off, etc. on the chalk will need to be considered and addressed in the design.

CIRIA C574: Engineering in Chalk, 2002 gives the following recommendations:

Concentrated ingress of water into the chalk can initiate new dissolution features, particularly in low-density chalk, and destabilise the loose backfill of existing ones. For this reason, any soakaways should be sited well away from foundations for structures or roads, as indicated below:

- In areas where dissolution features are known to be prevalent, soakaways should be avoided if at all possible but, if unavoidable, should be sited at least 20m away from any foundations.
- Where the chalk is of low density, or its density is not known, soakaways should be sited at least 10m away from any foundations.
- For drainage systems, flexible jointed pipes should be used wherever possible; particular care should be taken for the avoidance of leaks in both water supply and drainage pipework.
- As the chalk is a vitally important aquifer, the Environment Agency and Local Authority must be consulted when planning soakaway installations where chalk lies below the site, even where it is mantled with superficial deposits.

## Checklist for Phase 2: Geo-environmental Assessment

### Trial pits

- Strata profile and description
- In-situ gas testing for methane, carbon dioxide and oxygen
- Landfill gas, marsh gas and mine gas
- In-situ shear strength testing
- In-situ Mexe Cone Penetrometer for CBR/in-situ shear strength
- Full description of ground and ground water conditions
- Soakaway testing
- Geotechnical contamination laboratory testing

### Boreholes

- Cable percussive, window sampling, dynamic probing or rotary drilling to BS 5930
- Use of British drilling association accredited drillers
- Full description of ground and ground water to BS 5930
- Installations for long-term gas and water monitoring (if required)
- Geotechnical laboratory testing (BS 1377) and contamination testing if suspected by accredited laboratories

### Other methods of investigation

- Geophysics
- Cone penetrometer

**Recommendations for reports:****Foundations and retaining walls**

- Foundation type, depth, bearing capacity and settlement
- Ease of excavation
- Sulphate/acidity/concrete class
- Shrinkage/heave
- Effect of vegetation, including building Near trees
- Buoyancy or flotation effects
- Ground improvement options, e.g. Piling, Vibro, compaction, etc.

**Mining**

- Precautions for foundations in respect of past or future mining
- Treatment of shallow mine workings
- Capping of shafts

**Landfill/mine gas/Radon**

- Requirements for long term monitoring
- Protection measures for structure
- Venting measures

**Road construction**

- CBR of subgrade and its preparation
- Sub-base type and thickness
- Excavation of unsuitable material
- Soil stabilisation
- Frost susceptibility

**Drainage and excavations**

- Ground water regime including de-watering
- Use of soakaways
- Support and ease of excavation
- Rock levels
- Use of sheet piling, diaphragm, bored piles and ground anchors

**Earthworks**

- Compaction characteristics
- Surcharging and self-settlement
- CBR at formation level
- Slope stability and slope stabilisation
- Suitability of excavated material for re-use

**Contamination**

- Full assessment of contamination testing
- Hazard-Pathway-Target scenarios/Conceptual Site Model
- Risk assessment and liability
- Precautions or remediation of contamination

**Further investigation**

- Is further investigation needed?
- Nature of further investigation

**1.1.5 Phase 3 Geo-Environmental assessment - Unforeseen hazards**

Where unforeseen hazards are encountered, a phase three assessment shall be carried out by a competent person who has experience with ground investigations.

In some cases of intrusive investigations reveal hazards which are unforeseen where further investigation may be required or where the earlier Phase 2: Geo-environmental assessment has been preliminary. The requirement for additional ground investigation is required to determine the extent and condition of this unforeseen hazard.

Unforeseen hazards may also become evident during construction. When such occurrence happens the developer is to ensure that the building designers are notified of the potential hazard. A scope for the additional investigative works is established. The concluding comments of the additional report and the management of the unforeseen hazard is conveyed to the regulatory authorities, designers and the Warranty provider.

## 1.1.6 Site and laboratory testing

Where site and laboratory testing is required as a part of the phase 2 or 3 Geo-Environmental assessment, it shall be undertaken by testing laboratories who:

- Have an appropriate quality assurance programme in place, **and**
- Are accredited to carry out such tests by bodies such as UKAS or MCERTS.

Where in-situ testing is required, it shall be undertaken by a competent person.

In all circumstances, soil testing shall be undertaken to recognised standards.

All samples shall be stored and kept in such a way that will not cause inaccuracy when soils are tested.

Site and laboratory testing such as those in the following list should be undertaken to recognised standards and be completed by a competent geologist or Engineer:

- |                                               |                                 |                                       |
|-----------------------------------------------|---------------------------------|---------------------------------------|
| ▪ Gas monitoring                              | ▪ Liquid and plastic limits     | ▪ Strength characteristics            |
| ▪ Soil strength                               | ▪ Particle size distribution    | ▪ Compaction                          |
| ▪ Soakaway testing                            | ▪ Bulk density                  | ▪ California Bearing Ratio (CBR) test |
| ▪ Contamination testing/monitoring            | ▪ Permeability                  | ▪ Chemical tests                      |
| ▪ Natural or in-situ moisture content testing | ▪ Consolidation characteristics |                                       |

## References

### British Standards Institution

- |                                                                                                                                |                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| ▪ BS 1377: Methods of test for soils for civil engineering purposes (Parts 1 to 8)                                             | ▪ BS EN 1997-2: Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing                      |
| ▪ BS 3882: British Standard specification for topsoil                                                                          | ▪ BS ISO 14688-1: Geotechnical investigation and testing - Identification and classification of soil - Part 1    |
| ▪ BS 5930: British Standard Code of Practice for Site Investigations                                                           | ▪ BS ISO 14688-2: Geotechnical investigation and testing - Identification and classification of soil - Part 2    |
| ▪ BS 8485: British Standard Code of Practice for the characterization and remediation from ground gas in affected developments | ▪ BS ISO 14689: Geotechnical investigation and testing – Identification, description and classification of rock. |
| ▪ BS 10175: British Standard Code of Practice for the investigation of potentially contaminated sites                          | ▪ BS8004: British Standard Code of Practice for Foundations                                                      |
| ▪ BS EN 1997-1: Eurocode 7 - Geotechnical design - Part 1: General rules                                                       |                                                                                                                  |

### BRE

- |                                                                          |                                                                        |
|--------------------------------------------------------------------------|------------------------------------------------------------------------|
| ▪ Radon: Guidance on protective measures for new dwellings, BR 211       | ▪ Concrete in aggressive ground, Special Digest SD1, 3rd Edition, 2005 |
| ▪ Protective measures for housing on gas-contaminated land, BR 414, 2001 | ▪ BRE IP 5/97: Building on Fill – collapse compression on inundation   |
| ▪ Cover systems for land regeneration, 2004                              |                                                                        |

### CIEH

- The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd Edition)

### CIRIA

- |                                                                            |                                              |
|----------------------------------------------------------------------------|----------------------------------------------|
| ▪ Assessing risks posed by hazardous ground gases to buildings, CIRIA C665 | ▪ Engineering in chalk 2002, CIRIA C574      |
| ▪ Shaft friction of CFA piles in chalk 2003, CIRIA PR 86                   | ▪ CIRIA C758D Abandoned Mine Workings Manual |

### DoE

- |                                                                                  |                                                                          |
|----------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| ▪ CLR Reports 1-4                                                                | ▪ Waste Management Paper No. 27, Landfill gas: A technical memorandum... |
| ▪ Waste Management Paper No. 26A, Landfill Completion: A technical memorandum... |                                                                          |

### DEFRA

- |                                                                         |                                                                                   |
|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| ▪ Contaminated land report CLR 11, 2002 (7-10 withdrawn)                | ▪ Improvements to contaminated land guidance - Outcome of the "Way Forward", 2008 |
| ▪ R & D Publications TOX 1 - 12, 14, 16 - 25                            | ▪ Exercise on soil guideline values, 2008                                         |
| ▪ R & D Publications SGV 1, 3, 4, 5, 7, 8, 9, 10, 15 and 16 (withdrawn) | ▪ Guidance on the legal definition of contaminated land, 2008                     |

### DETR

- Circular 02/2000. Contaminated land, 2000
- Guidelines for environmental Risk Assessment and management, 2000

**Environment Agency**

- Guidance for the safe development of housing on land affected by contamination, 2000
- Guidance for waste destined for disposal in landfills, Version 2, 2006
- Protective measures for housing on gas-contaminated land remediation position statements, 2006
- Guidance and Monitoring of Landfill Leachate, Groundwater and Surface Water
- Human Health Toxicological Assessment of Contaminants in Soil (Science Report SC050021/SR2), 2008
- Updated Technical Background in the CLEA Model (Science Report SC0520021/SR3)
- Using Soil Guideline Values, 2009

**HMSO**

- Environmental Protection Act 1990
- Environment Act 1995
- UK Water Supply (Water Quality) Regulations 2000
- The Water Act 2003

**Institution of Civil Engineers**

- Contaminated Land: Investigation, Assessment and Remediation (2nd Edition)
- Specification for Piling and Embedded Retaining Walls

**Joyce, M.D.**

- Site Investigation Practice, 1982

**London District Surveyors Association**

- Notes for the design of straight shafted bored piles in London Clay

**OPDM**

- Planning Policy Statement 23: Planning and Pollution Control Annex 2: Development on Land Affected by Contamination

## Introduction

This section provides guidance on meeting the performance requirements for managing ground contaminants.

The term ground contaminants is used throughout this section. For the purposes of Warranty, ground contaminants refers to gases and/or vapours in the ground, including, methane, carbon dioxide, volatile organic compounds (VOC's) and radon. Ground contaminants can occur on their own, or in combination.

### 1.2.1 Compliance

Hazardous ground contaminants<sup>1</sup> shall be effectively managed under the supervision of a consultant or specialist acceptable to us.

Historical reports greater than 5 years may be used as a reference document for the desk study but investigative reports of ground conditions must be undertaken and dated within 5 years of construction starting on site.

<sup>1</sup> For the purposes of Warranty, ground contaminants refers to substances that pose significant health and environmental risks include those that can cause cancer, are poisonous, or can lead to suffocation, as well as substances that can, catch fire, explode, be corrosive or emit harmful radiation where a statutory notice could be given if the hazard isn't effectively managed. Ground contaminants can occur on their own, or in combination.

### 1.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings, specifications, investigations and reports should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. All sites must have an appropriate level of site investigation in accordance with:
  - a. The 'Ground Conditions – Site Investigation' section of this Technical Manual.
  - b. BS 8576 - Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs).
  - c. BS 10175 - Investigation of potentially contaminated sites. Code of practice.
2. A remediation strategy which also incorporates a plan for verification and testing of the protection measures prior to any works starting on site. This should be completed by a suitably qualified professional.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 1.2.3 Site Investigation and assessment of ground contaminants

The developer shall provide an appropriate level of site investigation for the specific site which accurately assesses and investigates potential ground contaminants which may affect the development.

A site investigation should be carried out in accordance with:

- The 'Ground Conditions – Site Investigation' section of this Technical Manual.
- BS 8576 - Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs).
- BS 10175 - Investigation of potentially contaminated sites. Code of practice.

The findings from the site investigation/s should be used to formulate a detailed remediation strategy as detailed within this section. This should be completed by a suitably qualified professional.

## Carbon dioxide and methane

Where the site investigation reveals the presence of carbon dioxide and/or methane, they should be characterised and assessed in accordance with BS 8485.

Residential buildings should not be built on CS4 or higher sites (as characterised in BS 8485) unless the type of construction or site circumstances allow additional levels of protection to be incorporated.

## VOC's

CIRIA report C682 should also be referred to for guidance on investigating and assessing the risks posed by VOC's.

## Radon

The United Kingdom Health Security Agency (UKHSA) has published maps which highlight the radon potential on 1km grid squares, these should be reviewed by the designer prior to any works commencing on site. The level of protection required is site specific.

### 1.2.4 Remediation strategy

The findings from the site investigation shall be used to formulate a detailed remediation strategy report which shall be completed by a suitably qualified professional.

Remediation techniques may include:

- Risk avoidance by changing the pathway or isolating the target, by adjusting the layout and/or by building protective measures into the construction.
- Engineering-based treatments that remove or isolate contaminants or modify the pathway by excavation, providing ground barriers or covering and capping.
- Process-based treatment to remove, modify, stabilise or destroy contaminants by physical, biological, chemical or thermal means.

As a minimum, the following should be included in the remediation strategy report:

- Remediation objectives for ground, groundwater and ground gas/contaminants.
- Summary of ground contaminants present in accordance with the cited site investigation report.
- Site plan showing effected plots/areas of site.
- Detailed remediation techniques to be employed.
- Installation plan including method statements.
- Design drawings for remediation techniques where applicable.
- Details of all materials to be used along with installation guidance.
- Proposed plan for the supervision and monitoring of works.
- Proposed plan for verification and testing. Verification of gas protection systems is about more than gas membranes – it covers inspection of underfloor voids, ventilation, oversite capping and venting layers etc that may not be the responsibility of the gas membrane installer.

### Carbon dioxide and methane

BS 8485 should be used by the designer to determine an appropriate remediation strategy. 3 forms of protection are defined in BS 8485 and these include:

- The floor structure (referred to as the structural barrier in BS 8485).
- A gas resistant membrane.
- Sub-floor ventilation.

The remediation strategy should incorporate at least 2 forms of protection as a single element should not be solely relied upon to provide effective protection as there would not be redundancy to allow for defects in the component.

BS 8485 uses a scoring system to determine what level of protection is required in different situations; the designer should use this system to determine the forms of protection required.

### VOC's

CIRIA report C716 provides an overview of the techniques available for treating or managing the risk presented by VOCs and this should be used by the designer to formulate a detailed remediation strategy report to base their proposals on.

### Radon

The designer should provide an appropriate design where basic and full radon protection is required in accordance with BRE report BR 211.

#### Basic radon protection

Where basic radon protection is required, a radon barrier should be provided in accordance with BRE report BR 211.

The radon barrier can be installed at high level (above or below the ground floor construction), or at low level (solum level). Where the radon barrier is installed at high level it should be lapped with the cavity tray in the cavity wall construction. Care should be taken to maintain the integrity of the radon barrier.

The DPC to a cavity wall should be in the form of a cavity tray to prevent radon entering the building through the cavity.

Where radon protection is required for a framed structure, the radon protection should not impede on drainage and/or ventilation of the framed structure and its sole plate. For further guidance, please refer to our 'External Walls – Timber Frame' and 'External Walls – Light Gauge Steel Frame' sections.

#### Full radon protection

Where full radon protection is required, additional protection can be provided to that of basic protection in the form of a radon sump or a ventilated sub-floor void.

Where sub-floor ventilation is required, the designer should determine the amount of ventilation and the number of air bricks required. Ventilation must be cross-flow on two opposing sides of the building. Any obstructions such as sleeper walls, beams etc., should have adequate provision to allow for cross-flow ventilation. Landscaping and other external works should not block the air bricks.

Where periscope subfloor ventilators are used, the joints between the upper and lower halves should be taped to reduce the risk of radon entering the cavity.

Where a radon sump is required, guidance on the number and specification of sumps should be sought from BRE report BR 211.



**Other considerations for radon protection**

- Where a radon barrier is specified, the guidance on gas resistant membranes within this section should also be followed.
- Whilst thicker radon barriers may be more robust, they may be difficult to bend or fold around edges and corner details. As such, preformed components should be used where possible.
- The cavity tray in the external wall should be supported with concrete or other suitable material.
- Manufacturer's instructions should be followed for jointing details and sealing of service penetrations for radon barriers. Some materials may be difficult to seal in adverse weather conditions and this should be taken into account prior to works starting on site.

**1.2.5 Gas resistant membranes**

Gas resistant membranes shall:

- Be capable of providing a complete barrier and be impervious to the relevant ground contaminants specific to that development.
- Have a third party product conformity certificate.
- Be installed in accordance with the manufacturers recommendations.

Where a gas resistant membrane is required, a DPM should not be specified or used instead, as they are thinner and made from lower grade materials; this may allow the transmission of ground gases/contaminants.

Please note, gas membranes manufactured from recycled products are not acceptable for Warranty purposes.

**Penetrations**

Where elements of construction require fixing through the membrane (such as curtain walling systems, stud walls etc.), a sealing gasket should be used. This should be part of the membrane system (see manufacturer's data sheet) and its third party product conformity certificate. The recommended detail should be clearly outlined in the remediation strategy report and construction drawings.

**Services**

Care should be taken around service penetrations, stanchions and columns with pre-fabricated top-hats and corner seals the preferred method of providing a robust and complete barrier around these elements. The sealing of service penetrations, stanchions and columns should be carefully considered during the design phase and these elements should be avoided very close to walls due to difficulties in providing a robust seal.

Service ducts should be sealed between the duct internal wall and the utility pipe. Sealing of individual flexible cables and/or ducted cable bundles can be difficult to achieve and specialist systems should be used. The method chosen should also be a part of the third party product conformity certificate.

**Sealing**

Membranes can either be tape sealed or welded, the method of sealing and all associated components should be part of the membrane system (see manufacturer's data sheet) and its third party product conformity certificate. The jointing strategy should be clearly outlined in the remediation strategy report and construction drawings.

**Installing gas resistant membranes on a beam and block floor**

There should be consideration for where gas resistant membranes are specified with beam and block floor constructions. The specialist designer should provide a suitable design proposal in such circumstances.

**Gas resistant membranes and external walls**

Where gas membranes bridge the external cavity wall, a cavity tray should be provided above the gas membrane. Cavity trays should be sealed to the gas membrane in accordance with the manufacturer's instructions to prevent capillary damp ingress at the joint.

Where gas membranes bridge the cavity between the external cladding and a framed structure, detailing should not impede on drainage and/or ventilation of the framed structure and its sole plate. For further guidance, please refer to our 'External Walls – Timber Frame' and 'External Walls – Light Gauge Steel Frame' sections.





# 2.

## Waterproofing Below Ground Storeys and Structures

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### Contents

2.1 General Requirements

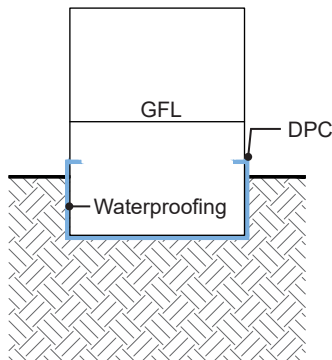
26

## Introduction

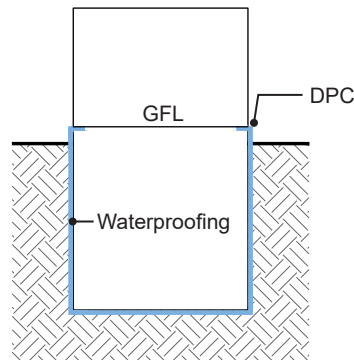
This section provides guidance on meeting the performance requirements for waterproofing below ground storeys and structures. The following situations are covered by this section:

- A building storey wholly or partially below ground e.g. basement.
- Lower ground storeys partially below ground e.g. semi-basements, split levels with voids, stepping slabs.
- Lift pits.

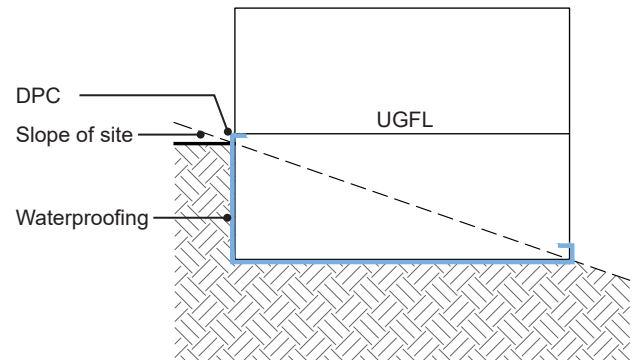
## Examples of below ground situations



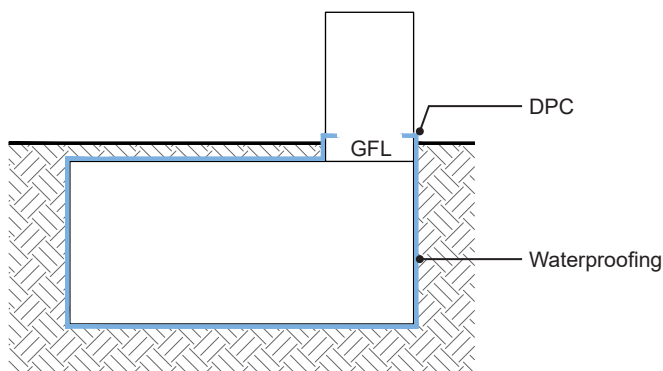
**Storey partially below ground**



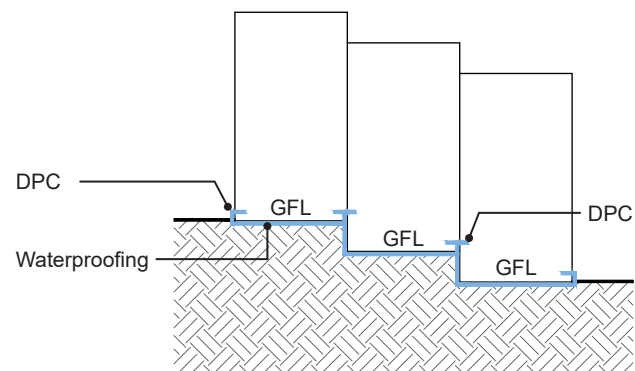
**Storey wholly below ground**



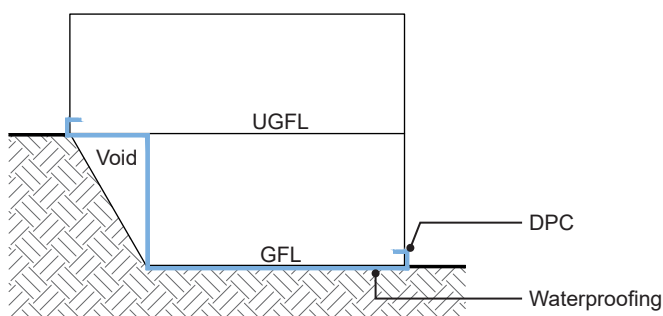
**Semi-basement on 3 sides**



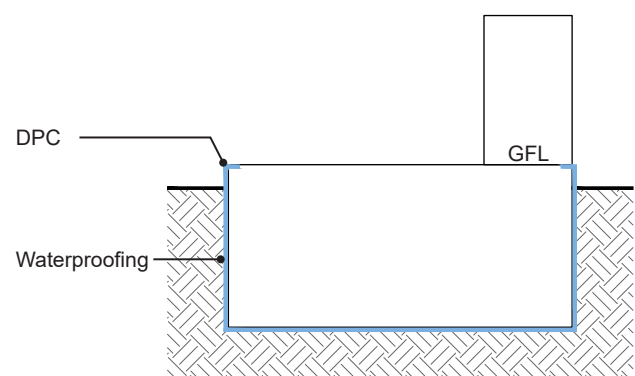
**Buried roof**



**Stepped site**



**Split level**



**Podium above ground**

## 2.1.1 Compliance

The construction of any below ground storey or structure shall meet the performance requirements of this section.

## 2.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

All information related to structural waterproofing design and specification shall be provided at least 8 weeks before the commencement of the waterproofing of any below ground storey(s) and/or structure(s).

1. The Developer is to provide, at least 8 weeks before the commencement of the basement, evidence to us of a waterproofing design specification for protecting the below ground situation/environment and include as a minimum:
  - a. A site specific waterproofing design philosophy provided by a suitably qualified Waterproofing design specialist.
  - b. A site investigation report (Phase 1 & 2 Geo-Environmental Assessment Report - see the 'Ground Conditions' section of this Technical Manual) to identify the risks, for which the waterproofing design is to be based on.
  - c. The 'Environmental Grade' requirement for each below ground situation in accordance with BS 8102.
  - d. Site level survey drawings highlighting existing site features.
  - e. Proposed general arrangement drawings identifying all the plots and location of any below ground storey levels, lift pits and basements.
  - f. Drainage layout plans showing maintainable drainage runs, access provisions and outfalls (this includes all drainage relating to the structural waterproofing proposals).
2. Additional supporting information will be required prior to the work commencing on site and must include, but not limited to:
  - a. Waterproofing materials – Systems and material specification for the Design Strategy including sump(s) and pump(s) specification.
  - b. Site specific detailing for waterproofing of all construction jointing and service penetrations.
  - c. Below ground drainage provisions e.g. below slab - internal drainage systems, surface and foul water, storm water attenuation tanks, etc.
  - d. Drainage provisions to hardstanding features e.g. light wells and flush pavement lights.
  - e. Landscaping - Intensive roof, podium deck and transfer decks – drainage and waterproofing provisions (see also the 'Roofs' section of this Technical Manual).
  - f. Construction and structural waterproofing methodology e.g. Engineers foundation design, walls, floor(s) and roof slab design, temporary and permanent works.
  - g. Evidence of a competent approved installer for the structural waterproofing works.
3. On completion of the works the following documentation will need to be provided.
  - a. Sump pump(s) commissioning certificate.
  - b. Operations and maintenance manual for maintainable systems installed including land drains.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

## 2.1.3 Durability

The design of the structure and the materials used shall be durable. All load bearing structural elements providing support to the home shall have a service life of not less than 60 years.

The below ground structure and any waterproofing materials should be specified and designed to be durable against the identified site hazards found in the ground investigation. This may include resistance for the effects of:

- Freeze-thaw actions.
- Aggressive chemicals in the ground.
- Dispersal of water on the structure.

## 2.1.4 Structural design

Elements that are integral to any below ground storey or structure including foundations, walls and floors shall be designed by an Engineer. The following shall be taken into account:

- Vertical loading, horizontal loading and surcharges.
- The influence of site features such as nearby trees, topography and/or ground characteristics.
- Structural movement.

Analysis of the applied loadings should be considered in the design of the structure and should be co-ordinated with the design of the waterproofing, and shall include for:

- Loading from the superstructure and other parts of the building.
- Buoyancy and ground heave.
- Lateral forces from retained ground, ground water and surcharges.
- Temporary loading conditions e.g. the effects of site traffic, proximity of heavy plant placement.
- Ground movement and the effect of trees.
- Movement limitations of proposed waterproofing materials.

Design considerations shall be informed by the:

- Geo-environmental report (Phase 2).
- Structural design.
- Expected structural movement e.g. deflection, load surcharge.
- Below ground environment.
- Durability of materials.

Where a movement joint is deemed to be necessary by the Engineer, it should be constructed as per the Engineers design. Any calculated movement in the structure should be communicated to the Waterproofing Design Specialist and reflected by their system/material choice. Situations where periodic inspection of the movement joints is required by the Engineer should be taken into account within any designs.

Below ground structures and/or below ground storeys e.g. basements, semi-basements, spilt-levels formed from Insulated Concrete Formwork (ICF) are not acceptable for Warranty purposes.

### 2.1.5 Ground conditions

The waterproofing design shall be based upon specific ground and site conditions.

The waterproofing design strategy provided to the Warranty provider should clearly identify the information sources used to determine the approach taken and the Waterproofing Design Specialist must clearly indicate their findings and conclusions to validate their design decisions.

The Waterproofing Design Specialist shall develop their waterproofing design based upon site specific information contained within the relevant Phase 1 and Phase 2 Geo-Environmental Assessment Reports. Any supplementary sources of information should be clearly identified within any waterproofing design strategy.

The following information should be used to inform the design:

- Topography, ground levels, and site features e.g. roads, ponds and watercourses, trees.
- Historical geological data e.g. ground characteristics, strata profile and description.
- Hydrogeology and hydrology details e.g. ground water, perched water tables, flood risks.
- Drainage characteristic, soakage testing and water infiltration rates.
- Potential contamination from past history due to former usage e.g. brownfield, land fill.
- Ground gases.

Where ground gas protection and/or protection from contaminants in the ground is considered to be required for the site, the Waterproofing Design Specialist should consult with an Engineer (or person holding relevant specialism) with suitable knowledge and relevant experience within this area.

For further guidance on ground conditions, please refer to the 'Ground Conditions' section.

### 2.1.6 Waterproofing designer competence

The waterproofing design shall be provided by a suitably qualified Waterproofing Design Specialist.

The waterproofing design must be completed by a suitably qualified and experienced Waterproofing Design Specialist holding a qualification recognised by the Warranty provider e.g. Certificated Surveyor in Structural Waterproofing (CSSW).

The Waterproofing Design Specialist should be appointed to the design team to co-ordinate the waterproofing design and consider the impact of waterproofing designs and material choices on other elements of the structural and/or architectural design.

It is the responsibility of the Waterproofing Design Specialist to adequately assess the accuracy and appropriateness of any waterproofing product manufacturer's standard details which are included into a waterproofing design strategy.

### 2.1.7 Waterproofing design

The waterproofing design shall be suitable for the intended use of the below ground space and provide appropriate protection against ground and surface water. Habitable areas shall have a combined system of waterproofing protection.

The following shall be taken into account:

- Intended use & grades of waterproofing protection.
- Defect repair.
- Waterproofing systems, materials and components.
- Interface with the above ground structure.
- Joints and penetrations.
- Risk mitigation (drainage and maintenance).

A site specific waterproofing design strategy document must be provided to the Warranty provider. It should include:

- The name of the Waterproofing Design Specialist who has prepared the document, along with their credentials and relevant experience.
- An index of documents used to create their document e.g. Architects drawings, Engineers Drawings, titles of any assessments and reports.

- An outline description of the applied waterproofing principles and any referenced standards used to formulate the design e.g. BS 8102.
- Clear and concise observations that are relevant to and influence the waterproofing design. This shall include:
  - Scheme type e.g. residential, commercial, etc.
  - Site topography and the interaction of the structure with that topography.
  - Any features which may impact on the areas of building below ground level.
  - Ground conditions on site such as geology, hydrology, and hydrogeology.
  - The proposed use of the space or spaces e.g. habitable space, plant rooms, lift pits.
  - The construction methods and type e.g. reinforced concrete retaining walls, slab construction.
- Precise statements in relation to the waterproofing strategy. This shall include:
  - A list of all spaces contained below ground.
  - A clear determination of the environmental grade required for each space.
  - A brief statement of how the environmental grade will be maintained and the chosen waterproofing protection repaired in the event of a defect.
- Annotated drawings in relation to the waterproofing strategy, provided by the Waterproofing Design Specialist.
- A brief list of the selected products being used to deliver the strategy, inclusive of any supporting drawings in relation to detailing or interfaces with other elements e.g. penetrations, terminations above ground with cavity trays, etc.
- The extent of drainage required to support a structural waterproofing design by lowering the effects of both ground water and percolation of rainwater into the ground.

## Identifying grades of waterproofing protection

The following guidance is based upon BS 8102 and is provided to assist in establishing the use of the space and performance levels.

| Grade | Use of structure                                                                                                                                                                                                                                                         | Performance level                                                                                                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1a    | Enclosing structure of underground car parking <sup>1</sup> , underground refuse stores, cycle stores, external light well enclosures.                                                                                                                                   | Seepage and damp areas from internal and external sources are tolerable, where this does not impact on the proposed use of below ground structure.<br><br>Internal drainage might be necessary to deal with seepage. |
| 1b    | Non habitable use:<br>e.g. Enclosing structure of underground car parking <sup>2</sup> , plant rooms <sup>3</sup> , lift pits <sup>4</sup> .                                                                                                                             | No seepage or beading. Damp areas from internal and external sources are tolerable (dependent on intended use).                                                                                                      |
| 2     | Non habitable use:<br>e.g. Enclosing structure of underground car parking <sup>5</sup> , plant rooms <sup>6</sup> , lift pits <sup>7</sup> , access stairs and lobbies serving non-habitable storeys.                                                                    | No seepage or beading is acceptable. Damp areas as a result of internal air moisture/condensation are tolerable; measures might be required to manage water vapour /condensation e.g. ventilation might be required. |
| 3     | Habitable accommodation:<br>e.g. Enclosing structure to ventilated residential and commercial areas including offices, restaurants, leisure facilities, associated access stairs and lobbies serving habitable storeys or habitable spaces within non-habitable storeys. | No water ingress or damp areas are acceptable. Ventilation, dehumidification or air conditioning necessary, appropriate to the intended use.                                                                         |

<sup>1</sup> Standard car parking environment where seepage and damp areas from internal and external sources are tolerable.  
<sup>2</sup> Parking structures where no seepage is acceptable.  
<sup>3</sup> A room containing equipment which supplies building services, and remains unaffected in their operation within a damp environment e.g. water tanks and pipework, sprinkler system pumps and pipework, etc.  
<sup>4</sup> A lift pit containing structure or working components of the lift remaining unaffected in their operation by the presence of dampness.  
<sup>5</sup> Private car parking where no seepage or dampness through the structure is acceptable.  
<sup>6</sup> A room containing equipment which supplies building services, and may be affected in their operation by the cumulative effects of dampness e.g. electrical components and services, generators, communication systems, etc.  
<sup>7</sup> A lift pit containing electrical equipment and/or working components and may be affected in their operation by the cumulative effects of dampness.

The terms used in the table are defined below for Warranty purposes.

- **Damp:** When touched, a damp patch may leave a slight film of moisture on the hand, but no droplets of water or greater degrees of wetness are left on the hand. On a concrete surface a damp patch is discernible from a darkening of the colour of the concrete.
- **Beading:** Beading of water is the state in which individual droplets of water (held by surface tension effects) form on the surface of the wall and adhere to the wall. The water beads do not coalesce and do not flow.
- **Seepage** (weeping): Seepage or weeping of water is the state in which droplets of water form on the surface of the wall and coalesce with other droplets. The coalesced water does not remain stationary on the wall surface, but instead flows down the wall.

## Habitable space: grades of waterproofing protection

The Warranty provider requires habitable space to be protected a combined system of waterproofing capable of achieving a Grade 3 environmental protection level. Appropriately designed environmental control measures must be included to control vapour introduced by occupation, and thereby preventing problems of condensation.

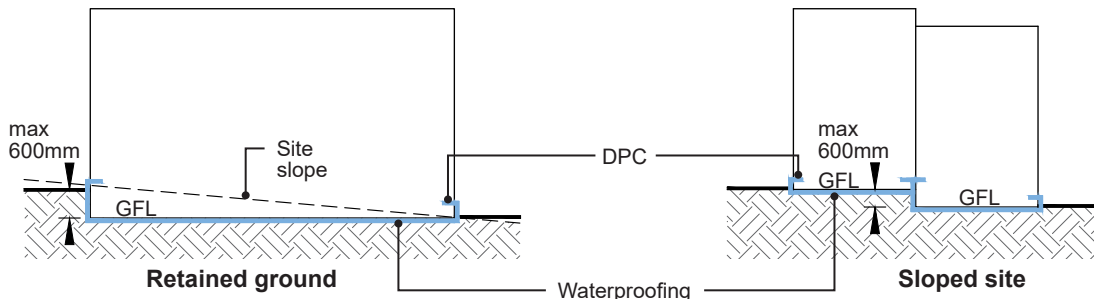
A single form of waterproofing protection to a habitable space where a Grade 3 environmental protection level is required may be acceptable on shallow stepped / gentle sloping sites where all of the below is applicable:

- Is no greater than 600mm above the lowest finished floor level.
- The water table has been proven to be permanently below the lowest floor level.
- A repair strategy for the single protection system has been provided.

In these circumstances, the site conditions must be proven to not result in an unacceptably high risk and the consequences of failure are substantially low. This must be substantiated by a site investigation report and agreed with the Warranty provider before commencing work on site.

A site specific design proposal must be provided before commencement of construction on site, to demonstrate the proposed waterproofing solution (Type A, B or C) is appropriate for the ground conditions (based on the site investigation report). The solution will include proposals for waterproofing walls and floors.

Such scenarios are limited to the above described and as shown in the following images.



In all habitable situations ventilation, dehumidification or air conditioning will be necessary, appropriate to the intended use.

## Ancillary spaces: grades of waterproofing protection

The Warranty provider requires that the environmental grade required for ancillary spaces is considered against the proposed use of the space e.g. car parks, plant rooms, lift pits.

It must be assumed that any below ground structure will be exposed to a full height of water during the design life of the building. As such any waterproofing design strategies that propose only 1 system of waterproofing protection for ancillary spaces will only be considered acceptable where a practicable and reasonable approach to defect repair for the end user in the proposed waterproofing protection system has been provided and agreed with the Warranty surveyor at the design stage.

## Lift pits

For developments with lift pits, whether they occur within storeys below ground or at ground level, there is a requirement that the lift pit remains free from water to avoid issues with the lift installation e.g. corrosion of fixings, damage the lift mechanism that may heighten risks around lift failures and breakdowns. It is therefore a requirement that lift pits achieve:

- A Grade 1b protection level as a minimum, **and**
- Use a system that is accessible for repair of any defects occurring in service.

## Underground car parking

For developments with underground car parking, the grade of waterproofing should be clearly defined as part of the waterproofing design. The use of Grade 1a waterproofing strategies for underground car parking must be supplemented by clear statements from the Waterproofing Design Specialist around the degree of seepage or dampness (water tightness) agreed with all interested parties, including the Warranty surveyor at the design stage.

## Waterproofing protection - defects and remedial measures

For all situations, an accessibility and reparability statement for the waterproofing system(s) chosen should form part of any structural waterproofing design.

## Waterproofing systems, materials and components

All waterproofing systems, materials and components shall be appropriately tested and approved for their intended purpose – please refer to 'Appendix C'.

The following systems are considered acceptable to the Warranty provider when integrated into any waterproofing design strategy by the appointed Waterproofing Design Specialist:

- Type A Barrier protection (can be referred to as 'tanking'). Barrier membranes must be fully bonded.
- Type B Structurally integral protection.
- Type C Drained protection (can be referred to as 'water management').

Glass Reinforced Plastic (GRP) liners are not acceptable for Warranty purposes. This applies to lift pits in isolation or as part of a larger waterproofing scheme.

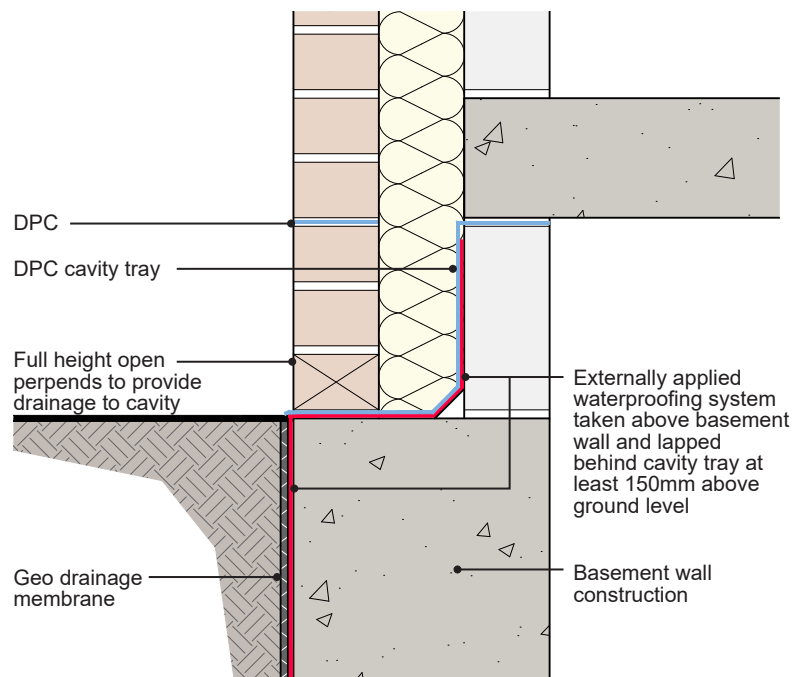
## Interface with the above ground structures

Below ground waterproofing must be continuous and link to the damp proofing provision in the superstructure.

Where detailing interfaces with walls above ground level, all detailing should terminate at a level 150mm above ground level into a horizontal damp proof course or cavity tray within the superstructure. Where detailing interfaces directly with a horizontal ground floor damp proof membrane, the minimum overlaps determined by the Waterproofing Design Specialist should be observed. In certain circumstances, proprietary components supplied by the waterproofing system manufacturer shall be used for complex shapes or interfaces.

In all instances, the Waterproofing Design Specialist should take responsibility for all junctions as part of the waterproofing design strategy, and ensure that materials used:

- Are compatible.
- Achieve a watertight seal.
- Are capable of taking loads.
- Are appropriately tested and approved for their intended purpose.



## Dealing penetrations through waterproofing protection

Penetrations through the waterproofing should be avoided where possible. Where penetrations cannot be avoided, the Waterproofing Design Specialist shall provide an appropriate design and use appropriate materials capable of creating a continuous waterproofing solution that is watertight and durable.

Penetrations resultant from wall ties must be appropriately detailed by the Waterproofing Design Specialist, approved by the manufacturer of the waterproofing system and appraised by an Engineer to ensure structural performance of the wall ties is not impeded.

Penetrations occurring due to services and drainage systems should be detailed by the Waterproofing Design Specialist and use manufacturers proprietary seals as far as practicable.

Where detailing requires site formation, the manufacturer of each respective system should provide explicit instruction around application to the Waterproofing Design Specialist for inclusion into their waterproofing design strategy.

## Risk mitigation measures

The provision of drainage to supplement structural waterproofing is a means of reducing the risk of failure by ensuring that the effects of water in the ground or percolating through the ground from higher levels does not stand against the structure.

External ground-level surfaces around the basement can provide a natural defence against water infiltration into sensitive areas, such as the excavated and backfilled ground, and the implementation of appropriate hard standing and cut-off drains to divert standing water away from these areas may be beneficial.

The use of land drainage can act to remove water from around the structure, thus alleviating pressure and should be considered in all cases to reduce the risk of water ingress where practical.

However, the use of land drainage may not be viable on all sites, examples being:

- Where there is no available location to discharge collected ground water.
- Where high water tables and permeable ground conditions make it impractical to sufficiently remove the quantities of water present.
- Restrictions on the site curtilage due to adjacent buildings close to or on the site boundary.
- Draw down, e.g. affecting the stability of other structures by the introduction of a land drain.

Notwithstanding such conditions, the provision of effective land drains is often an economic means of greatly reducing risk and must be included where viable.



### 2.1.8 Sub-surface drainage systems

Any sub-surface drainage system supplementing the waterproofing design shall be suitably designed and installed. The system shall direct water to a suitable outfall and have provision for maintenance.

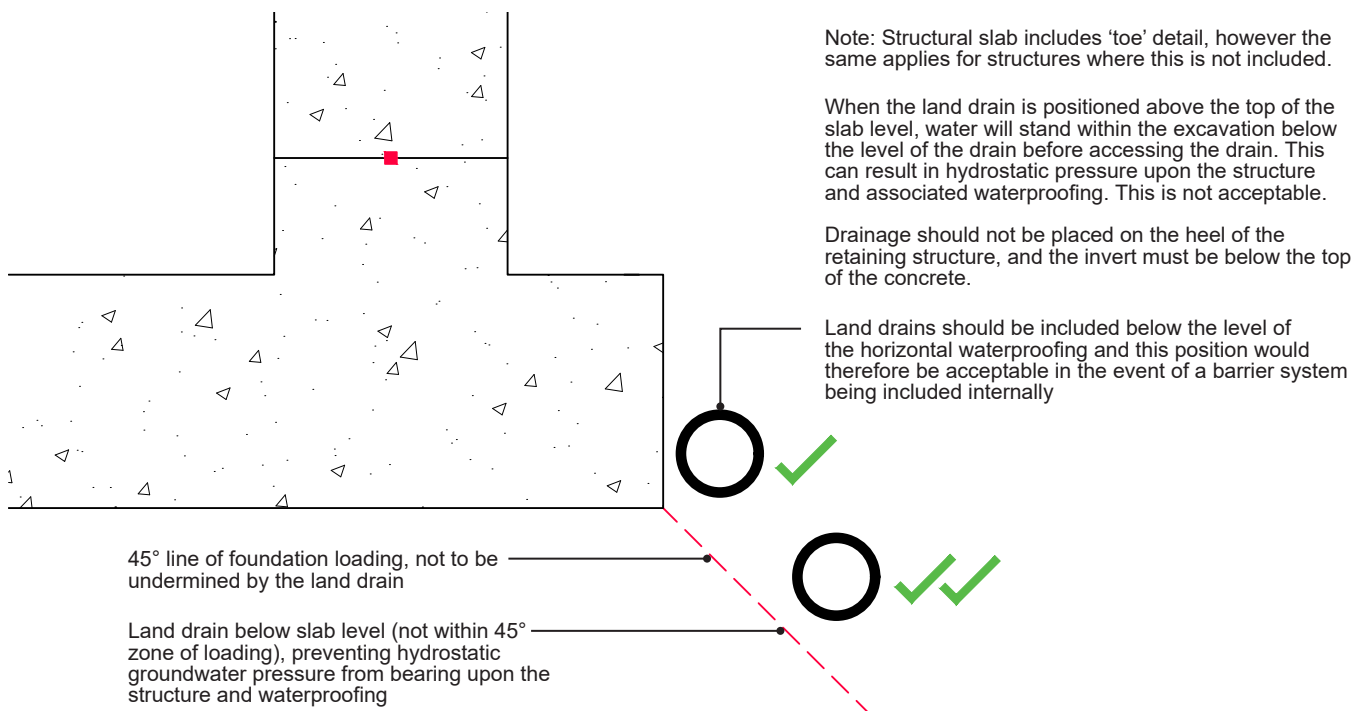
Any proposal must be fully detailed with drainage layout plans showing the line and invert level of all maintainable drainage runs, and include information in relation to access provisions and outfalls related to all drainage supplementing the structural waterproofing proposals.

The Warranty surveyor is to be supplied with design details where external land drainage is included.

Sub-surface drainage systems shall be designed by those holding an appropriate specialism e.g. drainage engineer, and shall ensure that:

- Any perforated land drains are to be surrounded in clean graded stone and wrapped in a suitable geo-textile filter fabric to reduce the risk of clogging. This is particularly important in fine granular and clay soils where land drains are susceptible to clogging.
- Rodding points are included at the heads of runs and any changes in direction to facilitate clearance of blockages and periodic maintenance undertaken at suitable intervals (annually as a minimum), with the detail of this being written into the documentation passed to homeowners.
- Land drains must discharge into a suitable outlet. Land drains must not be directly linked to soakaways by gravity, unless it is not possible for water to surcharge, e.g. where the top of the soakaway is below the level of the actual land drains.
- The use of geo-drainage membranes applied to the external face of a retaining wall are detailed to link into any suitable geo-textile filter fabric wrapped around the land drain to reduce the risk of clogging and facilitates water to drain down to the level of the land drains without pressuring the structure.
- Land drains must be positioned at a low enough position to prevent perched water pressure from bearing upon the structure and waterproofing but must not undermine foundations.

#### Land drain and external drainage



### 2.1.9 Waterproofing systems, materials and components

All materials, products and building systems shall be appropriately tested and approved for their intended purpose.

All waterproofing systems, materials and components shall be appropriately tested and approved for their intended purpose. Further guidance on acceptable and appropriate testing of material for Warranty purposes can be found in 'Appendix C' of the Technical Manual.

#### Type A Barrier protection

This form of waterproofing relies on the installation of a physical barrier material applied onto the interior or exterior face of the structure. Types of barrier material considered as Type A Barrier protection are:

- Pre-applied membranes
- Post-applied membranes
- Liquid-applied coatings
- Geosynthetic (bentonite) clay liners
- Cementitious systems

For the purpose of Warranty, when selecting a Type A barrier protection material specifiers should:

- Be fully bonded in their completed state. Any test evidence provided in support of attainment of a full bond, and with an internally applied material should be specific to the substrate and effects of negative pressure.
- Discuss the resistance generated by the waterproofing barrier with the responsible Engineer to incorporate into structural design considerations.
- Ensure that continuity detailing can be achieved without risk of deformation or damage to the waterproofing material e.g. resistance to extrusion or damage under loading when linking through structure and/or linking with DPC within the superstructure.
- Consider the limitations of materials in relation to any complexed detailing created by the structural form e.g. 'Buildability'.
- Consider the environmental factors affecting the waterproofing work e.g. temperatures, weather conditions, risks of standing water in excavations.
- Consider the feasibility of reparation to the system - externally applied systems are not accessible for repair once buried and as such require additional measures to act as risk mitigation e.g. sub-surface drainage, combined protection measures.
- Consider any additional performance expectations not related to the waterproofing performance but integral to any design and specification of material e.g. ground gases, contaminants and aggressive ground conditions may require the inclusion of materials capable of performing a suitable ground barrier to protect the structure appropriately. Specialist advice must be sought in respect of dealing with ground gases, and designers are advised to check current standards at the time of construction for suitable guidance.

Completed waterproofing should be protected by a suitable protection board or cusped drainage material where a sub-surface perimeter drain is provided as part of the waterproofing strategy. Backfill materials used should be appropriately graded material exhibiting an appropriate rate of drainage.

In all instances, Type A Barrier protection materials and systems should be installed in accordance with the manufacturer's instructions by operatives who are suitably qualified or have been trained by the manufacturer or supplier. All materials and work execution must be strictly in accordance with the Waterproofing Design Specialist design and specification, and supplemented by a Quality Control plan covering aspects of installation, which may be requested by the Warranty surveyor at their discretion.

## Type B Structurally integral protection

Type B Structurally integral protection uses reinforced concrete structure to provide protection against water ingress. This form of protection relies on reinforced concrete structural walls, floors and connections being designed by an Engineer to resist and restrict the passage of moisture and water.

Engineer completed designs should be in accordance with all the relevant parts of BS EN 1992, and relevant parts of Appendix C of the Technical Manual in relation to the reinforcing and use of admixtures with concrete.

The Warranty provider considers Type B Structurally integral protection as acceptable, when they are designed by an Engineer and use an approach of:

1. In-situ concrete with waterproofing admixtures, where crack widths are limited to 0.3mm maximum width for flexural cracks, and 0.2mm maximum width for cracks that pass through the section by the design and use of reinforcement.

**OR**

2. In-situ high-strength concrete without waterproofing admixtures, constructed to a 250mm minimum sectional width, where crack widths by design of reinforcement and post-construction crack injections are limited to 0.2mm maximum for both flexural cracks and for cracks that pass through the section.

The Engineers design should include as a minimum:

- Concrete specification e.g. type, strength, consistence class, aggregate size.
- Details of reinforcement e.g. size, type, position, spacing, required cover.
- Methodology and approaches taken to control crack widths and execute construction joints.
- Type and proportion of any admixture – admixtures shall be appropriately tested and approved for their intended purpose, and used strictly in accordance with the manufacturers recommendations.
- Methodology for placement e.g. – delivery to the area of work, method of delivery into the shutters.
- Extent of temporary works e.g. formwork, support, removal, making good concrete after removal.
- Reparation of foreseeable defects and limitations to effective repair work.
- Construction tolerances.

The Engineer and Waterproofing Design Specialist should work together to:

- Align the waterproofing grades required by the design with the structural designs and water tightness classification.
- Select the concrete mix required to achieve the necessary robustness, durability and waterproofing performance required.

Where the site is affected by ground gases, contaminants and aggressive ground conditions, concrete specification and performance should also be discussed with relevant specialists to determine any additional protection measures that should be included.

Evidence will be required by the Warranty surveyor that concrete has been sourced from a third party accredited supplier registered to either:

- 'The Quality Scheme for Ready Mixed Concrete' (QSRMC), or
- BSI Kitemark Certification.

**Trained operatives and quality control**

Work should be carried out by operatives with demonstrable experience in reinforced concreting works. All materials and work execution must be strictly in accordance with the Engineers design and specification, and supplemented by a Quality Control plan, which may be requested by the Warranty surveyor at their discretion.

The Quality Control plan should include as a minimum:

- All mix designs and supporting delivery documents to site.
- Details of controls for reinforcement work e.g. procurement, storage, bending operations, installation.
- Accurate and organised records of placement e.g. pour locations, pour size, pouring dates and times, weather conditions.
- Photographic records and documented controls relating to preparation and formwork construction.
- Records of concrete testing linked back to each concrete pouring operation e.g. slump testing, cube strength testing.
- Evidence of post-formwork strike checks e.g. areas of defective work, presence of cracks, use of electromagnetic cover meters to determine concrete cover over reinforcement.

**Type C Drained protection**

Type C Drained protection systems are often referred to as water management systems as they collect and remove any seepage of water occurring through the structure and direct to a suitable point of discharge.

The Warranty provider considers Type C Drained protection to be:

- Proprietary systems formed using cusped drainage membranes and drainage channels designed in accordance with BS 8102.

A designed system shall satisfactorily dispose of collected water to a suitable point of discharge, either by gravity or through a sump and pump system, and:

- Allow for the regular inspection, servicing and maintenance of drainage channels, pumps and fitments via appropriately located access points.
- Include control measures to avoid the depositing of free lime and/or mineral salts within the system e.g. effective surface preparation, use of inhibitive or sealer treatments onto structure before system installation. The Waterproofing Design Specialist should provide a specification of the treatments to be used appropriate for the particular construction and this should be made available to the Warranty surveyor.
- Include safeguards against the risks associated with backflow e.g. non-return valves, drain surcharging, and the risks associated with flooding e.g. flood loops.
- Include safeguards to address issues associated with ground gas and/or ground contamination that have been developed with an appropriate specialist. These jointly co-ordinated designs should ensure systems avoid risks to the end user(s) via pathways into the protected space and/or that systems are suitably resistant to any identified ground gas or contamination issue.

**Drainage capacity**

The capacity of the system shall be calculated by the Waterproofing Design Specialist to ensure the required internal environment is maintained and shall factor in the expected levels of water seepage occurring through the structure. The rate of water seepage may be influenced by:

- The structures resistance to water ingress e.g. materials, construction method.
- Size and complexity of the structure e.g. area, shape, junctions and penetrations.
- Hydrostatic pressure e.g. drainage characteristics of the ground, water table, perched water.
- The inclusion of risk mitigation measures e.g. external land drains, applied barrier membranes.

Drainage channels, sumps and pumps and all relevant system components shall be suitably sized to achieve the desired capacity, including any additional capacity identified by the Waterproofing Design Specialist to deal with foreseeable events that may temporarily increase burden on the drainage system e.g. flood events, surcharging.

Expected rates of water entering the drainage system should be communicated to the Engineer responsible for the overall project drainage design to enable determination of suitable points of discharge.

Where collected water is discharged into a suitable drainage system, any proposal shall be supported by appropriate designs that demonstrate receiving systems have suitable capacity for the water expected and include safeguards against risks posed by back-flow of water through the pipes due to water-logging and/or flood events.

Any proposal to discharge collected water via infiltration into the ground must not adversely affect the buildings structural performance or be detrimental to the building fabric. Further guidance can be found within the 'Drainage' section of the Technical Manual.

**Positioning of drainage system and components**

The position of drainage channels, sumps, access provisions and points of discharge shall be clearly determined by the Waterproofing Design Specialist within the waterproofing design strategy via appropriate plans and sections. As the location of drainage channels are typically local to the external wall-to-floor junctions, any formation whether formed during the concrete slab casting or cut into the concrete at a later stage, must be communicated to the Engineer to factor into relevant structural designs. Where larger footprints are involved, cross floor channels required by the design will ideally be local to construction joints where the structure is more vulnerable to seepage.

**Pump systems**

Pump systems should operate automatically, and be designed to safeguard against any foreseeable mechanical redundancy and any accidental situation that results in deactivation. They should include:

- A primary pump with an independent power supply.
- A secondary pump with an independent power supply, and a battery or generator backup.
- A suitable audio or visual alarm that indicates pump failure or loss of power supply.

Flood testing of a system should be undertaken during construction to check efficiency and that water flows as per the design. The Warranty provider at their discretion may request that such testing is witnessed by the appointed Waterproofing Design Specialist.

### **Trained operatives, quality control and commissioning**

In all instances, Type C Drained protection systems should be installed in accordance with the manufacturer's instructions by operatives who are suitably qualified or have been trained by the manufacturer or supplier. All materials and work execution must be strictly in accordance with the Waterproofing Design Specialist design and specification, and supplemented by a Quality Control plan covering aspects of installation, which may be requested by the Warranty surveyor at their discretion.

Upon completion, and prior to issuing the Certificate of Approval, the Warranty surveyor will require:

- A commissioning certificate for the pump system.
- A copy of the 'Operation and Guidance Manual' and all other documentation that will be made available to the end user in relation to the correct operation of the system, system guarantees, and their obligations to manage an appropriate inspection, servicing and maintenance regime for the installed system.

### **Combined protection**

A combination of waterproofing protection systems may be required to lower the risk of failure, or where the consequences of a single system failure and the loss of use to the protected space considered too high. Any combined protection designs should use materials that have different performance characteristics to mitigate the risk of failure due to a common cause or defect.

For Warranty purposes, habitable spaces must be protected by combined protection.



# 3.

## Foundations

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### Contents

|     |                              |    |
|-----|------------------------------|----|
| 3.1 | Mass Fill and Strip          | 38 |
| 3.2 | Piles                        | 43 |
| 3.3 | Raft                         | 49 |
| 3.4 | Engineered Fill              | 52 |
| 3.5 | Vibratory Ground Improvement | 58 |
| 3.6 | Trees and Clay               | 66 |
| 3.7 | Retaining Walls              | 74 |

## Introduction

This section provides guidance on meeting the performance requirements for mass fill and strip foundations for buildings up to 3 storeys<sup>1</sup>. The following situations are not covered by this guidance:

- Mass filled foundations and strip foundations for buildings other than dwellings.
- Foundations on filled ground.
- Mass fill foundations and strip foundations where foundation depths exceed 2.5m.
- Building new structures off existing foundations.

<sup>1</sup> For buildings which are 4 storeys or more, mass fill or strip foundations should be Engineer designed.

### 3.1.1 Compliance

Mass fill and strip foundations shall meet the performance requirements of this section.

### 3.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Site investigation report appropriate for the site specific conditions (please note, a minimum phase one desktop study is required in all circumstances).
2. Where the ground is contaminated a full design package including details of all materials to be used along with a remediation report will be required.
3. Full set of detailed drawings including:
  - a. Foundation layouts.
  - b. Section drawings showing depth and width of foundations.
  - c. Layout drawings showing position of trees in proximity to any foundations.
  - d. Location of any services in close proximity to the foundations.
  - e. Details of movement joints, junctions or steps in the foundations.
  - f. Details of heave precaution requirements.
4. Full set of structural calculations and drawings.

### 3.1.3 Design

Mass fill and strip foundations shall be appropriately designed to safely transfer loads from the superstructure to the ground without excessive movement and in accordance with the relevant Building Regulations.

Mass fill and strip foundations should follow the guidance provided within this section and BS 8103-1.

## Ground conditions

Mass fill and strip foundations should only bear onto original ground, where it does not, the foundation should be designed by a Structural Engineer and appropriately reinforced. It is therefore important that site conditions are appropriately assessed prior to the building design. Please see the 'Ground Conditions' section.

## Settlement

Mass fill and strip foundations shall be designed to ensure that the building is appropriately supported at all times without excessive settlement.

For 'low rise structures', the foundations should be designed to ensure a maximum settlement of 25mm is not exceeded.

In relation to differential settlements, a design limit for maximum tilt of 1/500 is appropriate for the load case, 100% Dead load plus 30% superimposed live load. Where it is clear 100% superimposed live loads will occur for long periods of time, differential settlement checks shall be carried out for 100% Dead and 100% superimposed live load. More stringent values may be required due to the particular circumstances (e.g. medium and high rise structures).

## Influence of trees in clay soils

Foundation design should take into account influence from nearby trees. Where construction is to take place in cohesive soils and trees are/were/will be present:

For mass fill foundations:

- If the foundation depth is greater than 1.5m, then heave protection will be required.
- Where foundation depths exceed 2m, short bored piles with ground beams or piled rafts slabs are recommended. All pile designs should be undertaken by an Engineer.
- Foundation depths required to exceed 2.5m are beyond the scope of the online foundation depth calculator and must be a piled engineered solution.

For strip foundations, where construction is to take place in cohesive soils and trees are/were/will be present, and the foundation depth is required (using the online foundation depth calculator) to exceed 1.5m, heave protection will be necessary and strip foundations will not be suitable. Mass fill or short bored piles should be adopted (see the 'Foundations - Mass Fill' and 'Foundations - Piles' guidance).

Further guidance can be found in the 'Foundations - Trees and Clay' section.

## Minimum foundation dimensions

### Foundation widths

Mass fill and strip foundations should be of a 600mm minimum width for external walls and must take loadings and ground conditions into account. For widths that are less than 600mm for the external wall, an engineer design must be provided.

For single leaf internal walls up to 150mm thick, foundations may be reduced in width to 450mm ensuring that a 150mm projection either side of the internal wall is provided.

In all situations foundations should be situated centrally below the wall.

### Thickness of strip foundations

The minimum thickness of strip foundations should be 150mm.

## Foundation depths

The depth of all foundations should be determined by specific site conditions. All foundations must bear onto virgin stable subsoil and, except where strip foundations are founded on rock. The foundations should have a minimum depth of 450mm, measured from finished ground level to their underside, to avoid the action of frost. This depth however, will commonly need to be increased in areas subject to long periods of frost or in order that loads are transferred to suitable ground. If the finished ground level will be above the existing ground level then, the foundation depth should be calculated from the existing, not finished, ground level.

Where trees are situated close to a proposed building founded on a clay soil, the foundation depth/design will be affected; further guidance is available in the 'Foundations - Trees and Clay' section. In clay soils with a plasticity index greater than or equal to 10%, foundations should be taken to a depth where anticipated ground movement will not impair the stability of any part of the building, taking into account the influence of vegetation and trees on or adjacent to the site. The depth to the underside of foundations on clay soils should not be less than 750mm, as measured from finished ground level, and depths may need to be increased in order that loads are transferred to suitable ground.

For minimum depths of foundations in cohesive soils where trees are/were/will be present, please use the online foundation depth calculator. Further guidance can be found in the 'Foundations - Trees and Clay' section.

Where the depth of mass fill or strip foundations is in excess of 2.5m, they must be designed by a Chartered Structural Engineer in accordance with current British Standards and Codes of Practice. For trench fill, it is imperative to check that the finished foundation level is correct and horizontal. It will be difficult to adjust for discrepancies in the small number of brick courses between foundation and DPC level.

Prior to concreting, excavations should be 'bottomed out' to remove any debris that may have fallen into the trench; the excavations should be free from water, and if it has been left open for a long period of time, further excavation may be required to a non-weathered strata.

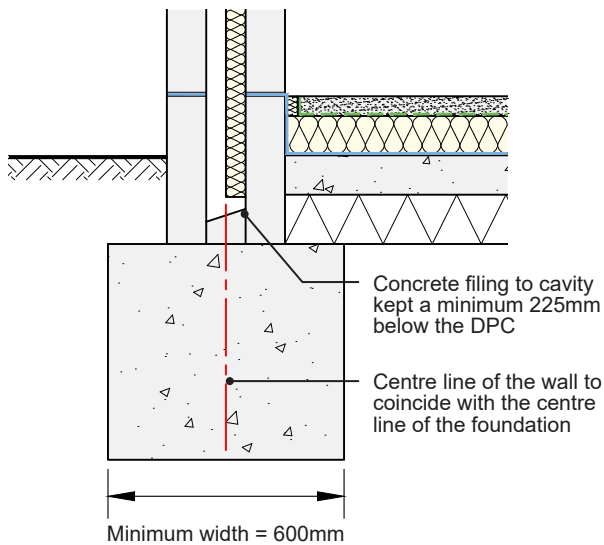
| Minimum foundation depths                                                                                   |                         |                      |
|-------------------------------------------------------------------------------------------------------------|-------------------------|----------------------|
| Modified plasticity index                                                                                   | Volume change potential | Min foundation depth |
| 40% and greater                                                                                             | High                    | 1.00m                |
| 20% to less than 40%                                                                                        | Medium                  | 0.9m <sup>1</sup>    |
| 10% to less than 20%                                                                                        | Low                     | 0.75m <sup>1</sup>   |
| <sup>1</sup> If the modified plasticity index is not confirmed, the minimum foundation depths should be 1m. |                         |                      |

The Plasticity Index may be used without modification; for soils comprising of pure clays, with 100% of particles less than 425µm, the Plasticity and Modified Plasticity Indexes will be the same. The adoption of the Modified Plasticity Index in mixed soils, such as glacial till, however, may result in a more economical design.

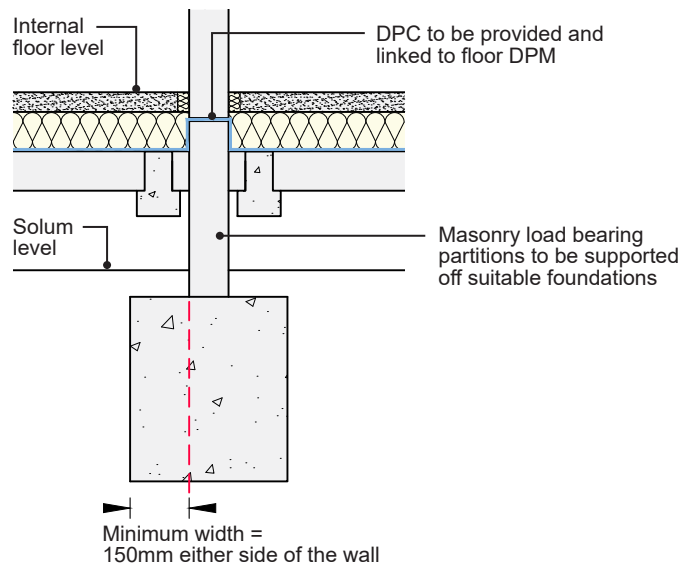


### Typical mass filled foundation

#### External wall



#### Internal wall



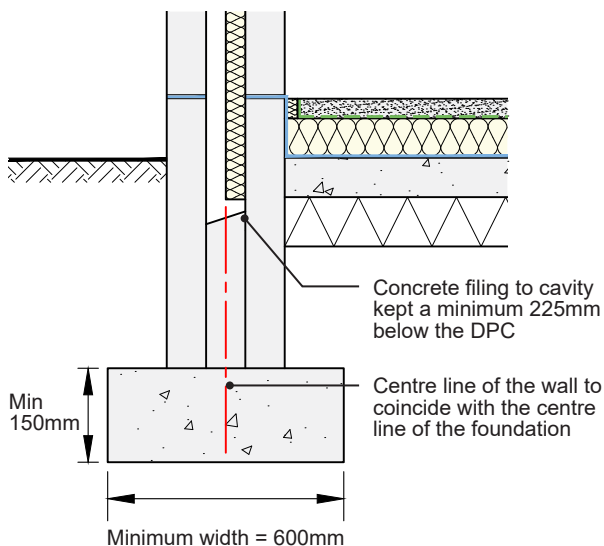
Depth of foundation (below ground level) to be taken to:

- Suitable virgin sub-soil.
- A depth that gives sufficient bearing and protection from frost.
- When building on cohesive soils, is at a depth that is not under potential influence of nearby trees.
- Below the invert level of any adjacent drain/sewer.

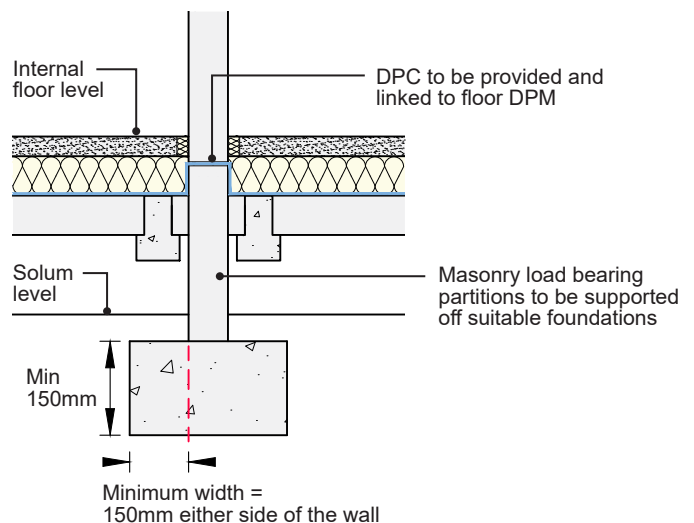
- Foundation to be centrally located under the wall.
- The foundation width should be in accordance with the relevant Building Regulations.

### Typical strip foundation

#### External wall



#### Internal wall



Depth of foundation (below ground level) to be taken to:

- Suitable virgin sub-soil.
- A depth that gives sufficient bearing and protection from frost.
- When building on cohesive soils, is at a depth that is not under potential influence of nearby trees.
- Below the invert level of any adjacent drain/sewer.

- Foundation to be centrally located under the wall.
- Width of the strip foundation to ensure a 150mm minimum projection either side of the wall is provided.
- The foundation width should be in accordance with the relevant Building Regulations.

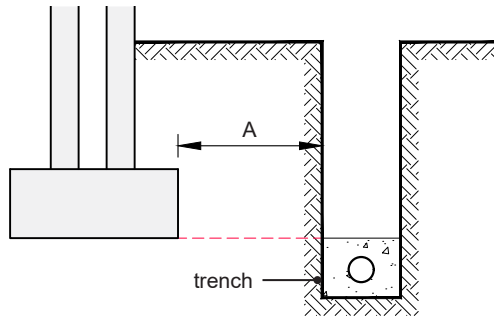
## Reinforcing

Reinforcement, if needed, should be clean and free from loose rust and should also be placed correctly. Bars, of an appropriate size, should be supported to guarantee that they are 75mm above the base of the foundation, or as indicated in the design. They should be secured at laps and crossings. If in doubt about any soft spots, the Engineer's advice should be taken prior to placing the concrete.

## Protecting pipes and services adjacent to foundations

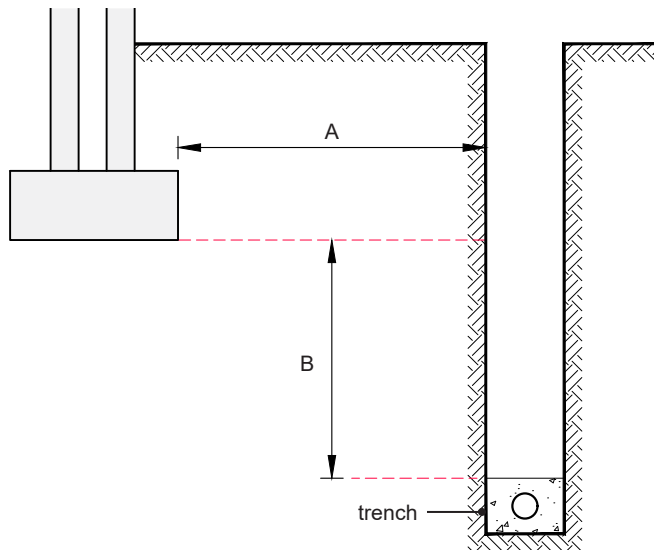
Where it is not physically practical to locate drains so they are not impacted by foundation loads, the pipes should be protected. Examples of how the pipes may be protected are given below:

### Scenario 1 - where A is less than 1m



Where the trench is 1m or further from the foundation, the trench is to be filled with concrete up to measurement B as shown above.

### Scenario 2 - where A is 1m or greater

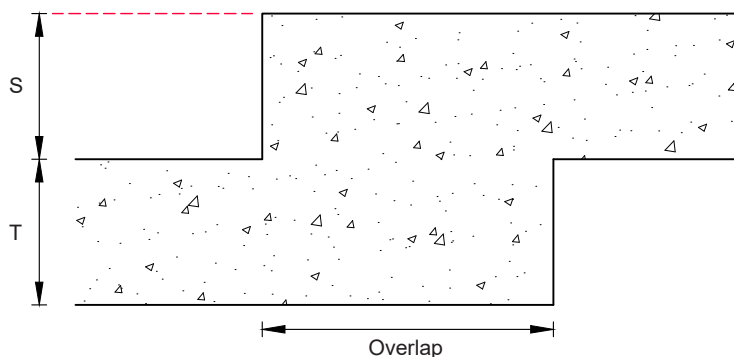


Mass fill and strip foundations must be:

- Constructed to a depth which will not be affected by nearby drainage or other services.
- Any drain or service pipe must not pass through the base of the foundation. Where such services are at the same level, the base of the foundation must be stepped below and the drain/services sleeved through the substructure wall above.
- Existing ground water drains should be diverted to a suitable outfall.

### Steps in foundations

Steps in foundations must not be of a greater dimension than the thickness of the foundation. Where foundations are stepped (on elevation), they should overlap by twice the height of the step, or 1m whichever is the largest.



#### Mass foundations

The overlap should not be less than:

- 2 x S, or
- 1m

whichever is the largest.

#### Strip foundations

The overlap should not be less than:

- 2 x S, or
- T (max 500mm), or
- 300mm

whichever is the largest.

### 3.1.4 Setting out foundations

Mass fill and strip foundations shall be accurately set out to take account of the design.

The accuracy of setting out foundations should be checked by set controlled trench measurements, including their location relative to site borders and neighbouring buildings. Levels should be checked against benchmarks, where appropriate. In particular, for excavations check:

- Trench widths.
- Trench lengths.
- Length of diagonals between external corners.

Walls should be located centrally upon the foundation, unless specifically designed otherwise. Any discrepancy in dimensions should be reported promptly to the designer. Resulting variations should be distributed to all concerned with site works, including the Warranty surveyor.

Standards referred to:

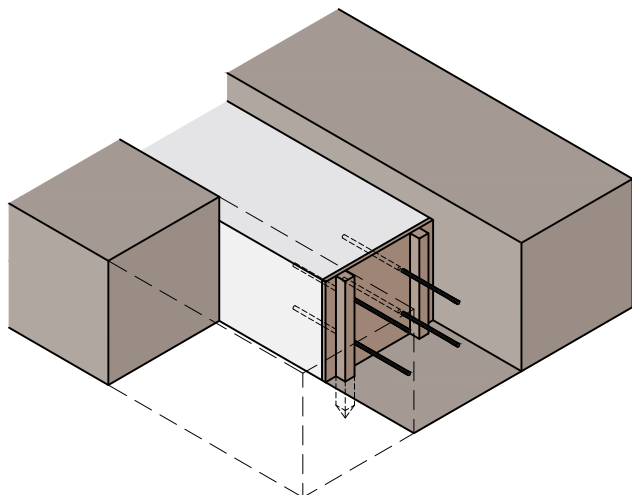
- BS 8004 Code of Practice for foundations and Eurocode
- BS 5950-1 Structural use of steelwork in buildings and Eurocode
- BS 6399 Loadings for buildings and Eurocode
- BS 8103 Structural design of low rise buildings and Eurocode
- BS 8110 Structural use of concrete and Eurocode

### 3.1.5 Construction joints

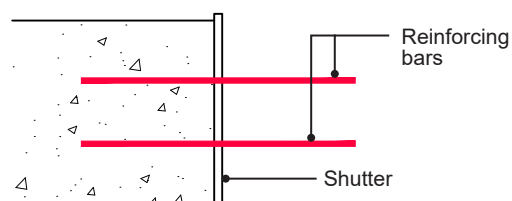
Where construction joints are required, they shall be suitably formed in accordance with the design.

If construction joints are necessary, they should not be positioned within 2m of a corner or junction in the foundation. All shuttering should be removed before work progresses beyond the construction joint.

#### Using reinforcement bars across a joint

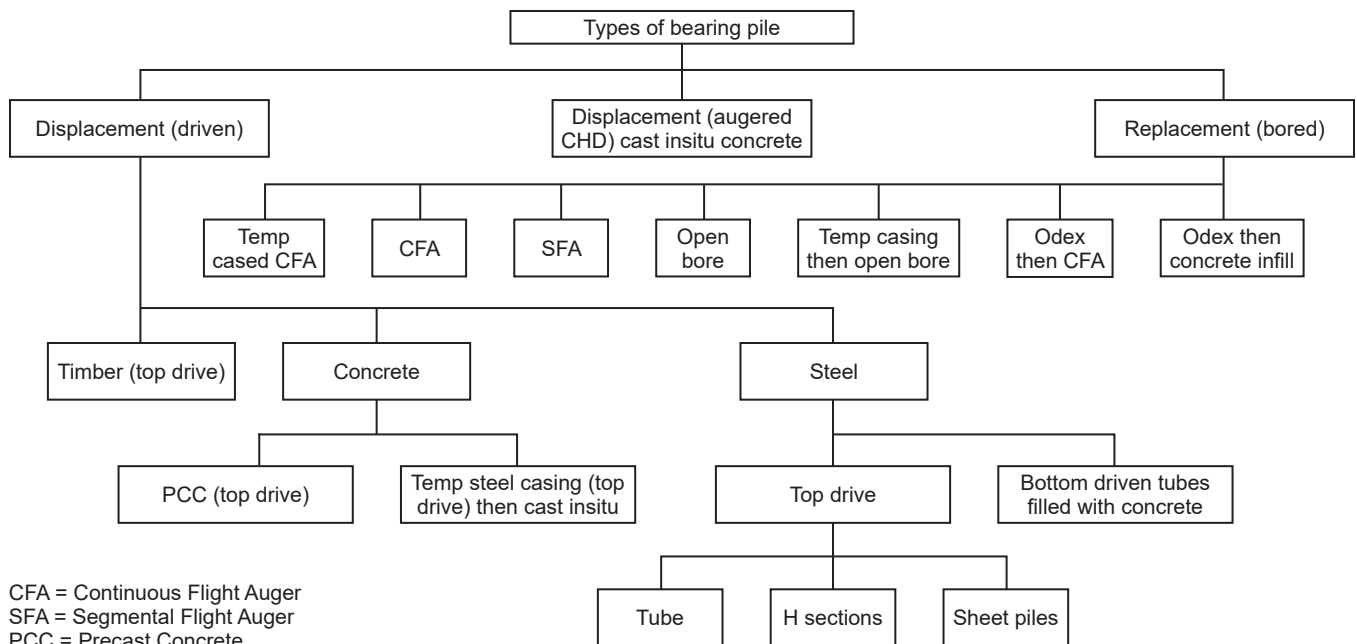


#### Section



## Introduction

This section provides guidance on meeting the performance requirements for piled foundations. Displacement and replacement pile types are covered within the guidance for this section:



If alternative pile types or non-standard design methods are being considered, please contact the Warranty Structural Engineer prior to commencement of piling.

## Limitations of guidance

The following situations are beyond the scope of this guidance.

- Innovative foundation systems that do not have third party approval or accreditation.
- Piling systems where the structural design is not endorsed by the Specialist Piling Contractor.

### 3.2.1 Compliance

Piled foundations shall meet the performance requirements of this section.

### 3.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design details, calculations, reports and other supporting information should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

## To be submitted prior to commencement on site

1. Desk study, investigative and interpretive Site Investigation Report(s) (to a suitable depth beneath the pile toe as outlined in the guidance within this section) with associated geotechnical testing sufficient for pile design including DS / ACEC requirements for buried concrete, heave and shrinkage.
2. Foundation drawings, pile layouts and pile schedule (with pile reference numbers and loadings).
3. Engineer's specification for piling works to include the allowable pile settlements and testing requirements.
4. Calculations for the substructure and for the derivation of the load on each pile.
5. Pile design calculation (for vertical, horizontal, tensile and heave forces) to geotechnical parameters in site investigation report. This should include the pile designer's written confirmation that the site investigation is adequate to ensure that the pile design complies with British Standards. This should also include confirmation, justification, type and number of any preliminary and/or working pile load tests required to satisfy the design.

### To be submitted prior to construction continuing over the piles

1. Pile installation logs (with pile numbers cross-referenced to the pile layout drawing), including details of re-strikes, rock sockets, rig telemetry records, and concrete volume.
2. Concrete mix details and cube test results for the concrete used in the piles with tabulated results.
3. Integrity testing of all concrete piles with interpretive summary and conclusion.
4. Dynamic load testing results with analysis of long-term settlement, interpretive summary, and conclusion. The correlating static load test for each differing length, load and diameter must be included (and the relevant boreholes if the static testing was undertaken at a different site).
5. Static load test results.
6. Pile Designers interpretive summary and conclusion on completion of the works.

Please note: In the absence of approval, works are proceeding at the Developer's own risk.

The Warranty surveyor and/or Warranty Structural Engineer, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 3.2.3 Ground conditions and site investigations

All sites shall have an appropriate level of site investigation which accurately assesses and investigates potential hazards which may effect the pile foundation design.

The pile foundation design shall take account of the site specific ground conditions.

The choice of piling system to support the structure will depend entirely upon the ground conditions. It is important to have the appropriate site investigation works carried out to determine depths of filled ground, the bearing capacity of soils, ground contaminants, soil type and any existing workings or services that may clash with pile locations.

For further guidance on ground condition assessments, please refer to the 'Ground Conditions' section.

Analysis of the site investigation report should be completed by a Specialist Piling Contractor and Structural Engineer.

### Site investigations

Site investigations must be in accordance with the requirements of BS 5930 / BS EN1997-2.

The depth of the site investigation should extend to depths beneath the pile toe of at least 3 x pile diameter or 5m or the smallest plan dimension encompassing the pile group (whichever is the greatest). However this may be relaxed where (subject to prior discussion and agreement with the Warranty provider):

- Rock is encountered and the geology of the site is well known.
- The geology of the site is well known to a substantial depth in strong soils.

Generally, boreholes should be at centres of 10m to 30m for structures and at a minimum of 3 points on the site. However, closer borehole / probe / CPT spacings should be used where there are site specific hazards where there is the potential for large variations in soil properties across the site (e.g. a soil infilled valley, a quarry high wall, chalk dissolution features, subterranean salt, gypsum, shallow coal mining etc).

The investigation should include sufficient soil strength testing, throughout the anticipated pile length and beneath the pile, to enable geotechnical design of the piles, using proven design methods.

The Geotechnical Engineer must provide a risk assessment statement (in the site investigation) for the potential of ground water levels to rise in the next 60 years – taking into account the potential for increased rainfall, sea level rise, the reduction of flood plain storage in and around the site and possible failure of flood defences (assess the risk of potential climate change, increased development in flood plain areas and over-topping of flood defences by flood water).

If the site investigation is found to contain insufficient information to verify the proposed design of the piles, the pile designer should request additional investigation and testing e.g. additional boreholes to the above depth, as considered necessary to establish the required geotechnical parameters.

### Checklist for site investigation information required:

The following information if applicable should be provided prior to any works commencing on site:

1. Phase 1 Desk Study report detailing the history of the site, potential hazards / risks below and above ground and likely soil types present on the site.
2. Topographical survey drawing of the site before the construction of the proposed development.
3. Cut and fill proposal drawings for the site.
4. External works finished ground levels around the proposed buildings.
5. Finished ground floor levels of the proposed buildings.
6. Tree report providing the locations, species and heights of all trees, hedgerows, bushes and shrubs in and around the site and which of these are to be removed.
7. Phase 2 Ground Investigation report(s) providing a summary of the development proposals and the following information by the use of appropriate investigation techniques and testing:
  - a. Descriptions of soil types and stratification.
  - b. Soil strength profiles with depth.

- c. Level(s) of ground water.
- d. Mining risk assessment specific to the site.
- e. If subterranean mine workings are present, then the extent, depth and thickness of worked seams must be identified and fully specified by the use of reliable investigation techniques. A Coal Authority Mining Report, for the site, is required.
- f. Identification of buried and overhead services on the site and wayleaves which must be complied with in the design.
- g. An assessment of the risk of rock dissolution features on the site.
- h. If there is a medium to high risk of rock dissolution features on the site, then appropriate investigations must be carried out to locate them - further detailed proposals will be required.
- i. Plasticity indices and moisture contents of near surface soils to a depth of 4m.
- j. Ground gas monitoring results on 6 separate site visits plus an interpretation of the results to provide the Characteristic Situation of the site - following the guidance of the current version of BS8485.
- k. Classifications of the chemical aggressiveness of the soils and ground water in contact with new and existing concrete on site.
- l. Identification of the contaminants in the soil and water and their concentrations.
- m. Site remediation strategy statement to deal with soil and water contaminants.
- n. An interpretive report giving recommendations for suitable foundation solutions.

## Piles founded in or through difficult ground

Difficult ground is defined as ground with any of the following characteristics:

- The presence of rock.
- Chalk with dissolution features and/or bands of flint or large flint nodules.
- Hertfordshire pudding stone.
- Ground with cavities (potash, coal, brine and gypsum extraction).
- Backfilled quarries with no validated engineered fill.
- Backfilled quarries with buried highwalls.
- Subterranean mine workings which haven't been remediated by drill and grout remediation.
- Landfill sites where the landfill material identification is unknown or variable in composition.
- High water table.
- Ground water regime where the water table is effected by tidal influences.
- Collapsible soils.
- Severely contaminated ground and/or ground water.
- Fill with significant buried obstructions.
- Significant peat layers at depth below a pile toe.
- Geological fault lines identified on the site.

## Replacement piles founded in rock

Where the pile design specifies a rock socket length at the toe of the pile, suitable piling installation equipment should be used and a suitable piling technique adopted to ensure the rock socket length is achieved (rock cutting lead auger). If the rock is too strong for cutting with an auger, then the Odex piling technique should be considered.

## Replacement and displacement piles founded in chalk with dissolution features

The pile design and pile installation must follow the guidance contained in CIRIA PR86 and CIRIA C574.

If the Phase 1 Desk study report identifies a medium to high risk of chalk dissolutions being present on the site, then each pile position must be probed to determine the soil strength profile, ground water regime and depth to the chalk horizon. The dynamic probing technique is not acceptable in chalk (remoulding of the chalk occurs giving false relative strength data). Ideally, cone penetration testing with a gamma cone should be used for probing. Each pile is then designed based on the specific soil strength profile, water table level and chalk depth horizon.

In the case of replacement pile types, the piling rig drilling telemetry records for each pile must be provided. These records must identify drilled depth, continuous recording of bore diameter with depth, theoretical amount of concrete to fill the bore and the actual amount of concrete to fill the bore and the percentage overbreak. Where the percentage overbreak is greater than 30% on a pile, the Warranty provider and Pile Designer must be informed. The Pile Designer must check to determine whether the pile meets the load bearing requirements. This check must be submitted to the Warranty provider as soon as possible.

## Replacement and displacement piles founded in ground subject to cavitation

Where the ground is subject to potential cavitation as a result of gypsum dissolution, brine dissolution etc. the pile design and installation should take into account any existing and future cavitation. As such, some form of redundancy may need to be considered within the foundation design to mitigate the effects of any unknown conditions. Since the presence of solution features cannot be readily identified during the installation of the piles, it is recommended that the probing of each pile position should be undertaken. Geophysical investigation or similar is recommended in order to locate existing cavities.

## Piling over mine workings

With regard to piling over or near to historical mine workings reference should be made to CIRIA SP32 and CIRIA C758D. Generally, piles are not suitable unless founded below the grouted mine workings. If there is sufficient rock cover over the validated grouted mine workings, then piles founded above the grouted mine workings maybe acceptable if suitable calculations are produced (point load check at pile toe and equivalent raft bearing pressure analogy acting on a horizon 2/3rds of pile depth).

When piling adjacent to existing mine entries, assurance must be provided that adequate competent rock is present to found the piles and the stipulated rock socket lengths have been achieved. In addition, it must be proved that the piles will be unaffected by any partial or full collapse of a mine entry.

## Piling in made ground

Piles terminating in, or relying on, made ground or un-engineered fill are not acceptable.

### 3.2.4 Pile design

The piling scheme shall be designed by a suitably qualified and experienced Engineer to safely transfer all loads without causing excessive settlement whilst taking account of parameters obtained from geotechnical testing and contained within the site investigation report.

The following piling information should be provided by the project structural engineer for all piles types:

- Assessment of loads on piles split dead, live and horizontal loads.
- Pile design calculations based on site investigation and structural engineers design loads.
- Pile layout drawings with unique pile reference numbers.
- Foundation general arrangement drawings.
- Pile schedule providing vertical and horizontal loads split dead, live and horizontal applied to each pile.
- Pile testing requirements.

### Replacement piles

The following should be provided by the piling contractor for replacement piles:

- Pile design calculations using geotechnical soil strength parameters, groundwater regime, the Structural Engineer's loads and taking account of potential clay heave/shrinkage – where near surface soils are clays and any requirement for a rock socket at the toe of the pile.
- Fully detailed pile schedule.
- Concrete mix design certificates for piling concrete from all suppliers.
- A statement regarding any requirements for pile load testing.

### Displacement piles

The following should be provided by the piling contractor for displacement piles:

- Complete description of the pile composition material's, section size and driving method (top drive or bottom driven).
- Driving hammer weight and drop height.
- Drop hammer efficiency. An in date hammer efficiency certificate must be provided for the actual hammer used on site.
- Pile set calculations using the Modified Hiley formula.
- Pile design calculations using the soil profile strength parameters, ground water regime, the Structural Engineer's loads and the potential for clay heave/shrinkage – where near surface soils are clays and any requirement for a rock socket at the toe of the pile.
- Pile load testing requirements (static load tests and dynamic load tests).

### Influence of trees in clay

Where construction is to take place in cohesive soils and trees are/were/will be present:

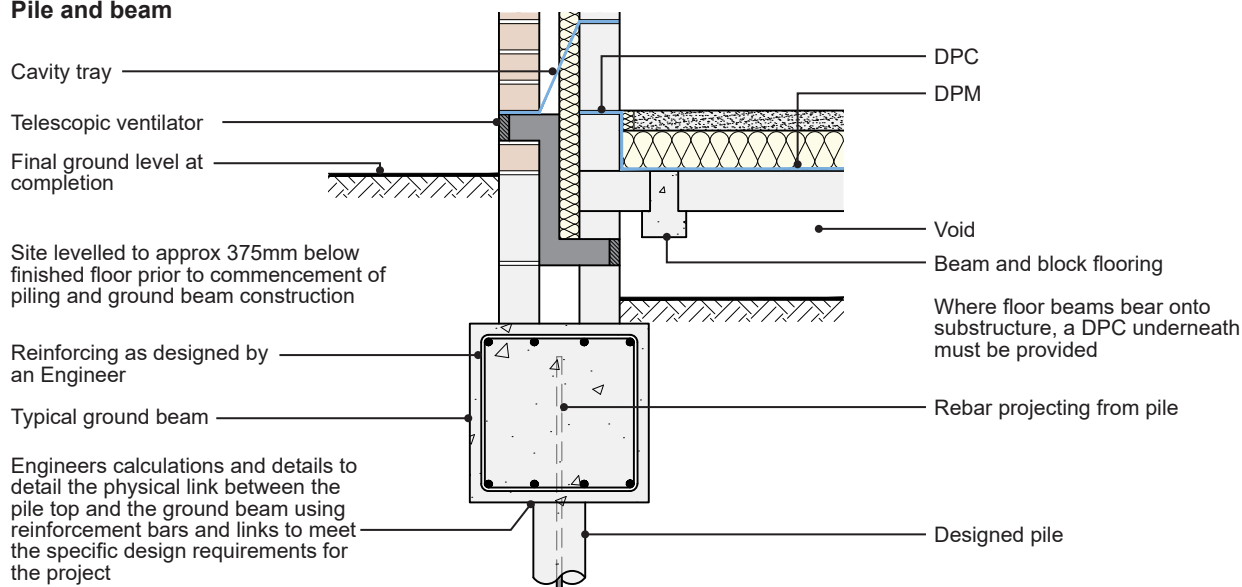
- Suitable heave precautions should be included in the design details for the protection of the piles, and ground beams or piled raft slabs.
- The piles must be deep enough to cater for heave.

For more information on trees, clay and heave precaution, please see the 'Foundations - Trees and Clay' section.

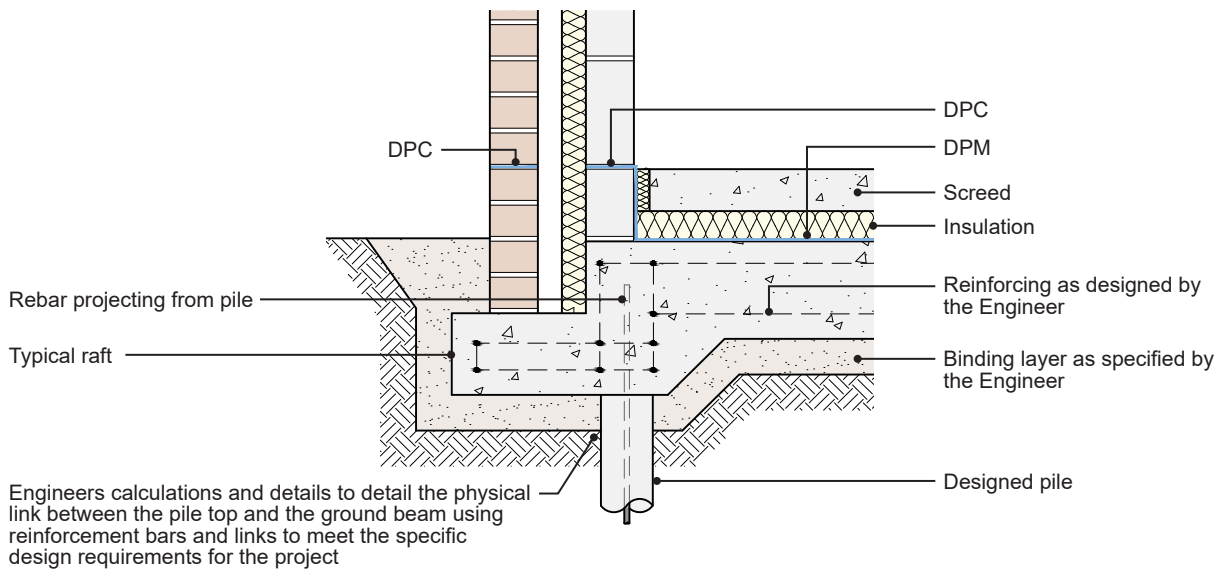
### Ground beam and piled raft slabs

There should be adequate connections between the beam or slab to the pile to ensure that the loads are transmitted effectively. The beam/slab should be adequately anchored to the pile to resist uplift on sites that are susceptible to heave. All external, internal, partition and party walls can be accommodated using this system. The foundation design should be supported by structural calculations provided by an Engineer or Specialist sub-contractor.

#### Pile and beam



## Piled raft



### 3.2.5 Pile testing

Pile testing shall be conducted according to current British Standards and Codes of Practice, taking into account the specific ground conditions present on site. The testing proposal shall be discussed with the Warranty Engineers at the earliest opportunity.

### 3.2.6 Pile installation records

Pile installation records shall be made available for all piles installed.

## Replacement piles

The following must be provided for all piles:

- Pile installation records (site logs) must be provided for all piles. These records must include details of:
  - The piling company.
  - Piling rig used.
  - Rig crew details.
  - Pile type.
  - Pile diameter.
  - Unique pile references.
  - Piling platform levels.
  - Pile depth installed.
  - Details of the rebar installed in the pile.
  - The day of drilling.
  - The concrete mix used to fill the piles and which piles had concrete test cubes taken.
  - Any problems experienced with installation of the piles must be recorded.
- Pile integrity test reports including vibration traces for all piles and a summary of the results (pass or fail).
- 28 day concrete test cube results for piling concrete for each day of piling.
- Piling rig telemetry records must be provided – if they are available.

If there are pile installation difficulties, then the Project Structural Engineer and Warranty provider must be informed as soon as possible.

## Displacement piles

Pile driving installation records (site logs) must be provided for all piles. These records must include details of:

- The piling company.
- Piling rig used.
- Rig crew details.
- Hammer weight.
- Driving efficiency of the actual hammer used on site (including in date efficiency certificate).
- Hammer drop height.
- Pile type (steel, concrete or timber).
- Pile section size.



- Unique pile reference numbers.
- Piling platform levels.
- Pile depth installed.
- The levels of segmental pile section joints (where applicable).
- Pile driving records for each pile (penetration for each ten blows to build up a driving / penetration profile for the pile) and the date of driving each pile. Re-strikes of particular piles must be recorded and issued to the Warranty provider.

If the driven piles gain the majority of their support from clay or chalk, then 10% of the piles shall be subjected to a re-strike, after a suitable length of time (allowance for increased pore water pressures to dissipate at pile toe or shaft annulus slurries to drain after the initial drive). The purpose of the re-strike records is to determine whether the pile has improved driving blow count / vertical displacement characteristics (stiffer) or worse blow count / settlement characteristics (less stiff than assumed). If the latter, then the Pile Designer, Structural Engineer and Warranty provider must be informed, as soon as possible, and a technical discussion held on, maybe, downrating the ultimate load capacity of particular piles, exhibiting this characteristic, and the possibility of installing additional piles.

Where particular driven piles display the characteristics of quake during and/or after driving (upward movement of the pile head). The reasons for this phenomenon must be established and the implications on foundation design identified and communicated, to the Structural Engineer and Warranty provider, as soon as possible. If it is decided a foundation re-design is required to counter the quake characteristics of the driven pile, then these re-designs must be submitted, as soon as possible, to the Warranty provider, for consideration. Further discussion within the Design Team will be required and agreement reached with the Warranty provider. Any works constructed on top of these piles, before agreement with Warranty provider, will be at the Client's risk. The Client, in this case, is the company applying for a Building Warranty.

Where driven pile depths vary considerably over short distances (using a driven pile set formula to determine pile depth), the reasons for this phenomenon must be established as soon as possible – for example, a possible scenario could be short piles into a backfilled quarry side wall (into rock) or internal subterranean highwall (into rock), end bearing piles onto subterranean cobbles and boulders and long piles into deep fill.

It is probable that additional ground investigation will be required to establish where these subterranean features are present – to allow a detailed appraisal of the problem.

The choice of driven piling method, piling rig and pile section material type is important for particular ground conditions. It is not acceptable to state on pile driving records that a pile has been driven to refusal – if the following applies:

1. 220mm diameter, steel cased, bottom driven piles are driven into stiff to very stiff clays. Alternatively, driving into rock strata where a rock socket cannot be achieved and required by the geotechnical design of the pile (a pile driving set formula calculation on it's own is not acceptable).
2. Top drive precast concrete piles driven into moderately weak rock or stronger. The Warranty provider will consider top drive thick walled steel tubes driven into this type of strata – if practical refusal is achieved (10 blows for 25mm vertical displacement) using a suitable heavy hammer and hammer drop height.
3. Where, as installed driven piles have not achieved the depths required by the geotechnical pile design (using appropriate soil / rock parameters), then static load tests on sacrificial piles are likely to be required where the soil/rock strata present are stiff clays or the unconfined compressive strengths and rock quality indices are unknown.

### 3.2.7 Alignment of piles

The Piling Contractor shall take care to ensure that the piles are installed vertically and pile tops are correctly aligned to support the foundation system.

An acceptable level of tolerance is for a pile to be offset in plan from the theoretical position by no more than 75mm, with vertical alignment no worse than 1m in every 75m (1:75).

### References

- BS EN 1997-1 - Eurocode 7: Geotechnical design (EC7)
- BS 8004 - Code of practice for foundations
- BS EN 1997-2 - Ground investigation and testing
- BS 5930 - Code of practice for ground investigations
- ICE Specification for piling and embedded retaining walls (3rd edition)
- London district surveyors association (LDSA) - Guidance notes for the design of straight shafted bored piles in London clay
- PERKO, H.A. Helical piles – a practical guide to design and installation. Hoboken, New Jersey: John Wiley, 2009, ISBN 978 0 470 40479 9
- BS EN 1993-5: Eurocode 3: Design of Steel Structures – Part 5: Piling

## Introduction

This section provides guidance on meeting the performance requirements for raft foundations. For the purposes of Warranty, a raft foundation may be defined as a reinforced concrete slab, whose thickness and stiffness are designed to spread the applied wall and column loads over a large area and reduce differential settlement gradients.

### 3.3.1 Compliance

Raft foundations shall meet the performance requirements of this section.

### 3.3.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section. This may include:

A full set of design drawings, calculations and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Phase 1 Desk Study Report and Phase 2 Geotechnical Site Investigation Reports including site-specific recommendations for raft foundations (and allowable bearing pressures) to ensure long term settlement does not exceed 25mm or 1/500 (differential).
2. Structural drawings:
  - a. GA and RC drawings, including a drawing register sheet.
  - b. Details of internal and external thickening to cater for loadings and the effects of frost.
  - c. Details of any insulation beneath the raft.
3. Structural calculations:
  - a. Demonstrating that the ground bearing pressure does not exceed the allowable value specified in the Site investigation report. Localised areas of higher bearing pressures (e.g. beneath load-bearing walls, thickening or point loads) should be considered.
  - b. Demonstrating that the raft (i.e. the thickening, slab and beams) can span a 3.0 metre 'soft spot' and cantilever 1.5 metres.
  - c. Demonstrating the adequacy of any insulation beneath the raft (in relation to loadings, creep and groundwater). The insulation must have an appropriate third party product conformity certificate and compressive creep must be limited to a maximum 2% reduction for a 50/60 year period.
4. Plans and details of the proposed raft showing reinforcing positions and a bar schedule, to be used by the reinforcing steel supplier and installer.
5. Confirmation that all made ground and organic matter beneath the foundation has been or shall be removed/replaced with appropriate material, or treated.
6. Details of engineered granular fill below the raft (including its depth and lateral extent, ensuring a 45° spread from the edge), along with its compaction specification, testing and Geotechnical Engineer's validation. Where Manual for Highway Works (MHW) specification for engineered granular fill is indicated, details shall conform with MHW Volume 1 Series 600 Earthworks Cl:610 'Fill to Structures'.
7. Calculations demonstrating how the depth of granular fill has been determined to cater for the effects of heave and shrinkage (if shrinkable soils are present).
8. Details of any ground treatment (e.g. vibro treatment, cement-lime stabilisation etc.).

Please note: if there are queries with regard to anything not covered or it is intended to deviate from the above guidance, then please contact the Warranty surveyor for agreement prior to commencement. Following acceptance of the proposals, please refer back to the Warranty surveyor if anything is subsequently discovered on site, which affects the design and/or construction of the raft.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 3.3.3 Materials

All materials shall be suitable for their intended purpose.

## Concrete

Concrete should be of a suitable mix design to achieve the required strength, and resistance to chemical and frost attack. For further guidance, please refer to 'Appendix C - Materials, Products, and Building Systems' section.

## Bricks and blocks below ground

The selected bricks should be appropriately durable against saturation. For further guidance, please refer to 'Appendix C - Materials, Products, and Building Systems' section.

If there are sulphates in the ground and/or there is ground water present, confirmation by the manufacturer that the brick or block is suitable for use below ground should be provided.

### 3.3.4 Ground conditions

The site specific ground conditions shall be taken into account for the raft foundation design.

Raft foundations are usually designed for sites with variable ground conditions with low ground bearing capacities. It is therefore important to complete a suitable Site Investigation to meet the requirements of the 'Ground Conditions' section and ascertain the bearing capacity and suitability of the ground.

### Heave and shrinkage

Rafts are not considered an accepted method of foundations where the ground conditions are susceptible to heave or shrinkage (e.g. where trees are present or have been removed) unless appropriate measures have been taken to mitigate the effects of heave or shrinkage. For further clarification, please refer to the 'Foundations - Trees and Clay' section.

### 3.3.5 Structural design

The raft foundation shall be appropriately designed to safely transfer loads from the superstructure to the ground without causing excessive long term total and differential settlement.

Structural calculations should be provided by an Engineer, confirming that the raft design is suitable for bearing onto the ground and that the ground bearing capacity safely supports the structure and it will limit long term total and differential settlements to acceptable levels.

The raft foundations shall be designed to clearly demonstrate that the rafts, insulation and any treated ground are capable of supporting and transferring the foundation design loads safely to known soil strata that are, in turn, capable of supporting the loads, using the appropriate soil properties obtained from geotechnical testing and contained in the appropriate Site Investigation report.

### Settlement

The rafts shall be designed in accordance with BS 8004:2015 and shall ensure that long term settlement does not exceed 25mm or 1:500 (differential), unless more stringent criteria are required by the Engineer.

### Allowance for movement joints

Where required by the Engineer, movement joints should be provided and constructed in accordance with the design using appropriate materials.

### 3.3.6 Damp prevention

Damp proof courses and damp proof membranes incorporated in the raft design shall be suitable for their intended purpose and be provided to prevent moisture rising or entering the home.

The raft foundation and the junction with the wall should be appropriately constructed to resist ground moisture penetration.

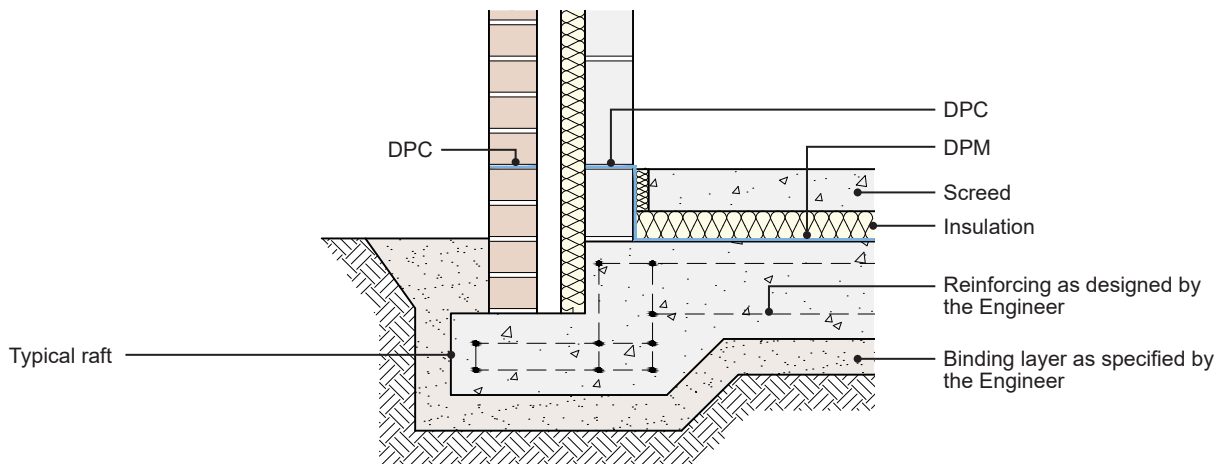
A DPM should be provided beneath all ground-supported slabs or cast in-situ reinforced slabs. DPM's should be linked to the DPC and be a minimum 1200g polythene. Other DPM's may be considered if they have an appropriate third party product conformity certificate and are installed in accordance with the manufacturer's instructions.

A DPM can be placed beneath the raft, wrapped around the external toe and lapped into the internal DPC. However, this detail can be difficult to implement on-site, and puncturing of the membrane can commonly occur when placing reinforcing. The preferred method is to place the DPM on top of the raft slab beneath the floor insulation or screed.

Prior to concreting, any water or debris that may have collected on top of the DPM should be removed.

DPM should be continuous where floors are stepped, a waterproof specialist must select an approved waterproof membrane to meet the requirements of BS 8120 to provide a continuous barrier that is compatible with the floor DPM/DPC.

## Typical damp proof membrane linked with damp proof course



## Cavity trays

For guidance on cavity trays, please refer to the 'External Walls' section.

### 3.3.7 Thermal insulation products below the structural raft

Thermal insulation shall be specified to be:

- Suitable for the intended purpose.
- Avoid damp and interstitial condensation.
- Demonstrate the insulation is structurally adequate to be used under the raft.

Where thermal insulation products are used below the structural raft they should:

- Meet the requirements of BS EN 1606 Thermal insulation products for building applications.
- Meet BS EN 13163 (for EPS insulation).
- Meet BS EN 13164 (for XPS insulation).
- The Engineer should ensure that the design limits 'compressive creep' to a maximum 2% reduction for a 50/60 year period.
- The insulation product must have a third party product conformity certificate for use below a structural raft foundation (including below external walls).

### 3.3.8 Ducts and sleeving

Any service penetrations that pass through the raft shall be appropriately designed in respect to:

- Structural integrity of the raft being maintained.
- Prevention of damp entering the building.
- Preventing thermal loss.
- Prevent the entry of any hazardous substances.

The specification of service penetrations through a raft slab should be appropriately designed by to maintain the integrity of the raft.

Any service penetrations that pass through the raft should be appropriately sleeved to protect the service duct. Service duct positions should be planned and indicated on drawings to prevent reinforcing bars from being cut, unless the structural design has catered for this.

## Reference documents

- BS EN 1997-1 - Eurocode 7: Geotechnical design (EC7)
- BS 8004 - Code of practice for foundations and Eurocode
- BS EN 1997-2 - Ground investigation and testing
- BS 5930 - Code of practice for ground investigations
- Manual for Highway Works Volume 1 Series 600 Earthworks

## Introduction

This section provides guidance on meeting the performance requirements for engineered fill.

Fill or made ground can be divided into 2 main types:

- **Engineered Fill:** When placed as part of the construction process and carried out to an engineered specification to high standards with good quality control and adequate engineering supervision, then risks can be assessed and may be quite small.
- **Non-Engineered Fill/Made Ground:** Risks associated with sites covered with existing fill are more difficult to assess and short of complete excavation, the risks cannot be fully quantified. Therefore, alternative foundation solutions where loads can be transferred to competent strata are required.

The following situations are beyond the scope of this guidance:

- Where the original ground or sub-strata is unstable or will continue to settle.
- Sites with soft clays with a low bearing capacity (undrained cohesion = 30kN/m<sup>2</sup> or less).
- Filled ground where high levels of voids are anticipated.
- Clay fill, where the water will influence the foundation or where collapse may occur.

Each development site has its own specific characteristics, and where conditions do not clearly fall within the guidance given, clarification should be sought from the Warranty surveyor or a suitably qualified and experienced expert.

### 3.4.1 Compliance

Engineer fill shall meet the performance requirements of this section.

### 3.4.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section. This may include:

A full set of design details, calculations, reports and other supporting information should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Site investigation reports including site-specific recommendations for foundations to ensure long term settlement does not exceed 25mm (10mm for piles) or 1/500 (differential).
2. Structural drawings:
  - a. Site layout plan including proposed finished floor levels for all plots.
  - b. Topographical survey confirming existing ground levels. Subsequent site level surveys indicating areas where earthworks are required to achieve final construction levels. If piling or ground improvement techniques are to be adopted, piling platform and/or vibro platform levels are required.
  - c. GA and RC drawings, including a drawing register sheet.
  - d. Piling & Vibro layout drawings (if applicable), including a drawing register sheet.
  - e. The design of the dwellings should allow a degree of articulation with movement joints sufficient to accommodate the maximum allowable differential settlement above, also at thresholds and service entries.
3. Structural calculations:
  - a. Demonstrating that the ground bearing pressure does not exceed the allowable value specified in the Site Investigation Report.
  - b. Piled foundation calculations (please refer to the 'Piling Good Practice Guide' available on our website).
  - c. Vibro foundation calculations (please refer to the 'Piling Good Practice Guide' available on our website).
4. Earthworks Specification including:
  - a. Confirmation that works are supervised by a suitably experienced independent Chartered Geotechnical Engineer.
  - b. Proposals for load testing to determine the expected long-term settlement and differential settlement of the fill. Please note: We consider that plate load tests do not confirm the expected long-term performance of the ground.
  - c. Allowable bearing pressures, expected settlement and differential settlement.
  - d. Consideration of the effects of slag, burnt shale and expansive soils.
  - e. Consideration of self-weight settlement of the fill.
  - f. Collapse compression analysis in accordance with BRE IP5/97.
  - g. Details of any ground treatment (e.g. vibro treatment, cement-lime stabilisation etc.).
5. Geotechnical validation report including:
  - a. Confirmation that all made ground and organic matter was removed.
  - b. Details of formation levels prior to filling works.
  - c. Depths of all cut and fill carried out across the site with levels linked to the original site investigation.
  - d. Details demonstrating compliance with Clause 610 of the Specification for Highway Works (for structural fills).
  - e. Details and locations of all tests and interpretation by the Geotechnical Engineer.
  - f. Confirmation of the bearing capacity achieved by the earthworks and confirmation that long-term settlement will not exceed 25 mm or 1:500 differential settlement.

If there are queries with regard to anything not covered within this document and/or it is intended to deviate from the above guidance, then please contact the Warranty Engineers for agreement prior to commencement. Following acceptance of the proposals, if anything is subsequently discovered on site, which affects the design and/or construction, please contact the Warranty surveyor immediately.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

## 3.4.3 Site preparation and disposition of fill

The site shall be suitably prepared to receive the Engineered fill.

The site should be cleared of all topsoil and other unsuitable material.

Soft spots and hard spots, such as derelict foundations, should be removed together with ponds and surface water from depressions. Removing water by pumping may be necessary when filling some excavations below the ground water level.

When a variety of material types are used as fill, they should be deposited in horizontal layers across the site. If there is only a limited amount of good granular material, it will be best to use it in layers interspersed between layers of poorer cohesive fill.

The fill thickness should be reasonably constant beneath a structure to minimise differential settlement.

Feather-edges, resulting in foundations set partly on fill and partly on natural ground, should be avoided, and the site worked in such a way that structures are located either directly on natural ground or directly over fill of a consistent thickness.

If fill is to be placed over sloping natural ground, some stepping of the ground formation level will be necessary. Construction over the face of a quarry or an opencast mining high wall should be avoided.

Special measures may have to be taken by providing flexible connections for services at the location of high walls and by thickening construction for service and estate roads.

If the natural ground on which the fill rests is soft and compressible (for example, layers of peat or soft clay), the surface of the fill may settle appreciably and unevenly as a result of the weight of the fill consolidating the soft layers below. This settlement will, of course, be additional to that resulting from the compression of the fill itself.

Sensitive structures may warrant a surface (or capping) layer formed from special fill compacted to more onerous standards than the underlying fill. This should help minimise the differential settlement suffered by the structure.

Where landscaped or other non-load bearing areas form part of a development, they need less compaction than the load-bearing areas. There should be a transition zone around the load-bearing area.

## 3.4.4 Design and specification of engineered fill

Engineered fill shall be designed and specified by a suitably qualified and experienced Engineer. All loads shall be safely transferred to the Engineered fill without causing excessive settlement. The following should be taken into account:

- Fill selection.
- End product criteria.
- Fill placement.
- Provision of quality control and testing of fill during placement.
- Provision for monitoring of fill performance - post compaction.
- Building on fill.
- Provision of testing.

Generally cohesive/granular homogeneous material specifically selected to replace either made ground or infill voids left by other processes is adopted. Fill has been divided into 2 further categories. These are:

- Shallow fill (i.e. less than 2.5m depth below ground level).
- Deep fill (i.e. greater than 2.5m).

For further guidance on foundation types suitable for building on shallow fill and deep fill, please refer to our Warranty good practice guide 'Building on Fill' which can be found on the website.

Careful selection of the material and controlled placement should ensure that the engineered fill forms an adequate foundation material; however, in some circumstances, significant ground movements can occur.

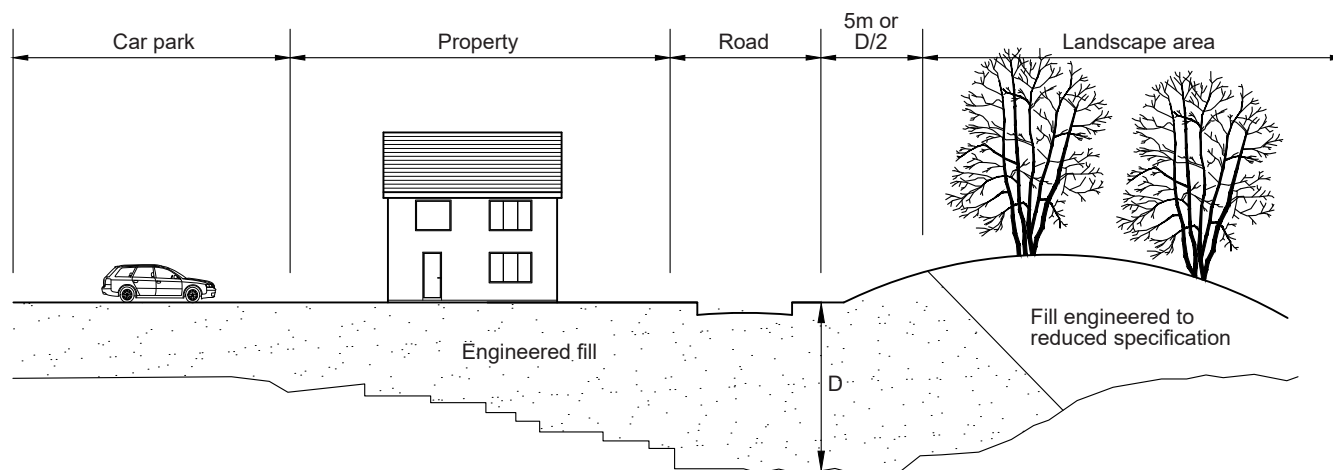
Engineered fill should be designed and placed in accordance with recognised good practice, as noted in the references at the end of this section.

Engineered fills used to produce suitably shaped landforms for structures should be constructed to high standards to minimise the risk of ground movements causing damage to property built on shallow foundations.

In designing and specifying a fill to form a foundation for buildings, the following technical requirements should be established:

- A well-constructed excavation, safely executed, with all soft and hard spots removed and made reasonably dry and well drained.
- Sound fill without undesirable material and capable of compaction as specified, provided with starter and capping layers as necessary.
- Placement and compaction to ensure that the performance of the fill will meet required criteria as a foundation fill.

Typical engineered fill construction – Figure 1



### Fill selection

Fill should be clearly categorised into material that may and may not be used: unsuitable fill, general fill, restricted fill and special fill. Fill materials must not present an environmental or health hazard.

Unsuitable fill should not be used at any location on the site.

General fill is all material except that which is unsuitable, restricted or special, and is normally the majority of the material used. It may include natural soils as well as some waste products.

Restricted fill is material that would be general fill except that it contains minerals hostile to the built environment. It can include natural materials such as pyritic shales, sulphate-bearing clays and waste materials, including burnt colliery discard and steel slag. Its use is precluded where ground water could rise to the underside of the deepest foundation, or where it is rejected for pollution reasons. For some developments, such as housing with gardens, restricted fills would include fills that are harmful to people.

Special fill is high-quality material, such as well-graded natural sands and gravels, crushed rock or clean demolition rubble. Its use will often have to be reserved for specifically defined purposes, such as a capping layer or backfill to retaining walls. Where possible though, granular soils should be used as general fill since these materials drain readily and consolidate quickly. The smaller the predominant particle size, the longer the potential time required for consolidation under the self-weight of the fill.

Materials considered to be unsuitable for use as fill are:

- Swamp or marsh land materials.
- All organic or part organic materials.
- Materials subject to spontaneous combustion.
- Colliery shales, ironstone shales and similar materials which have the potential for expansion due to oxidation of pyrites.
- Frozen materials or materials which are frost susceptible.
- Any materials which have a higher moisture content than the maximum permitted for such materials as defined in the specification.
- Clays with high plasticity index exceeding 55%.

The following materials require testing to ensure their suitability for use as fill to support structural foundations and slabs, or as backfill to associated trenches:

- Acid wastes.
- Reactive materials.
- Materials that include sulphates (e.g. gypsum).
- Organic materials.
- Toxic materials.
- Materials that cause noxious fumes, rot, undue settlement or damage to surrounding materials.

The sample tests should be carried out by a suitably qualified person and it may be necessary to take a number of samples to identify the material characteristics of the fill accurately.

### End product criteria

The greatest threats to successful in-service performance are:

- Collapse settlement due to inundation of dry or inadequately compacted fills.
- Excessive consolidation settlement of wet compressible fill.
- Heave or settlement of clay fill due to climatic changes or vegetation.

These ground movements depend on moisture movement, so by reducing the voids in a fill, the opportunities for excessive in-service movements should be restricted. A maximum allowable air-voids content of 5% is a suitable criterion for most clay fills. However, specifying a 5% air-voids content is insufficient, as this value may easily be achieved by adding water to the fill without increasing compactive effort.

A suitable alternative control method is to specify a minimum acceptable density as a proportion of the maximum dry density measured in a standard laboratory compaction test. Limits on moisture content are also required.

If the fill is too wet, there could be excessive consolidation settlement and if the fill is too dry, it might be vulnerable to collapse compression.



## Fill placement

Fill should be placed in horizontal layers, with each layer separately compacted.

For a given item of plant, compaction performance will be determined by fill layer thickness, fill moisture content and the number of passes of the compaction equipment. There are however, other factors such as the need to avoid excessive handling.

Whenever possible, site trials should be undertaken to determine the correct criteria. Some general information about placing fills is given in BS 6031.

Each layer should be of a thickness that allows the compactive energy to spread throughout the layer, producing the specified fill density and low air-voids content. Loose layers with a thickness greater than 250mm are unlikely to be satisfactory for earth fills compacted to support low rise structures. It may be necessary to use layers of 200mm or less.

Moisture content at the time of placing a fill is fundamental to subsequent performance, particularly where the fill contains a large proportion of fine grained cohesive material. If the fill is too dry, there is the possibility of heave or collapse settlement; if it is too wet, there is the possibility of insufficient strength and high compressibility. It will be difficult to achieve air-voids content of 5% or less when the moisture content is low. In the same way that the addition of too much water can detract from the performance of engineered fill, soil can be over compacted.

Granular soils and cohesive soils drier than optimum, when rolled excessively, become over-stressed and what should have been a firm compacted surface becomes a loose tilth. This should be avoided whenever possible. Where a fill containing a large proportion of fine grained cohesive material (for example, clay) is used, filling during wet weather should be avoided.

## Provision of quality control and testing of fill during placement

The nature of the control procedure will depend on the type of specification adopted.

The end product specification requires an appropriate type and quantity of testing of the fill during placement to ensure that the desired end product is being achieved. Depending upon the type of contract, quality control may be the responsibility of the Engineer or of the contractor working under the supervision of the Engineer.

Control parameters should be the same as those determined during the site investigation stage. Both design and control parameters must be reproducible, a term that denotes the range within which measurements made on the same fill by different operators using different equipment should agree.

The following are the most significant control parameters:

- Moisture content, in respect of an optimum moisture content established at the Site Investigation stage.
- Dry density, in respect of the already established maximum dry density.
- Air-voids content, which depends on moisture content and dry density.
- Un-drained shear strength, which is an alternative to monitoring moisture content and dry density for clay fills.

The laboratory compaction tests and the associated field control tests are suitable for a wide range of fill types and form the most generally applicable approach. For cohesive soils, un-drained shear strength forms an alternative basis for specification and control testing. However, different methods of measuring the un-drained shear strength, such as the unconfined compression test and the vane test, can give significantly different values. The measured value of cohesion can be sensitive to a detailed test procedure, such as the rate of shearing.

It is important for the method of testing to be strictly specified. Where a cohesive fill contains gravel, it may not be possible to obtain sufficiently undisturbed samples for strength tests. On larger sites, employing in-situ methods, such as the cone penetrometer (BS 1377: Part 9), could be considered.

Small sites are generally more difficult to work than large sites, as finished work may be damaged more easily in confined working areas and deficiencies in site preparation usually reflect more readily in poorer quality compaction than on larger sites. Consequently, it is necessary to test more frequently on a small site than on a large one.

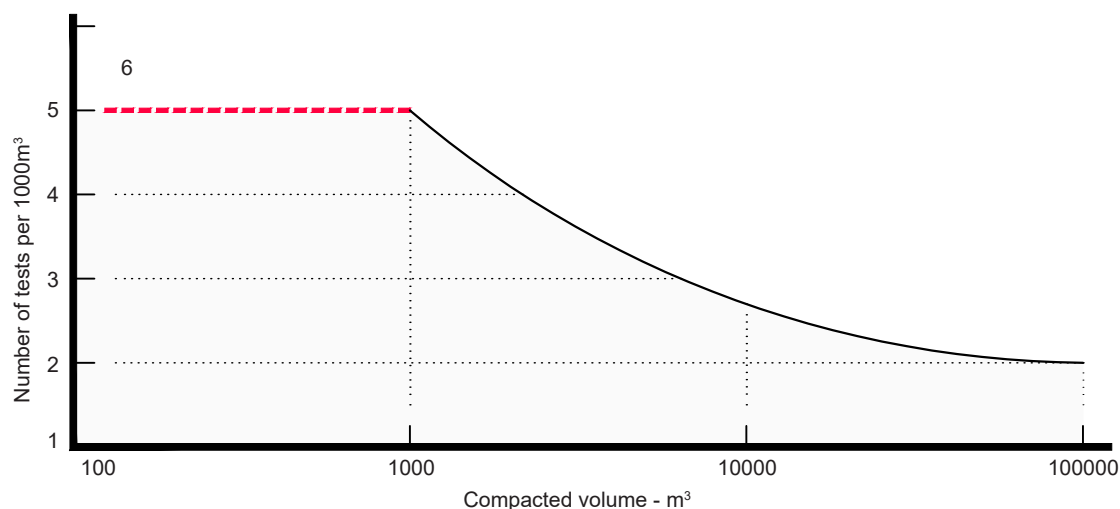
A suggested minimum test frequency is presented in Figure 2. However, each site should be judged on its own merits, with careful note taken of any problems revealed during site investigation. In very variable or difficult conditions, more frequent testing may be required. Tests in visually doubtful areas, and re-tests of failed areas, should be carried out in addition to those recommended in Figure 2.

Modern compaction control requires laboratory and field testing during the Site Investigation, and during, and possibly following, the earthworks. The results of this work must be recorded, collated and presented to demonstrate the quality of the operation. The required documentation includes:

- Summary of the specification requirements and the end product in terms of the selected geotechnical parameters for the various fills (based on-site investigation information).
- List of the required suitability tests; one form to be completed for each borrow pit under investigation.
- Suitability test results for each borrow pit.
- List of the required control tests.
- Results of the control tests on each fill type, layer or area, as appropriate.
- A list of post-compaction monitoring requirements.
- The results of post-compaction monitoring; all completed forms should be signed and dated by the person responsible and a list prepared of any required action or remedial work to be carried out.



Number of tests - Figure 2



### Provision for monitoring of fill performance - post compaction

Monitoring provides a check on the performance of the fill after compaction and is particularly important where vulnerable structures are to be built or foundation loading is unusually large. It is also required where the fill is relatively deep or substantial ground water rise within the fill is expected.

Monitoring techniques include:

- Surface levelling stations to measure the settlement of the fill surface.
- Magnet extensometers to measure the settlement of incremental depths of fill.
- Standpipe piezometers to measure the rise in the ground water table in the fill after placement.
- Load tests for direct estimation of settlement of surface layers produced by loadings.

Surface levelling stations are easy to install and very effective. By optical levelling of the stations, measurement can be made of the total vertical movement of the fill upon which they rest, together with any movement of the underlying natural ground. Although this is unlikely to be large if all soft material has been removed prior to compaction. Levelling stations should be sufficiently robust to resist damage due to construction traffic. A round headed bolt cast into a 1m concrete cube set 300mm into the fill has been found to be effective.

Magnet extensometers are unlikely to be necessary in shallow-depth fill. Standpipes or piezometers will be of advantage if there is reason to suspect that ground water will rise into the fill at any time in the future, with consequent settlement.

### Building on fill

The foundation scheme shall be designed to clearly demonstrate that the foundations are capable of supporting and transferring the design loads safely to known soil strata that can be demonstrated from the appropriate project site investigation reports to be capable of carrying the load, using the appropriate soil properties obtained from geotechnical and load testing.

The following guidance outlines recognised good practice in relation to building on fill. The structural design and construction should be in accordance with the Functional Requirements of this Technical Manual and recognised publications from British Standards, Eurocodes, CIRIA, BRE and ICE.

#### Key requirements

Groundwork shall be designed and validated by an Engineer to ensure that settlement will not exceed 25 mm (10mm for piles) or differential settlement tilt greater than 1:500 for low-rise buildings unless more stringent criteria are required by the Engineer.

Partial depth foundation solutions where either piles or ground improvement techniques (i.e. vibro stone columns, vibro concrete columns etc.) terminate in the fill material, and do not penetrate to naturally occurring competent strata below, are not acceptable.

Untreated made ground/fill material is inherently variable in nature and unpredictable when considering its settlement properties. Foundations proposing to bear upon untreated made ground /fill as a formation for strip, trench or raft type foundations are unacceptable.

### Provision of testing

Testing should be carried out to confirm that the ground improvement works meet the design criteria. The tests are usually completed to determine the ground bearing capacity.

The Engineer shall require the specialist contractor to verify that the ground treatment has been completed to a satisfactory standard. This will usually include carrying out suitable testing to establish the degree of ground improvement, its load-bearing characteristics and settlement potential.

These tests may include:

## Plate tests

This test will not determine the design but will allow for an assessment of the workmanship on the stone columns. Plate tests should be carried out on stone columns or treated ground at a frequency of at least one test per day per rig.

The plate tests should be carried out with a 600mm diameter plate and minimum test load of 11 tonnes.

## Mini zone tests

A mini zone test (dummy footing) can be used as a limited substitute for zone tests. The test should be applied to at least two stone columns and the area of foundation they support. To be useful, mini zone tests should be continued for long enough to establish the presence of creep behaviour.

Mini zone tests (dummy footing) should be carried out at a rate of one test per 1000m<sup>2</sup>-3000m<sup>2</sup> of treated ground, along with penetration tests at a rate of one test for 20-50 stone columns, or one test for not more than 500m<sup>2</sup> of treated ground, with a minimum of one test per structural unit. Alternatively, in the absence of penetration tests, one test per ten houses (with a minimum of two tests per site) would suffice.

## Zone tests

An isolated pad or strip footing is used to test up to eight stone columns and the intervening ground. Loadings, which should simulate the building loads, are held for 24 hours at predetermined stages to examine creep behaviour.

## In-situ tests

Where vibration will improve the ground itself, e.g. granular materials, then in-situ testing is appropriate. The improvement can be assessed when the test results are compared with the in-situ test results recorded during the pre-treatment investigation.

## Trial pits

Trial pits can be excavated around trial stone columns to prove that they are fully formed and to the required depth and diameter. This is a destructive test, and allowance should be made accordingly.

On completion of the treatment, the Engineer is to confirm that the treated ground has achieved the anticipated condition assumed in the design, and provide evidence in writing to the Warranty surveyor.

## Reference documents

Relevant British Standards Codes of Practice and authoritative documents include:

- Current regional Building Regulations
- BS 6031 Code of Practice for earthworks
- BS 8004 - Code of Practice for Foundations
- BS 5930 - Code of Practice for Ground Investigations
- BS 1377: Part 9 Methods of tests for soils for civil engineering purposes. In-situ tests
- BS 10175 Investigation of potentially contaminated sites - Code of practice
- BS EN 1991 Actions on structures
- BS EN 14731 Execution of special geotechnical works. Ground treatment by deep vibration
- BS EN 1997-1 General rules
- BS EN 1997-2 Ground investigation and testing
- BS EN ISO 14688 Geotechnical investigation and testing - Identification and classification of soil
- BS EN ISO 14689 Geotechnical investigation and testing - Identification and classification of rock
- BS EN ISO 22476 Geotechnical investigation and testing - Field testing
- BR 391 Specifying vibro stone columns
- Institute of Civil Engineers (ICE) specification for ground treatment: Notes for guidance, 1987
- CIRIA C572: Treated ground: Engineering properties and performance, 2002
- CIRIA C573: A guide to ground treatment, 2002
- BRE 424: Building on fill: Geotechnical aspects
- BRE Information Paper 5/97: Collapse compression on inundation
- Department of Transport Specification for Highway Works, Part 2, Series 600 Earthworks
- Warranty Good practice guides, to ensure long term and differential settlement criteria remain compliant:
  - Raft Foundations (Long term settlement 25mm and 1/500 differential)
  - Piling (Long term settlement 10mm and 1/500 differential)
  - Vibro ground improvement (Long term settlement 25mm and 1/500 differential)

## Introduction

This section provides guidance on meeting the performance requirements for vibratory ground improvement.

Vibratory ground improvement techniques are generally used to increase load-bearing capacity and reduce settlements to acceptable limits within undisturbed natural soils and filled ground.

Where vibratory ground improvement is proposed, early engagement with the Warranty provider is recommended for the key stages below:

- Once the specialist contractor has confirmed the viability of the scheme.
- Proposed start date for ground improvement.
- If the ground conditions are approaching or exceeding the recommended technical limits in this section.

## Limitations of guidance

The following situations are beyond the scope of this guidance:

- Where the original ground or sub-strata is unstable or will continue to settle.
- Sites with soft clays with a low bearing capacity (undrained cohesion = 30kPa or less).
- Sites with water saturated sands with high silt content.
- Filled ground where high levels of voids are anticipated.
- Clay fill, where the water will influence the foundation or where collapse may occur.

Each development site has its own specific characteristics, and where conditions do not clearly fall within the guidance given, clarification should be sought from the Warranty surveyor or a suitably qualified and experienced expert.

### 3.5.1 Compliance

Ground improvement techniques meet the performance requirements of this section.

### 3.5.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section. This may include:

A full set of design details, calculations, reports and other supporting information should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

Items 1-3d should be submitted prior to commencement of vibro treatment on site. In the absence of approval, works are proceeding at the Developer's own risk. Items 3e-3g shall be submitted as soon as they become available, prior to construction continuing over the vibro stone columns.

1. Phase 1 Desk Study Report (including Groundsure) and Phase 2 Geotechnical site investigation reports with appropriate geotechnical testing.
2. Structural Engineer's foundation drawings and design calculations. Strip footings should be designed for the specified bearing pressures and be designed to span between vibro stone columns.
3. Vibro stone columns:
  - a. Written confirmation from the vibro designer that the ground conditions are suitable for vibro treatment and that the Site investigation report is adequate for the purposes of the design and installation of stone columns. Deepening of foundations in respect of trees/clay soils to be taken into account.
  - b. Vibro stone column layout drawings.
  - c. Vibro design calculations confirming full-depth of made ground and soft/loose natural strata.
  - d. Confirmation of proposed testing regime (i.e. plate and dummy footing tests etc., see notes below). A minimum of 1% of stone columns should be subject to dummy footing test.
  - e. Vibro installation logs (with vibro column numbers referenced to the vibro layout drawing). Logs should include date, column number, depth, diameter, weight of stone, confirmation of the platform level in relation to the finished floor levels and site investigations and details demonstrating that all low-strength/loose natural strata (SPT<8) and all made ground/fill have been suitably treated.
  - f. Copies of all testing carried out (with the locations referenced to the drawings) and interpretation of test results.
  - g. Written confirmation from the vibro designer that the as-built installation has achieved the required bearing capacity and settlement characteristics.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

## 3.5.3 Desk study and site investigation

All projects shall have a site specific phase 1 desk study report (including Groundsure or similar) and a phase 2 geotechnical site investigation reports with appropriate geotechnical testing.

The ground must be suitable for vibratory ground improvement and designed in accordance with recognised methods (e.g. Priebe). The treatment must extend through the full extent of the filled or poor ground and reach natural competent ground.

A site specific geotechnical site investigation should take place and be in accordance with BS 5930/EC7 and extend into adequate strata beneath the filled or poor-strength strata above. The investigation should include enough geotechnical testing to enable accurate geotechnical design of the vibro stone columns in accordance with proven design methods.

The scheme shall be designed to clearly demonstrate that the foundations and treatment of the ground with vibro stone columns are capable of supporting and transferring the foundation design loads safely to known natural soil strata'.

The foundations and vibro stone columns shall be designed in accordance with BS 8004:2020 and shall ensure that long term settlement does not exceed 25mm or 1:500 (differential) at working load, unless more stringent criteria are required by the Engineer.

The developer shall obtain written confirmation from the Engineer and specialist contractor that the site is suitable for the proposed ground improvement system, and that all detrimental factors associated with the site and the proposed development have been taken into account.

The results of the investigation should be presented to the Warranty Engineer prior to the commencement of work on site.

### Desk study and site investigation results

#### Properties of the natural materials under the site

The site investigation should determine the depths and properties of the natural materials under the site, including the presence of geological hazards, cavities, mine-workings and associated features, rocks or soils that may dissolve or erode when water passes over them.

Through the process of a site investigation, it should first be established by the Engineer or suitably qualified specialist that the ground is capable of being improved by a vibratory ground improvement technique.

#### Extent of any areas of made ground on the site

The extent of any areas of made ground on the site should be established, including its history, composition and behaviour.

A site specific geotechnical site investigation should take place and be in accordance with BS 5930/EC7 and extend into adequate strata beneath the filled or poor-strength strata above.

#### Materials susceptible to heave or shrinkage

The extent of any shrinkable materials or materials susceptible to heave (clays, slag, burnt shale etc.) should be established. The necessary Atterberg tests and swelling tests should be conducted as appropriate.

#### Constituent materials

The proportions, compaction and distribution of the constituent materials throughout its depth should be established.

The investigation should include enough geotechnical testing to enable accurate geotechnical design of the vibro stone columns in accordance with proven design methods.

#### Fill materials

The grading and particle size distribution of fill materials should be established. See Conditions acceptable for treatment.

#### Existing or redundant services

The presence and extent of any existing or redundant services and drains should be investigated, and the associated backfill to the excavations. In addition, the effect that any proposed sustainable drainage system (SUDS) or soakaways might have on the ground conditions should be identified.

#### Ground water

The investigations should identify the presence, level and nature of any ground water, and if it is likely to rise and cause heave or collapse by saturation.

#### Contaminated substances

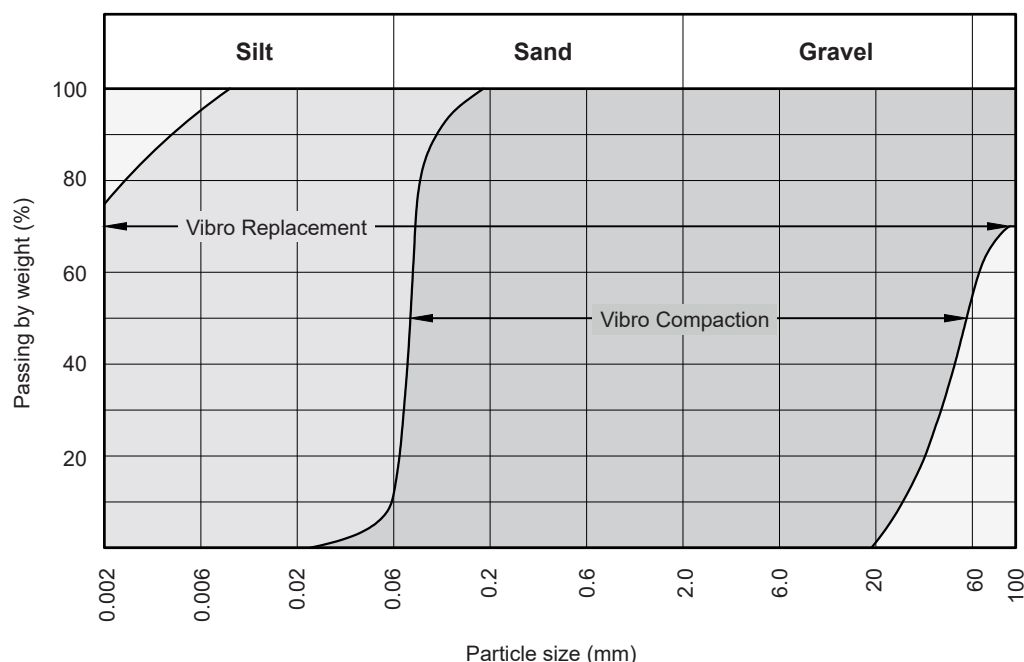
Contaminated substances including any potential for gas generation from fill materials such be identified. Any potential for combustion from contaminated substances should also be risk assessed.

The Engineer should supervise the site investigation, taking account of the findings of the desk study, and first establish whether there are any contaminated substances or gases present.

#### Existing obstructions

It should also be established at an early stage whether the site has previously contained any buildings or structures, and whether they have been completely removed, including basement walls, floor slabs, etc.

### Conditions acceptable for treatment



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### Ground conditions not generally acceptable for vibratory ground improvement

For Warranty purposes, the following ground conditions are not considered suitable for vibratory ground improvement.

- Highly shrinkable clays with a plasticity index greater than 40%.
- Soft clays with undrained shear strength less than  $C_u = 30\text{kPa}$ .
- Ground with a peat layer greater than 200mm should be viewed as unsuitable. Multiple peat layers with a combined depth greater than stone column diameter are unsuitable. In addition, variations in peat thickness may cause differential settlements.
- Voided fill ground created by landfill or with concrete rubble or brick fill of unsuitable grading.
- Non-engineered fill material may result in the following:
  - Original ground or sub-strata is unstable or will continue to settle.
  - The location and mobility of ground water within or entering the fill – as this has the potential to trigger inundation settlement (if the fill has not been previously saturated).
  - Inundation settlement (also known as collapse compression) – associated with the permeation of water into poorly compacted fills and partially saturated fills with a high air voids ratio. Refer to BRE IP 5/97.
- Ground containing degradable material may cause unexpected settlement to foundations.- Consequently, the percentage of organic material per volume should not exceed 15%.
- Ground gases including carbon dioxide and methane - Stone column installation will involve stone compaction, however, remaining voids can act as vertical vents to dangerous gases.

### Ground conditions and other factors that may increase the complexity of vibratory ground improvement

- Shrinkable material with volume change potential (VCP). If the presence of shrinkable soils is suspected, and no testing data is available to verify the VCP then high volume change potential should be assumed.
- Foundations should be designed to accommodate volume changes, where volume change potential soils have a modified plasticity index of 10% or greater.
- The installation of Stone Columns in cohesive material should consider any adverse effects on existing structures and site drainage.
- For all soil types, stone columns can transmit water down to lower fills causing softening and inundation of the fill materials.
- Deepening of foundations and heave precautions need to be assessed in accordance with the guidance within our 'Foundations' section of this Technical Manual regardless of the vibro treatment.
- Obstructions - buried structures including drainage.
- Variations in the density of material to be treated.
- Variations in ground water - long or short term alterations to ground water levels that may cause settlement or heave of existing buildings.
- Partial depth treatment of filled ground:
  - Sites designated for partial treatment will be considered on a case-by-case basis.
  - Engineer should consider the combined performance of both treated and untreated zones considering overall settlements.
  - Partial-depth treatment of loose/low-strength natural soils ( $SPT < 8$ ,  $C_u < 40\text{kPa}$ ) and partial-depth treatment of made ground/fill should be avoided.
- RC Raft Foundations are more suitable than RC strips for partial depth treatment schemes.
- RC Monolithic Ring Beams maybe viable provided suitable calculations can justify the design.

## Limitations of treated ground

Buildings and long blocks with sensitive finishes should be avoided in areas with considerable variations in ground conditions.

In the case of stone columns, the un-cemented stone particles develop end bearing and skin frictional stresses. This process requires the soil surrounding the stone column to provide adequate lateral stresses to counter excessive bulging.

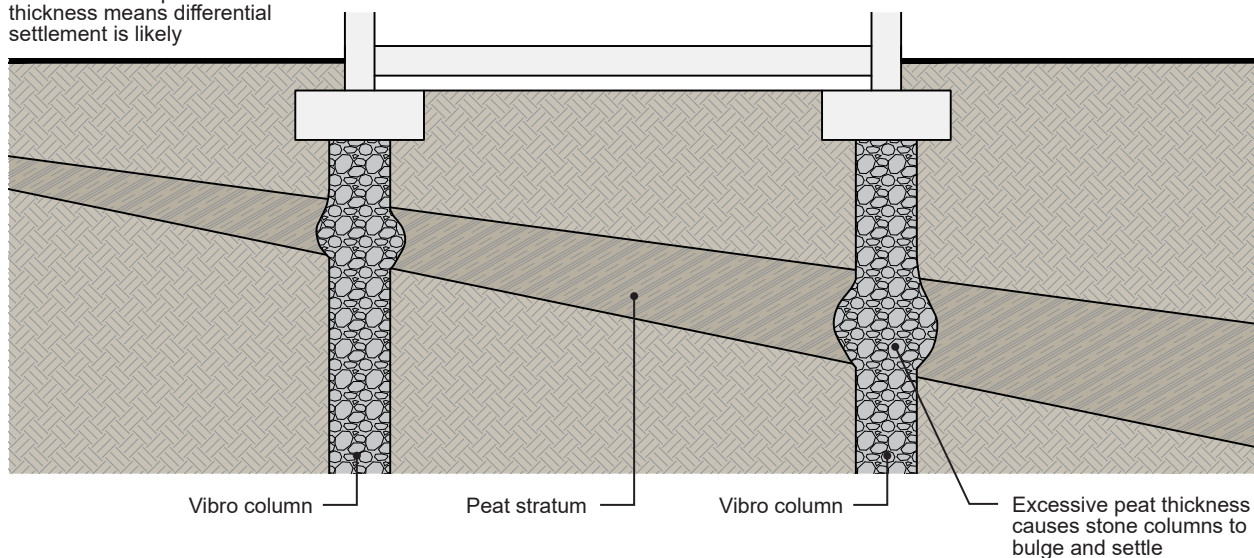
Soil types, such as peat and other weak materials, which include variations in thickness, may cause differential settlements.

Where the above limitations are found on site, the Engineer should:

- Determine foundation loads.
- Confirm the safe bearing pressure and settlement characteristics required.
- Compare design requirements with Interpretative Soil Investigation.
- Discuss viability of proposals and assess viable alternatives with specialist contractor.
- Submit proposals to the Warranty provider at the earliest possible opportunity.

## Vibro compaction not suitable on sites containing thick bands of peat

The variation in peat thickness means differential settlement is likely



### 3.5.4 Fill materials

Fill materials shall be suitable for their intended purpose.

## Testing

The following materials require testing to ensure their suitability for use as fill to support structural foundations and slabs, or as backfill to associated trenches:

- Acid wastes.
- Reactive materials.
- Materials that include sulphates (e.g. gypsum).
- Organic materials.
- Toxic materials.
- Materials that cause noxious fumes, rot, undue settlement or damage to surrounding materials.

The sample tests should be carried out by a suitably qualified person, and it may be necessary to take a number of samples to identify the material characteristics of the fill accurately.

## Sources of fill material

Where the material is of a stable and uniform type from one source, the testing regime may be reduced. However if the material is variable, or from a number of sources, then regular inspections and/or testing may be required.

Recycled aggregate or other building materials, such as crushed brick, should only be used following an inspection by the Warranty surveyor.

Colliery shale and any other residue from mineral extraction or industrial process bi-products should only be used with specialist approval.

### 3.5.5 Hydraulically treated soils

Where hydraulically treated soils are proposed, the proposal shall be supported with adequate design information prepared by an Engineer.

Hydraulically treated soils are soils which have been treated with a hydraulic binder. The binder (which is a powder) is mixed into the soil in-situ or ex-situ by specialist contractors using specialist equipment.

The binder reacts with water to create a chemical reaction which strengthens and / or stabilises the soil. The stabilisation process creates a more workable mixture which can be compacted.

The following binders are used in the UK and generally acceptable for Warranty purposes:

- Lime
- CEM I
- Ground granulated blast furnace slag
- Coal fly ash
- CEM II, CEM III, CEM IV and CEM V cements
- Hydraulic road binders – factory produced blends of lime, cement, ggbs, coal fly ash and gypsum

### Our information requirements

The following information must be provided in a timely manner to allow our assessment of risk :

- Ground investigation desk study identifying all potential risks in the ground and in the ground water.
- Phase 2 ground investigation reports covering stratigraphy, soil strength profiles, ground water regime, ground gas, atterberg limits, sieve analysis grading curves, contamination results for the ground and ground water, total potential sulfate and foundation type recommendations.
- Treated soil mix designs and laboratory testing identifying optimum moisture content, maximum dry density to achieve 95% compaction (5% air voids), immersion / swellage test results for the mix and the moisture condition values (MCV).
- A fully detailed earthworks specification prepared by a suitably qualified specialist.
- A fully detailed construction method statement covering construction sequence, materials, plant machinery, site moisture content and total sulfate testing of the soil and the treated soil.
- The test methods to be used to prove the compaction of each layer of fill has met the requirements of the earthworks specification.
- The issue of site progress photographs and test results to the Warranty provider.
- Full details of the quality control measures to be adopted and full details of the independent consultant supervising the testing of the earthworks.
- A report validating that the earthworks comply with the Earthworks Specification. This report must be prepared by a suitably qualified independent company.

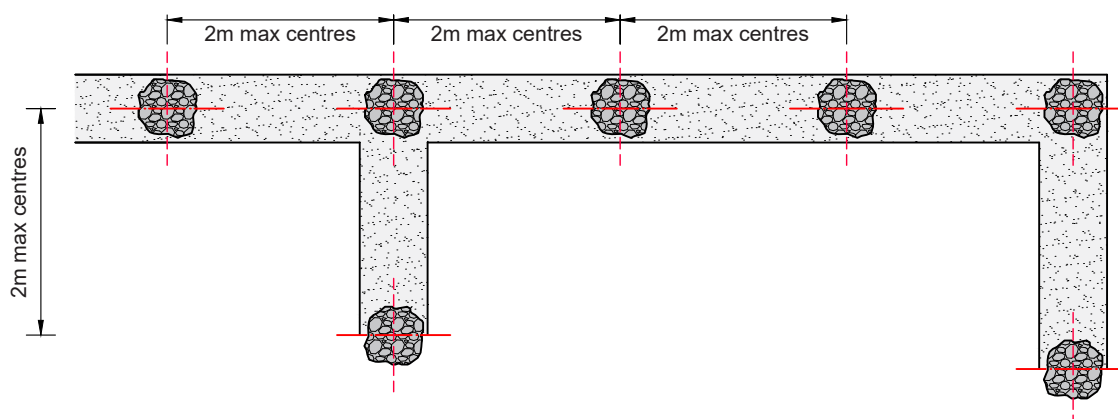
### 3.5.6 Installation

Installation shall be carried out by a suitably qualified and competent person in accordance with the Engineers specification.

A suitably qualified competent person should ensure:

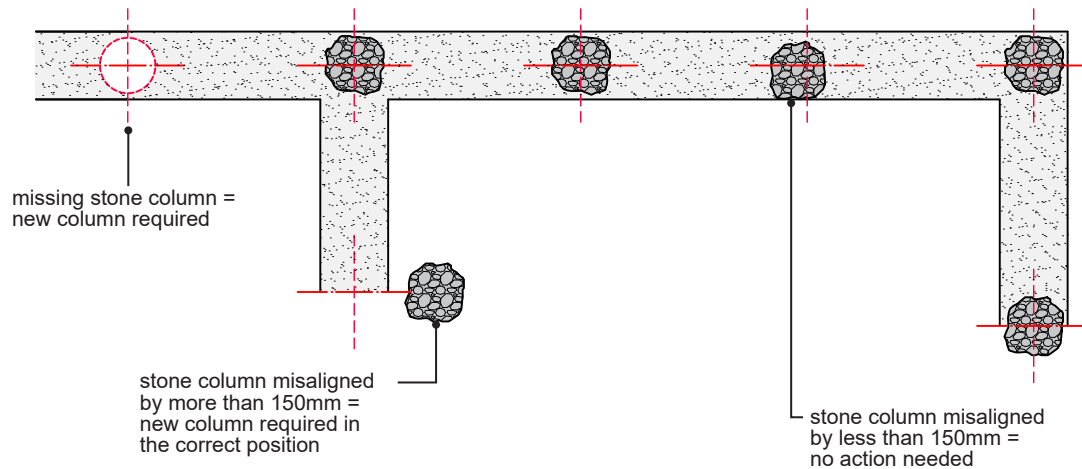
- There is appropriate site supervision and testing to achieve the required foundation design using vibro stone columns.
- Stone columns are located at the intersection of adjacent reinforced spread foundations.
- The minimum depth of stone columns is achieved.
- Any missing stone columns are replaced.
- All installation criteria, including location and depth, are checked by suitably qualified competent person prior to the specialist plant leaving the site.

Stone columns can be centrally positioned under the foundation. For wider foundations, stone columns can be installed in a predetermined staggered arrangement under the spread foundation.





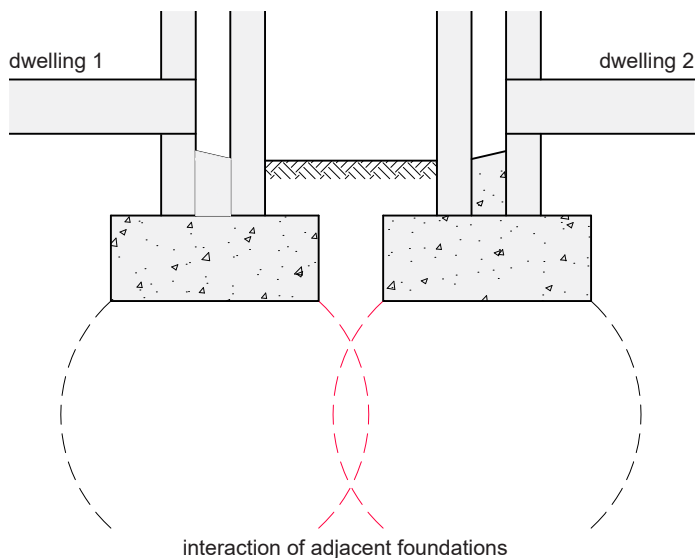
Stone columns which are misaligned by more than 150mm (centre to centre) in any direction should be replaced.



## Adjacent foundations and services

Design of Vibratory Ground Improvement should consider adjacent foundations. Volume of soil treated should allow for the interaction of pressure bulbs and the resulting combined stresses.

Service or drainage trenches - minimum clearance between foundations and excavations should be greater than depth of trench excavation minus the depth to the bottom of the concrete spread footing.



## Actions on unforeseen events

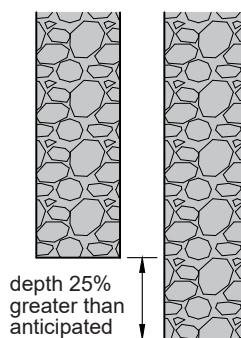
The following events should be reported to the design team/specialist contractor and Warranty provider as soon as possible.

- Where there is a reduction in treated depth in excess of 25%.
- Where there is a significant increase in the quantity of backfill in comparison with similar treated depths.

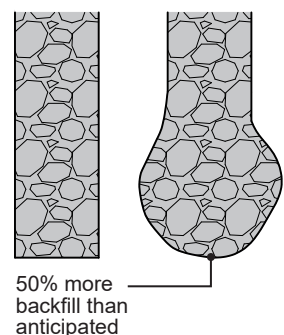
Design team/specialist contractor should submit recommendations to the builder and Warranty provider.

On completion of the treatment, the Engineer is to confirm that the treated ground has achieved the anticipated condition assumed in the design, and provide evidence in writing to the Warranty Engineer.

Where there is a reduction in treated depth in excess of 25%



Where there is a significant increase in the quantity of backfill in comparison with similar treated depths





### 3.5.7 Testing and validation of vibratory ground improvement techniques

Testing should be carried out across the full site and cover all of the various ground conditions to confirm that the ground improvement works meet the design criteria. The tests are usually completed to determine the ground bearing capacity.

The Engineer shall require the specialist contractor to verify that the ground treatment has been completed to a satisfactory standard. This will usually include carrying out suitable testing to establish the degree of ground improvement, its load-bearing characteristics and settlement potential. The testing also needs to be compatible with the following:

- Ground composition.
- Foundation design and depth of treatment.
- Quality of the site investigation.

### 3.5.8 Foundations

Foundations on sites with vibratory ground improvements shall either be of a reinforced strip or raft type. Both foundations will require a full design by an Engineer.

Foundation drawings and calculations should be prepared by the Engineer indicating the required bearing capacity and settlement characteristics for the purposes of design of vibro stone columns.

Foundations should be sized for the specified safe bearing pressures and be designed to span between the centres of the vibro stone columns.

The designer/engineer should ensure the following:

- RC foundations must be a minimum RC25/30 or FND concrete.
- Foundations shall be designed to span between vibro stone columns and must incorporate top and bottom reinforcement.
- Bottom profile of concrete foundations is located a minimum 600mm bgl and founded on firm material of adequate bearing capacity.
- For 'low rise structures' foundations should be designed for maximum settlements of 25mm.
- In relation to differential settlement, a design limit for maximum tilt of 1/500 is appropriate. More stringent values may be required due to the particular circumstances (e.g. medium and high rise structures).

Irrespective of the provision of vibro stone columns, foundation depths and heave precautions must be in accordance with the guidance provided in this Technical Manual, in respect of trees/clays, whilst ensuring that the vibro treatment is not detrimentally affected by deepening of the foundations. Further guidance can be found in the 'Foundations - Trees and Clay' section.

### Testing foundation performance

Plates tests and any combination of the following - zone tests, dummy footing tests and/or pre- and post-treatment investigation - should be used on sites where any of the following apply:

- The treated ground consists of variable types of fill.
- The treated ground includes either peat, silt or clay.
- The ground water level is less than 1.5 x the foundation width below the bearing level.
- Partial depth treatment of fill.
- Variable depth of ground beneath each building.
- The ground to be treated exceeds 6m in depth.

The combination of testing requirements maybe reduced (with prior agreement with the Warranty provider) where the following criteria apply:

- The ground to be improved is well graded and granular.
- There is a low static ground water level that is greater than 1.5 x the foundation width below bearing level.
- The treatment has been taken to a depth below the foundation that is greater than 1.5 x the foundation width and this depth is confirmed with site logs.
- The ground is fill, and is treated to its full depth.
- Uniform ground beneath each building.
- Installation Site logging including print outs from in-cab monitoring is available.
- The site investigation is undertaken to a depth of at least 1.5 x the depth of the treatment.

| Test                     | Description                                                                                                                         | Notes                                                                                                                                                                                |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Plate Tests              | 600mm diameter plates loaded to 3 x WL or 11 tonnes, whichever is greater. Minimum rate of 1 test per rig per day.                  | Plate tests alone may not provide a direct indication of the anticipated settlement of the completed structure. Usually they cannot be considered as the sole means of load testing. |
| Dummy Footing Test       | 1500 x 600mm plates loaded to at least 1.5 times Working Load (kPa) for a minimum period of 13 hours. Minimum rate of one per week. | The test should be applied to at least two stone columns and the area of foundation they support.                                                                                    |
| Penetration Test         | Rate of one per (20 to 50) stone columns or one test for not more than 500sqm with a minimum of 1 test for each structural unit.    | Penetration tests will not be required if dummy footing tests are carried-out at the recommended rate.                                                                               |
| Trial Pits               | Trial pits can be excavated around stone columns to prove they are fully formed to the required depth and diameter.                 | This is a destructive test and therefore allowance should be made accordingly.                                                                                                       |
| Cone penetration testing | As an alternative to the dummy footing test in granular soils - 6No. tests to 6m depth would be acceptable.                         | Densification can be checked using Cone Penetration Tests.                                                                                                                           |

## References

British Standards, codes of practice and good guidance relevant to vibratory ground improvement include the following:

- BS EN 1997-1:2004 + A1:2013 - Eurocode 7 Geotechnical Design (EC7)
- BS 8004:2015 + A1:2020 Code of Practice for Foundations
- BS EN 1997-2:2007 Ground Investigation and testing
- BS 5930: 2015 + A1:2020 Code of Practice for Ground Investigations
- BS 6031 Code of Practice for earthworks
- BS 1377 Part 9 Methods of tests for soils for civil engineering purposes. In-situ tests
- BS 10175 Investigation of potentially contaminated sites - Code of Practice
- BS EN 1991 Actions on structures
- BS EN 14731 Execution of special geotechnical works. Ground treatment by deep vibration
- BS EN 1997-1 General rules
- BS EN 1997-2 Ground investigation and testing
- BS EN ISO 14688 Geotechnical investigation and testing - Identification and classification of soil
- BS EN ISO 14689 Geotechnical investigation and testing - Identification and classification of rock
- BS EN ISO 22476 Geotechnical investigation and testing - Field testing
- BR 391 Specifying vibro stone columns (BRE)
- BRE Information Paper 5/97 Collapse compression on inundation
- BRE 424 Building on fill: Geotechnical aspects
- CIRIA C572 Treated ground: Engineering properties and performance, 2002
- CIRIA C573 A guide to ground treatment, 2002
- ICE Specification for ground treatment: Notes for guidance, 1987
- ICE Manual of geotechnical engineering: Volume II

## Introduction

This section provides guidance on meeting the performance requirements for foundation design when building near trees, hedgerows or shrubs.

The roots of all vegetation take water from the soil to make good the water lost from the leaves. If the soil contains clay, it will shrink as it dries (desiccates), or swell if it rehydrates. If the shrinking or swelling extends below the foundations, they will subside or heave in response. If the movements are in excess of those that can be tolerated by the building, then damage is likely to occur. In order to mitigate against this risk, foundations should be designed to accommodate the movement or taken to a depth below the level where significant changes in moisture content are likely to occur.

## Limitations of guidance

The following situations are beyond the scope of this guidance, and will require a site-specific assessment by a suitably qualified and experienced expert:

- Foundations with depths greater than 2.5m within the influence of trees in cohesive soils (note: Mass Fill or Piled Foundations should be adopted).
- Ground with a slope greater than 1:7.
- Man-made slopes, such as embankments and cuttings.
- Underpinning.
- Engineered foundation designs.

Each development site has its own specific characteristics, and where conditions do not clearly fall within the guidance given, clarification should be sought from the Warranty surveyor or a suitably qualified expert.

### 3.6.1 Compliance

Foundations shall meet the performance requirements of this section.

### 3.6.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings, specifications, site investigation reports and other supporting information should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Site investigation report appropriate for the site specific conditions. The volume change potential of the soil must be noted in the site investigation report.
2. A site plan showing retained, recently removed and/or newly planted trees. This should also detail tree species and their height
3. Detailed foundation design with reference to trees which are present, recently removed and newly planted and the site specific site investigation report.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 3.6.3 Ground conditions

A Phase 1 and 2: Geo-environmental Assessment shall be carried out in accordance with the 'Ground Conditions' section.

Cohesive soils can change volume as the moisture content of the soil changes throughout the year and due to the presence of tree roots. Potentially, these soils can damage foundations, if not engineered to take account of clay heave and shrinkage.

Unless there is clear evidence that a cohesive soil is not present, Site Investigations will be required to determine the soil type to at least the depth of potential influence of adjacent trees. Usually, trial holes are an acceptable method for determining the soil strata, but specialist Site Investigation reports are preferred if available.

The plasticity index should be calculated in accordance with BS 1377.

Soil samples should be taken from at least two depths, at 1.5m and 2.5m (or the base of the trial hole, whichever is the shallower), and sent to a soil laboratory for determination of plastic and liquid limit (and thus plasticity index). In addition, the moisture content of the samples is usually determined. The highest value of plasticity index should be used for determining foundation depth.

## Made-up ground

This refers to land or ground created by filling in a low area with non-original soils or other fill material. Often, such created land is not suitable for building without the use of specialist foundations. If there is high clay content within the made-up ground, then specialist foundations may require additional heave protection. It is also important to establish the depth of the made-up ground, because if it is a relatively shallow depth, the original soil below may be cohesive and within the zone of influence of the tree.

## 3.6.4 Tree influence

Foundation designs shall take account of tree influence in cohesive soils.

Prior to the site being cleared, a tree survey should be carried out. This should include a site plan showing retained, recently removed and/or newly planted trees along with details of tree species and their height.

Tree species differ in the ability of their roots to grow and exploit the available water in a cohesive soil, particularly if it has high clay content. This is commonly referred to as their 'water demand'. If a tree cannot be identified, it must be assumed to have high water demand (deep rooting).

Although some trees are managed as pollards or are subject to periodic reduction to control their size, unless such treatment can be assured in the future, mature height should be used.

The mature heights of common tree species are provided in our online foundation depth calculator. Mature height should be used unless an Arboricultural report is obtained, indicating that a lesser height is appropriate for the conditions of the site.

## Proximity

The closer the tree, the deeper the potential influence, and the guidance indicates the required foundation depth at any distance. The parts of the foundations closest to the tree require the greatest depth, but if preferred can be stepped down for more distant parts.

Measurement should be taken from the centre of the trunk to the nearest part of the foundations. If preferred, foundations depths can be stepped down at greater distances, by measurement to other locations around the building.

## 3.6.5 Foundation design

Foundations shall be appropriately designed and constructed to safely transmit loads without excessive movement. The following should be taken into account:

- Foundation depth calculator.
- Foundation depths.
- Trees removed prior and during construction.
- Heave precautions.
- Raft foundations in clay soils susceptible to heave/shrinkage.
- Sloping sites.
- Protection of drains.
- Strip and mass fill foundations in non-shrinkable soils overlying shrinkable soils.
- Changes in level.

The for the purposes of our Warranty, the extent of risk depends on:

- The plasticity index of the soils.
- The potential for the tree species to cause clay soil desiccation.
- The height of the tree.
- The proximity of the tree to the foundations.
- The likely climatic conditions in the locality.
- The removal of trees growing in clay soils.

These risks should be fully considered by the designer within the design.

## Foundation Depth Calculator

Foundation depth (see also 'Limitations of guidance' at the start of this section) can be determined using the foundation depth calculator found on our website. The depth of foundation is determined by inputting the:

- Plasticity index of soil.
- Tree type (this will determine the water demand of the tree).
- Mature height of the tree will automatically be determined.
- Distance of the relevant tree to the nearest part of foundations and distances elsewhere if stepping foundations.
- Allowance for climatic conditions.

Internal walls should also be taken to a suitable depth to avoid the effects of heave.

Where the foundation depth calculator identifies a minimum depth exceeding 1.5m, strip foundations must not be used. Mass fill or piled foundations must be adopted.

Foundation depth should be determined on the basis of the individual tree that requires the greatest depth.

## Foundations depths

### Depths in excess of 2.5m

Where the required foundation depths, are in excess of 2.5m, foundations must be designed by a suitable expert, i.e. an Engineer, taking account of the likely effect of soil movement on the foundations and substructure. Bored piles with ground beams or piled raft slabs are recommended, and may prove to be the most economical form of construction. Bored piles are an essential requirement for depths in excess of 3m. See the 'Foundations - Piles' section for further information.

### Foundation depths less than 2.5m

Mass fill foundations are likely to be most economic at depths below 1.5m, but can be economic to depths up to 2.5m. However, bored piles are recommended.

For foundation depths in excess of 2m, bored piles with ground beams or piled raft slabs are recommended. All pile designs should be undertaken by a suitable expert, i.e. an Engineer. See the 'Foundations - Piles' section for further information.

### Foundation depths to allow for proposed tree planting

Where there is a landscape plan specifying future tree planting, foundation depths should be calculated on the basis of the proposed species of tree and its proximity. If no species has been specified, they should be assumed to be high water demand.

Even if no tree planting has been specified, it is advisable to allow for reasonable future tree or shrub planting, or for the growth of self-seeded trees or shrubs, as shown in column 2 of Table 1.

If the building design or location is such that no tree planting is likely at any time in the future, minimum foundation depths, as shown in column 3 of the table below, should be used.

**Table 1: Minimum foundation depths**

| Plasticity index     | Minimum depth to allow for reasonable future tree/shrub planting | Minimum depth if no future tree/shrub planting likely |
|----------------------|------------------------------------------------------------------|-------------------------------------------------------|
| 40% and greater      | 1.50m                                                            | 1.00m                                                 |
| 20% to less than 40% | 1.25m                                                            | 0.9m                                                  |
| 10% to less than 20% | 1.00m                                                            | 0.75m                                                 |

Where the foundation depth calculator identifies a minimum depth exceeding 1.5m, raft foundations and strip foundations must not be used. Mass fill or piled foundations must be adopted.

As foundation depth depends on the proximity of the tree, the depth (see also 'Limitations of guidance' at the start of this section) can be reduced in steps with increasing distance. Steps should be in accordance with the 'Foundations - Mass Fill and Strip' section.

### Varying foundation depths

As foundation depth depends on the proximity of the tree, the depth can be reduced in steps with increasing distance. Steps should be in accordance with the 'Foundations - Mass Fill and Strip' section.

### Trees removed prior and during construction

If trees have been removed prior or during construction, then precautions must be taken to allow for the effects of rehydration and subsequent swelling of the soil. The design should be prepared on the assumption the tree is still present.

- Where the height of the removed trees is known, the foundation depth should be determined using the foundation depth calculator. Alternatively, if the height of a removed tree is more than 50% of the target mature height then the mature height should be used. Whereas if the height of the removed tree is less than 50% of the target mature height then use the actual height.
- If the identity is not known, it should be assumed the trees were deciduous with a high water demand, and if actual height is not known, it should be assumed to be 28m.
- Heave protection should be provided as per the guidance where trees remain.

Alternatively, the foundations and heave protection should be designed by an engineer taking into account the recommendations of this guidance, the site investigation report conclusions and recommendations incorporated from both a registered arboriculturalist and geo technical consultant reports. The design should be submitted before work commences on site.

### Heave precautions

Where heave precaution is required, compressible material should be used. The compressible material must have an appropriate third party product conformity certificate for its use and should be positioned in accordance with Table 2.

**Table 2: Position of heave precaution in various situations**

| Situation                                                                                                                              | Position of heave precaution                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| External mass fill and pier foundations <sup>1</sup>                                                                                   | Inside faces of external wall foundation that are greater than 1.5m in depth <sup>2</sup><br>All faces of pier foundations that are greater than 1.5m in depth <sup>2</sup> |
| Internal mass fill foundations <sup>1</sup>                                                                                            | None required                                                                                                                                                               |
| External wall ground beams for pier or piled foundations                                                                               | Inside face and underside to all external ground beams                                                                                                                      |
| Internal ground beams for pier or piled foundations                                                                                    | Underside of all internal ground beams                                                                                                                                      |
| Piled raft foundations                                                                                                                 | Underside of all piled raft foundations                                                                                                                                     |
| Notes:<br><sup>1</sup> Or trench fill.<br><sup>2</sup> Where required based on the Tree (see guidance on Foundation depth calculator). |                                                                                                                                                                             |

The material must be capable of being compressed to allow for vertical and lateral swelling, in accordance with column 3 of Table 3.

Ground bearing slabs should not be used in ground conditions where heave can occur or where the foundation depth is greater than 1.5m (unless a ground bearing raft is adopted designed using our guidance). For mass fill foundations, a suspended floor construction should be used (e.g. cast in-situ concrete, precast concrete or timber). This must incorporate either a clear minimum void of a specified depth under the suspended floor or a proprietary compressible material/void former below the underside of the floor construction.

Note: the compressible material/void former must have an appropriate third party product conformity certificate for use in this situation.

The depth of the void should be in accordance with Table 3, or if a compressible material is used, it should be capable of compressing to provide a void of this thickness. The manufacturer's specifications must be checked to establish the actual thickness of compressible material required to both accommodate movement and be able to compress to the dimensions in Table 3.

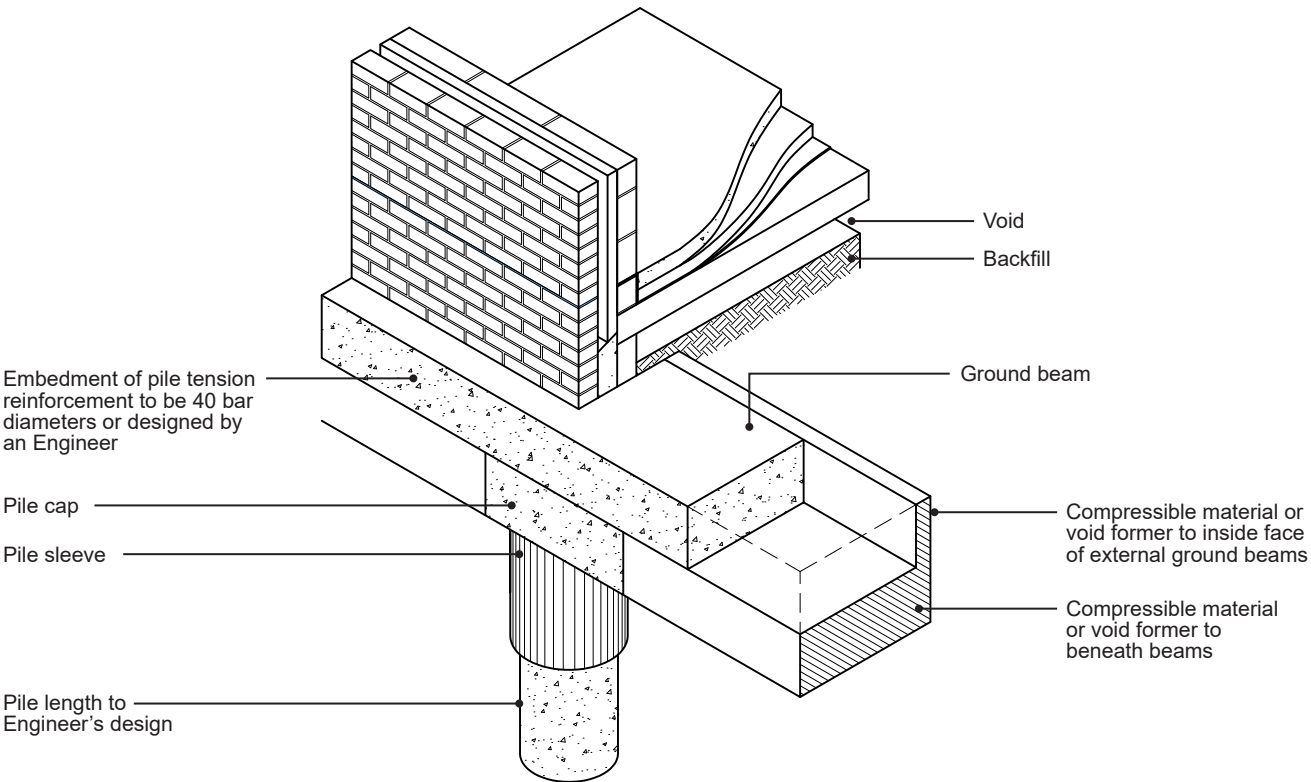
**Table 3: Minimum void dimensions for foundations, ground beams, and suspended floor slabs**

| Volume change potential                                                                                                                                           | Plasticity index     | Void dimension against side of ground beam and foundation | Void dimension underground beams, suspended in-situ concrete ground floor & piled raft slabs | Void dimension under suspended precast concrete and timber floors <sup>1</sup> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------------------------------------------------|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| High                                                                                                                                                              | 40% and greater      | 35mm                                                      | 150mm                                                                                        | 300mm                                                                          |
| Medium                                                                                                                                                            | 20% to less than 40% | 25mm                                                      | 100mm                                                                                        | 250mm                                                                          |
| Low                                                                                                                                                               | 10% to less than 20% | 0mm                                                       | 50mm                                                                                         | 200mm                                                                          |
| <sup>1</sup> Under suspended floors, the void dimension is measured from the underside of beam or joist to ground level and includes 150mm ventilation allowance. |                      |                                                           |                                                                                              |                                                                                |

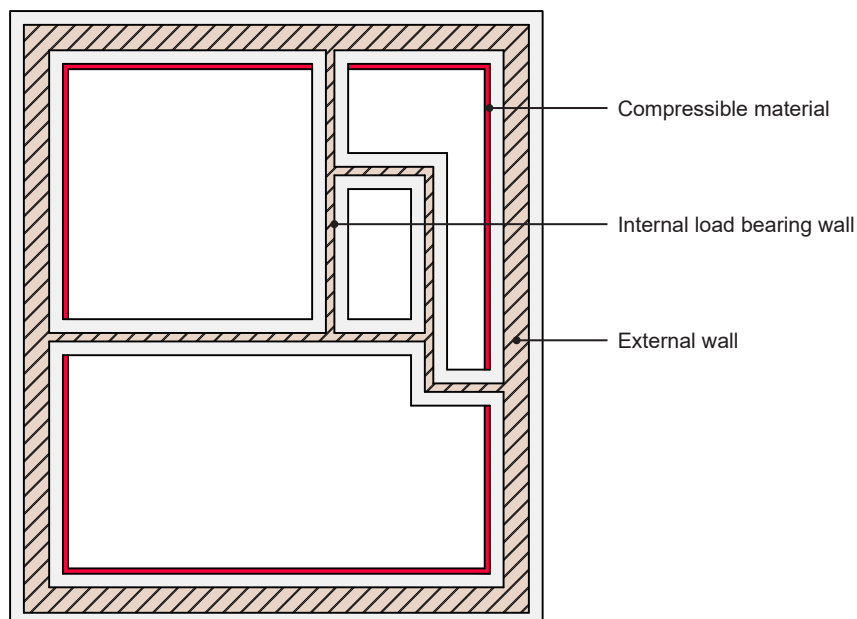
Please note: Void formers consist of materials that collapse to form a void into which the clay can swell. The compressible material/ Void former should have an appropriate third party product conformity certificate demonstrating their suitability as specified. The void dimension is the 'remaining void' after collapse. The thickness of the void former should be in accordance with the manufacturer's recommendations.

Typical foundation designs to allow for heave are shown in the following details.

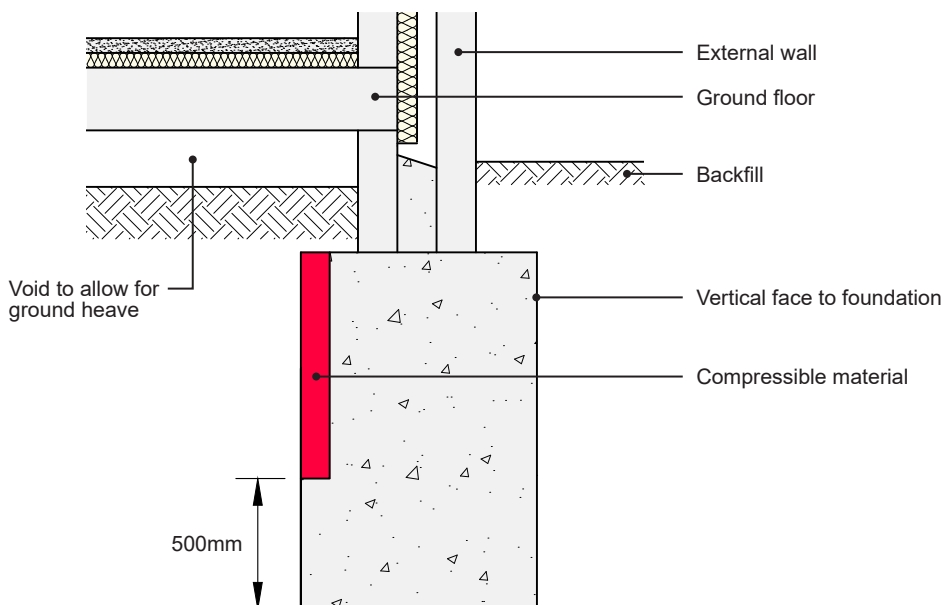
## Heave protection - Section through pile and beam foundation



### Plan of heave protection to a mass filled foundation



### Heave protection - Section through a typical mass filled foundation



### Raft foundations in clay soils susceptible to heave/shrinkage

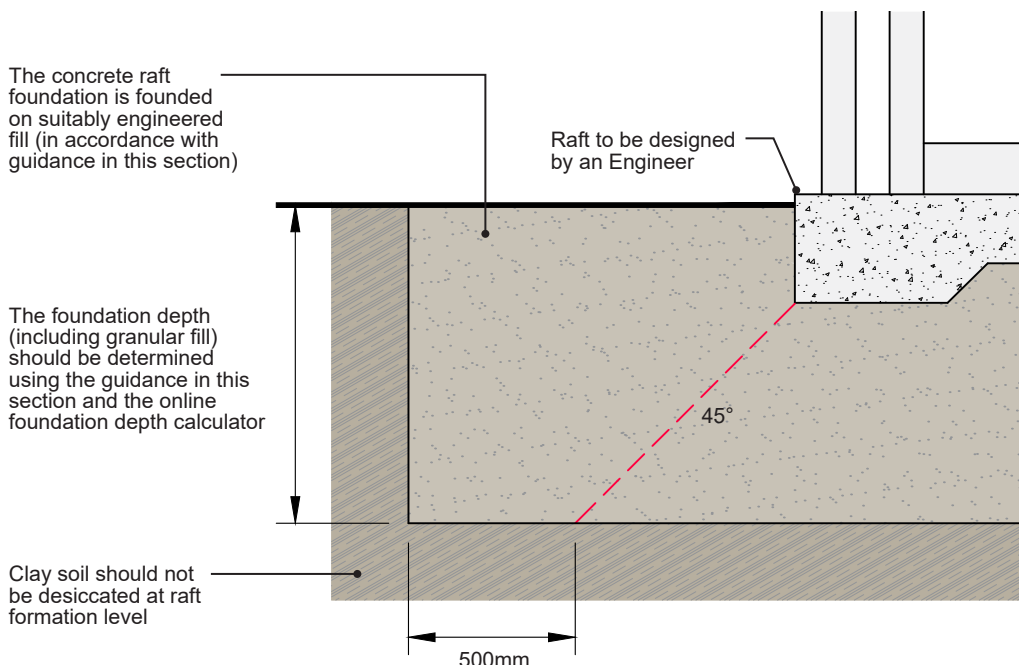
Where a raft foundation is proposed in shrinkable / expandable soil within the influence of trees (existing, removed or proposed), it will be acceptable only if it is designed to meet the following conditions:

- It is designed by an Engineer and the stiffness of the raft is sufficient to avoid damage to the superstructure and services of the building for the design life of the building.
- Clay should not be desiccated at raft formation level unless it can be demonstrated the residual long term clay heave uplift will be no more than 25mm under the SLS load case: dead load plus 30% superimposed live load.
- Settlement, heave and tilt shall be compatible with the structure without causing structural damage. In general, settlement should not exceed 25mm and differential settlement gradients, across the raft, should not be steeper than 1/500. However, if the structure is engineered to be serviceable with total settlements and differential settlement gradients greater than these figures, then this solution will be considered on a case by case basis using suitable geo-structural analysis. The analysis shall be conducted for the SLS load case: dead load plus 30% superimposed live load.
- The foundation depth (including engineered fill) should be determined using the guidance in this section and the online foundation depth calculator, **and**



- The concrete raft foundation is founded on suitably engineered fill and in accordance with the following:
  - The depth of granular fill shall be based on a minimum of 50% of the depth as calculated using the Foundation Depth Calculator for strip/mass fill foundations and is not more than 1.25m deep (measured from the original ground level where ground levels have not been altered). Please refer to our 'Foundations – Trees and Clay' section where ground levels are altered.
  - The fill must bypass any made ground and be placed directly on natural ground.
  - The fill should be fully compacted in layers in accordance with the Engineer's specification ensuring a minimum dry density of 95% and max air voids of 5%. Where the depth of granular fill is greater than 1000mm a site specific earthworks specification and validation report, including testing will be required.
  - The ground level shall be taken as existing or proposed whichever is more onerous.
  - The fill should extend a minimum distance beyond the concrete footprint by a distance equal to a 45° line taken from the underside of concrete plus 500mm. If external buried services are installed on the perimeter of the raft foundation and are below the 45° notional bearing pressure dispersal line, then suitable measures must be taken to ensure the raft ground bearing pressures are transmitted, effectively, to the lower soils e.g. specify concrete bed and surround of services up to the notional 45° bearing pressure dispersal line.
- All materials on the perimeter and 1 metre inside of the raft must be non-frost susceptible for a depth of 450mm from finished external perimeter ground level.
- Services to the building should be designed to accommodate any settlement, heave or tilt.
- Under the raft footprint, services shall be have a concrete bed and surround and be hung from the soffit of the raft.

Where the foundation calculator depth is greater than 2.5m the design condition is outside the guidance of this Technical Manual and should not be used. An Engineer design or alternative foundation type will be required.



## Sloping sites

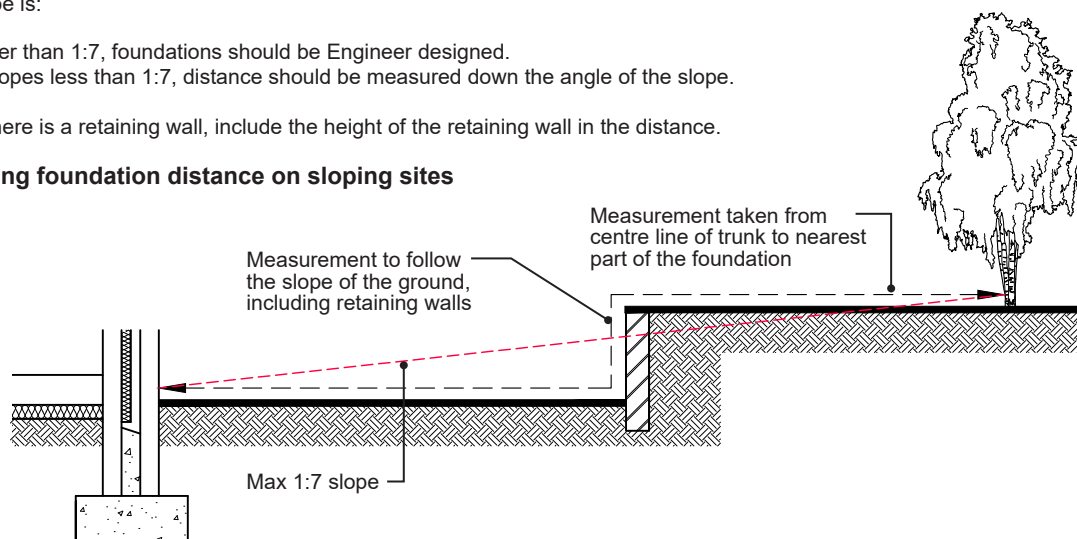
Foundations on sloping sites should be appropriately designed and constructed to safely transmit loads without excessive movement.

If the slope is:

- Greater than 1:7, foundations should be Engineer designed.
- For slopes less than 1:7, distance should be measured down the angle of the slope.

Note: If there is a retaining wall, include the height of the retaining wall in the distance.

## Measuring foundation distance on sloping sites





### Protection for drains

In addition to the requirements of the 'Drainage' section, drainage near trees should incorporate additional provisions. Where there is a volume change potential within the ground, the provisions include:

- Increased falls to cater for any ground movement.
- Deeper and wider backfill of granular material.
- A drainage system that is capable of movement should heave and shrinkage occur.
- Drainage pipes should not be encased in concrete.
- Additional clearance is required where drains pass through the structure of a building to allow for additional movement.

### Strip and mass fill foundations in non-shrinkable soils overlying shrinkable soils

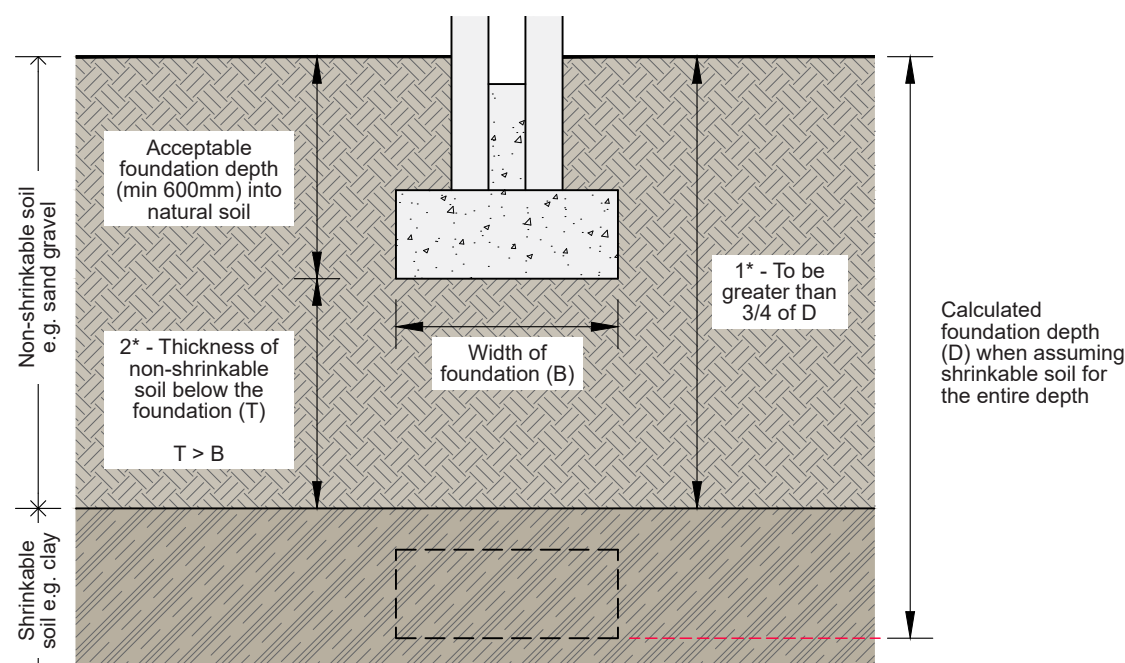
When a sufficient depth of non-shrinkable soil overlies shrinkable soil, the foundation depth can be assessed on the non-shrinkable material provided conditions 1 to 3 below are satisfied.

First, calculate the minimum foundation depth (D), assuming the soil type is shrinkable and under the influence of trees. This depth is taken from ground level.

**Condition 1\*** - Ensure the thickness of the non-shrinkable soil, as measured from the ground level, is greater than  $\frac{3}{4}$  of dimension D (as shown below).

**Condition 2\*** - Ensure the thickness of the non-shrinkable soil below the foundation (T) is greater than the width of the foundation (B) (as shown below).

**Condition 3** - Ensure all other relevant requirements in the 'Foundations' section of the Technical Manual are met.



### Changes in level

Where the ground level is raised or reduced, and trees are remaining, removed or proposed, the guidance in one of the below scenarios should be followed.

In all instances, ensure all other relevant requirements in the 'Foundations' section of the Technical Manual are met.

#### Scenario 1: Existing trees are remaining and the original ground level is raised

If ground levels are raised within the influencing distance of trees, the minimum foundation depth should be based on whichever provides the greater depth from either:

- The results given by the Foundation Depth Calculator when using the existing height of the tree or the mature height in instances where the existing height is currently at least 50% of the expected mature height, and the **original** ground level; **or**
- The results given by the Foundation Depth Calculator when using the mature height of the tree. This result should be measured from the **proposed** ground level.

#### Scenario 2: Existing trees are to be removed and the original ground level is raised

If ground levels are raised within the influencing distance of trees, the minimum foundation depth should be based on:

- The results given by the Foundation Depth Calculator when using the existing height of the tree or the mature height in instances where the existing height is currently at least 50% of the expected mature height, and the **original** ground level.

## Scenario 3: New trees are proposed and the original ground level is raised

If ground levels are raised within the influencing distance of trees, the minimum foundation depth should be based on whichever provides the greater depth from either:

- The minimum foundation depth as given in column 3 of 'Table 1: Minimum foundation depths' in this section of the Technical Manual. This result should be measured from the **original** ground level; **or**
- The results given by the Foundation Depth Calculator when using the mature height of the tree. This result should be measured from the proposed ground level.

## Scenario 4: Existing Trees are remaining and the original ground level is reduced

If ground levels are reduced within the influencing distance of trees, the minimum foundation depth should be based on:

- The results given by the Foundation Depth Calculator when using the mature height of the tree. This result should be measured from the **proposed** ground level.

## Scenario 5: Existing trees are to be removed and the original ground level is reduced

If ground levels are reduced within the influencing distance of trees, the minimum foundation depth should be based on whichever provides the greater depth from either:

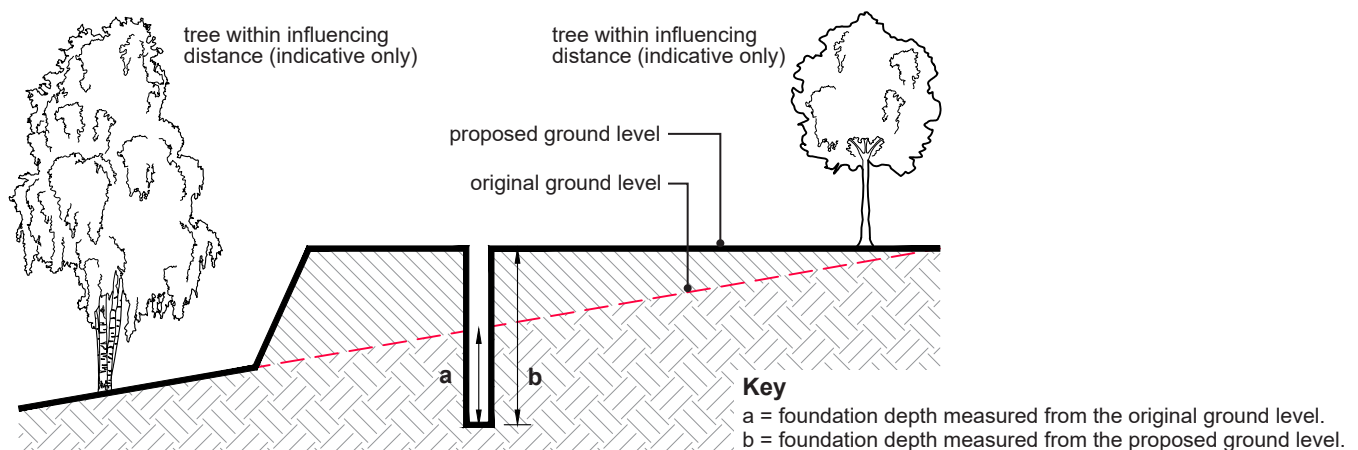
- The results given by the Foundation Depth Calculator when using the existing height of the tree or the mature height in instances where the existing height is currently at least 50% of the expected mature height, and the **original** ground level; **or**
- The minimum foundation depth as given in column 3 of 'Table 1: Minimum foundation depths' in this section of the Technical Manual. This result should be measured from the **proposed** ground level.

## Scenario 6: New trees are proposed and the original ground level is reduced

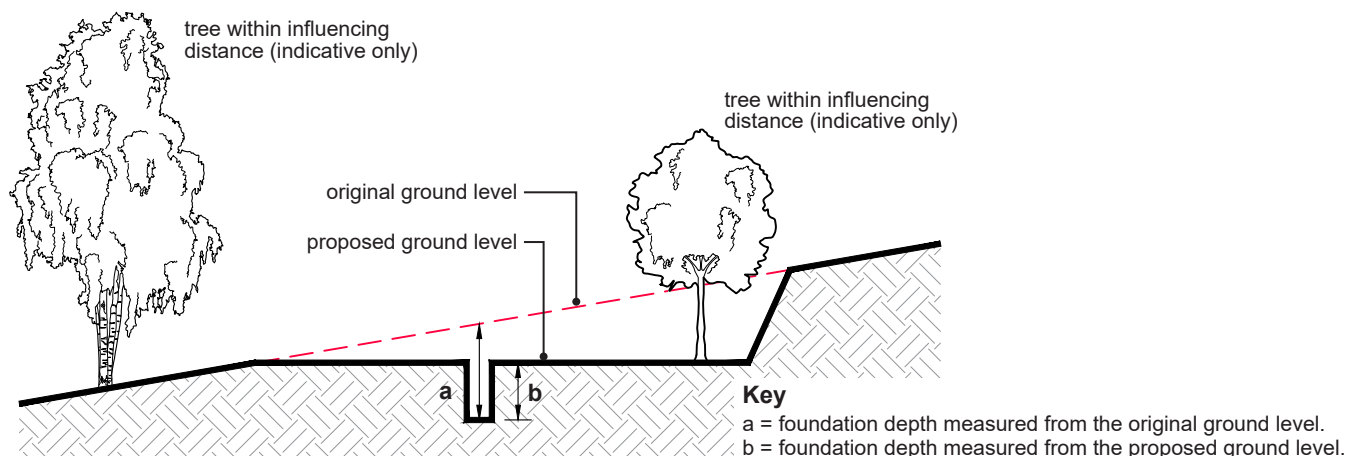
If ground levels are reduced within the influencing distance of trees, the minimum foundation depth should be based on:

- The results given by the Foundation Depth Calculator when using the mature height of the tree. This result should be measured from the **proposed** ground level.

### Where to measure when the ground level is raised



### Where to measure when the ground level is reduced



### Introduction

This section provides guidance on meeting the performance requirements for retaining walls which provide support to the home and/or any path or driveway within the curtilage of such property giving access to the principal entrance.

#### 3.7.1 Compliance

Retaining walls shall meet the performance requirements of this section.

#### 3.7.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. An Engineers design with supporting calculations which takes account of all loads and ground conditions.
  - a. Where reinforced earth retaining walls are specified, additional design items and testing/validation reports will be required in accordance with the guidance provided within this section.
2. An appropriate level of site investigation which accurately assesses and investigates potential hazards which may the retaining wall.

#### 3.7.3 Structural design

An Engineer shall design any retaining wall which provides support to the home and/or any path or driveway within the curtilage of such property giving access to the principal entrance.

#### Rigid retaining walls

Where rigid retaining walls are specified which support the foundations of a building, an Engineer's design must be provided to confirm capable of maintaining stability for a period of at least 60 years and all works to the rigid retaining wall should be completed prior to works for the foundations of the property starting.

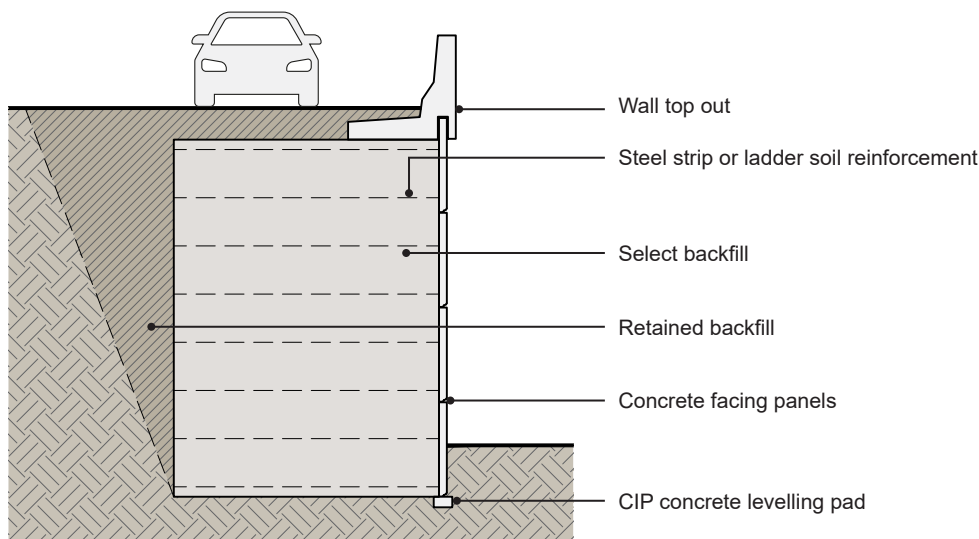
#### Flexible retaining walls

For the purposes of Warranty, flexible retaining walls may be defined as walls that support soil laterally whilst allowing deformations of the unsupported edge of the flexible retaining wall. Examples of flexible retaining walls include gabion, crib, block, timber or modular retaining wall systems.

Flexible retaining walls must not be used to support the structure of the property, garages, roads, drives, car parking areas or drainage systems.

#### Reinforced earth retaining walls

Reinforced earth retaining walls consist of a wall where the engineered fill is reinforced with a choice of geo-synthetics or steel. These soil reinforcements are connected to, any one of a wide choice of facing elements, including concrete panels, steel panels or galvanised steel wire grid mesh.



## Our design information requirements

The design of reinforced earth retaining walls must comply with BS 8006-1 and must provide the following information:

1. As built drawings of each reinforced earth retaining wall.
2. The reinforced earth retaining wall designer must define the category classification of the retaining wall to BS 8006-1:2010 Table 9.
3. Phase 1 ground investigation desk study identifying all potential risks in the ground and in the ground water (submitted as an appendix in the design submission).
4. Adequate phase 2 ground investigation reports covering stratigraphy, soil strength profiles, ground water regime, ground gas, atterberg limits, sieve analysis grading curves, contamination results for the ground and ground water, total potential sulfate and foundation type recommendations (submitted as an appendix in the design submission).
5. The reinforced earth retaining wall designer must provide a written statement that the ground investigation reports are satisfactory for the purposes of the design or a statement specifying what additional ground investigation and testing is required.
6. Assessments of the global stability of the existing hillside before and after terracing works (slip circle analyses demonstrating adequate factors of safety against global and local failure of the slopes – usually, the client's Geotechnical Engineer must provide this information or provide a statement stating that inadequate global and local slope stability factors of safety are not considered to be a problem on the site).
7. Assessments of the safe allowable bearing capacity of the ground upon which the retaining walls sit (i.e. is the ground strong enough to support the retaining walls without excessive vertical and horizontal movements?).
8. Assessments of the potential effects of planned and un-planned excavations at or near the toe of the retaining wall (lower level, passive side of the retaining wall e.g. excavation of drainage and services trenches).
9. Assessments of the ground water regime on the site. For example, is there a potential for subterranean water flows through the site which may cause soil erosion (washout) and/or softening of the ground supporting the retaining walls? If there is potential, then the retaining wall, drainage and external works designs must take account of this problem and mitigate the problem.
10. Assessments of the influence of existing and proposed foundations on the retaining walls and vice-versa. Generally, foundations of structures should not be constructed within the reinforced soil zone of the retaining walls. In exceptional circumstances, if appropriate geotechnical and structural analyses have been carried out to assess the effects on the reinforced retaining wall and the foundations, then this condition may be relaxed if the design of the reinforced earth retaining walls and structure foundations takes account of the effects.
11. Assessments of the vertical loads applied on the active and passive sides of the reinforced earth retaining walls.
12. Assessments of the horizontal loads applied to the reinforced earth retaining walls from handrails, fences and vehicle movements – or any other potential horizontal loads.
13. Assessments of the potential effects of existing trees and bushes and those removed.
14. The reinforced earth retaining wall designer's design brief statement defining the predicted long term vertical settlements and horizontal movements of the reinforced earth retaining walls and the maintenance free design life of the reinforced earth retaining walls (we would expect a minimum maintenance design life of 60 years).
15. A fully detailed material and workmanship specification for the construction of the reinforced earth retaining walls. This document must be produced by the specialist reinforced earth retaining walls designer.
16. A fully detailed construction method statement covering construction sequence, materials, and plant machinery to be used.
17. The test methods to be used to prove the compaction of each layer of fill has met the requirements of the earthworks specification.

## Testing results and validation reports required

The following information is required:

1. Compaction test results for the engineered fill.
2. Full details of the engineering fill (e.g. sources of the material, grading curves, moisture contents and chemical compositions).
3. Validation reports, prepared by a suitably qualified independent company, confirming compaction of the engineered fill has met the requirements of the reinforced earth designer's requirements and the Project Engineer's earthworks specification.
4. Full details of the quality control measures to be adopted including site progress photographs recording the construction of each reinforced earth retaining wall at regular time intervals. This must be retained and provided to the Warranty provider upon request.



# 4.

## Ground Floors

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### Contents

|     |                                                              |    |
|-----|--------------------------------------------------------------|----|
| 4.1 | Suspended Ground Floors                                      | 78 |
| 4.2 | Ground Supported Slab                                        | 85 |
| 4.3 | Stepped Floors, Screeds, and Underfloor Heating Requirements | 88 |

## Introduction

This section provides guidance on meeting the performance requirements for the following types of suspended ground floors:

- Proprietary precast concrete floor systems (such as beam and block)
- In-situ concrete slabs
- Proprietary pre-cast insulated concrete floor systems
- Suspended timber

### 4.1.1 Compliance

The design, specification and installation of suspended ground floors shall meet the performance requirements of this section.

### 4.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. For beam and block floor systems, manufacturer's floor layout drawings and calculations.
2. For cast in-situ suspended concrete slab:
  - a. An Engineer's full set of structural calculations.
  - b. Details on how the slab is to be reinforced.
  - c. Details of the concrete mix to be used.
3. For suspended timber ground floors, an Engineer's full set of structural calculations.
4. A third party product conformity certificate for proprietary precast concrete floor systems and proprietary pre-cast insulated concrete floor systems.
5. For all floor systems:
  - a. Plan details showing dimensions, levels and locations of incoming service penetrations.
  - b. Details indicating the depth and position of below ground services.
  - c. Details showing span and direction of structural members.
  - d. Details of junctions between DPM and DPC.
  - e. Ventilation provision should be detailed by the designer.
  - f. Details of ground hazards, contaminants, and their mitigation measures.
  - g. Details indicating the locations of all load and non-load bearing walls.
  - h. The manufacturer's third party product conformity certificate for the proposed insulation to be used within the floor.
  - i. Details of underfloor heating systems where being used.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 4.1.3 Influence of trees and clay

Suitable precautions shall be taken by the designer to protect the suspended ground floor from soil heave.

In clay soils if the foundation depth is greater than 1.5m, allowance should be made in the design for heave. This must incorporate either a clear void of a specified minimum depth under the suspended floor, or a proprietary compressible material/void former below the underside of the floor construction (where a cast in-situ suspended concrete slab is specified).

Please refer to the 'Foundations – Trees and Clay' section for further guidance.

### 4.1.4 Site preparation

The ground shall be suitably prepared prior to any suspended ground floor system being installed.

## Proprietary suspended precast concrete floor systems and proprietary suspended pre-cast insulated concrete floor systems

All topsoil and organic matter should be removed from beneath the suspended floor.

### Cast in-situ suspended concrete slabs

The material below the proposed floor slab should be compacted sufficiently to support the slab during the pouring and curing stages. Any backfill material should not contain any organic matter, or contaminants that could react with the concrete or be susceptible to swelling, such as colliery waste.

## 4.1.5 Gas protection systems

Where a gas protection system (e.g. gas membranes) is required it shall be specified in accordance with relevant standards. Gas protection systems shall be installed to manufacturers recommendations.

Ground floors must be designed and constructed to ensure adequate protection against ground gases emanating from the ground below.

Where a gas protection system is required it should be capable of providing a complete barrier and be impervious to the relevant ground contaminants specific to that development.

Where gas membranes horizontally bridges the cavity, a cavity tray should be provided above. Cavity trays should be sealed to the gas membrane in accordance with gas membrane manufacturers instructions to prevent capillary damp ingress at the joint.

Where gas a membrane is required for use with a proprietary pre-cast insulated concrete floor systems, the gas membrane must have a third party product conformity certificate for use with the proposed floor system.

Please refer to the 'Ground Conditions – Managing Ground Contaminants' section for further guidance.

## 4.1.6 Structural design

Suspended ground floors shall have adequate strength and durability, and safely transfer loads to the supporting structure.

### Proprietary precast concrete floor systems

Designs should be in accordance with BS EN 1992-1-1 with loads calculated to BS EN 1991-1-1. Proprietary precast concrete floor systems should have an appropriate third party product conformity certificate.

The manufacturer's details and specification for the floor must include:

- Structural calculations for the floor indicating depth and centres of the precast floor beams.
- The minimum specification of walls supporting the beam and block floor.
- Specifications for the blocks infilling between the beams, including compressive strength and thickness of the block.

### Proprietary pre-cast insulated concrete floor systems

Proprietary pre-cast insulated concrete floor systems should be designed by an Engineer with loads calculated in accordance with BS EN 1991-1-1 and have an appropriate third party product conformity certificate.

### In-situ concrete slabs

A cast in-situ suspended concrete slab should be designed by an Engineer with loads calculated in accordance with BS EN 1991-1-1.

Reinforced concrete should have a minimum strength of RC35 and be ready mixed and delivered on-site.

The structural design should include the following information:

- Adequacy of walls that support the concrete slab (intermediate and perimeter walls).
- Suitable thickness, correct durability of concrete and correct provision of reinforcing.
- Provision of anti-crack reinforcing to the perimeter of floors.

### Suspended timber

Suspended timber ground floors should be appropriately designed in accordance with the 'Upper Floors' section.

Timber joists should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure in accordance with BS 8417.

Timber joists should be appropriately seasoned to prevent excessive shrinkage and movement.

### Floor deflection limits for all suspended ground floors

The deflection limit must be 0.003 times the span with a maximum deflection of 14mm where strutting is provided and 12mm where strutting is not provided. This is based on the total and imposed loads for combined bending and shear.

The Engineer is responsible for designing the floor construction to maintain deflections within the specified tolerances, unless more stringent requirements are dictated by the relevant BS or EN design code.



### 4.1.7 Insulation

Insulation materials shall minimise thermal transmission through the floor and be suitable for their intended purpose and location.

In all circumstances, insulation within the floor construction should be chosen to take the following into account:

- The insulation should have an appropriate third party product conformity certificate.
- The insulation should be durable enough to withstand loadings, moisture and any ground contaminants.
- The insulation should comply with relevant Building Regulations.
- Any risk of thermal bridging is mitigated, especially at junctions with the floor and wall. The following can be considered at design stage:
  - Installing perimeter insulation to floors.
  - Linking floor and wall insulation.
  - Extending cavity wall insulation below floor slab level.

### Insulation below In-situ concrete slabs

Where insulation is specified below an in-situ concrete slab, the insulation should:

- Be compatible with the DPM.
- Only be installed on a suitable, compacted and even substrate.
- All foreseeable loading during and post construction.

### 4.1.8 Protection from moisture

Suitable precautions shall be taken to prevent the passage of moisture to the inside of the home. In respect of:

- Damp proof courses
- Sub-floor ventilation
- Damp proof membranes

### Damp proof courses (DPC)

Where DPCs are specified they should be of a flexible material that is suitable for its intended use and have an appropriate third party product conformity certificate.

DPCs should be laid on a mortar bed and correctly lapped at junctions and corners. The depth of lap should be the same as the width of the DPC.

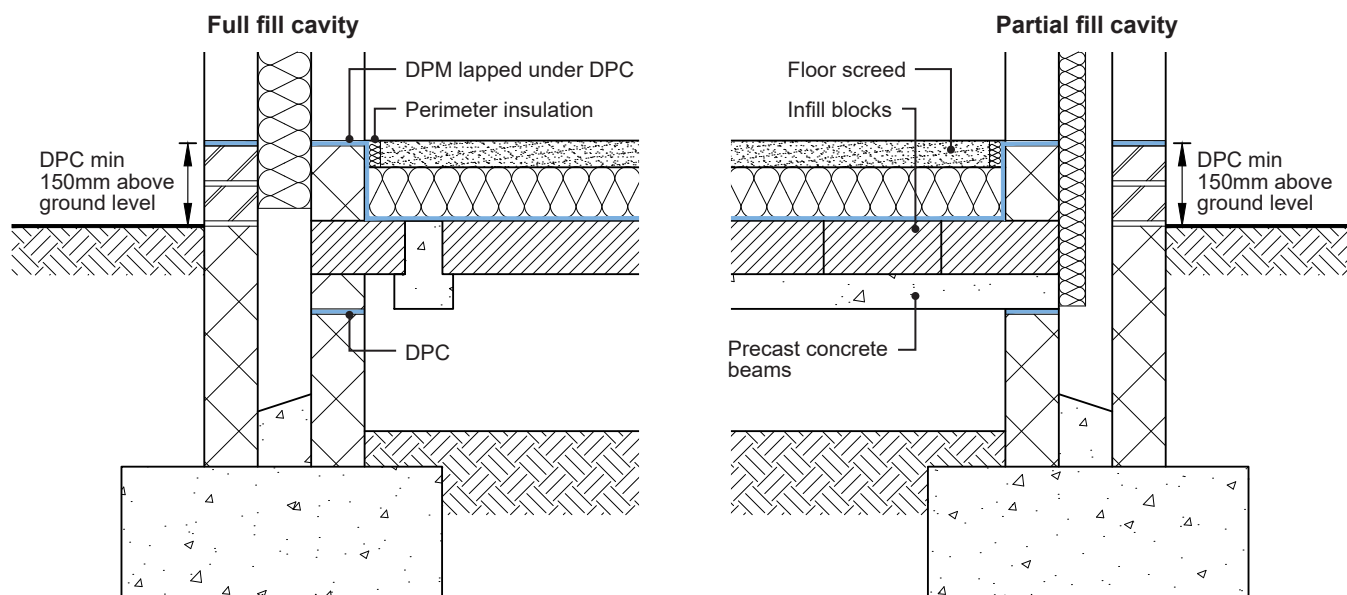
DPCs should not bridge any cavities unless it is acting as a cavity tray. Where a cavity tray is required, please refer to the 'External Walls' section for cavity tray, weep holes, and stop end requirements.

### Damp proof membranes (DPM)

Where DPMs are specified, the following should be satisfied:

- The DPM should be a minimum thickness of 1200g polythene.
- The DPM must be linked to the DPC with a minimum 100mm overlap.
- DPM sheets should be overlapped by at least 300mm.
- DPMs must be carefully protected where folded up the perimeter walls, and lapped under the DPC particularly at door openings.
- Temporary protection should be given whilst exposed.
- The DPM should not be cut at the floor junction as this will prevent correct lapping with the DPC.
- The DPM should be provided beneath the screed or insulation. A number of insulation products require an additional DPM to protect the surface of the insulation. It is important that this additional membrane is incorporated in these situations.

Other DPMs may be considered if they have an appropriate third party product conformity certificate and are installed in accordance with the manufacturer's instructions.



## Notes:

- Insulation must be installed to meet the manufacturer's installation requirements and relevant Building Regulations.
- Where the solum level is below the external ground line, suitable drainage provision to avoid build-up of ground water must be provided. Where the ground below the floor is to be drained, the design must be provided by an Engineer with relevant experience. The design must be based on site specific site investigation that meets the requirements of our 'Ground Conditions' section.
- DPCs must be provided under bearings of precast floors.

## Conditions to be satisfied where the DPM is to be omitted

Where no DPM is incorporated into the suspended ground floor system, the following provisions will apply:

- The sub-floor void must be ventilated as per the guidance provided within this section.
- DPCs must be provided under bearings of precast floors.
- The ground below the floor must be effectively drained if excavated below external ground levels.

Where the ground below the floor is to be drained, the design must be provided by an Engineer with relevant experience. The design must be based on site specific site investigation that meets the requirements of our 'Ground Conditions' section.

## Sub-floor ventilation requirements

A sub-floor void and cross-flow ventilation should be provided below:

- Proprietary precast concrete floor systems (such as beam and block)
- Proprietary pre-cast insulated concrete floor systems
- Suspended timber ground floors

## Void requirements

A minimum ventilation void of 150mm should be provided below the underside of all suspended ground floors. A larger void will be required for shrinkable soils where heave may take place:

- Low volume change potential – 200mm void dimension.
- Medium volume change potential – 250mm void dimension.
- High volume change potential – 300mm void dimension.

The void dimension is measured from the underside of beam to ground level and includes 150mm ventilation allowance.

## Ventilation to the sub-floor void

The sub-floor void should be provided with ventilators on at least two opposing sides of the external wall with air bricks appropriately ducted in accordance with the manufacturer's instructions.

Air bricks should be situated at least 75mm from the external ground level.

Internal walls should be constructed with sufficient openings to ensure cross-flow ventilation is maintained. All internal walls must have air bricks to allow the free flow of air, or be built using a honeycomb technique.

Void ventilation should be provided to whichever gives the greater opening area:

- 1500mm<sup>2</sup> per metre run of external wall.
- 500mm<sup>2</sup> per m<sup>2</sup> of floor area.

Please note, the typical net ventilation area for the air brick will vary by air brick manufacturer.

### 4.1.9 Installation requirements

Suspended ground floors shall be installed to:

- Ensure durability of materials is maintained.
- Ensure structural performance of the floor system is maintained.
- Ensure precautions to prevent the passage of moisture to the inside of the home is maintained.

#### Beam and block floors

All beam and block floors shall be installed ensuring that the following standards are met:

- The floor beams must be laid reasonably level and onto suitable solid and level bearings.
- End bearings on supporting walls should be as per the manufacturer's recommendations and in no case less than 90mm.
- Floor beams and blocks are grouted together using cement/sand slurry with a mix ratio of 1:6 respectively.
- The beam and block floor should not be used to support load-bearing walls.
- All walls should be built off an appropriate foundation, as indicated in the 'Foundations' section.
- A suitable mortar bed is required where block work between the floor beams bear onto load-bearing walls, e.g. perimeter walls.
- Holes must not be made through the floor beams and any service penetrations should pass through the holes made in the infill blocks. Any gaps around service penetrations should be filled with concrete (ST3) mix before screeding.

Where beam and block floors are to be installed to areas with higher potential point loads such as garages, additional reinforcing of the screed will be required to distribute loads effectively. This reinforcing should be of at least an 'A' mesh quality, and the screed should be thick enough to give an appropriate depth of cover.

#### Cast In-situ concrete slab

Prior to concreting, any water or debris that may have collected on top of the DPM should be removed. Site mixing of concrete is not considered suitable for cast in-situ concrete slabs. The poured concrete should be lightly vibrated and well tamped to ensure that no voids are left within the floor slab.

The floor slab should be appropriately shuttered around its perimeter to enable a cavity to be formed between it and the external wall. The shuttering can be expanded polystyrene (which is removed once the concrete has set) or a proprietary shuttering system.

The suspended floor construction must be laid reasonably level and onto suitable solid and level bearings.

#### Standard of fabric reinforcing

Reinforcing fabric should be free from loose rust, oil, grease, mud and any other contaminants that may affect the durability of the concrete. Reinforcing fabric should be of a 'B' mesh grade. This can be identified by the size of the primary and secondary bars. Primary bars are spaced at 100mm centres and secondary bars are placed at 200mm centres, as indicated in Table 1.

**Table 1: Standard 'B' mesh reinforcing details**

| BS reference | Primary bar |                 |                        | Secondary bar |                 |                       |
|--------------|-------------|-----------------|------------------------|---------------|-----------------|-----------------------|
|              | Size        | Spacing of bars | Area                   | Size          | Spacing of bars | Area                  |
| B1131        | 12mm        | 100mm           | 1131mm <sup>2</sup> /m | 8mm           | 200mm           | 252mm <sup>2</sup> /m |
| B785         | 10mm        | 100mm           | 785mm <sup>2</sup> /m  | 8mm           | 200mm           | 252mm <sup>2</sup> /m |
| B503         | 8mm         | 100mm           | 503mm <sup>2</sup> /m  | 8mm           | 200mm           | 252mm <sup>2</sup> /m |
| B385         | 7mm         | 100mm           | 385mm <sup>2</sup> /m  | 7mm           | 200mm           | 193mm <sup>2</sup> /m |
| B283         | 6mm         | 100mm           | 283mm <sup>2</sup> /m  | 7mm           | 200mm           | 193mm <sup>2</sup> /m |
| B196         | 5mm         | 100mm           | 196mm <sup>2</sup> /m  | 7mm           | 200mm           | 193mm <sup>2</sup> /m |

#### Lapping of reinforcing

It is accepted that reinforcing can consist of a number of sheets that can be joined together as identified in Table 2. The depth of cover may need to be increased to maintain minimum cover depending on the thickness of mesh reinforcing. All loose reinforcement that acts as part of the reinforcing layers must be adequately tied together.

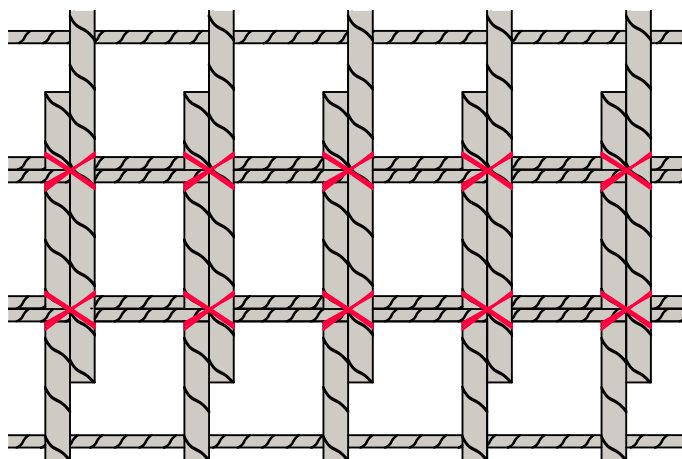


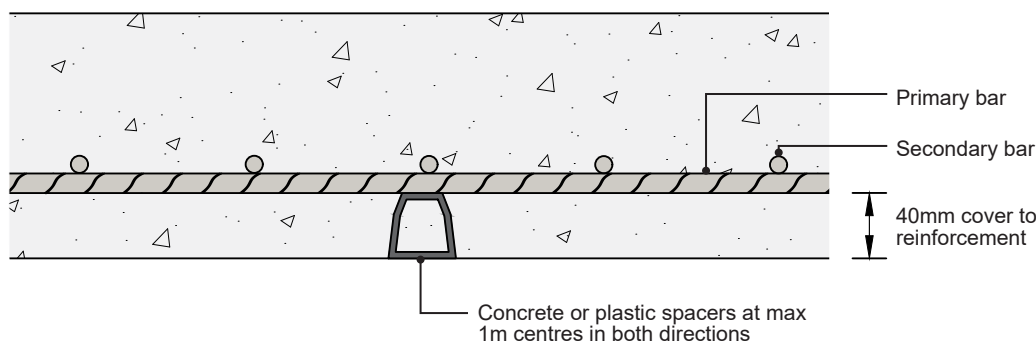
**Table 2: Minimum laps for reinforcing**

| Minimum laps for main reinforcing bars in fabric mesh <sup>1</sup> |             |
|--------------------------------------------------------------------|-------------|
| Fabric type                                                        | Minimum lap |
| B1131                                                              | 500mm       |
| B785                                                               | 400mm       |
| B503                                                               | 350mm       |
| B385                                                               | 300mm       |
| B283                                                               | 250mm       |
| B196                                                               | 200mm       |

<sup>1</sup> A minimum lap of 300mm is required for secondary reinforcing bars.

## Cast in-situ concrete slab - floor reinforcing cover and support

The main reinforcing bars must have a minimum concrete cover of 40mm. Suitable spacers should be provided to support the reinforcing prior to concreting.



## Party wall junctions

At party wall junctions, where required, the floor should have appropriate sound and fire resistance in accordance with the relevant Building Regulations.

### 4.1.10 Specific requirements for suspended timber ground floors

Suspended timber ground floors shall be installed to:

- Ensure durability of materials is maintained.
- Ensure structural performance of the floor system is maintained.
- Ensure precautions to prevent the passage of moisture to the inside of the home is maintained.

To prevent the decay of timber joists, the suspended timber floor should be constructed in such a way that:

- All joists and sole plates are above the DPC level.
- A minimum void of 150mm is provided between the joists and oversite.
- Air bricks are provided to give adequate cross ventilation to the floor void.
- Joists have adequate bearings and do not protrude into the cavity.

## Detailing of suspended timber ground floors

The floor joists must have consistent dimensions, be laid reasonably level and onto suitable solid and level bearings. Joists must be securely nailed to timber wall plates as per the Engineers specification.

Floor joists can be supported internally by sleeper walls. Sleeper walls should be built off an adequate foundation if the ground is of suitable bearing strata, or can be built of a reinforced thickened slab where designed by an Engineer. Sleeper walls should not limit ventilation to the sub-floor void.

To prevent the distortion of finishes, joists should be stopped from twisting over supports and provision provided to accommodate up to 12mm of drying shrinkage in floor joists supported by steel beams.

It is essential that joists are not overloaded during construction. Joints in joists should only be in place over a load-bearing support, or the joint be designed by an Engineer.

### Stepped floors

For lower ground floors on sloping sites and semi basements timber suspended ground floors are not recommended.

### Concrete oversite

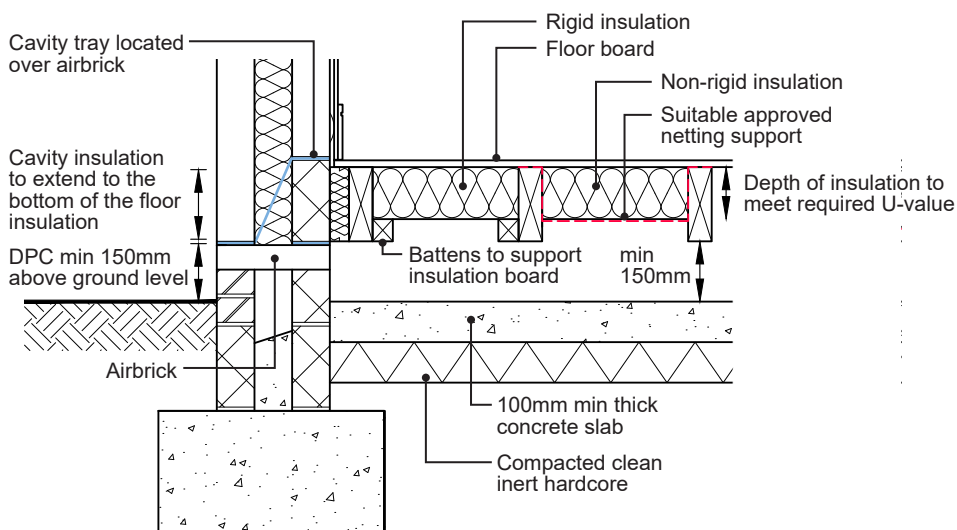
A suitable oversite should be provided at least 150mm below the timber suspended floor.

The oversite should be either:

- 100mm thick concrete over-site (GEN 3) on well-compacted hard core, **or**
- 50mm thick concrete over-site on a 1200g DPM laid on 25mm sand blinding and well-compacted hard core.

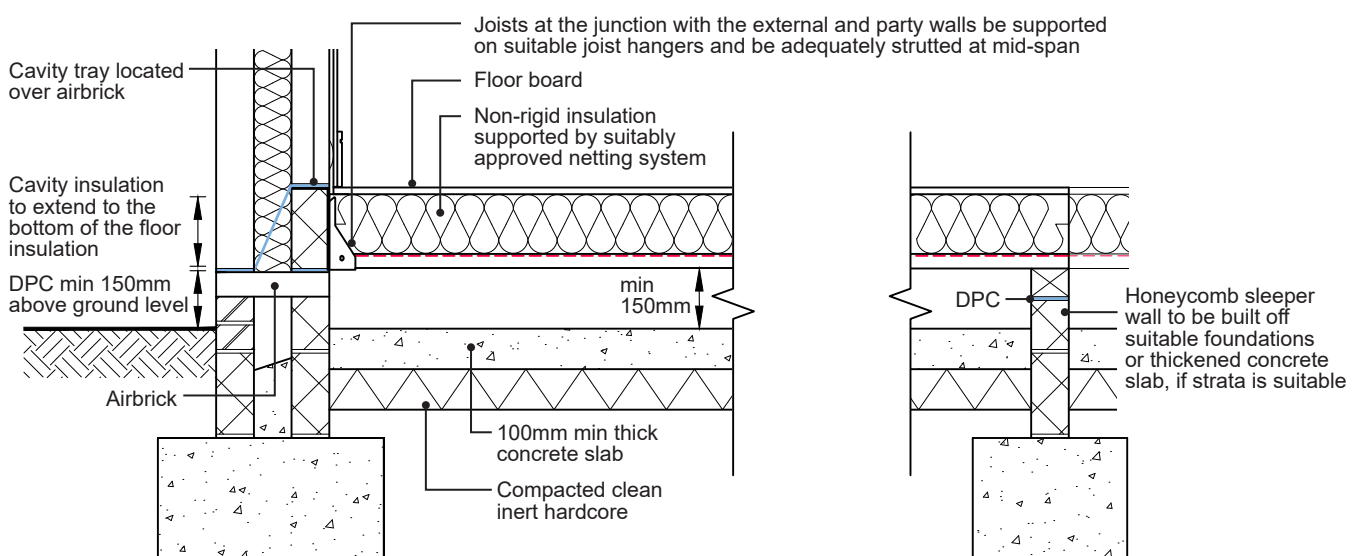
For sites that are susceptible to gas migrations, the oversite should incorporate gas protection measures designed by a suitable specialist.

### Suspended timber ground floor running parallel to wall



Note: If ground conditions consist of clay soils and trees are, were, or are likely to be present, the void under must allow for heave potential in the solum.

### Suspended timber ground floor bearing onto an external wall and a sleeper wall



Note: If ground conditions consist of clay soils and trees are, were, or are likely to be present, the void under must allow for heave potential in the solum.

## Introduction

This section provides guidance on meeting the performance requirements for ground supported concrete floor slabs.

Ground supported concrete floor slabs should not be used in ground conditions where heave can occur or where the foundation depth is greater than 1.5m. Under these circumstances a suspended floor construction should be used.

### 4.2.1 Compliance

The design, specification and installation of ground supported concrete floor slabs shall meet the requirements of this section.

### 4.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the performance requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Plan details showing dimensions, levels and locations of incoming service penetrations.
2. An Engineer's full set of structural calculations for the floor construction.
3. Details indicating the depth and position of below ground services.
4. Details of junctions between DPM and DPC.
5. The manufacturer's third party product conformity certificate for the proposed insulation to be used within the floor.
6. Details of underfloor heating systems where being used.
7. Details of ground hazards, contaminants, and their mitigation measures.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 4.2.3 Site preparation

The ground shall be suitably prepared prior to the ground supported concrete slab being installed.

The ground beneath the floor should be stripped of all topsoil, organic matter or tree roots prior to filling and compaction.

## Hardcore materials

Suitable hard core would include inert quarried material such as limestone or granite. Recycled aggregates may be used, which include crushed concrete or broken brick; however, these must be completely free of contaminants and plaster and should be delivered to site from a supplier that has a quality audit process in place.

Materials available as a result of any site demolition should not be used as hard core beneath floor slabs unless specifically agreed by the Warranty surveyor and only then if it can be demonstrated that the material is completely free of contaminants and plaster.

## Hardcore specification

Hard core should be placed and compacted in 150mm nominal layers and be fully consolidated using a mechanical compactor.

A ground supported concrete floor will not be acceptable where the depth of the hard core exceeds 600mm and an alternative suspended ground floor construction must be used. Hard core material should not be saturated and should be taken to ensure that the new walls are not disturbed by compaction of the hard core.

## Services

All services placed under the floor construction must be suitably protected and sleeved where penetrating through the floor slab. DPMs must be correctly sealed around these penetrations.

#### 4.2.4 Gas protection systems

Where a gas protection system (e.g. gas membranes) is required it shall be specified in accordance with relevant standards. Gas protection systems shall be installed to manufacturers recommendations.

Ground floors must be designed and constructed to ensure adequate protection against ground gases emanating from the ground below.

Where a gas protection system is required it should be specified and installed by suitably qualified persons.

Where a gas membrane horizontally bridges the cavity, a cavity tray should be provided above. Cavity trays should be sealed to the gas membrane in accordance with gas membrane manufacturers instructions to prevent capillary damp ingress at the joint.

Please refer to the 'Ground Conditions – Managing ground contaminants' section for further guidance.

#### 4.2.5 Structural design

Ground supported slabs shall have adequate strength and durability, and safely transfer loads to the supporting structure.

A ground supported concrete slab should be designed by an Engineer with loads calculated in accordance with BS EN 1991-1-1.

Concrete should be ready mixed and be of at least GEN1 grade. The concrete slab should be a minimum 100mm thick.

#### 4.2.6 Protection from moisture

Suitable precautions shall be taken to prevent the passage of moisture to the inside of the home, in respect of:

- Damp proof courses.
- Damp proof membranes.

##### Damp proof courses (DPC)

Where DPCs are specified they should be of a flexible material that is suitable for its intended use and have an appropriate third party product conformity certificate.

DPCs should be laid on a mortar bed and correctly lapped at junctions and corners. The depth of lap should be the same as the width of the DPC.

DPCs should not bridge any cavities unless it is acting as a cavity tray. Where a cavity tray is required, please refer to the 'External Walls' section for cavity tray, weep holes, and stop end requirements.

##### Damp proof membranes (DPM)

A DPM must be included within the construction of any ground bearing floor slab. The following should be satisfied for the DPM:

- The DPM should be a minimum thickness of 1200g polythene.
- The DPM must be linked to the DPC with a minimum 100mm overlap.
- DPM sheets should be overlapped by at least 300mm.
- DPMs must be carefully protected where folded up the perimeter walls, and lapped under the DPC particularly at door openings.
- Temporary protection should be given whilst exposed.
- Prior to concreting, any water or debris that may have collected on top of the DPM should be removed.

Membranes shall be laid onto an appropriate substrate - where the supporting substrate is sand blinded hardcore, the sand layer should be a minimum of 5mm thickness after compaction.

Other materials may be considered if they have an appropriate third party product conformity certificate and are installed in accordance with the manufacturer's instructions.

#### 4.2.7 Insulation

Insulation materials shall minimise thermal transmission through the floor and be suitable for their intended purpose and location.

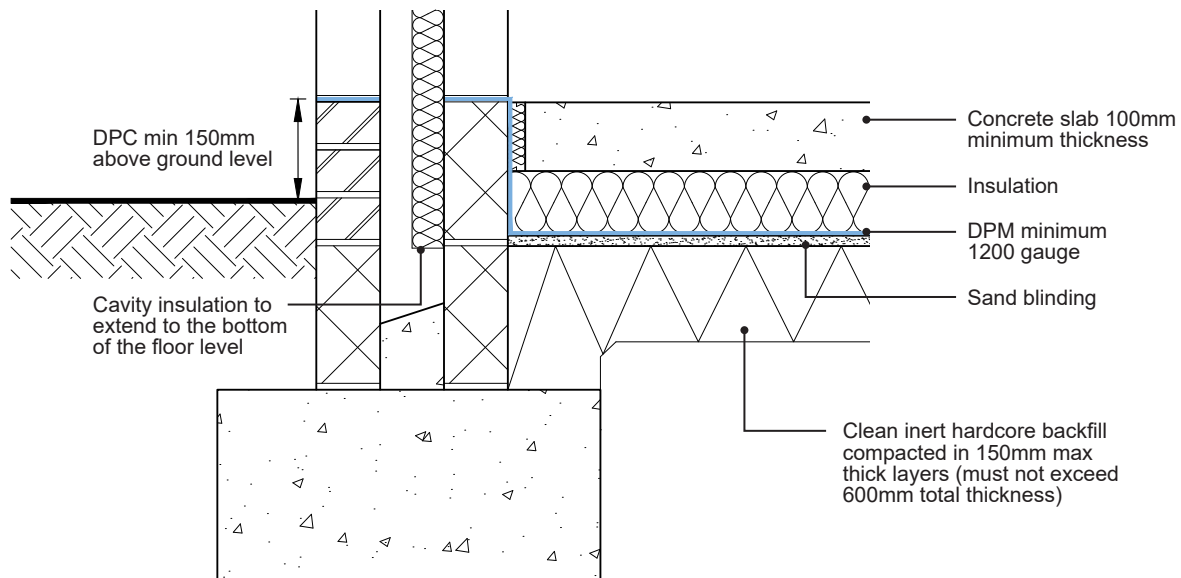
In all circumstances, insulation within the floor construction should be chosen to take the following into account:

- The insulation should have an appropriate third party product conformity certificate.
- The insulation should be durable enough to withstand loadings, moisture and any ground contaminants.

- The insulation should comply with relevant Building Regulations.
- Any risk of thermal bridging is mitigated, especially at junctions with the floor and wall. The following can be considered at design stage:
  - Installing perimeter insulation to floors.
  - Linking floor and wall insulation.
  - Extending cavity wall insulation below floor slab level.

Note: A number of insulation products require an additional DPM to protect the surface of the insulation. It is important that this additional membrane is incorporated in these situations.

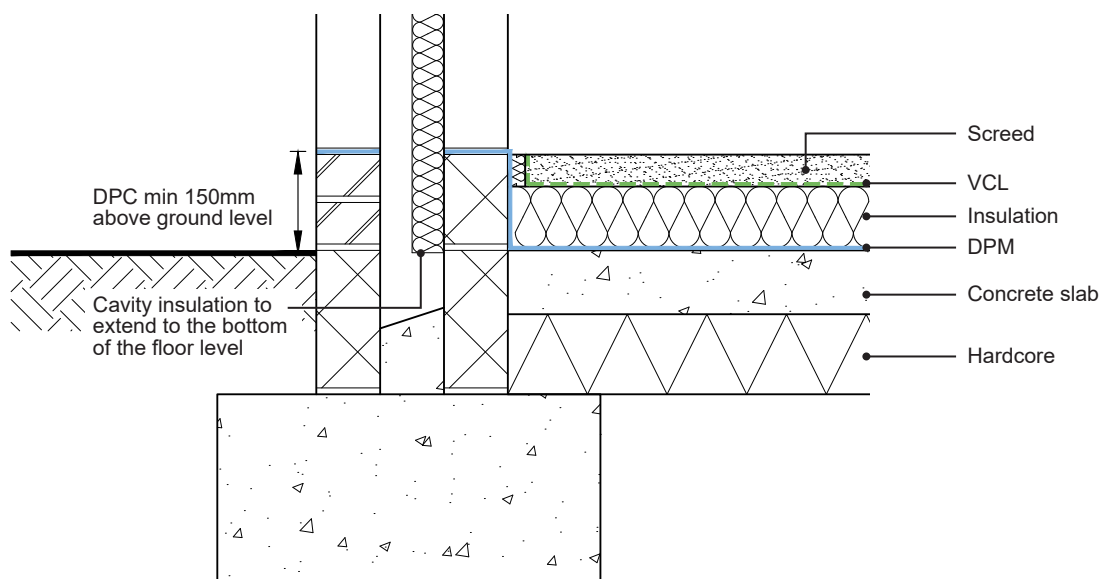
## Insulation below the ground supported slab



Where insulation is specified below the ground bearing slab, the insulation should:

- Be compatible with the DPM.
- Only be installed on a suitable, compacted and even substrate.
- Be strong enough to support wet construction loads.

## Insulation above the ground supported slab





## Introduction

This section provides guidance on meeting the performance requirements for stepped floors, screeds and underfloor heating requirements.

### 4.3.1 Compliance

Stepped floors, screeds and underfloor heating systems shall meet the performance requirements of this section.

### 4.3.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of proposed floor screeds including thickness and mix.
2. Details of substrates to which the screeds will be laid upon.
3. Details of proposed curing times and environmental constraints.
4. Details of underfloor heating systems where being used.
5. Where stepped party walling is proposed we require a full design proposal along with third party product conformity certificates where applicable.

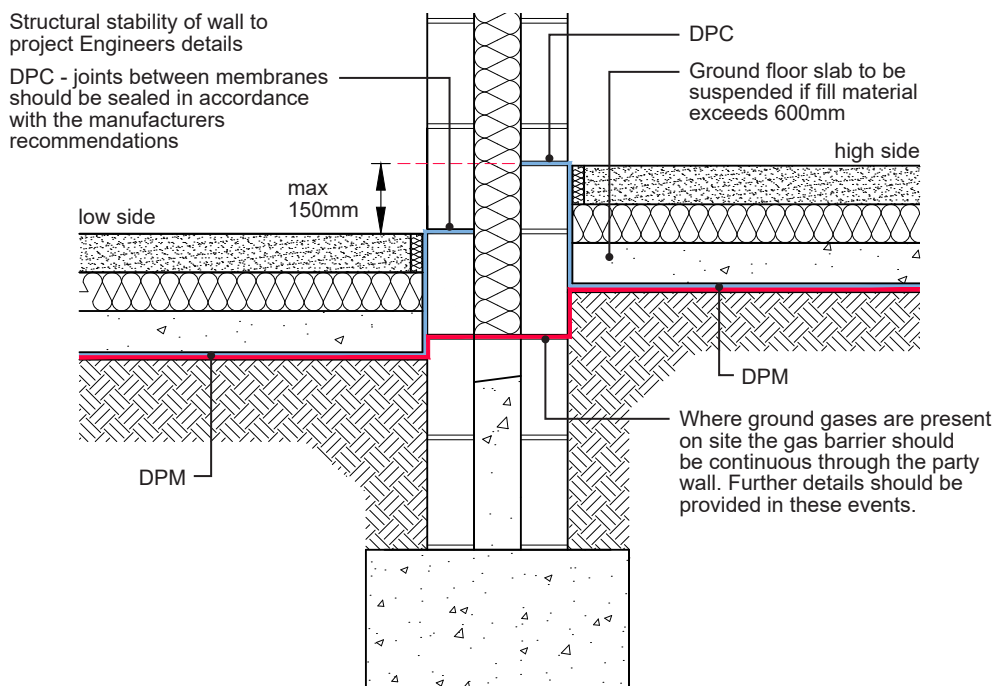
The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 4.3.3 Stepped party walls

Where stepped party walls are specified, suitable precautions shall be taken to resist the passage of moisture to the inside of the home.

#### Stepped party walls up to 150mm

Where a difference between finished floor levels of adjacent ground slabs internally or at a party wall does not exceed 150mm and the external ground levels of the perimeter external walls are a minimum of 150mm below the DPC in all locations, a waterproofing specialist solution is not required, however on sites where ground gases are present it is important that the continuity of the gas barrier is maintained through a party wall.



#### Stepped party walls exceeding 150mm

Where the difference between finished floor levels exceeds 150mm, the guidance of the 'Waterproofing Below Ground Storeys and Structures' section should be referred to.

## 4.3.4 Background surface for screeds

Background surfaces shall be suitably prepared to receive a screed.

Background surfaces where screeds are being supported should meet the following requirements:

### Bond

Background surfaces for bonded screeds must be prepared with an adequate mechanical key, supplemented by cement grouting or bonding agents if necessary.

### Moisture protection

The floor design should ensure that moisture from the ground does not enter the dwelling.

### Adequate support

Substrate structures must be adequately constructed to provide adequate support to the screed (note: Timber floor constructions are not suitable to support screeded finishes).

Substrates must be level with no pockets or high spots to ensure the thickness of the screed remains even.

Where screeds are laid over insulation; the insulation must be tightly butted together and level.

### Additional steps where constructing screeds over concrete substrates

Where a concrete slab is insulated from below and a finishing screed is required to the top surface:

- The concrete substrate slab must be of the correct thickness and not less than 100mm thick.
- Concrete substrate must be adequately dried out and not wet.
- Surfaces of hardened in situ concrete bases for bonded screeds should be roughened (scrabbled) and cleaned to remove laitance and to expose cleanly, but not loosen, the coarse aggregate particles.
- Brushing to remove laitance from a fresh concrete base is inadequate preparation before laying a bonded screed and is not recommended.
- Remove all loose debris, dirt and dust by appropriate means, preferably with vacuum equipment.
- Carry out the preparation of the surface with as little delay as is practicable before the screed is laid so as to reduce the risk of contamination.
- The surface of the prepared slab must be reasonably level to avoid variations in thickness's of the screed.

## 4.3.5 Screed specification

Floor screeds shall be of an adequate specification for the intended use and location. The screed shall also provide a suitable background for the desired floor finish.

Traditional floor screeds consist of sand and cement. If the ratios and properties of these screeds are not correctly controlled; cracking, peeling or collapse of the screed will occur (due to being too strong/weak).

Proprietary screeds typically are pre-blended to achieve greater consistency and strength and more suitable over larger areas. Where the floor area exceeds 50m<sup>2</sup> only a proprietary screed installed by the screed manufacturers trained installers will be accepted.

Screeds should be fit for purpose, have a suitable finish and be of an appropriate thickness and provide a reasonably level surface.

### Screed mix

Cement and sand screeds should have a mix ratio of between 1:3 and 1:4½.

Proprietary additives should have been assessed and have a third party product conformity certificate.

The minimum thicknesses of screeds are as follows:

| Surface                                                                                   | Minimum thickness at any point |
|-------------------------------------------------------------------------------------------|--------------------------------|
| Laid monolithically with base                                                             | 12mm                           |
| Laid and bonded to a set and hardened base                                                | 25mm                           |
| Laid on a separating membrane (e.g. 1000g polyethylene)                                   | 50mm                           |
| Laid on resilient slabs or quilts (screed reinforced with galvanised wire mesh)           | 65mm                           |
| Note: monolithic means that the screed and the concrete base are poured at the same time. |                                |

Where service pipes are bedded in the screed, the screed should be deep enough to provide at least 25mm of screed cover over service pipes, insulation and reinforcing.

### Maximum areas of screed

Screeds should be laid room by room. Unreinforced screeds should have a maximum area of 40m<sup>2</sup>. Expansion joints should be provided and consistent with joints in the floor slab below.

### Finishing of screeds

Screed should provide an even surface as appropriate, as defined in the 'Tolerances' section. Concrete floor slabs may be suitably finished to serve directly as a wearing surface without the need for an additional topping, in accordance with the recommendations of BS 8204. If required, surface sealers or hardeners should only be used in accordance with the manufacturer's instructions.

### Anhydrite (liquid) screeds

If an anhydrite screed is used, it must be sealed before the application of any cement based floor finish adhesive is proposed. Anhydrite screeds can be difficult to identify once laid, if the screed type cannot be identified the screed should be fully sealed as a precaution to prevent the possibility of the floor finish adhesive de-bonding from the screed.

The floor screed should be fully dry before the sealant is applied. The screed drying time will depend on the thickness and type of screed.

A decoupling membrane is also recommended as this can reduce the stress on the fixed floor finish layer.

### Dry times and curing

#### Drying times

- With cementitious levelling screeds, one day should be allowed for each millimetre of thickness for the first 50 mm, followed by an increasing time for each millimetre above this thickness (BS 8204).
- Polymer modified screeds: strictly follow the manufacturer's specifications and recommendations.
- The developer should keep an accurate record of the screed drying times elapsed before any fixed floor finish is constructed on top is laid and the Warranty surveyor may ask for this information.

Note: The moisture contents of levelling screeds onto which particular floorings are to be laid and methods for measuring moisture content are given in BS 5325, BS 8201, BS 8203 and BS 8425.

#### Curing

Screeds should be cured naturally and should not be covered for at least three weeks.

### Movement joints

Movement joints will be required in the screed in accordance with the Design. The following should also be taken into account:

- Movement joints will be required across door thresholds.
- Movement joints are required if bay sizes exceed 40m<sup>2</sup> with a maximum of 8m on any one side.
- Movement joints are also required where joints exist or a change of span occurs e.g. beam and block floors.

### Installation

Where screeds are being installed they should be correctly mixed, not be walked on during the drying period and shouldn't be constructed during cold periods (below 5°C).

#### 4.3.6 Insulation

Insulation materials shall minimise thermal transmission through the floor and be suitable for their intended purpose and location.

Insulation below screeds should have enough compressive strength to support the screed. DPMs should be installed in the correct positions, as indicated by the insulation manufacturer's instructions. Sound insulation should be installed in accordance with the manufacturer's instructions.

#### 4.3.7 Building services

Where building services pass through the screed, there shall be consideration for compatibility between the floor screed and the services.

Pipes should be protected against chemical attack (with the use of sleeves for example).

## 4.3.8 Screeds and underfloor heating systems

Where underfloor heating systems are specified under a screed there should be suitable movement joint and perimeter expansion joint provision.

The UFH system shall be commissioned in accordance with the manufacturer's recommendations by their approved installers. A commissioning certificate will be required.

### General requirements

Where underfloor heating systems are bedded into the screed:

- There should be a minimum 25mm cover over the highest point of the pipe or insulation.
- There should be consideration for thermal movement of water pipes.

### Provision and construction of movement joints

Movement joints should be provided in the floor screed / fixed floor finish where floor heating is provided in the following places:

- Between independently controlled heating zones.
- Between heated and unheated areas of screed.
- Additional joints should be considered in areas of high thermal gain e.g. large conservatories or glass atria.
- Across door thresholds.
- If bay sizes exceed 40m<sup>2</sup> with a maximum of 8m on any one side.

Bay joints should be formed using rigid joint formers where possible, which can be placed during the preparation phase and will remain in place during operation. The joint former should be 5mm lower than the finished screed depth to allow a smooth transition in height between bays:

- All joints in the screed should extend through to any subsequent bonded floor covering.
- Joint positions should be specified prior to the installation of the screed and full consultation between all parties including the main contractor, underfloor heating installer, finished flooring installer and the screed installer should take place to determine appropriate locations.
- Movement joints should be carried through the subfloor to the floor finish and all applied layers terminated either side of the joint.
- The joint should be filled with a suitable flexible filler and a proprietary cover strip applied to cover the joint. Grout must not be used.
- Movement joints should not be bridged by any resilient, textile or other adhered floor finish.
- Movement joint covers may be flush, surface mounted or bedded in mortar and metal, metal with a rubber insert or PVC.

### Provision of edge strip perimeter expansion joint

When incorporating under floor heating (UFH):

- Screeds should be isolated at all edges, abutments and columns to allow for movement due to thermal loadings.
- The floor screed and finished floor manufacturers guidance to be followed particularly when incorporating under-floor heating to determine the minimum thickness of edge strip required to allow for expansion. Typically, between 6-15mm may be required.
- The joint can be concealed by the skirting.
- These joints must be left empty, or else filled with a compressible material.
- Movement joints must not be filled with grout.

### Screed drying time

- The drying time allowed must be calculated for the proposed depth of screed, taking account of the environmental conditions present e.g. temperature and humidity. Where polymer modified type screeds are being used the manufacturer's requirements must be strictly followed for the actual depth of screed. Surface finishes placed on a screed too early will fail.
- Drying times for polymer modified screeds could potentially be different to cementitious screeds.
- All subcontractors involved with the screed and floor finishes (including installation of underfloor heating systems) must follow the installation requirements and not deviate or change materials.
- The screed should not be walked on until fully cured.

### UFH testing and commissioning

- Ensure there are no joints in the heating system loops.
- UFH systems should be commissioned before floor finishes are applied. This will add to the total time before any floor finish can be applied. If floor finishes are installed prior to the UFH being turned on and commissioned, any residual moisture in the floor is driven to the surface of the screed and can potentially cause delamination of the floor finish.
- Pressure testing of the system does not constitute commissioning of the system. The heat source has to be in place and operating in order to deliver the correct temperatures.
- The UFH system must be commissioned in accordance with the manufacturer's recommendations by their approved installers. A commissioning certificate will be required.

### Moisture testing of the screed where floor finishes are proposed

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- Moisture testing should be carried out after the commissioning of the UFH system but before any floor finishes are laid.
- Where UFH is not installed, moisture testing of the screed should still be carried out before floor finishes are installed.
- Moisture testing is carried out using a suitable approved method such as a flooring hygrometer or carbide bomb test. Due to the potential inaccuracies of using hygrometers at high humidity levels, a direct measurement should be used such as Carbide Bomb or oven dried sample.
- The base is deemed to be sufficiently dry when the relative humidity, as measured by a surface mounted flooring hygrometer/probe is 75% RH or less. For the use of a flooring hygrometer, reference should be made to dampness testing in BS 5325, BS 8203, BS 8425 and BS 8201.
- If underfloor heating is present in the base, the heating must be switched off 96 hours prior to any hygrometer test being carried out.
- The hygrometer must be allowed to remain in position until full equilibrium has been established. This is generally considered to be 72 hours but could be longer over thick sections and considerably longer on power floated concrete.

### Screed preparation for finishes

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- The top surface of screeds may require to be scored, sanded or keyed in preparation to accept the primer and floor finish.
- Preparation of the screed surface allows the penetration of primers. It also provides a "key" for the adhesive to grip onto.
- The surface must then be cleared of dirt and debris prior to primers being applied.
- Any primers and adhesives must not be applied until the screed has fully hardened and dried out. Drying times vary depending on the type of screed.
- Surfaces to receive fixed floor finishes should be rigid, dimensionally stable, flat with no dips and rises, sound, clean and free from laitance, paints, salts, grease, dust and any contamination which may prevent adhesion.

### Adhering to the manufacturer's process during the installation of the flooring finish

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All the relevant manufacturers recommendations should be followed which will identify timelines to adhere i.e:

- Removing the laitance by sanding to provide a key for the primer and/or adhesive.
- Commissioning the underfloor heating before installing the fixed floor finish.
- Allowing the UFH system to cool down for at least 48 hours before installing the fixed floor finish.
- Moisture testing to confirm the dryness of the screed before installing the fixed floor finish.
- Ensuring the time from screed completion to installing the fixed floor finish commencement is calculated and adhered to.
- Ensure the fixing of the finished floor finish has stabilized before walking on. Some finishes require typically 12-24 hours dependent on environmental conditions.
- Ensure the UFH system is not turned on for at least 48 hours after any adhered floor finish is completed.
- If an anhydrite screed is used, it must be sealed before the application of a cement based floor finish adhesive if proposed in conjunction with a finished floor surface covering.

### Exceeding the maximum 27°C floor temperature

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The underfloor heating system must be correctly commissioned to ensure temperature fluctuations are avoided and potential damage to the floor finishes.

BS 8203 Code of Practice for the Installation of Resilient Floor Coverings states: When used with many flooring materials underfloor heating can cause problems if the temperature at the interface between the subfloor and flooring exceeds 27°C, or is subject to rapid fluctuations in temperature.

Where a resilient floor covering is proposed: 'the temperature should never exceed the agreed maximum of 27°C at the underside of the floor covering (the adhesive line).

#### Notes:

- UFH designers may refer to this as the 'interface' temperature.
- BS EN 1264 - 2 refers to a max 29°C however for Warranty purposes a maximum 27°C is to be followed.

### End user information

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End users must be aware of how to use an UFH system, as these need to be operated differently than other heating systems both for in use and to avoid damage to screeds and finishes. The end user should also be made aware of any obligations to manage an appropriate inspection, servicing and maintenance regime for the installed system.

# 5.

## Drainage

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### Contents

|     |                       |    |
|-----|-----------------------|----|
| 5.1 | Above Ground Drainage | 94 |
| 5.2 | Below Ground Drainage | 99 |

## Introduction

This section provides guidance on meeting the performance requirements for above ground foul and surface water drainage systems.

### 5.1.1 Compliance

Above ground drainage systems shall meet the performance requirements of this section.

### 5.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Proposed drainage layouts including invert levels, gradients, pipe diameters, location of inspection chambers and rodding points.
2. Position of ventilation to the foul drain.
3. Specification of drainage pipes and supports.
4. Location and size of cold water storage cisterns and hot water storage cylinders.
5. Hot and cold water pipe runs.
6. Areas of roof drained to each gutter.
7. Downpipe and/or drainage hopper positions from roof.
8. Positions of hazards e.g. Flues, opening windows/doors.
9. Location of below ground surface water/storm drainage connections.
10. Rodding access provision.
11. Downpipe outlet positions - avoiding potential water ingress/splashing of external walls etc.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 5.1.3 Material specification

Materials and components shall:

- Be durable.
- Be fit for purpose.
- Be installed in accordance with the manufacturer's recommendations.
- Be constructed using non-hazardous materials.
- Satisfy the requirements of the relevant Building Regulations.
- Be suitable for exposure to sunlight without early degradation where materials are used externally.

## Foul drainage

The materials and components used for sanitary pipework, e.g. pipes, fittings and fixing accessories, should be proven to be suitable for their intended purpose and comply with BS EN 12056 parts 1, 2 and 5. For further guidance on suitability of products, please refer to 'Appendix C'.

## Surface water drainage

The materials and components used for rainwater drainage systems should be proven to be suitable for their intended purpose and comply with BS EN 12056 part 3. For further guidance on suitability of products, please refer to 'Appendix C'.

## Coastal locations

Where developments fall under the Warranty definition of a coastal location (see 'Appendix B'), the requirements of 'Appendix B' should also be satisfied.

### 5.1.4 Design and layout

All above ground drainage systems shall:

- Be designed to allow the unobstructed flow of waste water and surface water to an underground drainage system. The drainage system shall be adequately accessible for inspection and cleaning.
- Prevent the entry of hazardous ground substances, external moisture or vermin into the building.
- Not adversely affect the structural stability of the building.
- Be installed in accordance with manufacturer's recommendations and the design requirements.
- Meet the requirements of the Building Regulations.

## Foul drainage

The overall design of the drainage system should be in accordance with BS EN 12056. The above ground drainage should be connected to a suitable underground drainage system. In addition, the following should be satisfied:

- Provide rodding access facilities at all changes of direction.
- Avoid bends, connections and changes of direction in the wet part of the above ground drainage system.
- Pipe sizes should be adequate to take the expected rate of discharge and load at suitable gradients with the minimum of direction changes.
- Pipe sizes should not exceed the dimensions for diameter against pipe length.
- Pipes should be laid at gradient 1:80 or better and adequately supported to prevent sagging and back falls.
- Minimum trap sizes and seal depths should be in accordance with the Building Regulations.
- Sanitary pipework must be adequately supported (see table 1).
- Provision for expansion in the pipework must be given both in vertical pipes and branch/waste pipes (see table 2).
- The highest point of a drainage system (head of run) should always be vented to the external air.
- A soil or ventilation pipe should extend at least 900mm above an opening if it is less than 3m away from an opening into the building.
- The drains should be adequately protected from ground loads and movement in the building structure.
- Drains and pipes passing through the external waterproof envelope of the building or through the underground walls must be suitably sealed to prevent vermin ingress and dampness.
- Sound insulation will be necessary where soil pipes pass through rooms, to the underground connection. This can be achieved by:
  - Encasing the pipework within a boxed in framework with a minimum 15kg/m<sup>2</sup> board covering, **or**
  - Wrapping the pipework with mineral wool fibre at least 25mm thick, throughout the height of the pipe - up to the highest ceiling level.

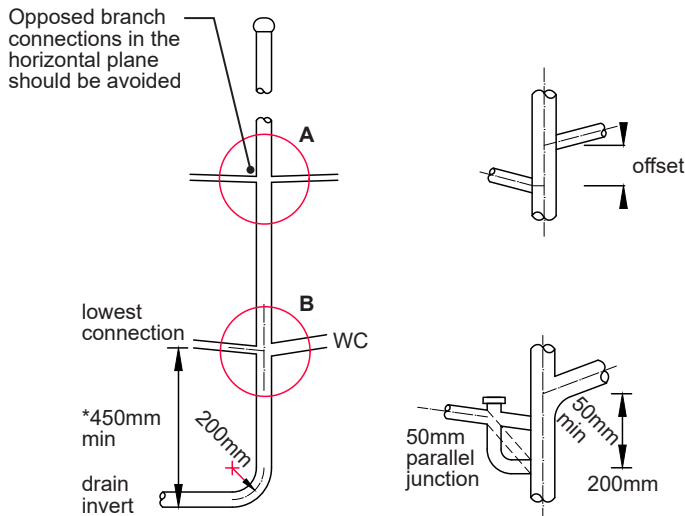
| Table 1: Maximum distance between sanitary pipe supports |                  |                |                    |
|----------------------------------------------------------|------------------|----------------|--------------------|
| Pipe material                                            | Normal pipe size | Vertical pipes | Low gradient pipes |
| Plastics (any type)                                      | 32mm to 40mm     | 1.2m           | 0.5m               |
|                                                          | 50mm             | 1.2m           | 0.6m               |
|                                                          | 75mm to 100mm    | 1.8m           | 0.9m               |
|                                                          | 150mm            | 1.8m           | 1.2m               |
| Cast iron                                                | All sizes        | 3.0m           | 3.0m               |
| Copper                                                   | 25mm             | 2.4m           | 1.8m               |
|                                                          | 32mm to 40mm     | 3.0m           | 2.4m               |
|                                                          | 50mm             | 3.0m           | 2.7m               |
|                                                          | 65mm to 100mm    | 3.7m           | 3.0m               |
| Galvanised steel                                         | 25mm             | 3.0m           | 2.4m               |
|                                                          | 32mm             | 3.0m           | 2.7m               |
|                                                          | 40mm to 50mm     | 3.7m           | 3.0m               |
|                                                          | 65mm to 75mm     | 4.6m           | 3.7m               |
|                                                          | 100mm            | 4.6m           | 4.0m               |

| Table 2: Design for thermal movement in runs of waste pipes                                                                                                                                                                                                                                                                                                                    |                                                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| Fitting type                                                                                                                                                                                                                                                                                                                                                                   | Movement provision                                                                                                        |
| Push fit                                                                                                                                                                                                                                                                                                                                                                       | Push fit joints should be assembled with clearance for expansion. Check expected movement and relate to number of joints. |
| Solvent-welded joints                                                                                                                                                                                                                                                                                                                                                          | Provide 'push-fit' couplings at calculated intervals, but not exceeding 1.8m.                                             |
| Notes:<br>1. The manufacturer's recommendations should be followed in respect of provision of movement (Polypropylene pipe work can expand more than UPVC pipework for the same length).<br>2. Ensure 'push-fit' joints are lubricated before assembly with specified lubricant that is approved for the pipe type.<br>3. Sleeve wastes through walls to permit pipe movement. |                                                                                                                           |

## Position of connections to soil stacks

A branch creates a no connection zone on a stack. No other branch may be fitted such that its centre line falls inside a zone, but its centre line may be on the boundary of the zone.





### Key

**A** - Opposed connections without swept entries not exceeding 65mm should be offset:

- 10mm on a 100mm stack.
- 250mm on a 150mm diameter stack.

Opposed connections larger than 65mm (without swept entries) should be offset at least 200mm irrespective of stack diameter. Unopposed connections may be at any position.

**B** - Angled connection or 50mm diameter parallel junction where a branch discharge pipe would enter the WC no connection zone.

Note: A waste (branch discharge pipe) manifold may be a suitable alternative.

\*this should be increased in buildings over 3 stories.

### Openings for pipes in fire resisting floors and walls

Pipes which pass internally through fire resisting floors and walls (unless in a protected shaft) must not compromise the required fire resistance of the element through which they pass. As a minimum, openings through floors and walls should be as few as possible in number, as small as practicable in size and fire-stopped to the surrounding construction.

The relevant Building Regulations should be consulted with for guidance on pipes passing through compartment walls and floors.

### Air admittance valve

Where air admittance valves are used to terminate soil pipes, they should comply with BS EN 12380 and have a current third party product conformity certificate and be used within the scope of that approval certificate.

Valves within the building should be:

- Positioned in areas with adequate ventilation. Where the pipes and valve are boxed in, adequate means of ventilation will be required by means of grilles or gaps. The amount of ventilation provided should be at least 2500mm<sup>2</sup> or whatever specified by the manufacturer.
- Positioned in areas that are not liable to freezing.
- Located above the highest flood level of any appliance connected to that stack pipe.
- Accessible for maintenance.

If the discharge stack provides the only ventilation to septic tanks or cesspits, the connecting drain is subject to periodic surcharging or is fitted with intercepting traps, air admittance valves are not suitable for providing ventilation in these circumstances.

### Sanitary fittings

Wash basins (WHB), baths, bidets, shower trays:

- Should be securely fixed with appropriate non rusting fixings.
- Floors should be capable of carrying the weight of the appliance.
- Excessive packing must be avoided.
- Must be connected to the drainage system and where applicable an appropriate water supply.

Where WC's, WHB's, baths and shower units are installed; where tiling is installed around these appliances, flexible waterproof mould resisting flexible sealant should be used to accommodate any movement between the appliance and tiles.

Baths and shower units should be correctly supported so that when in use the fittings will not deflect excessively and pull on the mastic seal.

Floor joists should be doubled up under the bath locations. Where heavier baths (e.g. cast iron baths or similar) are proposed, the floor joists must be designed to take the additional loadings and joist feet located over the joists.

### Macerators and pumps

When installing macerators and such pumps to above ground drainage the following must be considered:

- The electrical installation must be carried out by a qualified person.
- The system must be installed in accordance with the manufacturer's guidance.
- The system should be flushed through several times after installation and prior to first use.
- The client will need to be provided with details of appropriate maintenance, servicing and cleaning for the system on completion of the installation.

### Surface water drainage

The overall design of the drainage system should be in accordance with BS EN 12056-3. The exception would be where we require a higher standard. The above ground drainage should be connected to a suitable underground drainage system.

### Calculation of roof area and, gutter and outlet sizes

The effective design area of a drained roof / balcony area should be determined using Table 3. If the roof area is greater than 6m<sup>2</sup>, a roof will need to be provided with rainwater gutters and rainwater downpipes (RWP) that meet the minimum size requirements shown in Table 4.

Where a roof area is less than 6m<sup>2</sup>, thought should also be provided to the provision of rainwater drainage of such roof areas e.g. dormer roofs so as to ensure rainwater will be effectively disposed and not cause potential for damage and resulting water ingress into the building.

Note: Roof areas e.g. flat roofs, which are less than 6m<sup>2</sup> will still require to be laid to a fall.

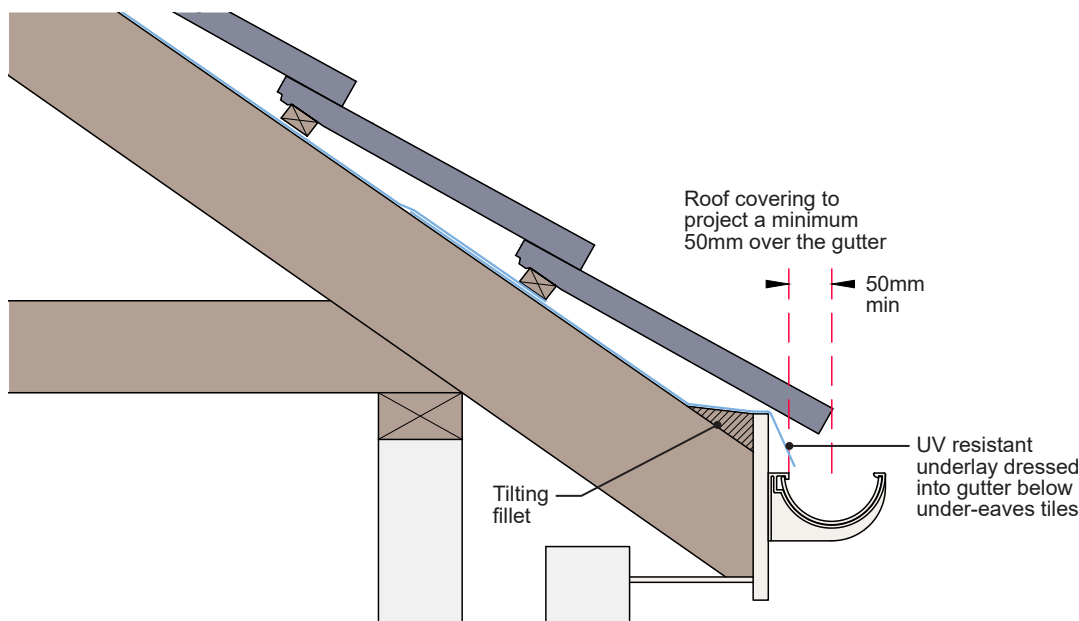
| Table 3: Calculation of roof area |                        |
|-----------------------------------|------------------------|
| Type of surface area              | Effective design area  |
| Balcony areas                     | Plan area              |
| Flat roof plan                    | Area of roof           |
| 30° roof pitch plan               | Area x 1.29            |
| 45° roof pitch plan               | Area x 1.5             |
| 60° roof pitch plan               | Area x 1.87            |
| Pitched roof over 70° or any wall | Elevational area x 0.5 |

| Table 4: Gutter sizes and outlet sizes |                        |                            |                 |
|----------------------------------------|------------------------|----------------------------|-----------------|
| Max effective roof area                | Gutter size (diameter) | RWP outlet size (diameter) | Flow capacity   |
| 6m <sup>2</sup>                        | -                      | -                          | -               |
| 18m <sup>2</sup>                       | 75mm                   | 50mm                       | 0.38 litres/sec |
| 37m <sup>2</sup>                       | 100mm                  | 63mm                       | 0.78 litres/sec |
| 53m <sup>2</sup>                       | 115mm                  | 63mm                       | 1.11 litres/sec |
| 65m <sup>2</sup>                       | 125mm                  | 75mm                       | 1.37 litres/sec |
| 103m <sup>2</sup>                      | 150mm                  | 89mm                       | 2.16 litres/sec |

## Gutters

- Gutters should be laid to a nominal gradient of between 1mm over 1m and 3mm over 1m where practicable.
- The gradient of an eaves gutter shall not be so steep that the gutter drops below the level of the roof to such an extent that water discharging from the roof will pass over the front edge of the gutter.
- Gutters should be fixed with the centre line vertically below the edge of the roof covering. Pitched roof UV resistant underlay should dress over the gutter.
- Gutters must be adequately supported and not sag. Fascia or rafter brackets should be typically no more than 1m apart or as recommended by the manufacturer.
- Additional support for gutters will be required at angles, corners, and outlet positions.
- Gutters should be laid so that any overflow in excess of the design capacity - caused by extreme conditions such as above normal rainfall, will be discharged clear of the building. On flat roofs, balconies, valley gutters and parapet gutters, additional outlets may be necessary.
- In areas where snow lies on roofs, the front edge of the gutter should not be higher than the projected line of the roof, unless snow guards or other precautions are used.
- Gutters should have stop ends fitted.
- Gutters should be designed to deal with concentrated loads e.g. from nearby downpipes discharging water from higher level roof areas such as dormers.

## Tile edge over gutter centre line



**Downpipes**

- Discharge of gutters into downpipes can be substantially improved by the careful location of downpipes:
  - Locating downpipes at end quarter positions will double the flow capacity if more than one downpipe is required.
  - The downpipe should be located within 200mm of the change in direction in order to maintain the flow capacity of the gutter where changes in the line of the gutter occur.
- Downpipes must be installed plumb and supported at regular centres throughout the height of the pipework.

**Other considerations**

- Ensure that joints in gutters, gutter outlets and downpipes are sealed in accordance with the manufacturer's recommendations.
- Gutters and downpipes must be installed to allow for thermal movement. Joint gaps must be to the manufacturers recommendations.
- Outlets should be correctly positioned relative to gullies.
- Where a rainwater downpipe discharges into a gully, it should terminate below the gully grating but above the water seal, preferably by the use of a back inlet.
- Sanitary pipework must not be connected/discharge into the surface water/storm drainage system.
- Pipework shall not reduce in diameter in the direction of flow, except in the case of siphonic systems.
- Siphonic roof drainage systems should be designed in accordance with BS EN 12056-3.
- Rainwater pipes from higher roof levels should not discharge onto a lower flat roof or balcony.

**Additional requirements for flat roofs and balconies**

(Please also refer to the 'Roofs - Flat Roofs' and 'Roof Terraces and Balconies' section)

- To ensure effective drainage of the 'roof area', balcony decking or other finish laid over the waterproof roof covering must not restrict water flow to the rainwater outlets e.g. decking supports must not be laid across the fall of the roof.
- Flat roofs and balconies must be designed and constructed to have a finished fall (allowing for deflection in the construction) of no less than 1:80.
- The roof area should fall away from a wall that contains any door/window opening and a minimum upstand of 150mm provided between the waterproof decking and the underside of the opening.
- Tapered insulation and 'crickets' must only be designed and manufactured by the insulation manufacturer (not cut to fall on site).

Rainwater outlets must be:

- Recessed and not stand proud above the flat roof water proof covering; to ensure water will flow freely into the outlet.
- Be accessible for maintenance (any decking above the outlet must easily be removable).
- Sized and be of sufficient numbers and position to deal with the local rainfall intensity in accordance with BS EN 12056-3.
- There must be 2 outlets (or one outlet plus one overflow) where the flat roof/balcony has an upstand to all sides.
- Drainage from roof gardens should enable inspection and access to the outlet and shall incorporate means of excluding soil and debris from entering the roof drainage system.
- Drainage outlets, formed through parapet walls, must be constructed with secondary protection to prevent water ingress into the wall structure.
- Drainage outlets, formed through parapet walls in timber framed construction where the outer leaf is masonry, must allow for shrinkage in the timber frame i.e. the frame will settle but the outer leaf will not, therefore a backfall could result in the outlet.

## Introduction

This section provides guidance on meeting the performance requirements for below ground foul and surface water drainage systems.

### 5.2.1 Compliance

Below ground drainage systems shall meet the performance requirements of this section.

### 5.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Position of soil stacks.
2. Location of foul drain connections and drainage runs.
3. Location of suitable outfall.
4. Proposed drainage layouts including invert levels, gradients, pipe diameters, location of inspection chambers and rodding points.
5. Where existing drains are retained, a CCTV survey will be required.
6. Position of any septic tank or packaged treatment plant in relation to adjacent buildings.
7. Where drainage fields are used, we would require:
  - a. Details of their layout, including length and depth.
  - b. Details of the trench width.
  - c. Site investigation report confirming the ground is suitable for a drainage field.
  - d. Results of percolation tests where treated effluent disposal is through a drainage field
8. Where soakaways are used, we require the following information:
  - a. Location of the soakaway in relation to any adjacent buildings.
  - b. Site investigation report confirming the ground is suitable for a soakaway.
  - c. Details of an onsite percolation test confirming the permeability of the ground.
  - d. Soakaway design to BRE 365.
9. Where rain gardens are specified, we require the following information:
  - a. Location of the rain garden in relation to any adjacent buildings.
  - b. Site investigation report confirming the ground is suitable for a rain garden.
  - c. A design from a suitably qualified professional.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 5.2.3 Material specification

Materials and components shall:

- Be durable.
- Be fit for purpose.
- Be installed in accordance with the manufacturer's recommendations.
- Satisfy the requirements of the relevant Building Regulations.
- Be constructed using non-hazardous materials.

Materials and components used for the below ground drainage system should be proven to be suitable for their intended purpose and comply with relevant parts of BS EN 12056 and BS EN 752. Material should be durable and suitable for use underground.

For further guidance on suitability of products, please refer to 'Appendix C'.

### 5.2.4 Outfalls

All below ground drainage systems shall connect to a suitable approved outfall.

## Foul drainage

Foul drainage systems shall connect to a suitable approved outfall such as:

- A sewer maintained by the Local sewerage undertaker.
- A suitable private foul drainage/sewer system that leads to an adopted sewer. Connections to private foul drainage systems will require agreement of the owners of such drain/sewer.
- A septic tank or packaged treatment plant. The outfall from the septic tank should either run to a designed drainage field or a mound.

### Surface water drainage

Surface water should drain into a suitable outfall, such as:

- A sewer maintained by the local sewerage undertaker.
- A suitable private sewer system that leads to an adopted sewer. Connections to private sewer systems will require agreement of the owners of such drain/sewer.
- A soakaway or other infiltration system if ground conditions and site location permit.
- A watercourse that has consent in writing from the appropriate regional agency; to allow or limit the rate of discharge. Consent from the EA, NIEA or LA means a clear confirmation in writing that they will allow discharge to the designated outfall for the period of Warranty cover.

Surface water drainage systems includes water from roofs, drives, paths and certain hard standing areas.

Drainage from impervious surfaces such as drives, paths and hard standings must drain to a suitable rain water drainage system or to a permeable area within the garden providing it is free draining.

Surface water drainage systems should generally be separated from foul drainage systems.

### 5.2.5 Drainage system design

All below ground drainage systems shall be designed to allow the unobstructed flow of foul and surface water.

The drainage system shall not adversely affect the structural stability of the building and shall prevent the entry of hazardous ground substances, external moisture or vermin.

Below ground drainage systems shall meet the requirements of the Building Regulations.

### Laying of pipes and minimum gradients

- Pipes should be laid to an even gradient (see table 1 or 2), and significant changes in gradient should be combined with an access point.
- Pipes should be laid in straight lines, but may be laid to slight curves, providing the length of drain can be effectively cleaned by the use of rods.
- Connections should be to inspection chambers or manholes, but connections to junctions are acceptable if access is provided to clear blockages. In all cases, discharge should be in the direction of flow.
- Bends should be positioned in, or adjacent to, terminal fittings, inspection chambers or manholes, and at the foot of discharge stacks. Bends should have as large a radius as practicable.
- The system should be ventilated at or near the head of each main drain to allow free passage of air throughout; the maximum length of any branch serving a single appliance being 6m, and for a group of appliances, 12m.
- Where appliances are not fitted with integral traps at the point of discharge, a trap must be provided using either a trapped gully or low back trap.
- Where existing drains are retained, a CCTV survey will be required.

**Table 1: Recommended minimum gradient of foul drains**

| Peak flow                                                                | Pipe size (diameter)   | Minimum gradient                                | Maximum capacity                                  |
|--------------------------------------------------------------------------|------------------------|-------------------------------------------------|---------------------------------------------------|
| <1 litre/sec                                                             | 75mm<br>100mm          | 1:40<br>1:40                                    | 4.1 litres/sec<br>9.2 litres/sec                  |
| > 1 litre/sec                                                            | 75mm<br>100mm<br>150mm | 1:80<br>1:80 <sup>1</sup><br>1:150 <sup>2</sup> | 2.8 litres/sec<br>6.3 litres/sec<br>15 litres/sec |
| Notes:<br><sup>1</sup> Minimum of 1 WC<br><sup>2</sup> Minimum of 5 WC's |                        |                                                 |                                                   |

**Table 2: Minimum gradient of surface water drains**

| Pipe size (diameter) | Minimum gradient |
|----------------------|------------------|
| 100mm                | 1:80             |
| 150mm                | 1:150            |

For surface water drainage systems:

- Silt traps should be incorporated where hard standings are being drained into the surface water drainage system to avoid build-up of material in the underground drains.
- Oil interceptors should be installed on car parks, or other areas where there is likely to be leakage or spillage of oil.

### Bedding and Backfill

#### Bedding

Pipes should be firmly supported throughout their length and bedded as specified in the design to resist loads from overlying fill and traffic.

## Backfill

In normal circumstances, the excavated material from the trench will be appropriate for backfilling above the chosen material. General backfill materials must be free from:

- Boulders.
- Building rubble.
- Timber.
- Vegetable matter.

Backfill needs to be positioned in layers not deeper than 300mm, and must be well compacted. When compacted backfill is at least 450mm above the crown of the pipe, only mechanical compacting should be used.

Below ground drains should not be supported on ground or fill that is susceptible to movement without adequate provision being made to:

- Maintain minimum design gradients.
- Protect against leakage.
- Protect against backfall.

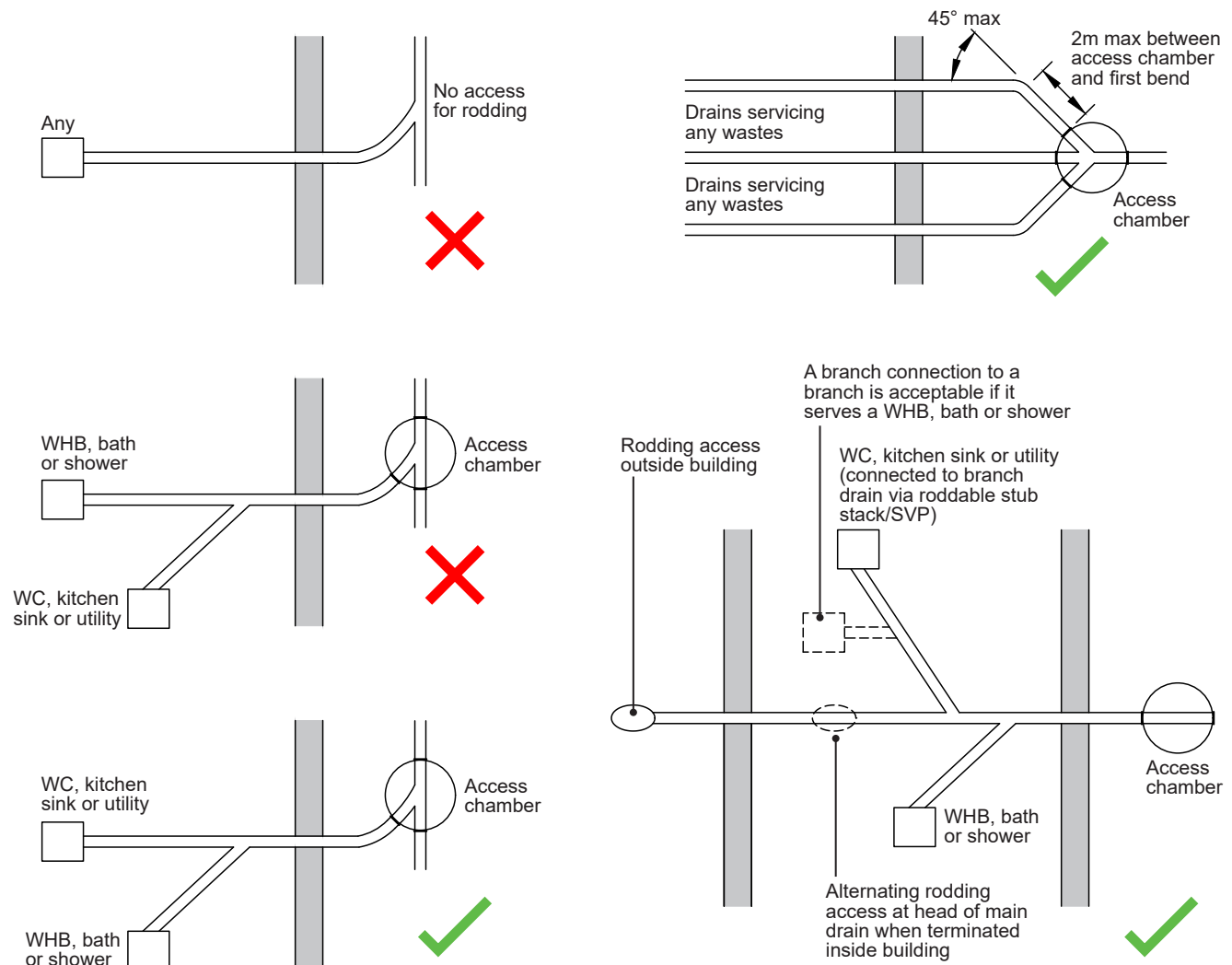
Bricks, blocks or other hard material should not be used as temporary or permanent supports for below ground drains.

## Junctions in drains under buildings

Drains under a building must be laid in straight runs – slight curves can be accepted, providing the length of the run can be effectively cleaned by the use of rods. Having junctions under a building makes it difficult to clear any blockages, however they can be accepted in some very limited circumstances.

If junctions are used below a building, they should only be used in the following circumstances:

- Where the branch drain discharges lightly soiled waste such as a wash hand basin, shower or bath, a junction may be used to connect to another drain under the building.
- The main drain should extend the full length of the building and external rodding access is provided at both ends of the main drain (see diagram for further details).
- If this is not achievable, an alternative rodding access point can be provided of the head of the main drain which terminates inside the building.
- Branch drains carrying heavily soiled waste are provided with a roddable stub stack. This should not involve removing any sanitary fittings or boxing (so an access plate should be provided).



### Access and connections

Suitable access must be provided to every length of drain to allow rodding access to deal with potential blockages.

Depending on the depth and position of the drain, one of the following should be provided:

- Rodding eye - capped extensions of pipes.
- Access chamber - small chambers on (or an extension of) the pipes but not with an open channel.
- Inspection chamber - chambers with working space at ground level.
- Manhole - deep chambers with working space at drain level.

The installation of access points must not impede the flow of waste and allow connections onto main runs to be in the direction of flow and not against it.

Access points must be provided:

- On or near the head of each drain run, **and**
- At a bend and change of gradient, **and**
- At junctions unless each run can be cleared from an access point (some junctions can only be rodded through from one direction).

Minimum dimensions for access fittings, inspection chambers and manholes can be referenced in the guidance supporting the relevant Building Regulations.

Inspection chambers and manholes should have removable non-ventilating covers of durable material (such as cast iron, cast or pressed steel, precast concrete or plastics) and be of a suitable strength for its location e.g. access points on driveways will require heavier duty covers than those in a garden.

Small lightweight covers should be secured to deter unauthorised access.

Access points within buildings should have mechanically fixed airtight covers.

### Drainage system covers

Drainage system access point covers in hard standing areas should be level with the adjacent ground level.

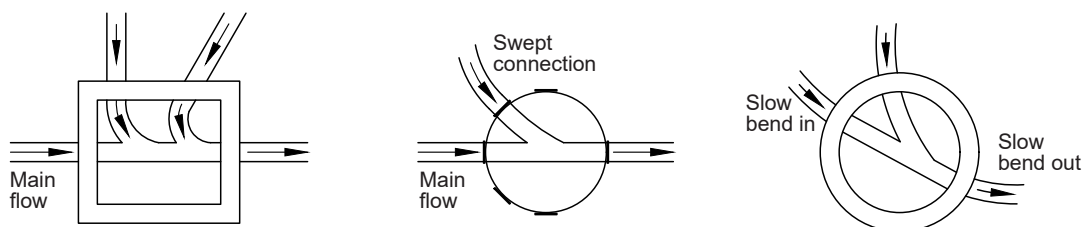
Access covers in garden areas should not be covered over by the soil/turf.

Construction of access points should be with one of the following materials and must be capable of containing the foul water under working and test conditions.

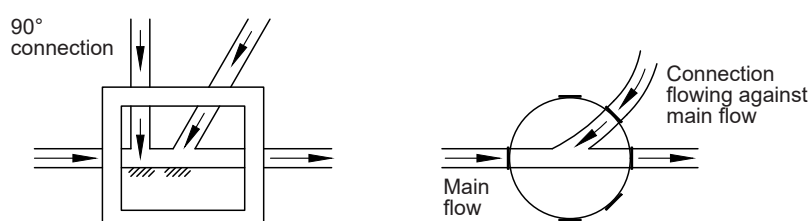
| Materials for access points (inspection chambers and manholes) | British Standard |
|----------------------------------------------------------------|------------------|
| Clay bricks and blocks                                         | BS 3921          |
| Vitrified clay                                                 | BS EN 295, BS 65 |
| Concrete - precast                                             | BS 5911          |
| Concrete - in-situ                                             | BS 8110          |
| Plastics                                                       | BS 7158          |

Rodding eyes and access fittings (excluding frames and covers) shall have an ETA or third party product conformity certificate.

### Swept connections into flow of drains – Acceptable



### Connections against flow of main drain - Not Acceptable





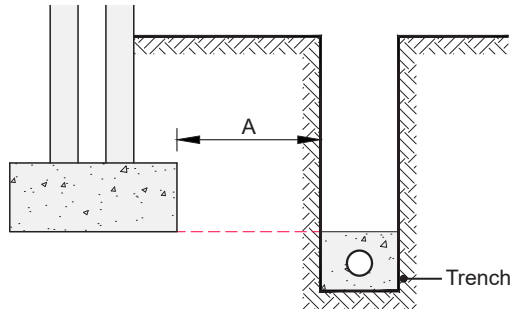
## Protection of pipes and other components

### Protection of pipes adjacent to foundations

Drains are to be located so that foundation loads are not transmitted to pipes. Where drainage trenches are located near to foundations, foundation depths should be increased or the drain re-routed further from the foundations.

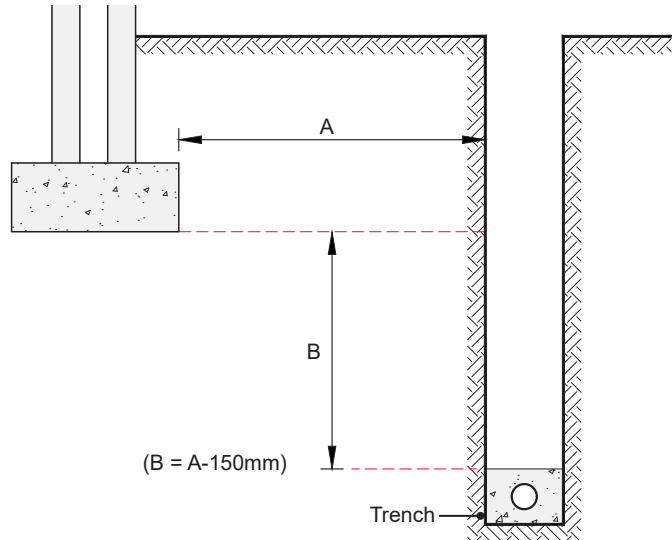
Where it is not physically practical to locate drains so they are not impacted by foundation loads, the pipes should be protected. Examples of how the pipes may be protected are given below:

#### Scenario 1 - where A is less than 1m



Where the trench is within 1m of the foundation, the trench is to be filled with concrete up to the lowest level of the foundation.

#### Scenario 2 - where A is 1m or greater



Where the trench is 1m or further from the foundation, the trench is to be filled with concrete up to measurement B as shown above.

### Ground movement

Drainage trench excavations should be taken down to solid ground, but when this is not possible, the drainage system should be designed to accommodate any movement and made-up ground with a well-compacted backfill to the required formation levels.

Where ground movement is likely to occur, flexible drainage systems should be provided, e.g. filled sites, mining areas and sites with shrinkable clay.

### Additional requirements for drains near trees

Drainage near trees should incorporate additional provisions where there is a volume change potential within the ground. Provisions include:

- Increased falls to cater for any ground movement.
- Deeper and wider backfill of granular material.
- A drainage system that is capable of movement should heave and shrinkage occur.
- Drainage pipes should not be encased in concrete.
- Additional clearance is required where drains pass through the structure of a building to allow for additional movement.

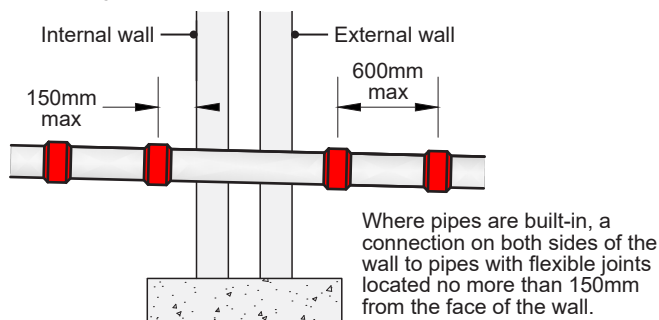
Where possible, avoid passing adjacent to tree roots. Adequate precautions should be taken where this cannot be avoided.

### Drains and services passing through walls

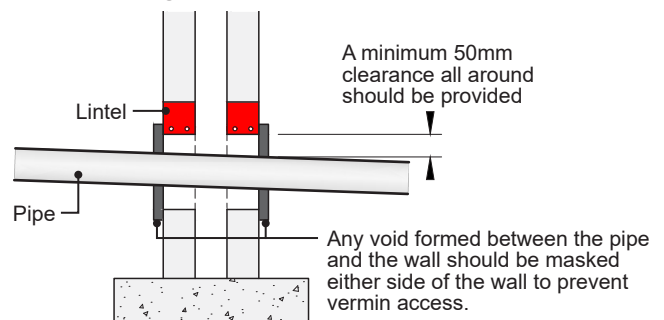
Walls should accommodate movement where drains pass through substructure by:

- Providing a minimum 50mm clearance all around or a sleeve with a 50mm clearance, or
- (If built in) A connection on both sides of the wall to pipes with flexible joints located no more than 150mm from the face of the wall.
- Any void formed between the pipe and the wall should be masked either side of the wall to prevent vermin access.

#### Flexible jointed pipes (rockers) either side of built in pipe



#### Lintel openings over pipes





### Protection of pipes and other components during construction works

The drainage system, including manholes, gullies, pipe connections, etc. should be protected from damage throughout the course of the construction works.

### Pumped systems

Pumped systems are acceptable where a gravity system is not possible. Pumped systems should be in accordance with BS EN 752 and BS EN 16932. Installations should include:

- A suitable warning system to indicate malfunction.
- A holding tank of sufficient volume to contain 24 hours of domestic effluent based on 120L/150L per head per day.

### Pump chamber design

The pump chamber must be properly designed for the depth including any concrete backfill support to ensure loads from water pressure, parking and other external loads are fully catered for. The depth of the chamber must also be taken account in the design.

### Testing

All foul and surface water drainage systems shall be adequately watertight and tested, where required by:

- The Warranty provider.
- The sewerage undertaker.
- The local authority.

### Requirements for septic tanks systems

#### Suitable outfalls

Septic tanks require a suitable outfall for treated effluent discharge which should be agreed with the relevant authority. The outfall from the septic tank should either run to a designed drainage field or a mound.

Surface water/storm water should not discharge into the septic tank or water treatment plant and should be directed to a suitably designed soakaway or sewer.

Percolation drainage fields for treatment and outfall drainage plants should not be situated uphill of dwellings.

#### Percolation tests

Where the septic tank or treatment plant discharges to drainage field or mound, suitable percolation tests should be provided in conjunction with the drainage design. The test should be carried out with at least two trial holes. The average figure from the tests should be taken. The test should not be carried out during abnormal weather conditions such as heavy rain, severe frost or drought.

#### Location of septic tanks

Septic tanks should be sited at least 7m from any habitable parts of the building and downslope. Septic tanks should have a minimum capacity of at least 2,700 litres below the level of the inlet, for up to 4 users. The size should be increased by at least 180 litres for each additional user.

Where they are to be emptied using a tanker, the septic tank should be sited within 30m of a vehicle access provided that the invert access does not exceed 3m below the level of vehicle access. Where the depth of the invert access exceed 3m this distance may need to be reduced.

Where possible tanks should not be located beneath vehicle access points unless adequate precautions are undertaken.

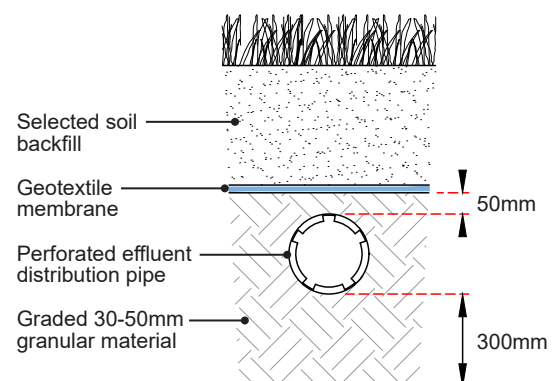
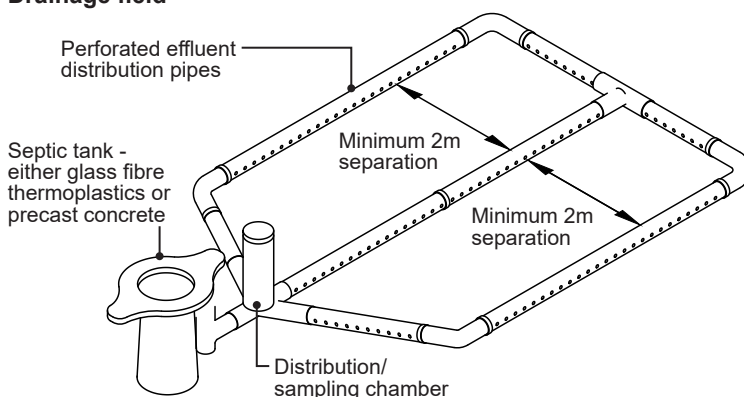
Septic tanks should be designed and constructed in accordance with the relevant Building Regulations.

### Drainage fields and drainage mounds

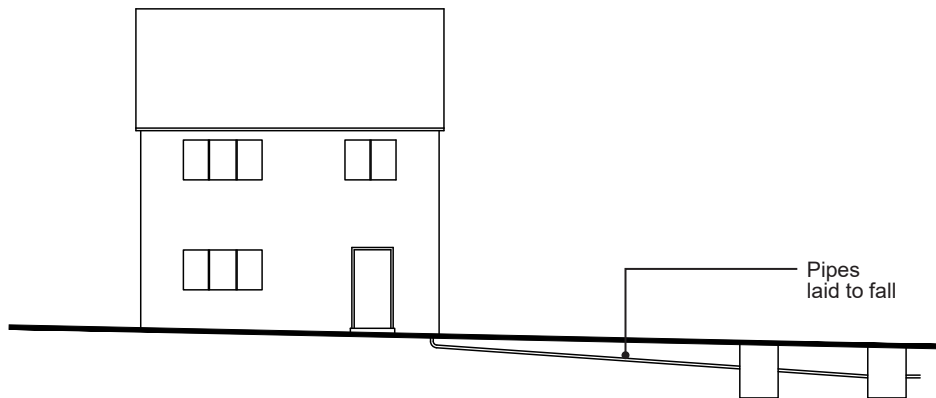
Drainage fields should meet the requirements of BS 6297. A drainage field or mound serving a wastewater treatment plant or septic tank should be located:

- At least 10m from any watercourse or permeable drain.
- At least 50m from the point of abstraction of any ground water supply and not in any zone 1 groundwater protection zone.
- At least 15m from any building.
- Sufficiently far from any other drainage fields, drainage mounds, soakaways or other ground infiltration system so that the overall soakage capacity of the ground is not exceeded.

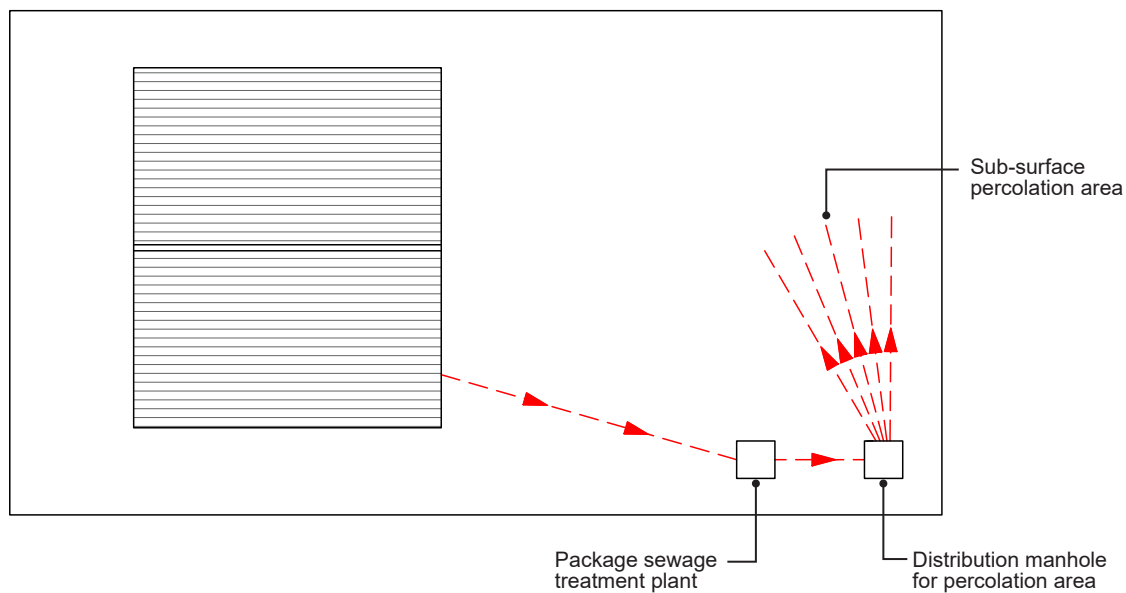
#### Drainage field



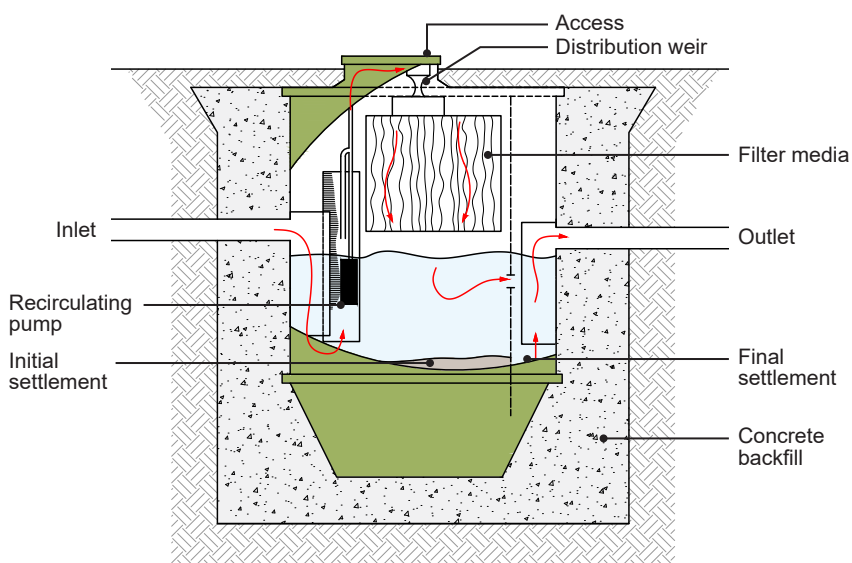
Typical sewage treatment plant (section)



Typical sewage treatment plant (plan)



Typical sewage treatment plant



### Requirements for packaged treatment plants

- Packaged treatment plants should meet the requirements of BS EN 12566 and have a suitable third party product conformity certificate.
- Packaged treatment plants require a suitable outfall to discharge to which should be agreed with the relevant authority.
- The discharge from the waste water treatment plant should be sited at least 10m away from watercourses and any other buildings.
- Where packaged treatment plants require power to operate it should be able to adequately function without power for up to 6 hours or have uninterruptible power supply.

### Requirements for soakaways

Soakaways are a simple way of percolating surface and storm water into the surrounding ground. Soakaways are part of the Sustainable Urban Drainage Systems (SuDS) technologies that handle storm water at the source rather than leading it into the public sewer systems.

Where soakaways are proposed, the Warranty surveyor must be provided with:

- A site investigation confirming the ground is suitable for a soakaway.
- Details of soakaway design in accordance with BRE Digest 365.
- An on-site percolation test confirming the permeability of the ground.

### Site conditions

Soakaways can only be considered in permeable conditions. A suitable site must be:

- In a location lower than or sloping away from the area being drained.
- At least 5m away from any building (BS 8301).
- Situated so that it will not saturate the foundations of any structure.
- Situated so that the base of any soakaway/infiltration system is permanently above the water table.
- Situated far enough away from other soakaways, infiltration systems or SuDS to ensure that the capacity of those other systems and the ground itself is not impaired.
- Situated so that there is no risk of contamination from pollutants.

### Soakaways where chalk is prevalent

For sites where chalk is prevalent, the CIRIA C574 Engineering in Chalk 2002 publication gives the following recommendations:

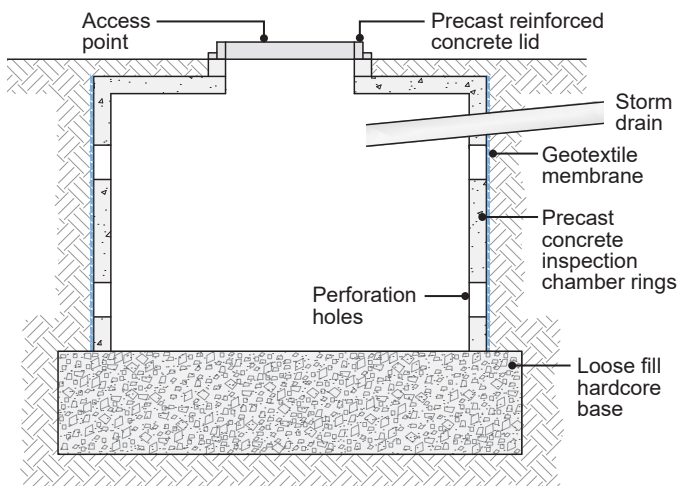
Concentrated ingress of water into the chalk can initiate new dissolution features, particularly in low-density chalk, and destabilise the loose backfill of existing ones. For this reason, any soakaways should be sited well away from foundations for structures or roads, as indicated below:

- In areas where dissolution features are known to be prevalent, soakaways should be avoided if at all possible but, if unavoidable, should be sited at least 20m away from any foundations.
- Where the chalk is of low density, or its density is not known, soakaways should be sited at least 10m away from any foundations.
- For drainage systems, flexible jointed pipes should be used wherever possible; particular care should be taken for the avoidance of leaks in both water supply and drainage pipe work.
- As the chalk is a vitally important aquifer, the Environment Agency and Local Authority must be consulted when planning soakaway installations where chalk lies below the site, even where it is mantled with superficial deposits.

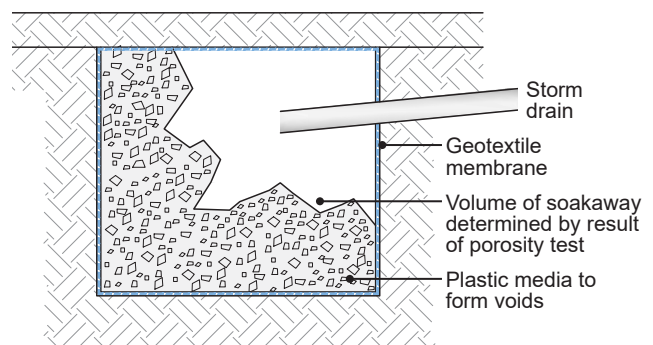
### Layout of land drains

Drain runs on sloping sites need to be positioned perpendicular to the fall of the site. Land drains should be positioned adjacent to paths, drives and outbuildings. The pipe soffit should be positioned at least 400mm below the finished ground level, and the backfill consolidated to the same degree of compaction as the adjacent soil.

### Chamber-type soakaway



### Typical soakaway design



## Requirements for rain gardens

For the purposes of Warranty, a rain garden is a small bio-retention systems that serves part of a single property surface water and storm water disposal system. They can be shallow landscaped depressions or raised component features designed to manage rainwater runoff, and treat rainwater through engineered soils and vegetation.

Rain gardens will require a positive drainage system and positioning to avoid impacting on the building foundations.

Detailed rain garden design proposals must be provided to demonstrate:

- The ability to deal with everyday rainwater discharge from the building.
- Adequacy to manage with extreme rainfall and runoff to receiving watercourses or outfalls.
- Rain gardens must have an overflow which discharges into the surface water system.
- Be correctly positioned in relation to the local topography, ground conditions and avoid potential damage to adjacent buildings.
- That a suitable maintenance plan is in place which is detailed in the handover pack to the homeowner clearly outlining the homeowners responsibilities.

As with all surface water ground filtration systems, the location of the water garden in relation to a building must avoid the potential for foundation movement to any building foundations.

Therefore for Warranty provision:

- If constructed on a sloping site, they must be positioned 'downhill' of the adjacent building.
- Any designs received where a rain garden is located nearer than 5.0m will require a detailed hydraulic design proposal by a SuDs qualified drainage engineer to demonstrate the rain garden will not pose a risk to the building foundations.

Guidance given in The SuDs Manual (CIRIA 753) Parts B; Design Philosophy and Part E: Supporting Guidance may be followed and a detailed proposal by the drainage engineer must be submitted at least 8 weeks before drainage works commences on site.

In situations where a rain garden is positioned on a building structure, additional guidance for waterproofing the structure is provided in the 'Roof - Green roofs' and 'Roofs - Podium Decks' section. Further guidance for effective waterproofing of structures can also be found in BS8102.

## Requirements for other Sustainable Drainage Systems (SuDS)

Developments proposing to use other types of SuDS which are not covered within this section should follow the guidance found in 'SuDS Manual' (a design manual published by CIRIA). The developer should also confirm if the Planning consent for the project imposes any additional requirements which may impact on the design of the sustainable drainage systems (SuDS). Any surface water drain, soakaway or other infiltration system (including a SuDS system) which is intended to discharge to a water course should have consent to discharge in writing from the appropriate regional agency.

### 5.2.6 Prevention of ground gases/contaminants entering the home

Where ground gases/contaminants are present in the ground, the designer shall take precautions to prevent the gases/contaminants entering the home.

For further information on managing ground gases contaminants, please refer to the 'Ground Conditions – Managing Ground Contaminants' section.



# 6.

## External Walls

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### Contents

|     |                         |     |
|-----|-------------------------|-----|
| 6.1 | External Masonry Walls  | 110 |
| 6.2 | Timber Frame            | 135 |
| 6.3 | Light Gauge Steel Frame | 155 |
| 6.4 | Render                  | 170 |
| 6.5 | Claddings               | 176 |
| 6.6 | Parapets                | 188 |
| 6.7 | Gable Spandrel Panels   | 196 |

## Introduction

This section provides guidance on meeting the performance requirements for the following types of external masonry walls:

- Masonry cavity walls.
- Masonry cladding to timber frame structures and light gauge steel frame structures.
- Solid masonry walls to single storey non-habitable garages.

### 6.1.1 Compliance

The design, specification and construction of external masonry walls shall meet the performance requirements of this section.

### 6.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of all proposed materials to be used in the construction of the external wall.
2. A full set of detailed drawings, including:
  - a. Plan layouts indicating dimensions, movement joints, position and size of openings, buttressing walls, etc.
  - b. Elevations with dimensions shown.
  - c. Junction details showing position of DPCs, cavity trays, other building elements such as roofs, floors, etc.
3. Engineers calculations and drawings for elements of load bearing masonry.
4. Masonry cladding and support systems. To include general arrangement drawings, sections and site specific supporting calculations (including a drawing register).

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 6.1.3 Structural design of walls

External masonry walls shall:

- Meet the requirements of relevant standards and Building Regulations.
- Be durable.
- Safely support and transmit intended loads to the foundations without undue movement.

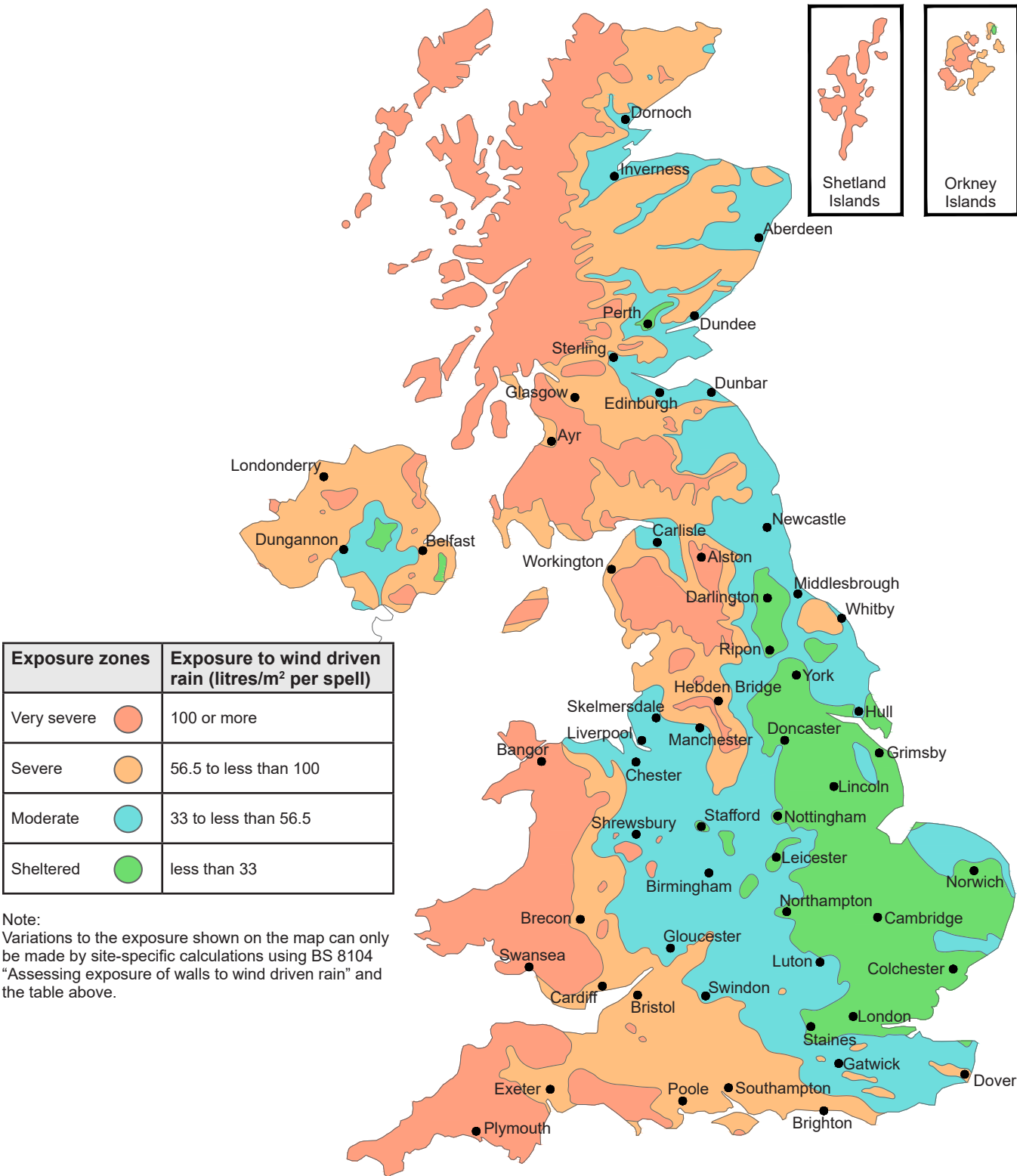
External masonry walls should satisfy the following standards:

- |                                                         |               |
|---------------------------------------------------------|---------------|
| ▪ BS EN 1996-1-1                                        | ▪ BS EN 845-1 |
| ▪ BS EN 1996-2                                          | ▪ BS EN 845-2 |
| ▪ BS 8103 in relation to lateral restraint requirements | ▪ BS EN 845-3 |

## 6.1.4 Exposure to the elements

The design and construction of external masonry walls shall be suitable for the site specific exposure location and shall be able to resist the passage of moisture to the inside of the home.

Materials, products, and building systems should be chosen to take into account wind driven rain exposure maps.



For further information on determining the exposure for the site location please see BS 8104 and BR 262 for further guidance.



**Specific requirements for cavity wall construction with full fill insulation**

The following table outlines the minimum cavity widths for full fill insulation types for masonry cavity walls in varying exposure locations.

| Suitable masonry cavity wall construction depending on exposure, for use with full fill cavity insulation |                                                                                                     |                                   |                                                                                 |                                  |
|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-----------------------------------|---------------------------------------------------------------------------------|----------------------------------|
|                                                                                                           |                                                                                                     | Minimum insulation thickness (mm) |                                                                                 |                                  |
| Exposure category                                                                                         | Suitable wall construction (max 12m in height)                                                      | Built-in insulation               | Retro-fill (other than UF foam) - blown in mineral wool, polystyrene beads etc. | Urea Formaldehyde Foam - UF foam |
| Very Severe (Exposure zone 4)                                                                             | Any wall with impervious cladding                                                                   | 50                                | 50                                                                              | 50                               |
|                                                                                                           | Fair-faced masonry with impervious cladding to all walls above ground storey                        | 100                               | 125                                                                             | Not permitted                    |
|                                                                                                           | Any wall fully rendered <sup>2</sup>                                                                | 75                                | 75                                                                              | Not permitted                    |
|                                                                                                           | Fair-faced masonry <sup>1</sup>                                                                     | 150                               | 150                                                                             | Not Permitted                    |
| Severe (Exposure zone 3)                                                                                  | Any wall with impervious cladding or render <sup>2</sup>                                            | 50                                | 50                                                                              | 50                               |
|                                                                                                           | Fair-faced masonry with impervious cladding or render <sup>2</sup> to all walls above ground storey | 50                                | 75                                                                              | 50                               |
|                                                                                                           | Fair-faced masonry <sup>1</sup>                                                                     | 75                                | 75                                                                              | Not permitted                    |
| Moderate (Exposure zone 2)                                                                                | Any wall with impervious cladding or render <sup>2</sup>                                            | 50                                | 50                                                                              | 50                               |
|                                                                                                           | Fair-faced masonry with impervious cladding or render <sup>2</sup> to all walls above ground storey | 50                                | 50                                                                              | 50                               |
|                                                                                                           | Fair-faced masonry                                                                                  | 50                                | 75                                                                              | 75                               |
| Sheltered (Exposure zone 1)                                                                               | Any wall with impervious cladding or render                                                         | 50                                | 50                                                                              | 50                               |
|                                                                                                           | Fair-faced masonry with impervious cladding or render to all walls above ground storey              | 50                                | 50                                                                              | 50                               |
|                                                                                                           | Fair-faced masonry                                                                                  | 50                                | 50                                                                              | 50                               |

**Notes:**

<sup>1</sup> In very severe exposure locations, fair-faced masonry with full fill cavity insulation must have a cavity width of at least 150mm and the insulation must have a third party product conformity certificate to confirm it can be used in this scenario.

<sup>2</sup> Render on an external leaf of clay bricks (F2, S1 or F1, S1 designation bricks BS EN 771) in severe or very severe exposures is not permitted where the cavity is to be fully filled with insulation.

- This table covers walls where the external leaf does not exceed 12m in height.
- The exposure category of the building is determined by its location on the map showing categories of exposure to wind-driven rain (see BRE Report 262).
- Fair-faced masonry includes clay, calcium silicate and concrete bricks and blocks and dressed natural stone laid in an appropriate mortar, preferably with struck, weathered or bucket handle joints. Cavity walls of random rubble or random natural stone should not be fully filled.
- Recessed mortar joints should not be used.

**Additional requirements in a coastal location**

Where developments are within a coastal location additional Warranty requirements should be met.

Further information on Warranty requirements within a coastal location can be found in 'Appendix B - Coastal Locations'.

## 6.1.5 Masonry suitability

Masonry units shall:

- Be capable of supporting intended loads.
- Be durable.
- Have appropriate compressive strength in accordance with Building Regulations.

The following shall be taken into account:

- Specification of masonry units.
- Freeze/thaw resistance.
- Sulfate attack.
- Frogs and perforations.
- Reclaimed masonry units.
- Corbelling and architectural brick detailing.
- Specification of natural stone masonry.

## Specification of masonry units

Masonry units should:

- Comply with BS EN 771 and PD 6697.
- Be used in accordance with BS EN 1996-1 and BS EN 1996-2.
- Be specified and installed in accordance with the manufacturers recommendations.

## Freeze/thaw resistance

Frost attack can occur through the repeated action of rain water freezing and thawing. When water turns into ice, there is increase in volume which can eventually cause stresses to masonry units and lead to spalling.

This can be avoided by specifying freeze/thaw resistant masonry units in areas that are prone to prolonged periods of saturation as per the below table:

| Freeze/thaw resistance category      | Possible use case*                                                                                                                                                                                                                                                          |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| F2 – Severe exposure to freeze/thaw  | Can be used in normal building situations and all exposures to wind driven rain. F2 rated masonry units should be used: <ul style="list-style-type: none"> <li>• Below DPC</li> <li>• Brickwork plinths</li> <li>• Chimneys</li> <li>• Capping, coping and sills</li> </ul> |
| F1- Moderate exposure to freeze/thaw | Provides a moderate freeze/thaw resistance and in general F1 rated masonry units can be used between DPC and eaves.<br><br>However they should not be used in areas of severe or very severe exposure to wind driven rain or elevated sites.                                |
| F0 – Passive exposure to freeze/thaw | Not freeze/thaw resistant – should not be used externally unless completely protected by impermeable cladding.                                                                                                                                                              |

\* The possible use cases are not an exhaustive list. In all situations, confirmation of suitability of the masonry unit for the intended use must be confirmed by the manufacturer of the masonry units and reference to PD 6697.

## Common influences which can lead to frost attack include:

- The freeze/thaw resistance of the masonry units.
- Saturation of the masonry.
- Degree of exposure to wind driven rain.
- Localised protection from other buildings, topography, roof overhangs, coping or capping.

## Details to reduce persistent wetting and lessen the risk of frost attack:

- Parapet walls should have a coping or capping (for further guidance on parapet walls, see 'External Walls - Parapets').
- Sills and coping should have a weathered upper surface.
- Paths around the building should drain away from walls to avoid saturating brickwork.

## Additional considerations

- External painted finishes on brickwork has the potential to trap moisture and as such the manufacturer should be consulted to ensure the decorative finish will not have a detrimental impact on brickwork durability.
- Masonry units with low soluble salts should be specified where there is a risk of brickwork being persistently wet.
- Most concrete bricks have a strength of 22N/mm<sup>2</sup> and are durable in most situations and are equivalent to frost resistance class F2 for clay bricks. For copings and sills, bricks with a compressive strength of 36N/mm<sup>2</sup> should be used.
- Concrete blocks used in the outer leaf without protective cladding or render must have a compressive strength greater than 7.3N/mm<sup>2</sup> or have a density of at least 1,500kg/m<sup>3</sup>.

- In Scotland, all clay bricks used externally should be frost-resistant, F2, S2 or F2, S1 to BS EN 771-1 and all concrete bricks used as facings should be 22 N/mm<sup>2</sup> to BS EN 771-3.
- In areas of severe and very severe exposure to wind driven rain, the following should be specified:
  - Clay facing bricks which are frost-resistant F2, S2 or F2, S1 to BS EN 771-1.
  - Concrete bricks with a minimum strength of 22N/mm<sup>2</sup> to BS EN 771-3.
  - Concrete blocks with a minimum density of 1,500kg/m<sup>3</sup> or compressive strength greater than 7.3N/mm<sup>2</sup>.
  - Calcium silicate masonry units must be confirmed to be F2 rated to BS EN 771-2 by the manufacturer.

If there are any doubts about the suitability of facing bricks in areas of severe frost exposure, written clarification by the brick manufacturer confirming the suitability of the brick should be provided.

### Sulfate attack

To reduce the chance of sulfate attack, sulfate resisting masonry units should be chosen.

### Frogs and perforations

Frogged bricks have a depression in the face of the brick. They should be laid with the major depression, or frog, facing up so that it is fully filled with mortar during laying. Bricks with a directional surface texture are intended to be laid frog up.

Care should be taken with the use of perforated bricks where the exposure rating of the wall is high, as water retention/collection has been found to exist in the perforations.

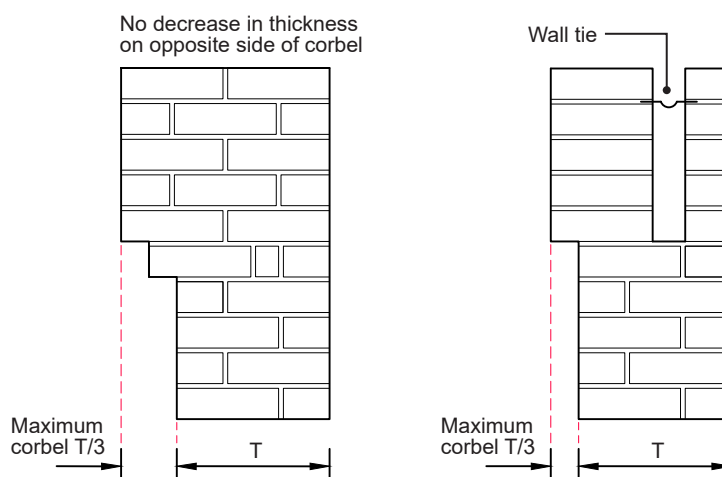
### Reclaimed masonry units

Due to difficulties in testing the durability of the exact batch proposed to be used, reclaimed masonry units should not be used for Warranty purposes.

### Corbelling and architectural brick detailing

The extent of corbelling of masonry should not exceed that indicated in the image to the right, unless supported or reinforced. Reinforced corbels should be designed by an Engineer.

Where architectural brick detailing is specified, the brick manufacturer should confirm the expected durability of the product in the proposed use will meet our Warranty service life requirement of 60 years.



### Specification of stone masonry

#### Natural stone masonry

Natural stone masonry must be selected by the designer, to be based on its suitability for the specific design requirements and site exposure and orientation of the building/plot.

The following should be satisfied:

- Natural stone masonry should also comply with BS EN 12370 or have evidence it is not susceptible to salt crystallisation when used below DPC level.
- The natural stone must be suitably durable for the proposed exposure to protect against freeze/thaw.
- The natural stone units must satisfy BS EN 771-6 and the units must be selected based on the performance of the actual sourced product and not a generic one.
- The selected stone performance information may be found in a Declaration of Performance document issued by the quarry supplier.
- A statement from the supplier, confirming the natural stone units are freeze/thaw resistant must also be provided.

The following should also be taken into account for natural stone:

- It is advisable to use a stone that has been quarried within a reasonable vicinity of the development.
- It is not recommended to use a soft, porous-type stone in a severe or very severe exposure zone.
- Consideration should be given to the compatibility of different stone to prevent staining and premature decay.
- Limestone and sandstone should not be mixed together.

It is important that the stone is laid with the grain running horizontal to the bed. In the case of jambs and mullions, the grain should be vertical.

## Sawn bed stonework and random rubble stonework (natural stone)

Sawn bed stonework in the outer leaf of a cavity wall must be at least 100mm thick, although 150mm is recommended. Where dressed stone is used and the sawn bed width falls below 100mm due to the irregularities of the stone, the stone should be backed with a standard brick or block wall to maintain structural stability. It is not acceptable for the stone to be packed or wedged to maintain line and level without the backing wall being in place.

In the case of random rubble stonework used as a facing in a cavity wall, the rubble should have a minimum thickness of 150 mm, which may be increased depending on the type of stone supplied by the quarry. The rubble facing may be built in two ways:

- As a facing to a standard two-leaf cavity wall that will be typically post-fixed to the outer leaf, **or**
- Forming the outer leaf itself – in this case the rubble stonework will normally be built up at the same time as the inner leaf, steps to the rear of this rain-screen must be avoided to prevent water running down the inner face and 'splashing' the insulation and inner leaf.

## Mortar specification for natural stone masonry

The mortar for use with stone should comply with the relevant British Standards for sand, lime and cement, as set out in BS EN 1996 or PD 6697.

This can vary in strength from 1:1:6 to 1:3:12 depending on the softness of the stone. It is important to use the correct mortar to allow for movement and associated shrinkage.

## Wall tie specification for natural stone masonry

Ensure that wall ties are stainless steel and of sufficient length to maintain a 50mm embedment. It may be necessary to double up the wall ties where the coursing is out of line due to the varying thickness of natural stone at the reveals, i.e. every other course, and to ensure that wall ties do not slope inwards.

## Insulation for natural stone masonry (applicable to masonry cavity walls only)

Full fill cavity insulation should only be considered where the outer leaf is backed by brick/blockwork, although this is still dependent on exposure, i.e. either partial fill, leaving a residual cavity of 50mm, or a clear cavity should always be the preferred options. A full third party product conformity certificate, BS8104 analysis, site specific designs, information on porosity of stone and strict acceptance from the manufacturer for any wall build-up will be required.

For guidance on insulation for framed structures, please see either the 'External Walls - Timber Frame' or 'External Walls - Light Gauge Steel Frame' sections.

## Movement joints for natural stone masonry

In movement control where sealants are used, it is important to select a non-oil-based sealant to help prevent any staining to the stone.

## Cavity trays for natural stone masonry

In addition to our guidance on cavity trays in this section, the following shall apply:

When stone heads are being used, it is advisable to double up the cavity trays, one below and one above the stone head, and to provide stop-ends and weep-holes.

## Jambs and mullions

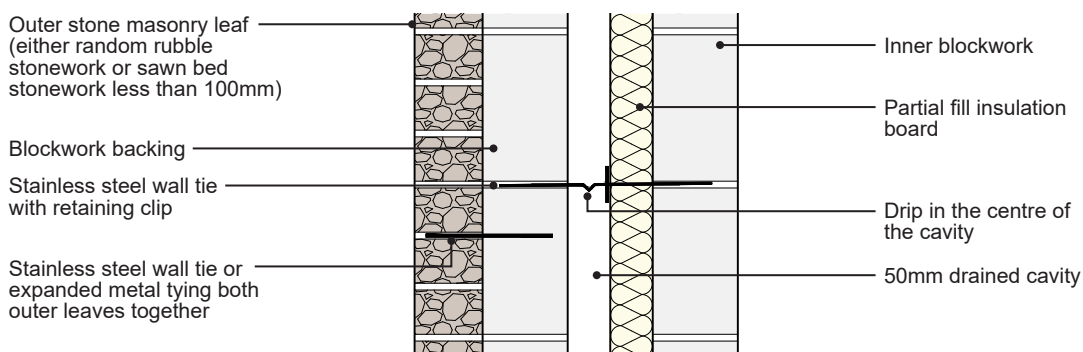
Stone jambs and mullions should be fixed at the top and bottom with stainless steel pins. Stainless steel frame-type cramps can also be used to give extra stability at jambs.

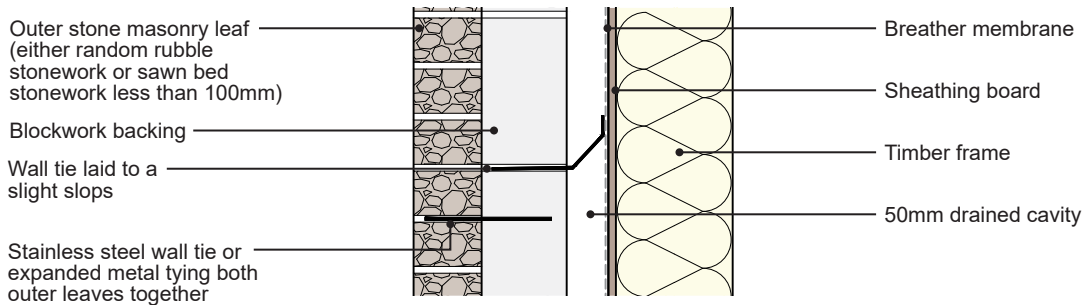
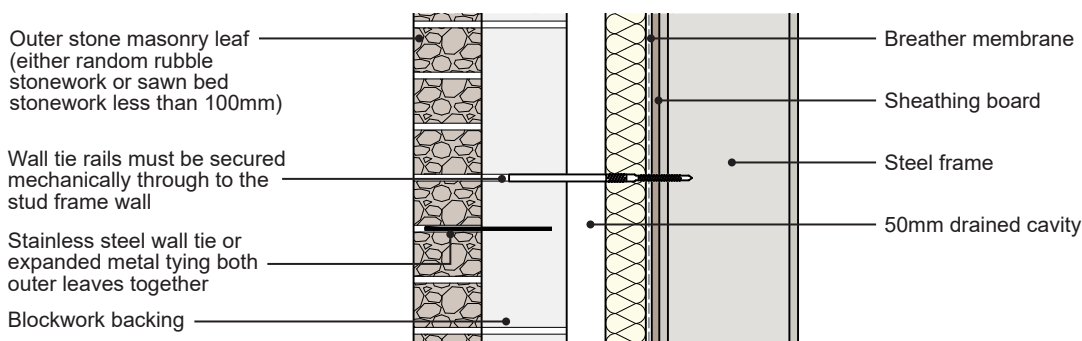
## Cast stone masonry

Cast stone masonry units shall satisfy the following:

- Meet the requirements BS EN 771-5 and proof of CE marking should be made available on request.
- Cub test data and capillary absorption test details should be provided.
- To comply with BS 1217:2008 the manufacturer should clearly state the weathering class i.e. either CAT and/or ISAT and the number and date of the British Standard applicable (i.e. BS 1217: 2008).
- The Manufacturer of the cast stone should provide evidence of UKCSA membership.

## Masonry cavity wall with stone outer leaf



**Timber frame with blockwork backing wall and stone outer leaf****Light gauge steel frame with blockwork backing wall and stone outer leaf****6.1.6 Mortar**

Mortar shall be selected to achieve adequate strength and durability and be suitable for the type of masonry units and exposure.

**Mortar specification**

Mortar shall:

- Comply with BS EN 1996-1-1
- Be used in accordance with PD6697

Mortar mixes shall be selected from BS EN 998-2.

Mortars below DPC are exposed to higher levels of saturation and therefore require higher durability classification (see BS EN 998-2).

**Mixing**

Mortar should be mixed by machine, or ready mixed retarded mortars should be used. Mortar should be carefully and consistently proportioned and then thoroughly mixed using a mechanical mixer, except for very small quantities.

Batching and mixing equipment should be kept clean to avoid contamination with materials used previously.

**Recessed mortar joints**

Recessed mortar joints should be avoided where:

- Bricks are not frost resistant unless the brick manufacturer has confirmed their use for that particular location.
- The development is on steep sloping ground, facing open countryside or within 8km of a coast or large estuary.
- Bricks are perforated closer than 15mm to the face.
- There is no reasonable shelter from driving rain, e.g. from buildings or groups of trees within 50m and of similar height to the home.
- The cavity is to be fully filled with cavity insulation.

## Sulfate attack

Mortar is susceptible to deterioration by sulfate attack, especially when masonry is at a high saturation risk and/or where S1 designated clay bricks are specified. High saturation risks include:

- Below DPC
- Areas of severe or very severe exposure to driving rain
- Parapets
- Chimney stacks
- Retaining walls

Where the mortar is at risk of sulfate attack, sulfate resisting mortar should be specified.

### 6.1.7 Horizontal damp proof courses (DPC)

Horizontal DPCs shall be suitable for their intended purpose and be provided to prevent moisture rising or entering the home.

- DPCs should be of a flexible material such as:
  - Bitumen based materials (BS 6398, BS EN 14967).
  - Polyethylene (BS 6515, BS EN 14909). Polyethylene DPCs should not be used as cavity trays in walls, below copings or in parapets.
  - Other Proprietary materials with an appropriate third party product conformity certificate.
- DPCs should be laid on a mortar bed and correctly lapped at junction and corners. The depth of the lap should be the same width as the DPC.
- DPCs must be located at least 150mm above the external ground level.
- Damp proof membranes should be lapped with the DPC with a minimum overlap of 100mm.
- The DPC should not bridge any cavity unless it is acting as a cavity tray where a cavity is required (e.g. over a telescopic floor vent).

Please note, for further guidance on correct selection of DPC and cavity tray materials see 'Appendix C.'

## Rendering below DPC

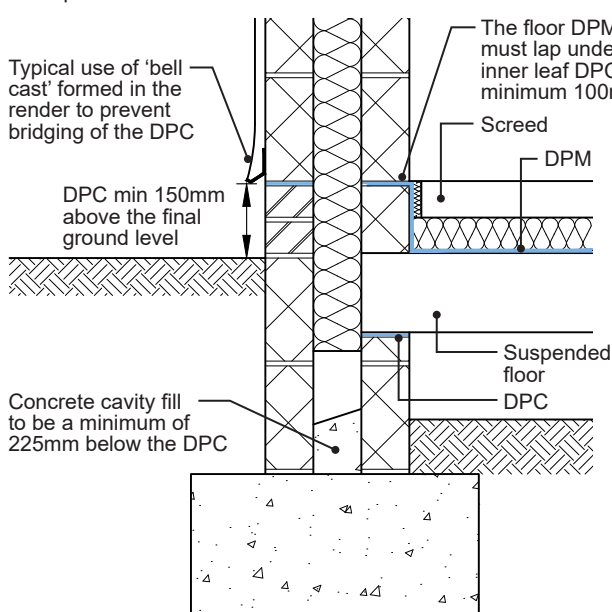
- Rendering below DPC should only be carried out using a specialist render manufacturer's specification.
- A proprietary uPVC bead or stainless steel bead should be used above and below where the renders meet at the DPC.
- DPC should extend through the rendering system in between the bellcast beads or render stop system.
- For bellcasts, uPVC beads or stainless steel beads are acceptable.

Note: For further guidance on the application of render please see the 'External Walls - Render' section.

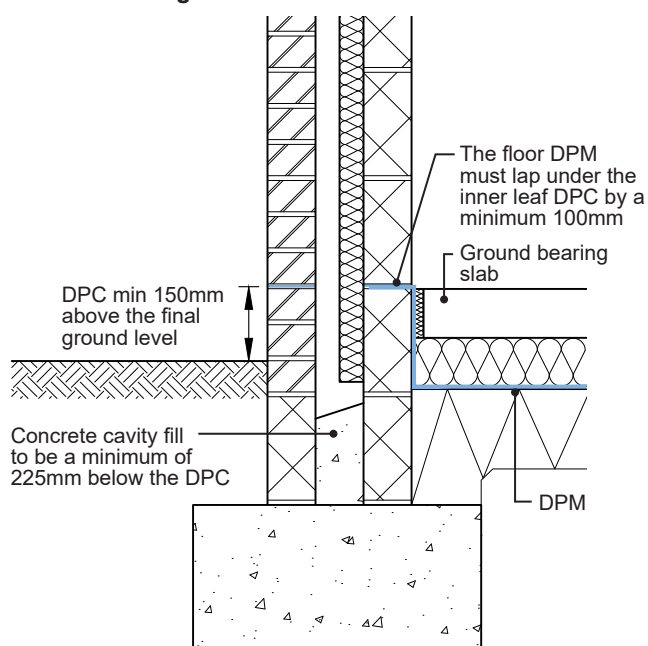
## DPC and DPM arrangement

### Suspended floor

Example shown with a rendered wall and beam and block floor



### Ground bearing slab



Please refer to the 'Drainage' section for further guidance on drainage passing through external walls.

### 6.1.8 Gas protection system

Where a gas protection system (e.g. gas membranes) is required it shall be specified in accordance with relevant standards. Gas protection systems shall be installed to manufacturers recommendations.

Where a gas protection system is required it should be specified and installed by suitably qualified persons.

Where gas membranes horizontally bridges the cavity, a cavity tray should be provided above. Cavity trays should be sealed to the gas membrane in accordance with gas membrane manufacturers instructions to prevent capillary damp ingress at the joint.

Please refer to the 'Ground Conditions – Managing Ground Contaminants' section for further guidance.

### 6.1.9 Cavities

External masonry walls shall be constructed using an inner and outer leaf with a cavity which resists the passage of moisture to the inside of the home.

- Cavities should not be bridged and should be kept clear of mortar snots and other debris.
- Cavities below ground should be filled with concrete ensuring there is a minimum gap of 225mm between DPC and the top of concrete. Concrete for cavities should be GEN 1 grade and a consistence class S3.
- The cavity should have a minimum width of 50mm.
- The two leaves should be appropriately tied.
- For traditional masonry cavity walls, the cavity may be fully or partially insulated depending on the exposure to wind driven rain. For partial fill insulation, a minimum clear residual cavity of 50mm should always be provided.
- For timber frame and light gauge steel framed buildings, partial fill insulation may be used however a minimum clear residual cavity of 50mm should be maintained. For further information please refer to the 'External Walls – Timber Frame' and 'External Walls – Light Gauge Steel Frame' sections.

#### Cavity drainage and ventilation for timber framed buildings

Cavity drainage and ventilation in timber framed buildings with masonry cladding should:

- Be provided with full height open perpend at a maximum of 1350mm centres or equivalent open area. Weep-holes alone are unsuitable for timber frame construction.
- Be provided in the brick or block course below the lowest timber sole plate above external finished ground level and below DPC.
- Be provided to ensure drainage and ventilation to each external wall concealed space directly above horizontal cavity barriers/trays.
- Be installed over openings in the external wall cavity e.g. windows and doors at a maximum of 900mm centres.
- Maintain a minimum 50mm clear cavity with care taken to reduce mortar droppings at the base of the wall.
  - Where the soleplate overhangs and a masonry outer leaf is specified, the setting out of the masonry should take the sole plate overhang into account and maintain a 50mm cavity from the face of the sheathing board to the back of the masonry.

#### Cavity trays at DPC level

Cavity trays must not be specified at DPC level between the external masonry cladding and the timber frame as it can impede on the drainage and ventilation requirements for the timber frame.

Where a cavity tray is proposed at DPC level, proprietary open perpend must be used above and below the cavity tray to provide:

- Drainage and ventilation to the timber frame above the cavity tray, and,
- Ventilation to the sole plate below the cavity tray.

Where flexible DPC materials are to be used as a cavity tray, they should have supporting evidence in the form of a Declaration of Performance to BS EN 14909:2012. They should also have a third party product conformity certificate their suitability for use as a cavity tray.

#### Cavity drainage requirements for light gauge steel framed buildings

Where masonry cladding is specified in front of the light gauge steel framed buildings, the cavity needs to have adequate drainage. Suitable drainage weeps and cavity tray systems should be provided.



## 6.1.10 Cavity barriers

Cavity barriers shall be durable and must not adversely affect the structure of the external wall or the performance weatherproof envelope.

Where required by statutory regulations, cavity barriers shall:

- Be of a suitable material.
- Specified and installed within the scope of the test certification and/or the third party product conformity certificate.
- Be installed in accordance with the manufacturer's recommendations.
- Be suitable for the location they are installed.

Where cavity barriers are required by statutory regulations, their specification, positioning and installation should satisfy the requirements of the Building Regulations.

Where vertical cavity barriers are required, they should be continuous for the full height of the wall and extend below DPC level.

Where horizontal cavity barriers are provided they must be tested for the scenario and have a third party product conformity certificate. A cavity tray must also be specified above with appropriate drainage.

## 6.1.11 Wall ties

Wall ties shall be of the correct type and suitable for the intended purpose and location.

Wall ties should be:

- In accordance with BS EN 845-1 or have an appropriate third party product conformity certificate for their intended use and location.
- Specified to accommodate movement where the design requires.
- Specified and installed as per the manufacturer's instructions.
- Spaced in line with the guidance in the 'External Walls' section or as per an Engineers design and specification. Wall ties should be specified at a minimum density in accordance with BS EN 1996 -1-1. This should not be less than 2.5 ties per m<sup>2</sup> and may increase with cavity width.

Wall ties should be installed so that they:

- Are long enough to be embedded a minimum of 50mm into each leaf.
- Have a slight fall towards the outer leaf and have the ability to hold insulation against an internal leaf for partial fill scenarios.
- Have the drip positioned in the centre of the cavity.
- Are clear of mortar droppings.
- Have a staggered or a diamond pattern.

### Wall ties for traditional masonry cavity walls

Wall ties for traditional masonry cavity walls should be stainless steel or a non-ferrous metal and should also satisfy the below requirements.

#### Spacing of wall ties

This table may be used for dwellings up to three storeys high in areas of sheltered and moderate exposure locations, with a cavity width between 100mm-150mm.

|                              | Max horizontal spacing (mm)       | Max vertical spacing (mm)      |
|------------------------------|-----------------------------------|--------------------------------|
| General wall area            | 900                               | 450                            |
| Openings and movement joints | Within 225                        | Not more than 300 <sup>1</sup> |
| Top of gable walls           | 225 (parallel to top of the wall) | Not more than 300 <sup>2</sup> |
| Top and bottom of openings   | 450                               | N/A                            |

<sup>1</sup> The vertical spacing of number of ties may need adjusting to produce equivalent number of ties when using insulation boards.

<sup>2</sup> The vertical spacing of number of ties may need adjusting to produce equivalent number of ties when using spandrel panels.

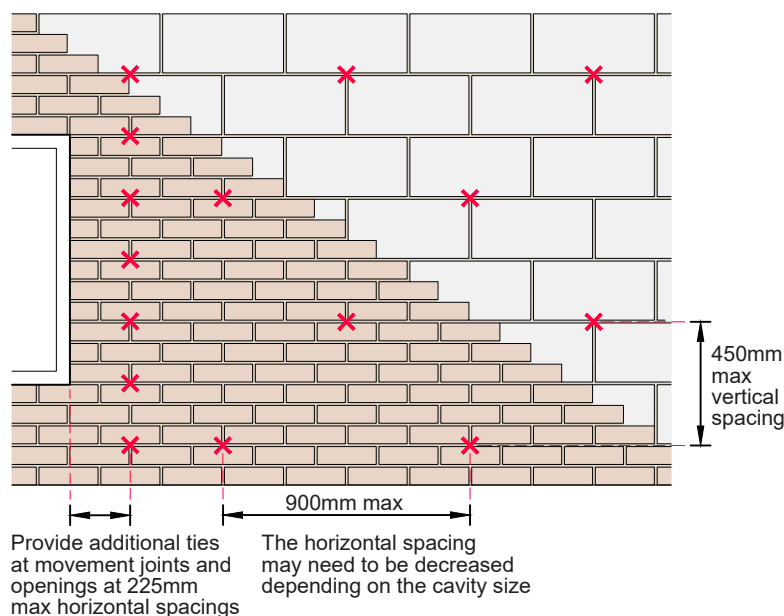
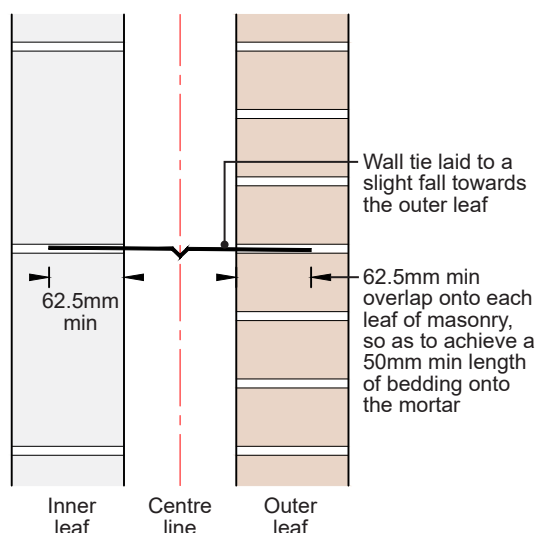
Notes:

- The design of wall ties for cavity wall construction will need to consider the site specific conditions and location of the masonry panels on the building façade.
- Proprietary ties must have an appropriate third party product conformity certificate.
- Proprietary insulation retaining clips compatible with the tie should be used where the cavity is partially filled.

#### Cavity widths between 100mm-150mm in severe and very severe exposure locations, or elevated locations of over 150m above sea level

A site specific assessment should be carried out by an Engineer. The 'Spacing of wall ties' table may be acceptable if used with stiffer wall tie types (e.g. types 1 or 2 in accordance with PD6697).



**Wall tie locations****Wall tie provision****Wall ties for timber framed buildings**

In addition, wall ties should also:

- Be constructed from austenitic stainless steel.
- Be installed into solid timber studs, not just through sheathing.
- Additional studs should be provided in the timber frame structure for wall ties at vertical movement joints and around openings in the masonry cladding.
- Angled to drain moisture away from the timber frame even after differential movement has occurred.
- Installed within 225mm of the head of the wall.
- Wall tie density:
  - For buildings up to three storeys in height wall ties should be installed at a minimum density of 4.4/m<sup>2</sup> (a maximum of 375mm vertically with studs at 600mm centres and a maximum of 525mm vertically where studs are at 400mm centres). A tie density of 4.4 ties/m<sup>2</sup> may be suitable for buildings on flat sites within towns and cities anywhere in the UK, except the north western fringes of Scotland (where the basic wind speed exceeds 25m/sec) and any areas where the site is at an altitude of 150m or more above sea level.
  - An increased wall tie density may be required in exposed locations or for buildings higher than three storeys in height, the actual performance required for each site location or building should be determined by an Engineer.
- For timber framed structures, maintaining a 225mm horizontal wall tie spacing can be difficult as the timber studs may be more than 225mm away from the movement joint or opening. Introducing additional timber studs may be impractical and therefore an alternative solution of using slip ties at 300mm vertical centres with 50mm embedment into the masonry either side of the movement joint, could be considered subject to an Engineers design.

**Wall ties for light gauge steel framed buildings**

Wall ties should also meet the following provisions:

- Wall tie density depends on a number of site specific factors and should be considered by an Engineer.
- External skin of brick should be attached to the metal frame with either epoxy coated galvanized ties or austenitic stainless steel ties (to DD140, BS 12, BS 5268, BS 8200).
- Ties are normally fixed in vertical channels, these channels are then fixed through the sheathing board or insulation board to the light gauge steel frame with stand-off screws (screws should be isolated from the channels with neoprene or similar washers).
- The wall tie rails, ties, and fixings, should come as a 'kit' supplied by the manufacturer. Wall tie systems made up from off the shelf products will not be acceptable for Warranty.
- The wall tie system 'channels' should be fixed to ensure the fixings go into the centre line of the steel frame studs.
- Cavity wall insulation should be of the rigid type and should be compatible with the manufactures requirements of the wall tie rail system.
- The wall tie length should be long enough to achieve the minimum overlap of the external masonry skin as specified by the manufacturer. This should not be less than 50mm.
- Top row of ties should be 225mm below top of brickwork (at eaves and verge levels).
- When studs are at 600mm centres, the vertical dimensions of wall ties should be 375mm centres maximum. When studs are at 400mm centres, the vertical dimension should be a maximum 450mm vertical centres.

## 6.1.12 Thermal insulation

Thermal insulation shall be specified correctly and installed to avoid damp and interstitial condensation issues occurring within the wall makeup. The overall insulation value of the wall shall meet the requirements of relevant Building Regulations.

Thermal insulation should:

- Have an appropriate third party product conformity certificate for use in its intended location.
- Be installed in accordance with the manufacturer's instructions.
- In all situations where partial fill insulation is specified, a 50mm residual cavity must be maintained.
- Not be cut or pierced to accommodate wall ties, unless increased centres at reveals or expansion joints are required.
- The wall ties should coincide with insulation joints.
- Partial fill insulation should be clipped or retained to the inner leaf using proprietary fixings in conjunction with wall ties.
- For insulated cavities, mortar joints to facing brickwork should not be recessed.

## Traditional masonry cavity walls

For traditional masonry cavity walls, cavity wall insulation may be either full fill or partial fill depending on the exposure location of the site.

### Injected and blown fill insulation

Where injected and blown fill insulation is proposed, the insulant material should have a third party product conformity certificate and be suitable for the wind driven rain exposure.

Injected and blown fill insulation should be installed by a manufacturer approved contractor and in line with the third party product conformity certificate.

## Framed walls

Cavity wall insulation to framed walls shall also satisfy the following:

- External walls should be subject to U-Value and condensation risk calculations. A wall build up will be considered satisfactory if there is no calculated risk of surface or interstitial condensation at any time of the year and it fulfils the minimum national requirement for thermal performance.
- Special consideration should be given to condensation risk where non-breathable insulation products are installed on the outside of the framed structure.
- Joints between the foil faced external insulation boards must not be taped as this forms a vapour control layer on the cold side of the insulation.
- Where the insulation manufacturer requires the joints to be taped, the tape must be of a type as recommended by the insulation manufacturer, breathable to allow water vapour to move freely and resist water penetration.
- Where the insulation board has an integral foil facing on one side only, the insulation should be fixed so the foil is facing towards the cavity side.
- The insulation board should be covered with a breather membrane adjacent to the cavity where required by the insulation manufacturer or third party product conformity certificate for the insulation.

### Timber framed walls

For timber framed walls, the following should also be satisfied where cavity wall insulation is specified between the timber frame and masonry cavity:

- Allowance should be made for differential movement to occur at floor zones.
- It should not retain or transmit moisture to cause the timber structure to exceed 20% moisture content.
- Stud locator marks should be transferred onto the outer face of the breather membrane adjacent to the external wall cavity.
- Wall ties should transfer loads to the timber frame structure. To achieve this, wall ties will typically need to be installed through the external insulation rather than bearing onto it.
- Foil faced insulation boards should not be taped.

For further information on thermal insulation for timber framed buildings, please refer to the 'External Walls – Timber Frame' section.

### Light gauge steel framed walls

For light gauge steel framed walls, The following should also be satisfied where cavity wall insulation is specified between the light gauge steel frame and masonry cavity.

The insulation should be fixed to the outside face of the steel studs to create a 'warm frame' construction.

Where the condensation risk has been assessed and shown to be negligible additional insulation may be placed between the studs. The additional insulation should be placed in contact with the studs to minimise air gaps and prevent local condensation.

### 6.1.13 Chases in masonry walls

Chases in masonry walls shall not impair on the structural integrity of the wall.

Chases should:

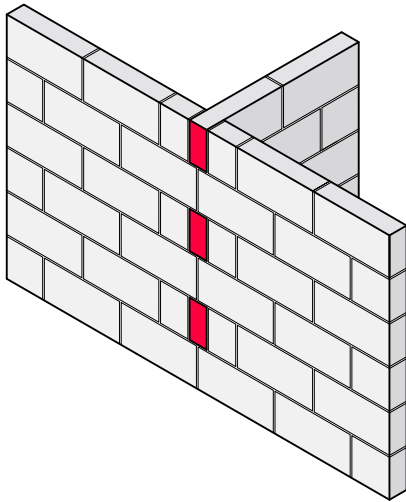
- Only be made in solid masonry (not hollow blocks).
- A horizontal chase must not exceed  $\frac{1}{6}$  the thickness of the single leaf.
- A vertical chase must not exceed  $\frac{1}{3}$  the thickness of the wall.

### 6.1.14 Bonding internal walls to external cavity walls

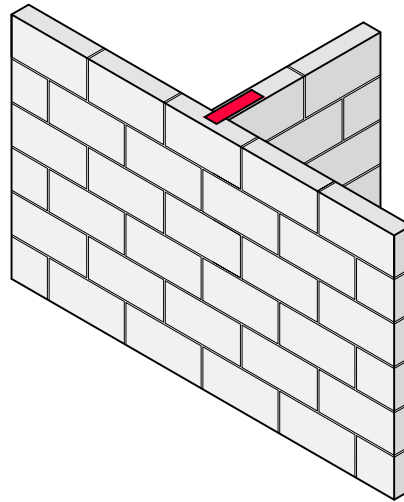
External walls shall be appropriately bonded to internal walls as specified by the designer.

Where an internal wall abuts an external wall, they may be tied or bonded together. Tied joints should be formed using expanded metal strip, wall ties or equivalent fixings, at maximum 300mm vertical centres.

#### Block bonding internal walls to inner leaf



#### Block bonding internal walls to inner leaf using ties



To reduce the risk of cracking, tied joints should be used where:

- Materials have dissimilar shrinkage or expansion characteristics.
- There is a connection between a load-bearing wall on foundations and a non-load-bearing wall supported on a ground-bearing slab.

Dissimilar materials in the same wall should be avoided (clay bricks used to make up courses in blockwork walls).

### 6.1.15 Movement joints in masonry

Movement joints shall be introduced to control expansion and contraction of masonry walls, reduce cracking and maintain structural stability of the wall. The width of the joint shall be sufficient to accommodate both reversible and irreversible movements whilst maintaining the weatherproof envelope.

Vertical movement joints should be provided to the outer leaf of cavity walls as indicated in the 'Spacing of movement joints' table. Movement should also satisfy the following:

- Movement joints should run the full height of the wall and not coincide with window and door openings.
- Generally the ratio of length to height of the panels should not exceed 3:1.
- The movement joints must be continued through the render construction and an appropriate weather resistant seal provided to prevent moisture ingress to behind the render finish.
- Movement joints below the DPC should also be provided at major changes in foundation level and at changes in foundation design.
- For any given wall elevation where there is a mix of masonry e.g. brickwork external leaf lower level with a rendered block upper level, the requirement of a full height movement joint should be based on the shorter spacing requirement e.g. for the blockwork at 6m not brickwork at 12m.
- Wall ties should be provided at 300mm maximum vertical spacing either side of the movement joint, and within 225mm horizontal spacing of the movement joint.
- It is not normally necessary to provide movement joints to internal leaf of cavity walls, but should be considered where rooms occur with unbroken lengths of wall in excess of 6m.

Where traditional cavity masonry walls or masonry cladding is specified for concrete/ (hot rolled) steel framed buildings, horizontal movement joints should be provided with the use of shelf angles at vertical centres in accordance with current design standards. They should be capable of accommodating at least 1mm movement per continuous meter of vertical clay masonry. Shelf angles should not be fixed back to a timber framed or LGSF structures. Please refer to the 'External Walls – Timber Frame' or 'External Walls – Light Gauge Steel Frame' sections for further guidance on accommodating differential movement.

## Materials for filling movement joints

The material for filling movement joints to accommodate expansion should be easily compressible to approximately 50% of its original thickness.

Flexible cellular polyurethane, cellular polyethylene or foam rubbers are satisfactory materials.

Hemp, fibreboard, cork and similar materials should not be used for expansion joints in clay brick masonry, but may be used for contraction joints in calcium silicate and concrete masonry.

## Sealants

Movement joints should be sealed with an appropriate sealant which can provide sufficient flexibility whilst resisting water penetration.

When sealants are used in proximity with stone it is important to select a non-oil-based sealant to help prevent any staining to the stone.

Elastic sealants (Type E) are suitable as they allow for reversible movement. Where a back-up material is used to control the sealant depth, it will also provide a compressible space into which the sealant can deform.

Allowances for compression thickness of the sealant must allow for the specified movement joint width plus the non-compressible thickness of the seal.

Where a backing material is used, the following must be considered:

- The material is compatible with the sealant.
- It will not adhere to the sealant, preventing cracking within the sealant.
- Provides sufficient density to allow the sealant to be applied.
- Allows sufficient flexibility so not to impede lateral movement (compressible to about 50% of its original thickness), fibreboard is not acceptable.

## Spacing of movement joints

| Material                                | Normal spacing                                                                                 | Joint thickness |
|-----------------------------------------|------------------------------------------------------------------------------------------------|-----------------|
| Clay brickwork <sup>2,3</sup>           | 12m (spacing up to 15m may be possible if sufficient restraint is provided - consult designer) | 15mm            |
| Calcium silicate                        | 7.5-9m                                                                                         | 10mm            |
| Concrete brickwork <sup>1</sup>         | 6m                                                                                             | 10mm            |
| Concrete blockwork (used in outer leaf) | 6m                                                                                             | 10mm            |
| Natural stone masonry                   | 15-20m <sup>4</sup>                                                                            | 10mm            |

Notes:

For clay, calcium silicate and concrete masonry, manufacturer's guidance for the spacing and sizing of movement joints should be considered. Where the designer seeks to deviate from the above table, the manufacturer should provide a site specific design and specification taking site and plot specific factors into account (examples include, orientation, mortar and wall build-up).

The first joint from a return should be not more than half the dimension indicated in the table. Movement joints are not acceptable in solid party or separating walls; however, where cavity wall construction is adopted, offset movement joints with a solid rubber compressible strip may be acceptable.

<sup>1</sup> Where openings are over 1.5m, masonry bed joint reinforcement should be considered.

<sup>2</sup> For unrestrained masonry such as parapets and free standing walls, vertical joint spacing should be reduced to 5m-6m centres and be 1.5m from corners.

<sup>3</sup> For clay brickwork, a variation can be accepted if the Engineer designs to PD6697.

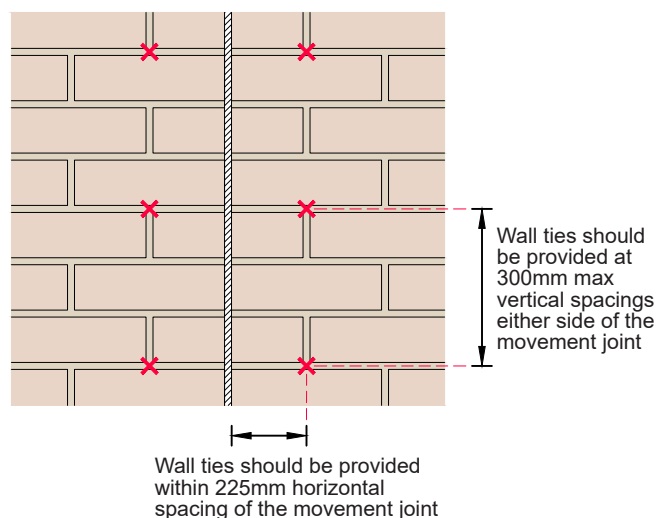
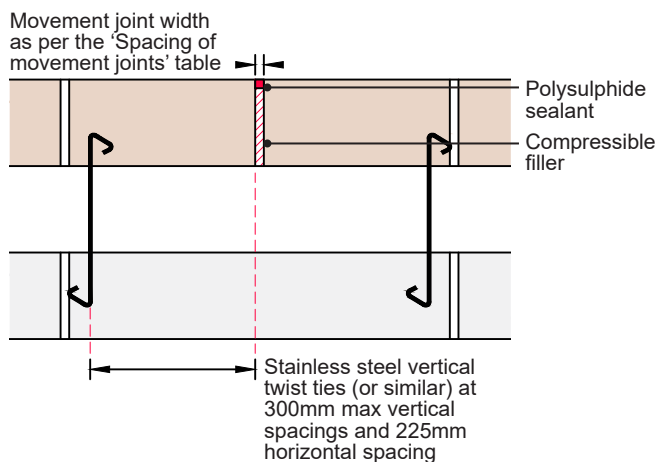
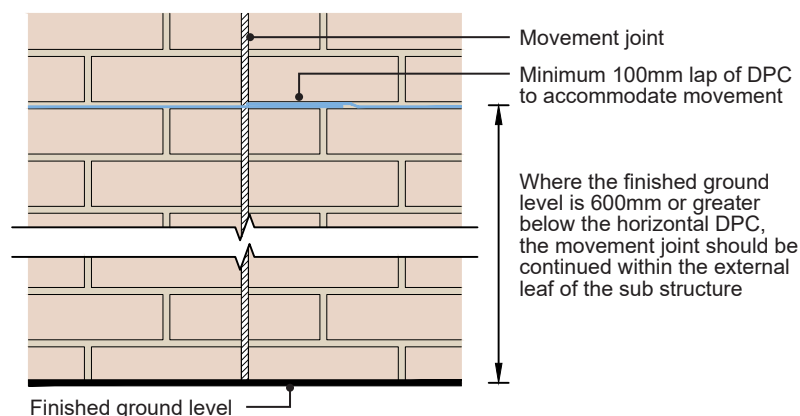
<sup>4</sup> Located no more than 7.5m from an external corner.

## Additional requirements on movement joints for concrete bricks

The rate and extent of movement in concrete bricks can be considerably different to that of clay bricks.

With the high differential of movement between the various available raw materials used in concrete brick manufacture, it is imperative that the design for movement in a wall panel is specific to the shrinkage capacity of the concrete brick used and the requirements of the manufacture should be followed.

In all cases site specific advice should be obtained from the manufacture before work begins.

**Wall ties in proximity to movement joints****Typical movement joint detail****Movement joints below DPC****6.1.16 Bed joint reinforcement**

Where bed joint reinforcement is specified, an Engineer's design must be provided. Bed joint reinforcement shall be of the correct type and suitable for their intended purpose and location.

Bed joint reinforcement may be required to critical areas to accommodate stresses such as above and below window openings. The Engineer may require this to be provided as part of the overall design specification.

Where provided, they will be in addition to movement joints, not instead of. Bed joint reinforcement potentially can increase spacing of movement joints subject to the Engineer's specification.

**6.1.17 Differential movement between masonry cladding and timber frame**

Where masonry cladding is specified for a timber framed building, the building shall be designed to ensure that differential movement occurs evenly to external elevations and the internal structure. Site specific calculations shall be used to determine movement gap sizes, however in absence of site specific calculations, the guidance within this section and the 'External Walls – Timber Frame' section can be followed.

Any material or component attached to the timber superstructure that overhangs the brick or blockwork (e.g. cladding attached to the timber frame, window sills, roof eaves, and verges) or projects through the masonry (e.g. balcony supports, flues, extractor fan vents, or overflow pipes) should have a clear gap beneath and at the top of the masonry cladding to allow differential movement to take place, thus avoiding damage to the components or cladding.

For the purposes of Warranty, a storey is defined as a space between two consecutive floors or between a floor and a roof. The number of storeys should be counted from the lowest external ground level and it should include the ground storey.

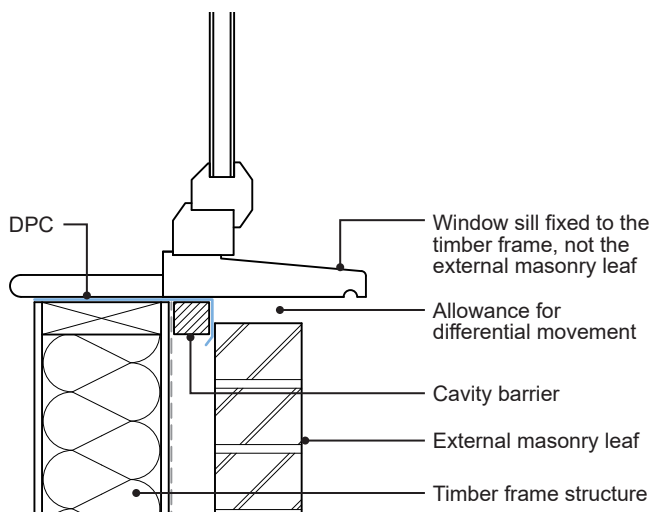
| Gap location                                  | Differential movement gap size <sup>1</sup> |                           |
|-----------------------------------------------|---------------------------------------------|---------------------------|
|                                               | Engineered floor joists                     | Solid timber floor joists |
| 4th Storey                                    | 45mm                                        | Engineer design required  |
| 3rd Storey                                    | 35mm                                        | 45mm                      |
| 2nd Storey                                    | 25mm                                        | 35mm                      |
| 1st Storey                                    | 15mm                                        | 20mm                      |
| Ground storey or lowest level of timber frame | 5mm                                         | 5mm                       |

<sup>1</sup> The compressed thickness of the material used to fill the gap must be added to the dimensions given.

- For eaves and verge, add 5mm to the dimensions given in the table.
- The product used for differential movement must be capable of compressing without causing undue stress to the surrounding construction.
- Where masonry extends continuously below the lowest level of timber, brickwork expansion should also be taken into account.
- Moisture content of all timber must be less than 20%.
- Table is based on a concrete ground floor. Where timber joists are used at ground floor level, 15mm for solid timber joists and 10mm for engineer I-Joists should be added.
- The table assumes outer leaf brickwork with expansion rates no greater than 2.5mm per storey.
- Services that are rigid from the foundations, e.g. soil stack, dry riser, gas and water, require differential movement gaps above the service entry. The gaps should be equal to those recommended for the bottom of openings at the appropriate floor level.
- There should be consideration for differential movement at lift door/thresholds and at the top of self-supporting element such as masonry or steel lift shafts.
- Table based on a maximum depth of timber joists and rim beam/header to be 240mm.
- Single head binder at the eaves. Maximum double sole plates.

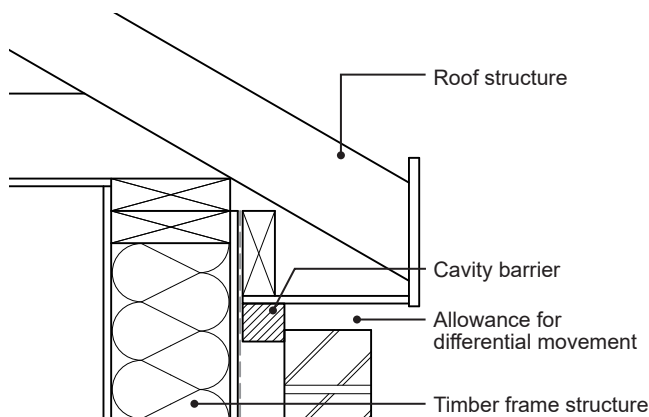
## Allowance for differential movement at sill

As the window frame will be fixed to the timber frame, as movement occurs a gap at the top of the window / door may open up and will need to be allowed for to prevent water ingress.

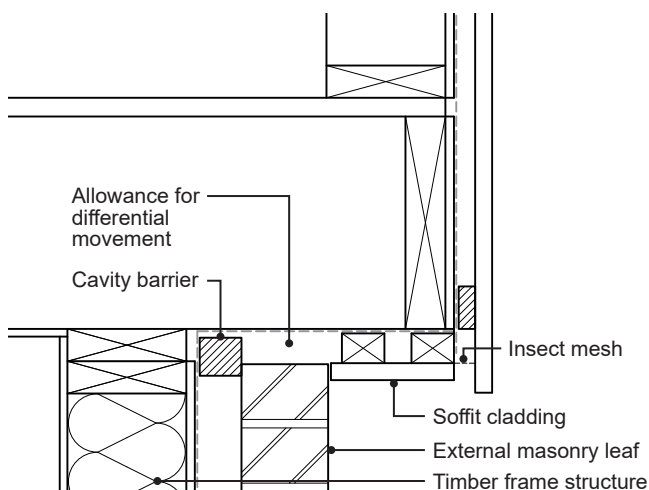


## Differential movement at eaves

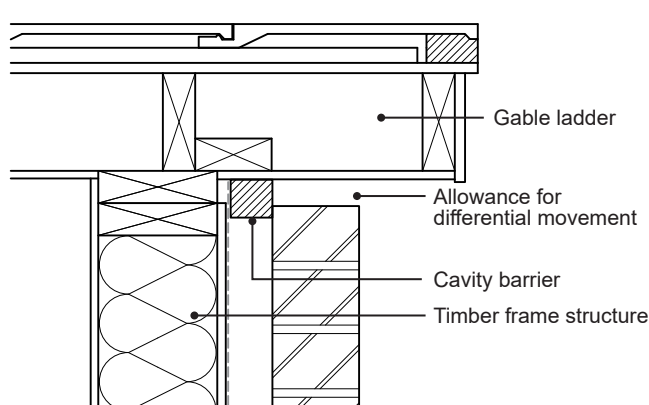
Where there is no overhang protecting the junction between the external masonry cladding and eaves or verge soffit and the movement gap exceeds 10mm, the gap should be protected with a compressible filler material or mesh to prevent the entry of birds. The compressible filler material or mesh should not impede on the differential movement between the external masonry cladding and timber frame.



## Differential movement at cantilevered overhang



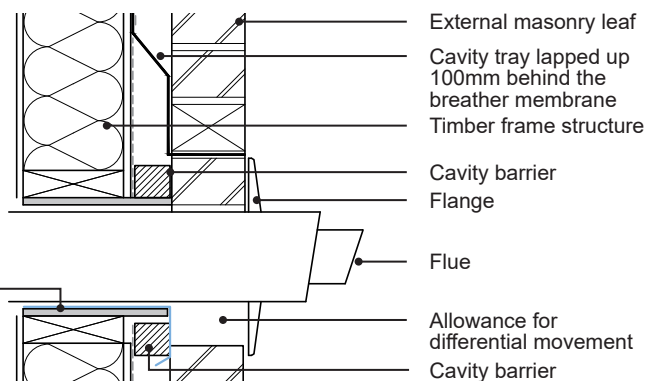
## Differential movement at verge



### Differential movement at services

Rigid services within the timber frame structure also require an equal allowance for differential movement, as shown. Examples include copper gas and water pipes, dry risers, internal downpipes, SVPs, cable trays and blockwork lift shafts. While gap allowances externally are allowed below, for example, a sill, when a branch comes off a rigid stack internally, the gap needs to be left above a service to allow the timber frame to drop around it.

Non-combustible sleeve. Extend to form cavity barrier around the opening, or insert separate cavity barriers around the opening.



#### 6.1.18 Lintels

Lintels shall safely support the applied loads, be of the correct type and size, and be suitable for the location and exposure.

Lintels should be the correct length and width for the opening and cavity width. Simple lintels should have a minimum bearing of 100mm for spans up to 1.2m. The lintel bearing may be increased to 150mm for spans over 1.2m. Lintels combined with a cavity tray should have a minimum bearing of 150mm. In all circumstances minimum bearing lengths should be in accordance with the manufacturer's recommendations. Lintels should also:

- Comply with BS EN 845-2 where steel or concrete lintels are used.
- Have padstones or spreaders present under the bearings where required.
- Be wide enough to provide adequate support for the loads above.
- Be provided where openings frames are not designed to support superimposed loads.
- Be provided over recessed meter boxes.
- Comply with relevant thermal requirements.

Lintels should not:

- Have masonry overhang the lintels by more than 25mm.
- Be supported on short lengths of cut blocks or make-up pieces.
- Have concrete loads applied before the brickwork is full bedded as per the lintel manufacturer's requirements.

Note:

- Support for masonry walls should not be provided by timber lintels or beams (Oak or any species).
- For guidance on Lintels in external walls in a coastal locations, please refer to 'Appendix B'.

### Separate lintels

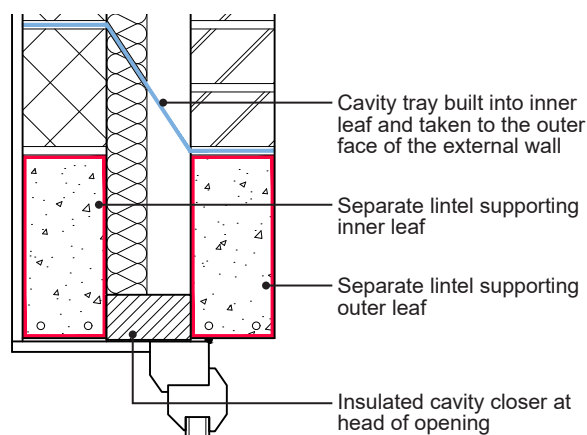
Separate lintels supporting inner and outer masonry leaves should:

- Have an insulated cavity closer installed at the head of the opening.
- Have a cavity tray which is built into the inner leaf and taken to the outer face of the external wall directly over the external lintel.
- Be able to carry loads without causing differential movement between both leaves of masonry.

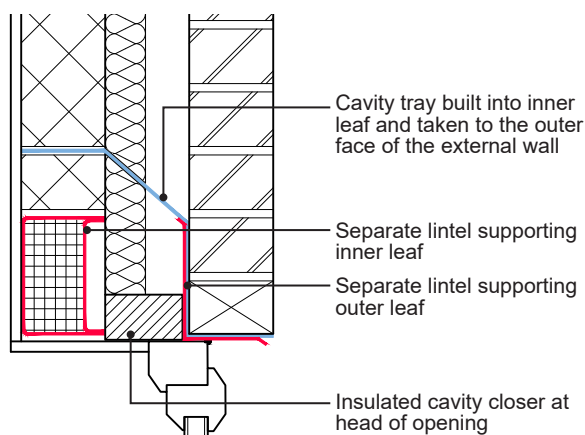
The outer lintel must be suitable for the exposure and be either:

- Continuous reinforced reconstituted cast stone without joints.
- Reinforced concrete without joints.
- Steel.

#### Reconstituted stone or reinforced concrete lintels

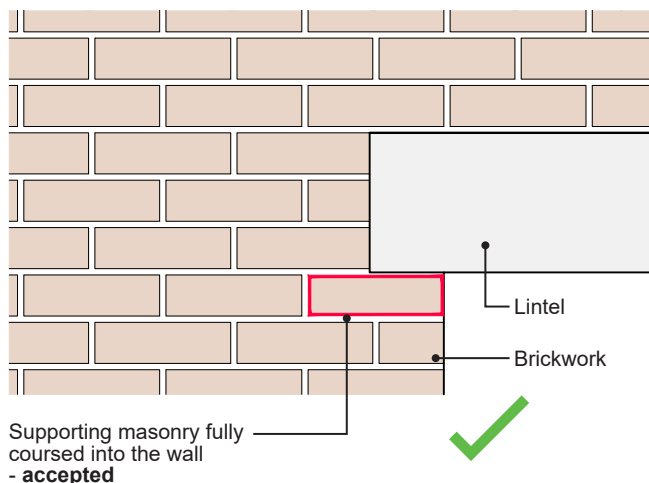


#### Steel lintels

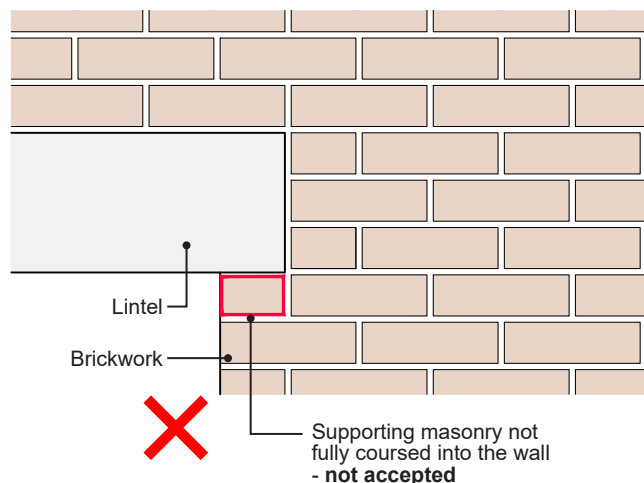




## Correct method of brick bond around lintels



## Incorrect method of brick bond around lintels



### 6.1.19 Forming a weather resistant opening

Openings within the external masonry wall shall be designed and constructed to resist the passage of moisture to the inside of the home and be appropriate for the exposure.

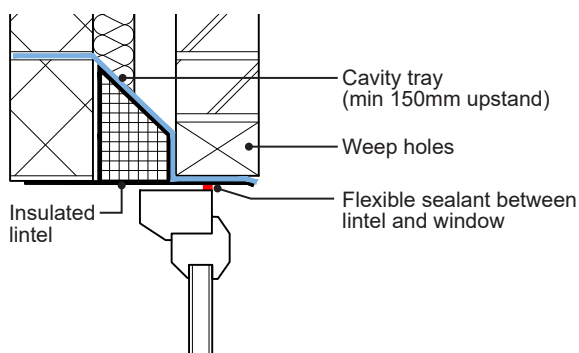
For guidance on gaps around window and doors, please refer to the 'External Window and Doors' section.

## Cavity closers

Proprietary cavity closers should be used to close the cavity between the inner and outer leaf. The cavity closer should be:

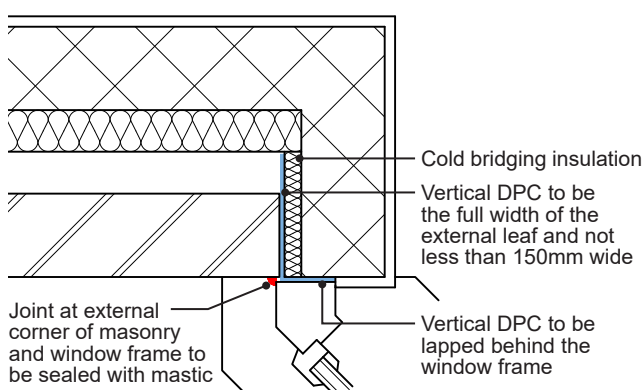
- Suitable for the site exposure.
- Insulated to prevent interstitial condensation.
- Specified and installed to prevent the passage of moisture to the inside.
- Installed as per the manufacturer's instructions.
- Fitted in one continuous piece unless the manufacturer provides detailed installation instructions for jointing.
- Fire resistant where required by the Building Regulations.

## Cavity tray detail in relation to window head

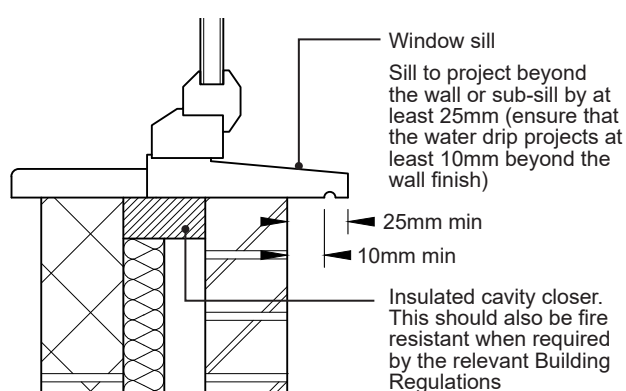


Lintel must comply with relevant thermal requirements.

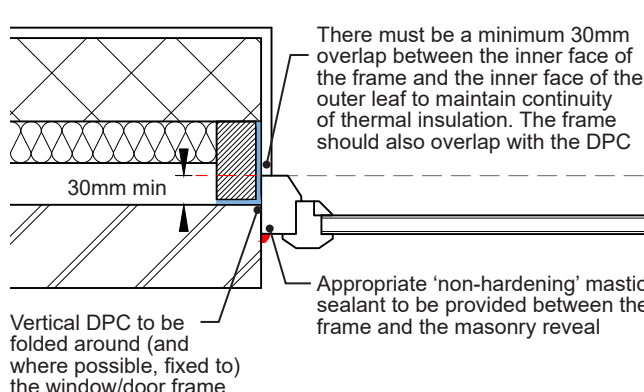
## Bay window detail



## Typical vertical section through window sill



## Typical window reveal detail (normal exposure)





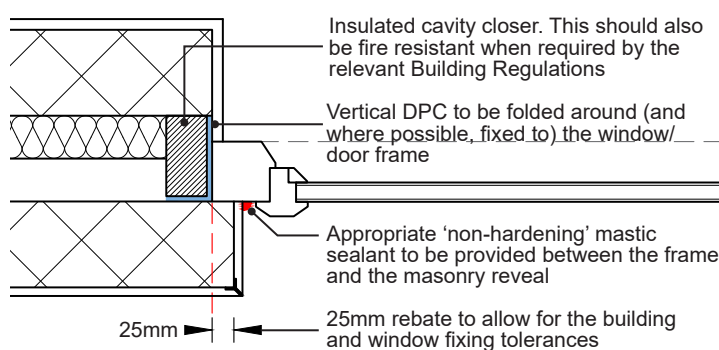
### Checked rebates

Checked (rebated) reveals are required in Scotland and in any areas of very severe exposure in England and Wales. The frame should be set back behind the outer leaf and should overlap.

A suitable DPC must be provided at all window and door openings to prevent the passage of damp to the internal finishes. A cavity closer with an appropriate third party product conformity certificate may be used.

The following illustrations show accepted practice for forming weather resistant openings and may not indicate the full extent of insulation requirements to meet relevant Building Regulations.

#### Typical rebated window frame detail



When installing window/door frames in a checked rebate, allow for the frame to be deeper:

- To allow for opening lights to open clear of the masonry/render, **and**
- Where rendered, the render will need to extend beyond the 25mm of masonry.

### 6.1.20 Cavity trays and their ancillary components

Cavity trays and their ancillary components shall be suitable and durable for their intended purpose and be provided to prevent moisture entering the home. Particular attention shall be paid to:

- Specification
- Cavity tray locations
- Weep holes
- Stop-ends
- Stepped cavity trays
- Flat roof abutments

### Specification

Cavity trays should:

- Meet the requirements of BS EN 14909.
- Have an appropriate third party product conformity certificate confirming suitability for use as a cavity tray.
- Rise at least 150mm from the outer to the inner leaf, be self-supporting or fully supported and have joints lapped and sealed.
- Comply with the relevant Building Regulations.

Cavity trays should be proprietary preformed cavity tray systems at stepped and lower storey abutments, complicated junctions and around corners in low rise masonry walls.

For framed structures, Cavity trays should lap behind the breather membrane by at least 100mm.

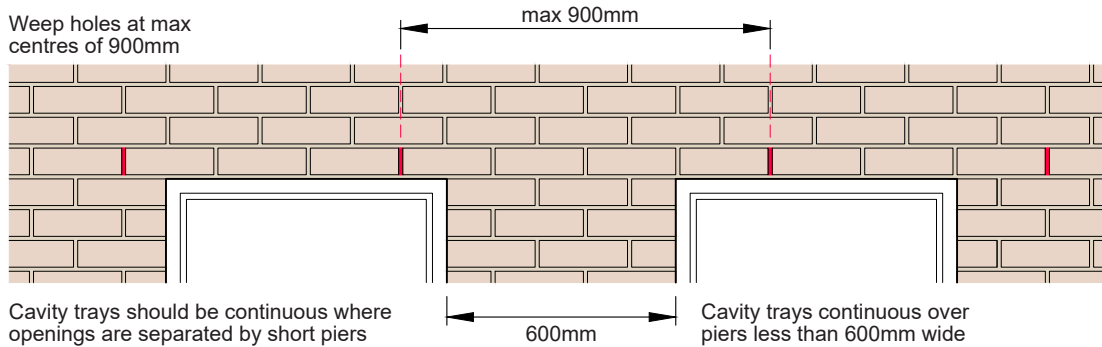
Please note: Polyethylene DPCs should not be used as a cavity tray. Please refer to 'Appendix C' for further guidance.

### Locations

Cavity trays should be provided in the following locations:

- Above all openings and interruptions likely to direct rain water across the cavity such as window and door openings, rectangular ducts, lintels and recessed meter boxes.
- Above horizontal cavity barriers.
- Above cavity insulation that is not taken to the top of the wall, unless that area of wall is protected by impervious cladding e.g. where a spandrel is provided cold pitched roof.
- Continuously above lintels where openings are separated by short piers.
- Above openings where the lintel supports a brick soldier course.
- Directly above openings that are under a compartment floor with a cavity barrier and cavity tray already present.
- Ring beams or floor slabs that partially bridge the cavity, e.g. when dimensional accuracy cannot be guaranteed, should be protected by a continuous cavity tray, especially when full fill cavity insulation is employed.
- Above lintels in walls in exposure zones 3 and 4. In zones 1 and 2 where the lintel is not corrosion-resistant and not intended to function as its own cavity tray.

## Continuous cavity tray over two openings and a small pier



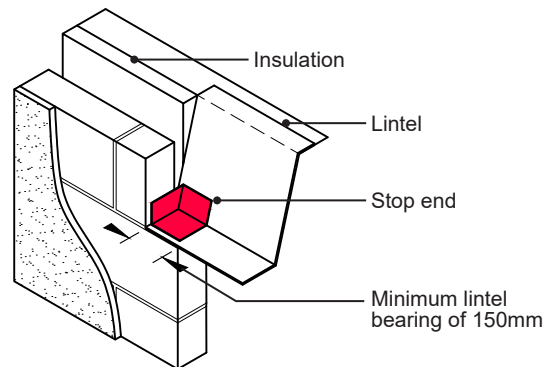
## Weep-holes

- Weep-holes must be installed at no more than 900mm centres to drain water from cavity trays and from the concrete cavity infill at ground level. When the wall is to be cavity filled, it is advisable to reduce this spacing.
- At least two weep-holes must be provided to drain cavity trays above openings.
- Weep-holes will be required in rendered masonry cavity walls for Warranty purposes.
- Weep-holes in exposure zones 3 and 4 should be designed to prevent ingress of wind-driven rain.

## Stop ends

Stop ends should be provided to the cavity tray and they may be bonded to the cavity tray material or clipped to the lintel, so that a stop to the structural cavity of at least 75mm high is provided. Normally, the stop-end is located to coincide with the nearest perpendicular to the end of the cavity tray.

Stop-ends may also be formed by sufficiently turning up the end of a DPC tray into the perpendicular joint. Surplus mortar should be removed from cavities and wall ties cleared of mortar droppings and debris as the work proceeds.

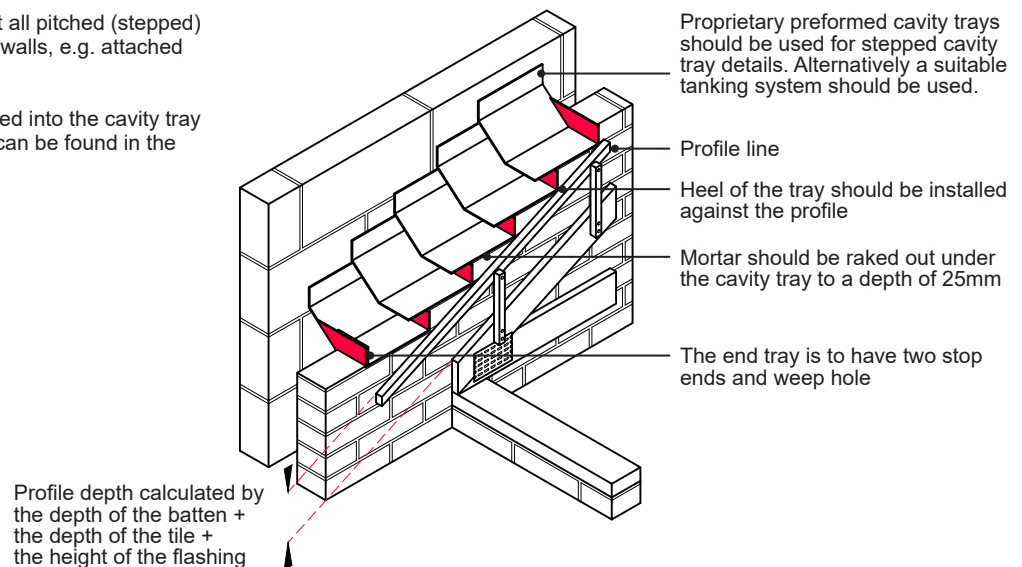


Note: Lintel must comply with relevant thermal requirements.

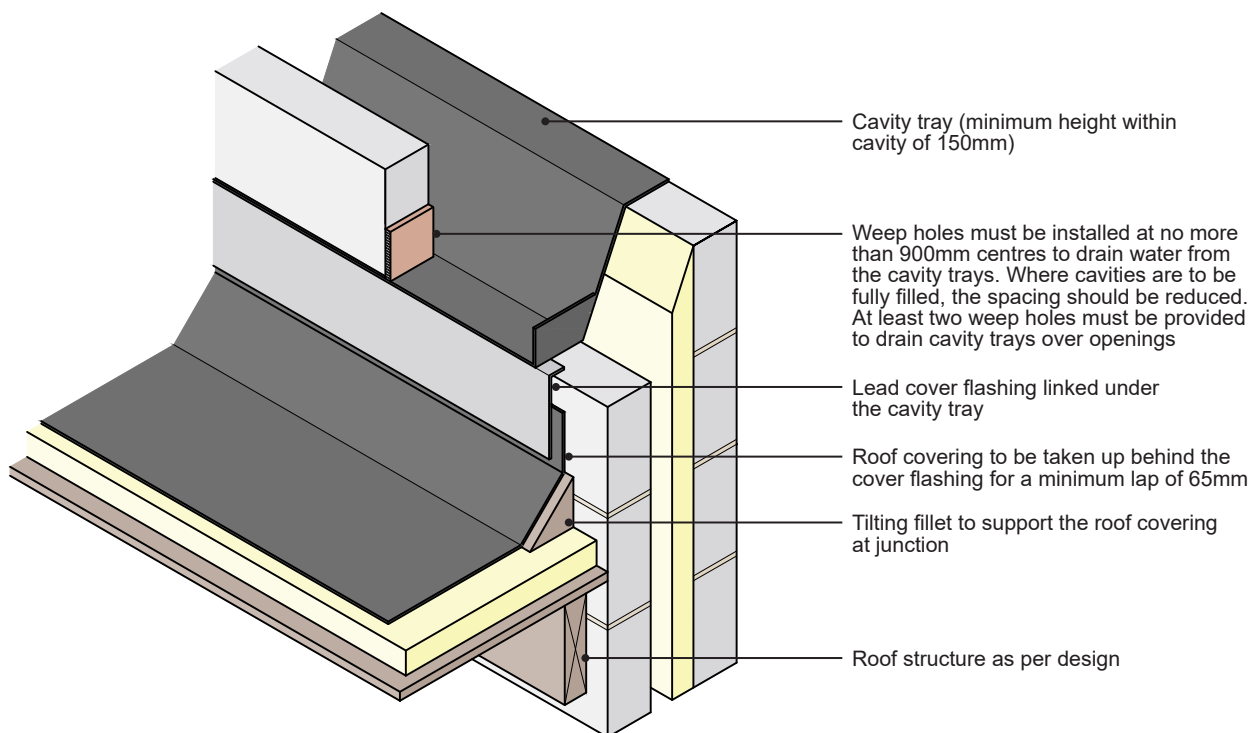
## Installation of stepped cavity tray

Stepped cavity trays are required at all pitched (stepped) roof abutments with external cavity walls, e.g. attached garages or staggered terraces.

A lead cover flashing should be linked into the cavity tray (lapped in below). Flashing details can be found in the 'Roofs' section.



### Flat roof abutment cavity tray construction



#### 6.1.21 Penetrations through the external leaf

Penetrations through the external leaf shall be appropriately sealed to prevent moisture or vermin entering the cavity or the inside of the building.

Proprietary elements, such as ventilators, soil pipes, etc. which penetrate the building envelope should be installed and sealed to prevent ingress of moisture or vermin in accordance with the manufacturer's instructions.

#### 6.1.22 Feature stone surrounds to openings

Feature stone surrounds shall be specified and installed to resist the passage of moisture or interstitial condensation to the inside of the home and shall be compatible with the surrounding structure. Particular attention should be paid to:

- Material specification
- Fixings
- Cold bridging
- Differential movement
- Sills
- Stone heads and cavity trays
- Mortar

#### Material specification

Where cast stone surrounds for openings are specified, the units must satisfy BS EN 771-5 and be durable for the proposed exposure to protect against freeze/thaw.

Where natural stone surrounds for openings are specified:

- The natural stone must be suitably durable for the proposed exposure to protect against freeze/thaw.
- The natural stone units must satisfy BS EN 771-6 and the units must be selected based on the performance of the actual sourced product and not a generic one.
- The selected stone performance information may be found in a Declaration of Performance document issued by the quarry supplier.
- A statement from the supplier, confirming the natural stone units are freeze/thaw resistant must also be provided.

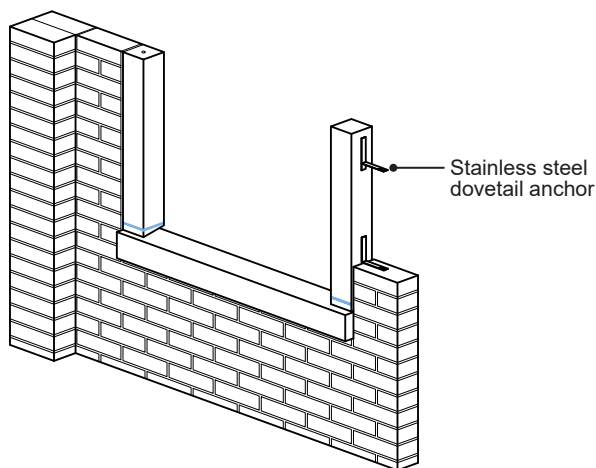
#### Fixings

Stone jambs and mullions should be fixed at the top and bottom with stainless steel pins as per the cast stone manufacturer's or Engineers specification. Stainless steel frame-type cramps can also be used to give extra stability at jambs. Where required, stone mullions should also be fixed to the surrounding structure.

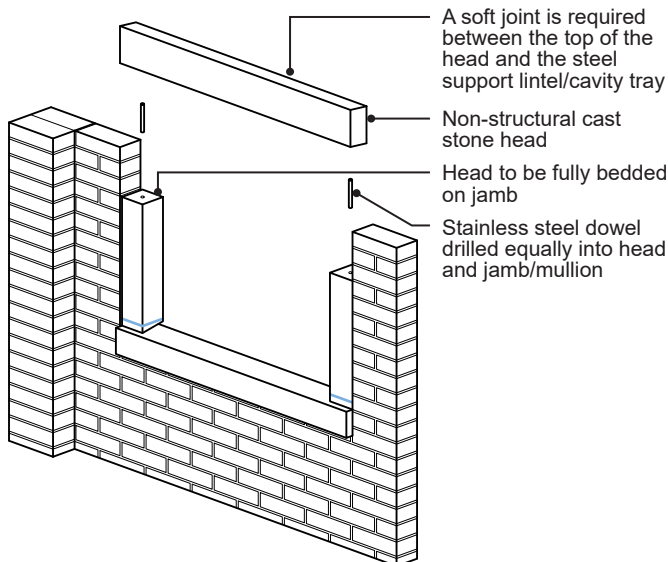
To control water penetration through joints in window surrounds, e.g. at junctions between jambs and mullions and sills, rectangular and T-shaped water bars should be provided.

Stainless steel dowels in the sides of jambs should be bedded into adjacent mortar joints as the masonry is constructed.

## Stone jamb mullion fixing to walls



## Stone jamb mullion fixing to walls



## Preventing cold bridging

Stone jambs, mullions, and heads should not project into the cavity and insulated cavity closers should be inserted to prevent cold bridging.

## Differential movement and slip planes

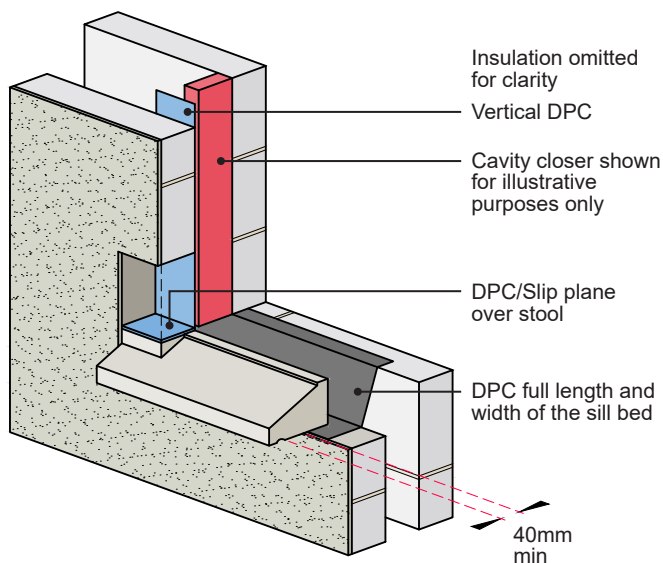
Where cast stone butts up to other materials, allowance must be made to accommodate differential movement e.g. where cast stone abuts clay brickwork, a slip surface between the stone and clay brickwork.

## Sills

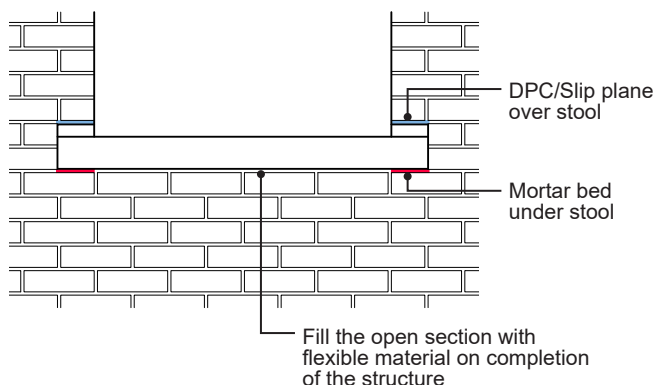
Where sills are specified, they should be laid on a DPC (slip plane) which should be turned up at the back and ends for the full depth of the sill.

The mortar bed below sills should be trowelled smooth, allowed to set, cleaned off, and then a DPC laid over. The open section below the sill should be sealed with a flexible material only on completion of the structure.

## Stone sills with insulated cavity closer



## Stone sill

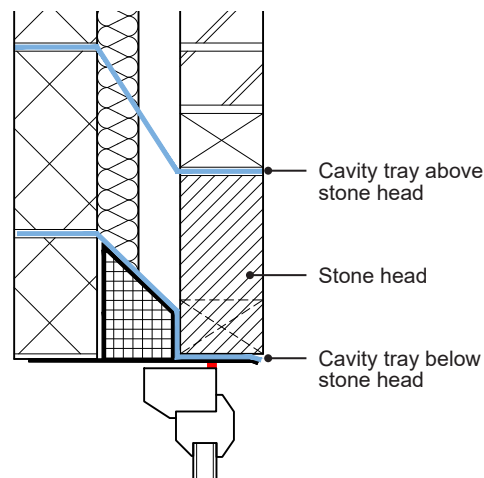


Note: The insulated cavity closer should also be fire resistant when required by the relevant Building Regulations.

### Stone heads

A cavity tray must be provided above all heads as this not only discharges water to the outside face of the masonry, but also acts as a slip plane. A slip plane will be required at the end of the cast stone head as well as a soft joint between the top of the head and the steel support lintel.

Cast stone heads should be manufactured in accordance with BS 1217, confirmation of this should be provided to the Warranty surveyor upon request.



### Cavity trays and weeps

When stone heads are being used, it is advisable to double up the cavity trays - with one above the stone head to provide stop-ends and weep holes.

### Mortar

The mortar for use with stone should comply with the relevant British Standards for sand, lime, and cement as set out in BS 5390.

#### 6.1.23 Lateral restraint

Masonry cavity walls shall be adequately restrained at floors and roofs. Particular attention should be paid to location, type and method of restraint.

Lateral restraint of walls can be provided by lateral restraint straps, restraint type joist hangers or other forms of restraint proven by an Engineer.

Floors, including timber, block and beam, and roofs should provide lateral restraint to all walls running parallel to them by means of 30mm x 5mm galvanised or stainless steel restraint straps at a maximum 2m centres.

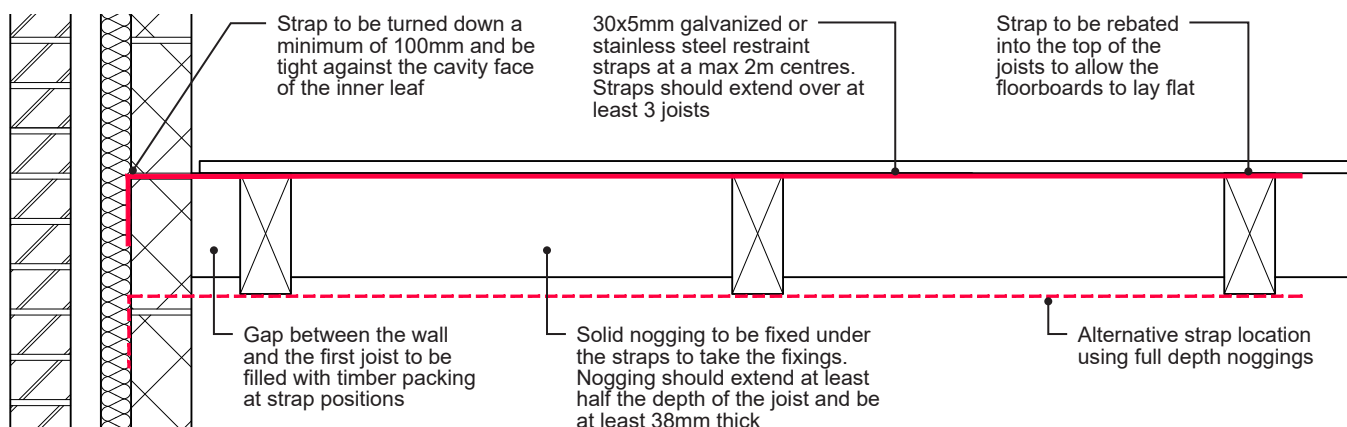
No straps are necessary in buildings, up to and including two storeys where:

- Joists are at maximum 1.2m centres and have at least 90mm bearing on supported walls or 75mm bearing on to a timber wall plate.
- Concrete floors that have a minimum 90mm bearing on supported wall.
- Restraint type joist hangers are used as described in BS 5268: 7.1.

### Timber joists

Where joists run parallel to a wall, restraint straps should:

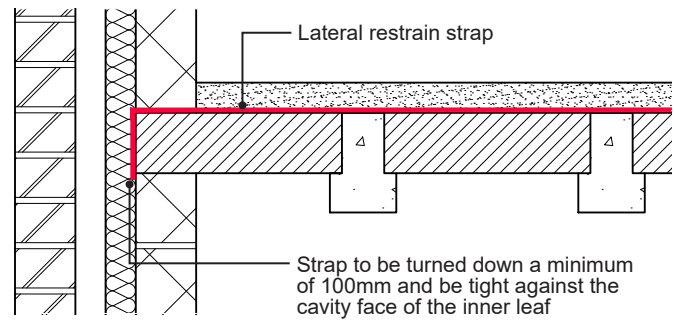
- Be fixed at 2m centres and should pass at least 3 joists.
- Be supported on noggings.
- Be fixed to timber members with steel 50mm long x 5mm diameter wood screws or by 100mm x 4mm (8SWG) round nails at not less than 110mm centres with a minimum of four fixings of which at least one fixing should be in the third joist, or in a nogging beyond the third joist.
- For metal web joists, lateral restraint straps should be fixed to strongbacks as per the strap manufacturer's details.



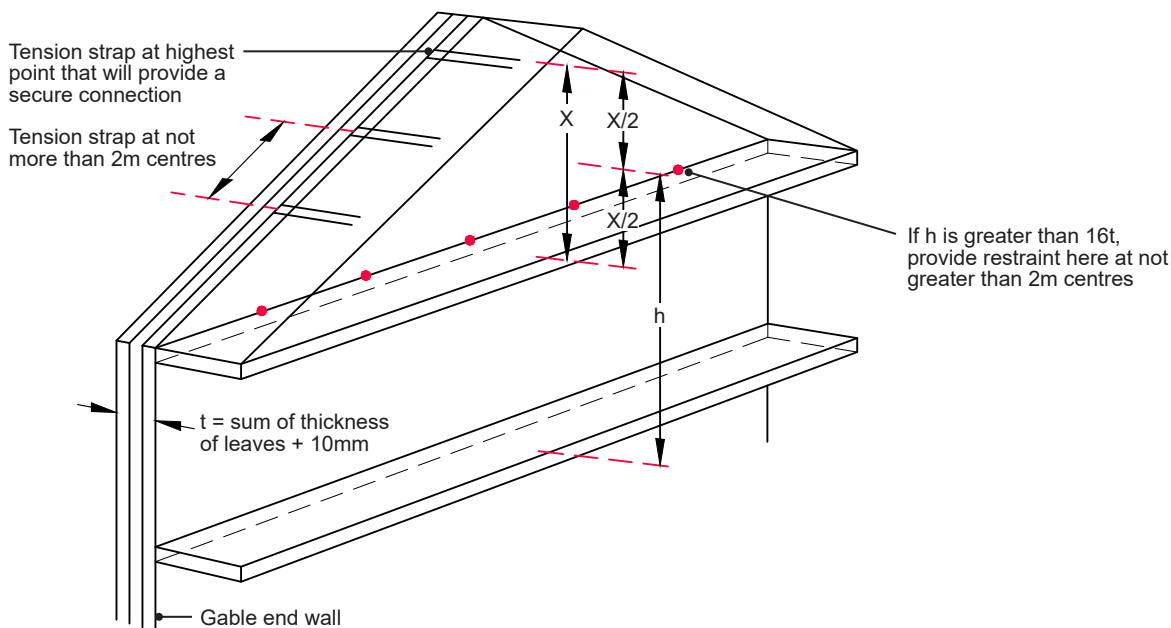
## Concrete beams or planks

Where concrete beams or planks run parallel to the wall, the restraint straps should:

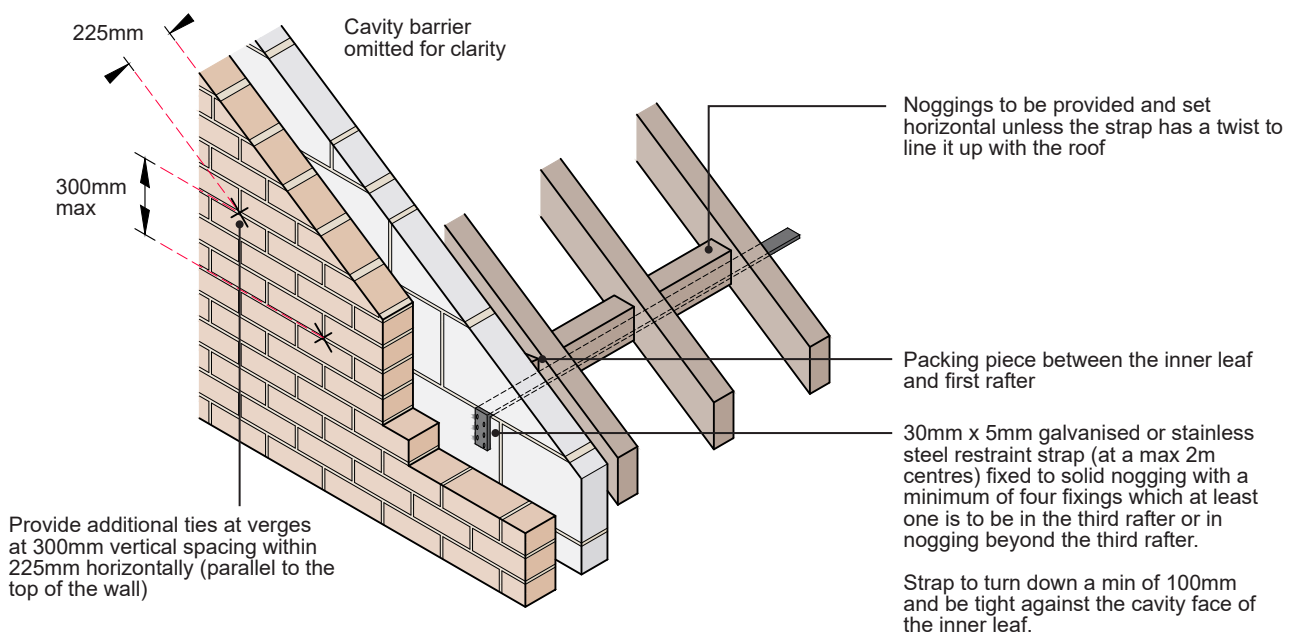
- Be spaced at 2m centres.
- Extend at least 800mm or up two beams, whichever is greater.
- Be tight against the face of the inner leaf wall and be turned down a minimum 100mm.
- Have their fixing specification designed by an Engineer.



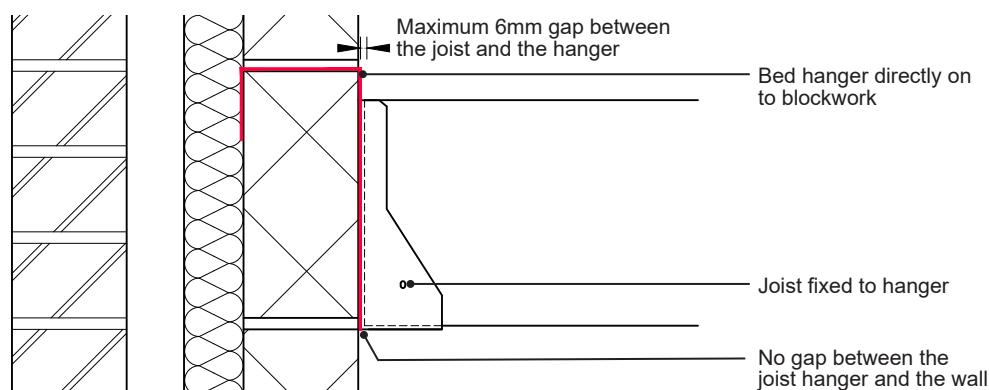
## Restraint strap at ceiling joist and rafter level



## Rafter/gable wall detail



### Restraint type joist hanger



It is necessary to ensure that:

- The hanger is bedded directly on the masonry and there is no gap between the hanger back-plate and the face of the masonry.
- At least 450mm of masonry is provided above the hanger.
- Hangers are spaced at centres of floor joists included in the design.
- The hanger is suitable for the loadings and masonry strength.

Do not:

- Apply load while the mortar is still green and has not gained sufficient strength.
- Use brick courses in block walls under joist hangers as the thermal insulation of the wall may be reduced unless similar units to the blocks are used.

#### 6.1.24 Masonry chimneys

Please refer to the 'Chimneys and Flues' section.

#### 6.1.25 Solid walls for single storey non-habitable garages

Solid walls for single storey non-habitable garages shall meet the relevant requirements of this section and the requirements of the 'Garages' section.

#### 6.1.26 Additional requirements for new walls connecting to existing walls

Where new walls are connecting to existing walls, the designer shall ensure structural stability is maintained, whilst maintaining the integrity of the weatherproof envelope and accounting for any differential movement.

### Damp Proof Course (DPC)

An effective DPC should be present in the existing wall, linked to the new DPC and damp proof membrane (DPM) of the new building.

Acceptable existing DPCs are considered as:

- A continuous felt or proprietary DPC material.
- A chemically injected DPC supported by an insurance-backed guarantee.
- A slate DPC is considered acceptable if the existing wall incorporates an independent wall lining system to the inner face of the new building.

The new DPC should lap the existing DPC by at least 100mm.

### New wall junctions

The junction of the new walls to the existing walls must ensure that dampness cannot track back into the new building or the existing building.

### Differential movement

At the junction of the existing and new structures, detailing should allow for differential movement without cracking. Any settlement should be limited to 2mm-3mm, which would not normally adversely affect the roof covering.

In order to prevent excessive differential movement, the new building should have the same foundation type as the existing building. Where the foundation types are different, e.g. new building pile and beam, existing building traditional strip foundation, the new building should be completely independent of the existing building.



## Introduction

This section provides guidance on meeting the performance requirements for open timber frame panels which are manufactured off-site under factory conditions.

For the purposes of Warranty, open timber frame panels include the fitment of the following elements:

- A sheathing board and breather membrane, **and**
- Insulation internally between the studs, **and**
- A transparent Vapour Control Layer (VCL) which is left unfixed in order that the connections between panels can be viewed upon inspection.

Please also refer to the 'MMC Systems' section for guidance on closed panel timber frame systems and MMC (such as SIP's).

### 6.2.1 Compliance

The design, specification and erection of open timber frame panel systems shall meet the performance requirements of this section.

All closed panels (where components cannot be inspected) shall meet the performance requirements of this section where applicable and the additional performance requirements of the 'MMC Systems' section.

### 6.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the performance requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

#### Accredited timber frame systems

1. Evidence of a quality assurance process in place that is acceptable to us.
2. A full set of detailed drawings, including:
  - a. Plan layouts indicating dimensions.
  - b. Elevations with dimensions shown.
  - c. Junction details showing position of DPCs, cavity trays, other building elements such as roofs, floors, etc.
  - a. Detailed drawings showing sole plate levels in relation to external ground levels for all elevations and how soleplate and timber frame is to be ventilated.
3. Details of proposed breather membranes and VCLs to be used.
4. Engineers drawings, calculations and fixing schedules for each connection made on site (framing, sheathing, structural connections, membranes, etc.) including number, spacing and method of fixing.
5. Details of proposed cavity barriers including location, materials and technical assessments (third party product conformity certificate).
6. Details of any cladding material fixed back to the timber frame including type, size, location of fixings provision of cavities. Where masonry cladding is present on the external leaf, details of wall tie and movement joint provision.
7. Where insulation in the external wall makeup are to be fitted on site we would require details of proposed insulation to be used.

Please note, closed panel systems must be sent to our Warranty Innovations team for acceptance before quote acceptance.

#### Non-accredited timber frame

Please note: this construction type is limited to a maximum of five plots per project.

Points 2–7 for accredited timber frame systems must be satisfied, in addition to:

1. Provide full structural calculations for each house type to Eurocode 5 (BS EN 1995-1-1).
2. Designs to account for any fixed non-timber components (e.g. sheathing boards), which may impact on the stability if shrinkage of the frame is not accounted for.
3. An independent third party Engineer must inspect each plot once erected and prior to any closing up. They must then provide a sign-off sheet at completion for the waterproof envelope confirming the timber frame construction meets the Eurocode as-built.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.



### 6.2.3 Structural design requirements

Load bearing timber frame elements shall meet the requirements of relevant standards and the Building Regulations, be durable and safely support and transmit the intended loads to the foundations without undue movement.

The following should be taken into account:

- Structural design
- Timber specification
- Preservative treatment
- Moisture content

#### Structural design

Timber frame panels should be designed in accordance with Eurocode 5, in particular BS EN 1995-1-1. Wind, roof, floor and cladding loads should be taken into account as a part of the overall design. The structural design should also take account of any loadings from external attachments (such as balconies).

Please note, designers should not mix and match codes or standards.

#### Timber specification

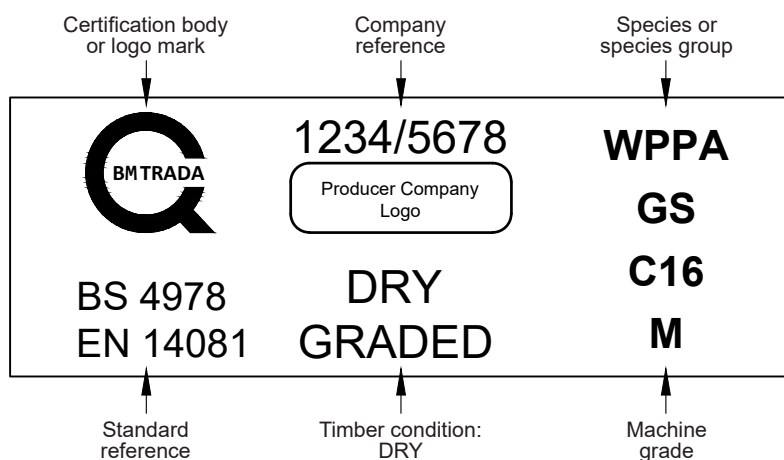
BS EN 338 should be used by the designer to determine the suitable strength class for structural timber components.

All structural timber should be:

- Machine graded to BS EN 14081 or, visually graded to BS 4978 for softwoods or BS 5756 for hardwoods.
- Dry graded.
- Marked in accordance with BS EN 14081.

All load-bearing solid timber studs, rails, binders and sole plates should be of a minimum dry graded C16.

#### Typical grading stamp



#### Oak

The guidance within this section is primarily for conventional timber frame open panel systems made off-site under factory Conditions. Oak used as a structural element and bespoke one off oak frame buildings will not be acceptable to us. See 'Appendix C' for further details.

#### Preservative treatment

All load-bearing timber components shall be either naturally durable or preservative treated in accordance with BS 8417: Preservation of wood code of practice. Sole plates and load-bearing timber studwork are considered to be in 'Use Class 2'. Sole plates are normally considered to be included in 'Service Factor Code C', while load-bearing timber studwork is included in 'Service Factor Code B'. For Warranty purposes, service factor code B is always required.

All structural timber should be treated with a preservative suitable for the 'Use Class' and 'Service Factor' applicable to its use.

Where treated timber is cut, the exposed end will not be protected by the original preservative treatment. When treated timbers are cut in the factory or on site, the cut ends shall be re-treated with a preservative compatible with the original treatment used, this treatment should be coloured to allow easy checking on site.

#### Moisture content

All structural timber components should be at a moisture content of 20% or less at the time of manufacture. Once panels are manufactured, they should either be stored in a covered storage area, or loosely covered with a water proof sheet material. Confirmed as square by sample checking for equal diagonal measurements, lengths and heights.

## 6.2.4 Quality assurance systems for open timber frame panels

All timber frame Designers, Manufacturers, and Erectors shall possess evidence of compliance from at least one of the following quality assurance schemes:

- Full system acceptance and factory inspection by the Innovations team.
- The BM TRADA Q-Mark Timber Frame Elements Certification Scheme.
- Gold or silver members of the Structural Timber Association.
- CATG - Frame Mark.
- Other relevant third party quality assurance scheme that is acceptable to us.

The level of membership may need to be clarified as some levels may not meet the above requirements.

## Where no evidence of quality assurance systems/bespoke site assembled timber frame is present

Where evidence of an appropriate quality assurance system cannot be provided or for bespoke site assembled timber frame, the following should be satisfied (max 5 per project):

- Provide full structural design calculations for each house type, confirming the design meets BS EN 1995-1-1. This must include fixing details for any non timber components.
- Ensure an independent Engineer (not the design Engineer) monitors the design, installation, erection and completion of the timber frame system and provide a sign off statement at completion of the waterproof shell confirming that the timber frame construction has been installed as per the design.
- Satisfy the Warranty surveyor that the materials/products used are suitable and meet the requirements of the Technical Manual (e.g. timber specification and treatment, tolerances, drained and ventilated cavity, etc.).

## 6.2.5 Manufacturing tolerances

Timber frame panels shall be manufactured within the tolerances outlined in the guidance.

The following are our manufacturing tolerances that timber frame manufacturers' must adhere to:

- Length: +/-3mm.
- Height: +/-2mm.
- Diagonals should be equal, acceptable deviation is +/-5mm.
- Opening dimensions: 0mm, +5mm.

## 6.2.6 Timber frame delivery and storage on-site

Timber frame panels shall be delivered and stored on-site so that the durability or service life is not impaired.

Timber frame components should be:

- Carefully unloaded to avoid damage or distortion of components.
- Stored off the ground on an adequate number of level bearers.
- Loosely covered with a waterproof membrane to allow protection from moisture while allowing ventilation if they are not to be used for a prolonged period.
- Unwrapped if tightly bound in polythene and loosely recovered with a waterproof membrane to allow ventilation.
- All structural timber components should be at a moisture content of 20% or less at the time of manufacture. Once panels are manufactured, they should either be stored in a covered storage area, or loosely covered with a water proof sheet material. Confirmed as square by sample checking for equal diagonal measurements, lengths and heights.
- Handled and stored with particular consideration to moisture damage where insulation and VCL are incorporated.

## 6.2.7 Site preparation

The substructure shall be correctly set out to receive the timber frame.

## Pre-commencement

To allow the building to be constructed as designed all necessary drawings, specifications and fixing schedules shall be provided to site before work commences.

## Foundations

It is important that the tight tolerances for timber frame are understood, getting the location and level of the foundation correct is one of the most important parts of the build process.

The foundations or upstands that support the timber frame should be set out to the dimensions noted on the timber frame drawings:

- Within +/-10mm in length, width and line.
- Diagonals should be within +/-5mm up to 10m, and +/-10mm more than 10m.
- Levelled to +/-5mm from datum.

### 6.2.8 Timber frame erection tolerances

Timber frame wall panels shall be erected to the tolerances outlined within the guidance.

Wall panels should be erected to the following tolerances:

- +/-10mm from plumb per storey height.
- +/-10mm from plumb over the full height of the building.
- +/-3mm from line of sole plate, with maximum +/-5mm deviation from drawing.
- +/-5mm from line at mid height of wall panel.
- Inside faces of adjacent wall panels should be flush.
- Adjacent wall panels should be tightly butted.

### 6.2.9 Timber frame and external ground levels

Timber frame construction shall be erected so they are at least 150mm above external ground levels.

Timber frame systems should be erected on a DPC at least 150mm above external ground level. Where cavity trays are included in any detailing, there shall be consideration for drainage and ventilation requirements of the timber frame system.

Where cavity tray detailing is proposed, ventilation must be provided above and below the cavity tray in order to provide:

- Drainage and ventilation to the timber frame cavity above the cavity tray, **and**
- Ventilation to the sole plate below the cavity tray.

Where flexible DPC materials are to be used as a cavity tray, they should have supporting evidence in the form of a Declaration of Performance to BS EN 14909:2012. They should also have a third party product conformity certificate confirming their suitability for use as a cavity tray.

### 6.2.10 Gas protection system

Where a gas protection system is required (e.g. gas membranes) it shall:

- Be specified in accordance with relevant standards.
- Not impede on the drainage and ventilation requirements of the timber frame system.
- Be installed to manufacturers recommendations.

Where a gas barrier is required it should be specified and installed by suitably qualified persons.

Please refer to the 'Ground Conditions – Managing Ground Contaminants' section for further guidance.

### 6.2.11 Sole plates

Sole plates shall be durable and safely transfer loads from the superstructure to the substructure and provide a level base for erecting the timber frame wall panels. The following shall be taken into account:

- |                                                                             |                       |            |
|-----------------------------------------------------------------------------|-----------------------|------------|
| ▪ Location. Sole plates must be located 150mm above external ground levels. | ▪ Damp proof courses. | ▪ Packing. |
|                                                                             | ▪ Fixings.            |            |
|                                                                             | ▪ Ventilation.        |            |

#### Location

Sole plates must:

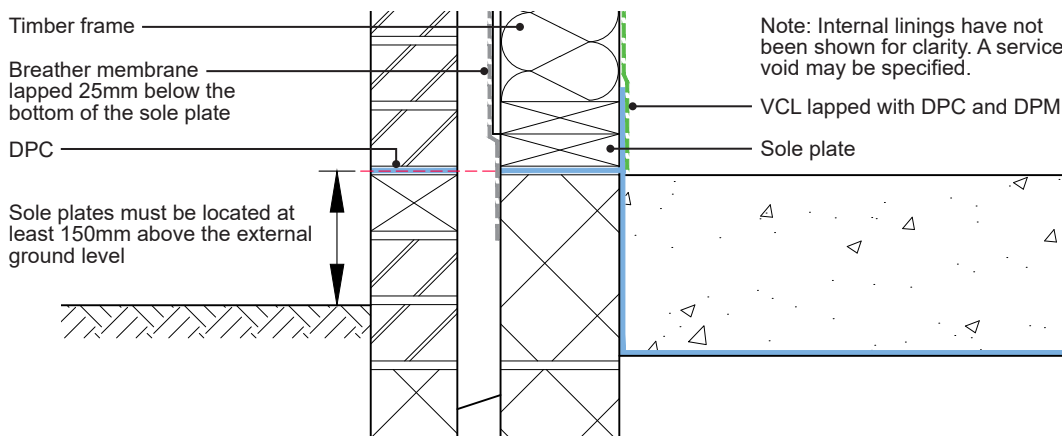
- Be located so that all structural timber is at least 150mm above external ground level. The use of a masonry foundation kerb upstand may be an appropriate method to achieve this. The exception to this is for localised ramping incorporating satisfactory drainage and ventilation detailing for level threshold requirements.
- Be levelled to +/-5mm from datum.
- Not overhang or be set back from the substructure by more than 12mm on a 89mm sole plate and 20mm for a 140mm sole plate. Ledges formed by the frame being set back from the supporting base should be protected from moisture by a membrane.

- Be set out within +/-10mm in length and in line within +/-5mm, as defined by the timber frame drawings.
- Diagonals should be within +/-5mm up to 10m, and +/-10, for more than 10m.

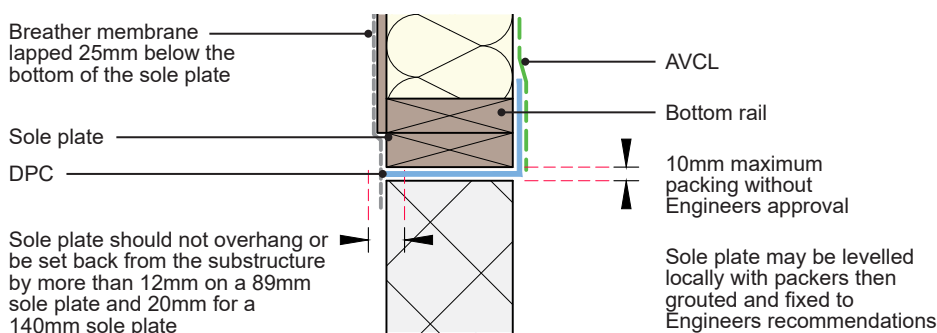
## Notes:

- Internal and party wall timber sole plates should not be installed below internal finished floor level.
- Localised level access provision should follow guidance in the 'Driveways and Paving' section. Infinity patio type scenarios are not acceptable for Warranty unless suitable drainage provision acceptable to us is provided between the external wall and the ground finishes.
- Where the soleplate overhangs and a masonry outer leaf is specified, a 50mm cavity must always be maintained.

## Sole plate/foundation junctions



## Locating sole plates



## Damp Proof Course (DPC)

A DPC should:

- Be located directly below all timber sole plates.
- Any junction formed in the DPC should overlap by at least 100mm.
- Be located flush to the outside edge of the sole plate.
- Provide 100mm lap to any AVCL provided within the wall panel.

## Fixings

Fixings should:

- Be installed to the Engineers specification.
- Not damage the substructure or sole plates during installation.
- Be placed to provide adequate lateral restraint at door openings.
- Be specified with consideration for use with gas membranes where appropriate.
- Sole plates should be fixed to foundations with shot fired nails, proprietary sole plate fixings, anchors, brackets, or straps, as specified by an Engineer.
- If holding down straps are used, they should be stainless steel grade 1.4301 steel to BS EN 10088.

## Ventilation to sole plate area

Regardless of the cladding system used, a cavity with provision for drainage and ventilation should be provided between the cladding and the timber frame ensuring that adequate ventilation provision is provided to all areas of the timber frame including the sole plate.

## Packing

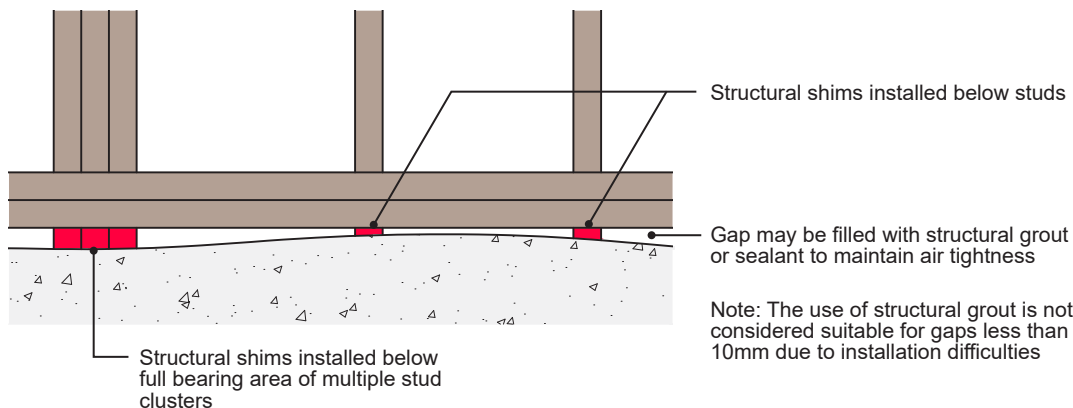
Structural shims or grout may be required under sole plates to level them and transfer vertical load. Longer fixings may be needed to allow for the size of the gap.

## Structural shims

Structural shims should be positioned below all timber studs and be of the same cross section. Lightweight window packers should not be used.

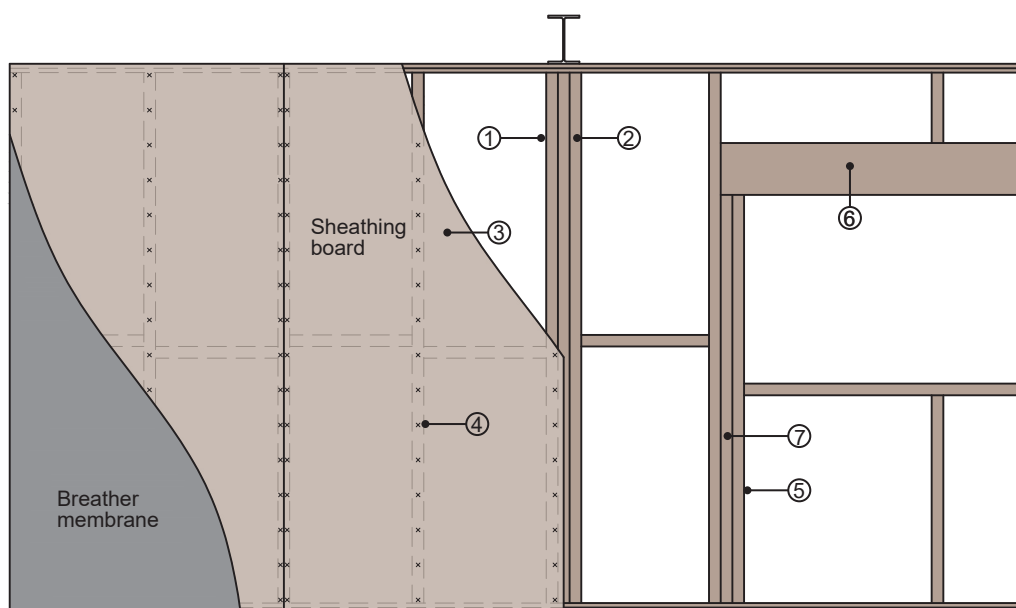
**Structural grout**

Structural grout should be as per an Engineers specification. The use of structural grout is not considered suitable for gaps less than 10mm due to installation difficulties. Where grout is used as permanent structural packing, installation should be checked to ensure full bearing is achieved.

**Packing of sole plates****6.2.12 Timber frame wall panels**

Timber frame external wall panels shall:

- Be manufactured and fixed in accordance with the Engineer's design and specification.
- Consist of solid timber studs and rails.
- Have studs at a maximum of 600mm centres and a minimum width of 37mm
- Be braced with a structural sheathing board.



1. Machine graded to BS EN 14081 or, visually graded to BS 4978 for softwoods or BS 5756 for hardwoods. All load-bearing solid timber studs, rails, binders and sole plates should be of a minimum dry graded C16.
2. Any point load imparted onto the timber frame should be transferred down through the building to the foundations with the use of multiple studs, as required by the Engineer's design. If these are not installed during the manufacture of the panels the requirement for installation must be clearly conveyed to site.
3. Wood-based board materials used for sheathing should be fixed to the studwork frame leaving a 3mm minimum gap between boards to allow for moisture-related movement.
4. The fixings securing the structural sheathing board to the timber studwork wall panels provide racking resistance as calculated by the Engineer. The sheathing board shall be fixed to the timber studwork in strict accordance with the Engineer's fixing schedule. Fixing centres should not exceed 150mm around the perimeter of the board and 300mm centres in the field of the board. Sheathing fixings must not be over-driven through the face of the sheathing board.
5. Studs should be provided around window and door openings and adjacent to movement joints to allow the installation of wall ties or other cladding fixings. They should be accurately cut to length and bear tightly against the wall panel top and bottom rails.
6. A lintel may be required where openings do not fall between studs unless the vertical load is adequately transferred by other elements.
7. Lintels will require support of cripple studs. All structural timber should be treated with a preservative suitable for the 'Use Class' and 'Service Factor' applicable to its use.

## Lintels and openings

Timber lintels should be provided within timber frame panel over openings. They should safely support the applied loads, be of the correct size, and have adequate bearing.

Openings in timber frame panels should have timber lintels which are supported off of cripple studs except where:

- The stud spacing is not affected by the opening, **or**
- Supported loads are carried by a ring beam or header joist.

For guidance on steel and concrete lintel provision in external masonry cladding, please refer to the 'External walls – External Masonry Walls' section.

## Fixings and junctions

All fixings are to be installed to the Engineer's specification, unless otherwise justified:

- Junctions of wall panels and sole plates/head binders should not occur together.
- Head binder laps should wherever possible occur over a stud, preferably at least 600mm from the panel junction.
- Wall panel to wall panel connections should be a maximum of 300mm centres.
- Bottom rail to sole plate fixings should be one or two per stud bay.
- Wall panels should be adequately braced during erection to maintain tolerances.
- Disproportionate collapse components and fixings must be installed if specified.
- Multiple stud clusters which are considered structural (e.g. point load-bearings) should be designed by an Engineer.
- Point loads must be transferred down through wall panels and floor zones to foundations.
- Engineered timber components should not be exposed to moisture for longer periods than those stated by the manufacturer.
- Roof trusses/rafters should be adequately fixed to wall panels.
- Floor joists should be nailed down to wall panels.
- If no head binder is present, floor joists must bear directly over studs.
- Waistbands and alignment of floors over walls should remain within tolerances for wall panels.

Timber framing components and structural sheathing boards may be fixed with either nails or staples.

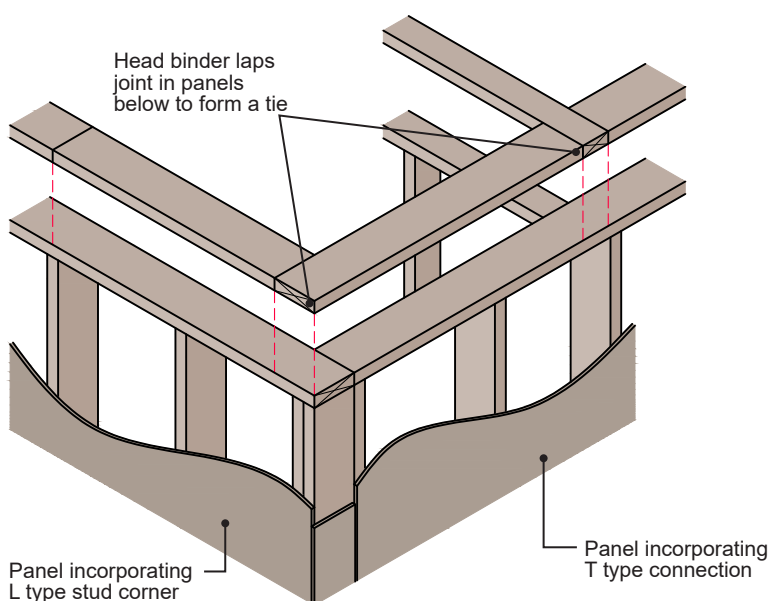
Nail fixings should be either:

- Austenitic stainless steel, **or**
- Galvanised, **or**
- Sherardized.

Staple fixings should be austenitic stainless steel or other material of similar strength and corrosion resistance.

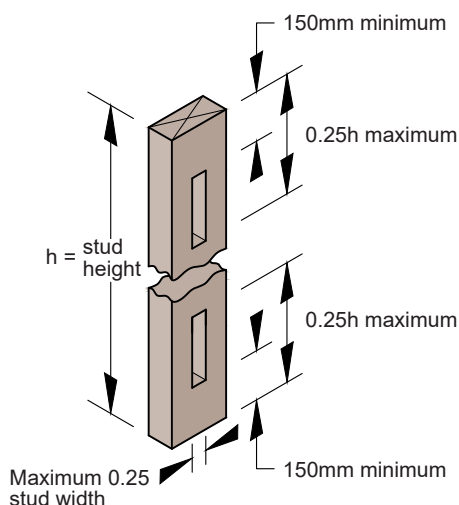
## Head binder lapping

- Head binder butt jointed over stud or lintel which is fixed to the underside of the top rail.
- Head binder nailed to frames. Fixings determined by timber frame engineer's calculations.



### Drilling of studs

Drilling on centre line only. Hole diameters should not be greater than 0.25 the stud width and hole centres should not be closer than 4d (d = hole diameter).



### 6.2.13 Structural sheathing boards

Structural sheathing boards shall be of a suitable strength and durability and be specified by the Engineer to provide racking resistance to the structure.

#### Materials

Structural sheathing board materials may be any of the following:

- Orientated strand board (OSB). OSB should be grade 3 or 4 in accordance with BS EN 300.
- Plywood. Plywood should be at least Class 2 or 3 Structural in accordance with BS EN 636.
- Impregnated soft board. Type SB.HLS in accordance with BS EN 622-4.
- Non timber based boards or other board material must have a suitable third party product conformity certificate which is acceptable to us.

All wood-based panel products should comply with BS EN 13986: Wood-based panels for use in construction characteristics, evaluation of conformity and marking.

Please note:

- We do not accept the use of MgO boards.
- The selection of materials for the structural sheathing boards should satisfy the relevant Building Regulations in respect to fire safety.

#### Fixings

The sheathing board shall be fixed to the timber studwork in strict accordance with the Engineer's fixing schedule. Fixing centres should not exceed 150mm around the perimeter of the board and 300mm centres in the field of the board. Sheathing fixings must not be over-driven through the face of the sheathing board.

### 6.2.14 Breather membranes

Breather membranes shall be installed to protect the timber frame system and sheathing board from moisture whilst allowing water vapour from within the frame to pass into the cavity. The following shall be taken into account:

- |                                 |                                     |
|---------------------------------|-------------------------------------|
| ▪ Specification of the membrane | ▪ Fixing                            |
| ▪ Positioning                   | ▪ Exposure of the breather membrane |
| ▪ Lapping                       |                                     |

#### Specification

Breather membranes should:

- Have an appropriate third party product conformity certificate.
- Have a vapour resistant to less than 0.6MNs/g (0.12 Sd) when tested in accordance with BS EN ISO 12572 using the set of conditions C and using five test specimens.
- Be a minimum Class W2 or better in accordance with BS EN 13859-2.

- Be a minimum Class W1 in areas of very severe exposure, where liquid water penetration of the cladding is anticipated or where the membrane is likely to be left exposed during construction.
- Be UV resistant in accordance with BS EN 13859-2 where the cladding does not exclude UV exposure (e.g. such as open jointed cladding panels).
- Be capable of resisting water penetration.
- Be durable to resist site damage when wet.
- Be self-extinguishing.
- Be securely fixed to protect the outside face of the timber frame structure with austenitic stainless steel staples.
- Be trimmed to leave 25mm lap below the lowest timber sole plate.
- Be repaired if damaged.
- Have the location of solid timber studs clearly marked on the outer face of the breather membrane to ensure that cladding fixings are installed into solid timber.

## Positioning

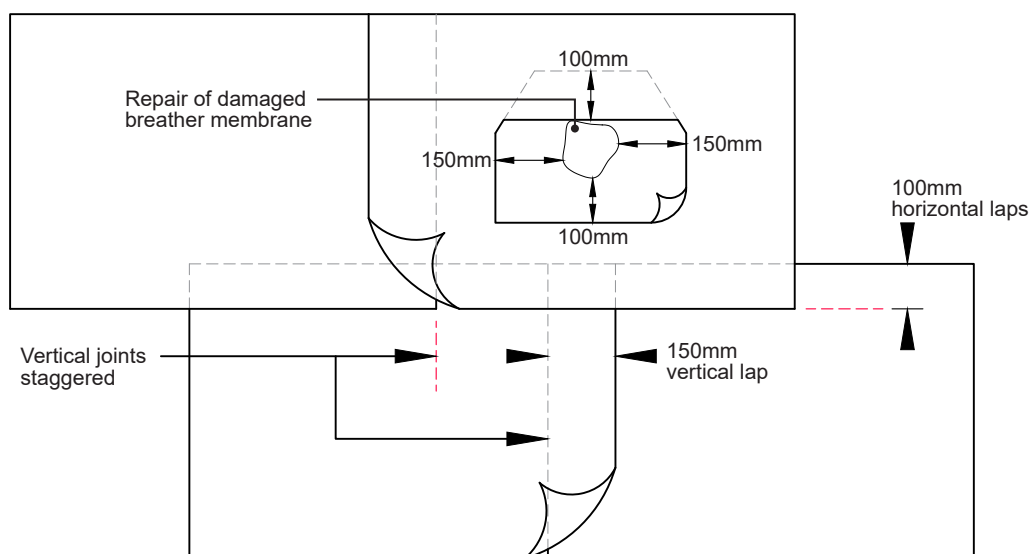
Breather membranes must be placed on the external face of the sheathing board to help provide weather protection to the sheathing board and the structural frame during construction. Any penetrations such as bracketry or fixings should be appropriately sealed as per the membrane manufacturer's instructions.

A breather membrane may also be required on the external face of the insulation which is in the cavity zone where required by the insulation manufacturer or third party product conformity certificate and subject to a condensation risk analysis.

A breather membrane must always be installed irrespective of the external sheathing board product.

## Lapping

Breather membranes should be lapped by a minimum of 100mm at horizontal joints, and a minimum of 150mm at vertical joints. Vertical joints should be staggered at regular intervals where possible. The breather membrane should be lapped to deflect moisture away from the timber frame structure (upper layers over lower layers).



## Fixing

Breather membranes should be fixed using austenitic stainless-steel staple nails at the following centres:

- Horizontal
  - Panel centres – 600mm max
  - Horizontal membrane joint - 150mm
  - Head and base of panels – 150mm
- Vertical
  - 300mm centres vertically (may be increased to a maximum of 500mm when verified with a third party product conformity certificate).
  - Vertical membrane joint – 150mm
  - Ends of panel – 150mm
- Around openings – 150mm

If breather membranes are trimmed flush with the edges of wall panels, additional strips of breather membrane, at least 300mm wide, should be supplied and site fixed over panel junctions.



### Exposure of the breather membrane

In situations where open jointed claddings are used, **and/or** the breather membrane is left exposed during construction for a duration which exceeds what the manufacturer recommends (or what the third party product conformity certificate for the breather membrane states):

- The performance of the breather membrane should be based on artificial aged behaviour in accordance with BS EN 13859-2.
- A ventilated tarpaulin (or similar protective sheeting) should be used where there is an expected period of heavy rainfall followed by freeze thaw conditions.
- Where the cladding is not open-jointed (render board, brick cladding etc.) performance should be based on artificial aged behaviour in accordance with BS EN 13111.

### 6.2.15 Thermal insulation

Thermal insulation shall be specified correctly and installed to avoid damp, interstitial condensation and thermal bridging issues occurring within the wall makeup. The overall insulation value of the wall shall meet the requirements of relevant Building Regulations. The following should be taken into account:

- Specification
- Location
- Thermal bridging

### Specification

Insulation materials should be chosen with consideration for their breathability and interaction with the timber frame and should have an appropriate third party product conformity certificate.

External walls should be subject to U-Value and condensation risk calculations. A wall build up will be considered satisfactory if there is no calculated risk of surface or interstitial condensation at any time of the year, and it fulfils the minimum national requirement for thermal performance.

Special consideration should be given to condensation risk where non-breathable insulation products are installed on the outside of the timber frame structure. Joints between foil faced external insulation boards, must not be taped as this forms a vapour control layer on the cold side of the insulation.

Depending on the specification of insulation materials to be added to the structural frame, timber battens may be required to support the insulation or allow fixing of plasterboard linings, or external cladding to achieve the specified period of fire resistance.

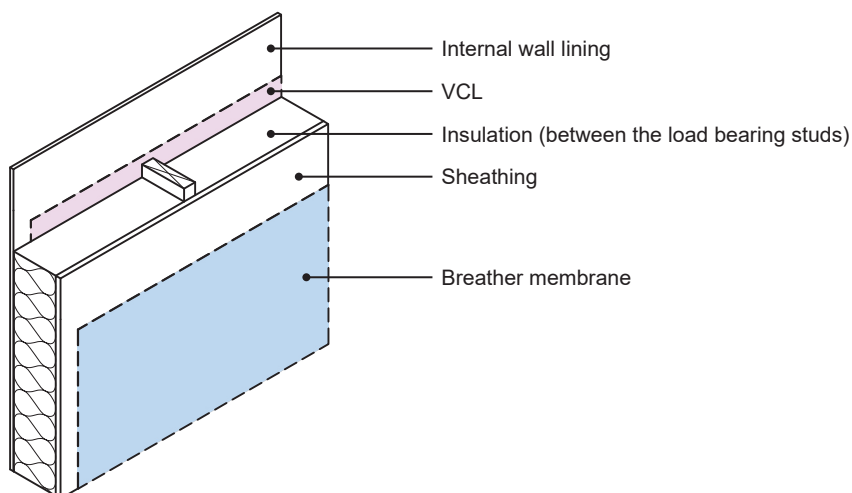
### Locations

Insulation may be specified in any or all of the following locations:

- Between studs.
- On the outside of the timber frame.
- On the inside of the timber frame.

The following images do not show the external wall cavity or cladding for clarity.

#### Insulation between studs



Insulation which is placed within the stud void must cover the whole wall area between the studs with no gaps present at:

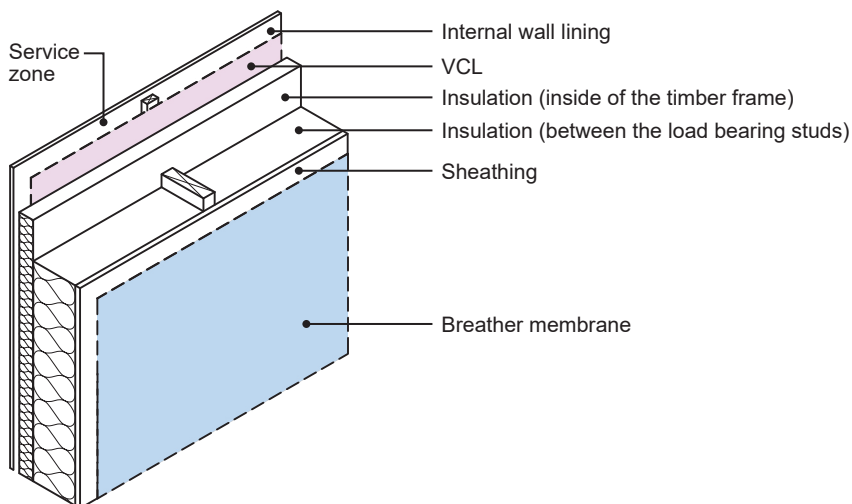
- Corners.
- At junctions with partitions.
- Against studs, rails or noggings.
- Behind services and pattern panels.

If insulation is specified between external walls studs all voids shall be filled with insulation to maintain the thermal envelope of the building. When noggings or boards are installed between studs to support services or heavy fittings the void behind them shall be fully insulated.

Insulation should not be installed until the structural timber frame is below 20% moisture content and the building is weather tight, as wet insulation can retain moisture. If closed panel timber frame is specified, additional care must be taken to protect the panels from exposure to moisture during construction, with moisture content checks carried out before full closure.

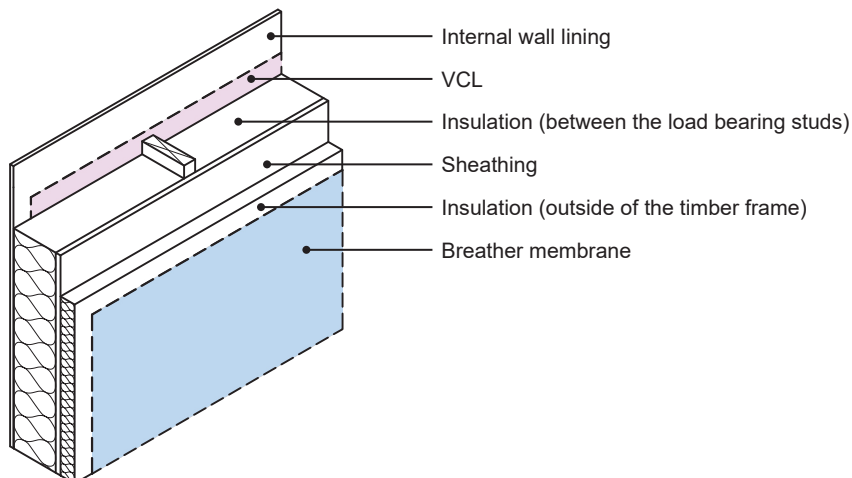
Note: The above also applies equally to insulated party wall cavities. There needs to be consideration for how party wall insulation is to be kept dry during the build process.

## Continuous internal insulation



Please note: we cannot accept the above build up without appropriate fire test reports confirming its suitability.

## Continuous external insulation



Insulation boards placed within the cavity space between the timber frame and external cladding shall also satisfy the following:

- Allowance should be made for differential movement to occur at floor zones.
- It should not retain or transmit moisture to cause the timber structure to exceed 20% moisture content.
- Stud locator marks should be transferred onto the outer face of the breather membrane adjacent to the external wall cavity.
- Wall ties should transfer loads to the timber frame structure. To achieve this, wall ties will typically need to be installed through the external insulation rather than bearing onto it.
- Where wall tie systems incorporate a vertical rail system:
  - The cavity insulation should be suitable for use with these systems.
  - The positioning the rails should ensure the fixings go back to the timber studs.
- Foil faced insulation boards should not be taped.

## Thermal bridging

Insulation should be continuous at all junctions and all voids within the wall panel should be insulated to ensure thermal continuity is maintained and any small gaps which cannot be insulated effectively should be avoided.

### 6.2.16 Air and vapour control layer (AVCL)

AVCL's shall be specified and installed to restrict the passage of air and water vapour from within the home into the timber frame system.

An AVCL is a moisture vapour-resistant material located on, or near, the warm side of the thermal insulation. Its purpose is to restrict the passage of moisture vapour through the structure of the wall and mitigate the risk of interstitial condensation.

The designer should take account of how the AVCL should be installed on site to ensure adequate air tightness is achieved. This will include provision of laps at junctions e.g. immediate floors.

#### Specification

The AVCL may take the form of:

- A vapour control plasterboard.
- A minimum 125 micron thick (500 gauge) polythene sheet.
- A proprietary vapour control membrane product which has an appropriate third party product conformity certificate.

#### Criteria for a condensation risk analysis

For Warranty purposes, the boundary conditions for a condensation risk analysis should be as follows:

- 60% relative humidity.
- External temperature -2°C.
- Internal temperature 21°C.

Where external temperatures are considered to fall below -2°C due to exposure or geographical locations, lower temperatures should be used based upon climatic data within relevant standards.

#### Installation

A sheet membrane (polythene or proprietary) VCL should be:

- Securely fixed to and cover all areas of the timber frame external walls, including all sole plates, head binders, and lapped/sealed fully into window/door reveals. The VCL should be Fixed at 250mm centres to the top and bottom of the frame.
- Lapped and sealed by at least 100mm at joints. Joints in the VCL should occur over studs, rails or noggins and be mechanically fixed.
- Lapped and sealed over studs, rails or noggins.
- Sealed around service penetrations.
- Lapped and sealed with DPM/DPC at the junction with the ground floor/foundation by a minimum of 100mm.
- Made good where damage as occurred to the VCL.

Vapour control plasterboard should be:

- Fixed in accordance with the plasterboard manufacturer's installation guidance.
- Tightly cut and fitted around service penetrations.
- Discarded if the vapour control backing is damaged.
- Junctions, joints and penetrations (switches and sockets for example) should be appropriately detailed to ensure the vapour resistivity is not adversely comprised.

Notes:

- The AVCL should not be installed until the structural timber frame is below 20% moisture content and the building is weather tight.
- Small holes in the AVCL should be sealed with a suitable self-adhesive tape. If a proprietary membrane is being used, the manufacturer's proprietary sealing tape should be used. Larger holes should be re-covered to lap over adjacent studs and rails.

### 6.2.17 Internal wall linings

The internal wall lining shall provide an adequate surface to receive the intended finish required by the design. Supporting evidence will be required, where the wall lining is intended to perform additional functions (e.g. racking resistance, fire resistance or acoustic performance).

Wall linings are typically:

- Gypsum plasterboard.
- Fibre reinforced gypsum board.
- Cement bonded particle board.

Lining materials should satisfy all relevant performance criteria, e.g. fire resistance, acoustic performance and have a relevant third party product conformity certificate.

- Moisture resistance linings should be specified in high moisture environments (e.g. bathrooms).
- Internal linings should only be installed where the moisture content of the timber frame is less than 20%.
- We do not accept the use of MgO boards.

## Plasterboard

### Installation

Plasterboard must:

- Protect all areas of the timber frame structure.
- Have all edges supported by timber studs or rails.
- Be fixed in accordance with the plasterboard manufacturer's guidance.
- Be cut and tightly fit around service penetrations.
- Have junctions of wall and ceiling linings detailed to maintain continuity.
- Be installed using the specified number of layers to achieve the required fire resistance.
- Have all joints staggered when installing multiple layers.

### Fixings

When fixing plasterboard linings:

- Each layer must be fully and independently fixed.
- Fixings of the correct length and centres should be installed in accordance with the plasterboard manufacturer's installation instructions.
- Walls requiring plasterboard to provide racking resistance should be clearly identified with plasterboard installed to the Engineer's specification or the plasterboard manufacturer's specification, whichever is more onerous.

### 6.2.18 Fire resistance

Timber frame walls shall have adequate fire resistance in accordance with the relevant Building Regulations. Supporting test evidence to an appropriate standard shall be made available upon request.

The designer should ensure timber framed walls and all associated components are fire resistance in accordance with the relevant Building Regulations.

### Fire performance for openings

All openings including doors, windows, flues and ventilation ducts, should also be designed and constructed to maintain fire performance. The following should be taken into account:

- Internal reveals require equal fire resistance to the rest of the structure.
- Window fixing straps should not compromise the integrity of any fire-resistant reveal linings.
- Cavity barriers should be installed in the external wall cavity around the perimeter of openings. They must be mechanically fixed to rigid construction (for both vertical and horizontal positions).
- If profiled steel lintels are used as cavity barriers, triangular gaps behind lintels, which occur at each end, should be closed with careful positioning of adjacent cavity barriers.

### 6.2.19 Provision of cavities

Timber frame external walls shall be provided with a drained and vented cavity which resists the passage of moisture to the inside of the home and prevents interstitial condensation.

### Minimum cavity width for different cladding types

| External leaf                  | Minimum cavity width |
|--------------------------------|----------------------|
| Masonry                        | 50mm                 |
| Render on un-backed lath       | 50mm                 |
| Render on backed lath or board | 25mm                 |
| Timber                         | 19mm                 |
| Tile hanging                   | 25mm                 |

### Drained and vented cavity

Cavities should have openings to the outside air of not less than 500mm<sup>2</sup>/m length of wall. Where cavities are not continuous (e.g. due to obstructions such as cavity barriers) each individual cavity should be vented. Drained and vented cavities should be provided in the following locations:

- At the base of the external wall concealed space.
- Above horizontal cavity barriers/trays.
- Over openings in the external wall cavity, e.g. windows and doors.

Measure should be taken to prevent the ingress of large insects, small mammals or birds and to avoid rainwater penetration. A nominal mesh/grill size of 4 mm should be used to avoid excessive resistance to airflow.

### 6.2.20 Cavity barriers

Cavity barriers shall be durable and must not adversely affect the structure of the external wall or the performance of the weatherproof envelope.

Where required by statutory regulations, cavity barriers shall:

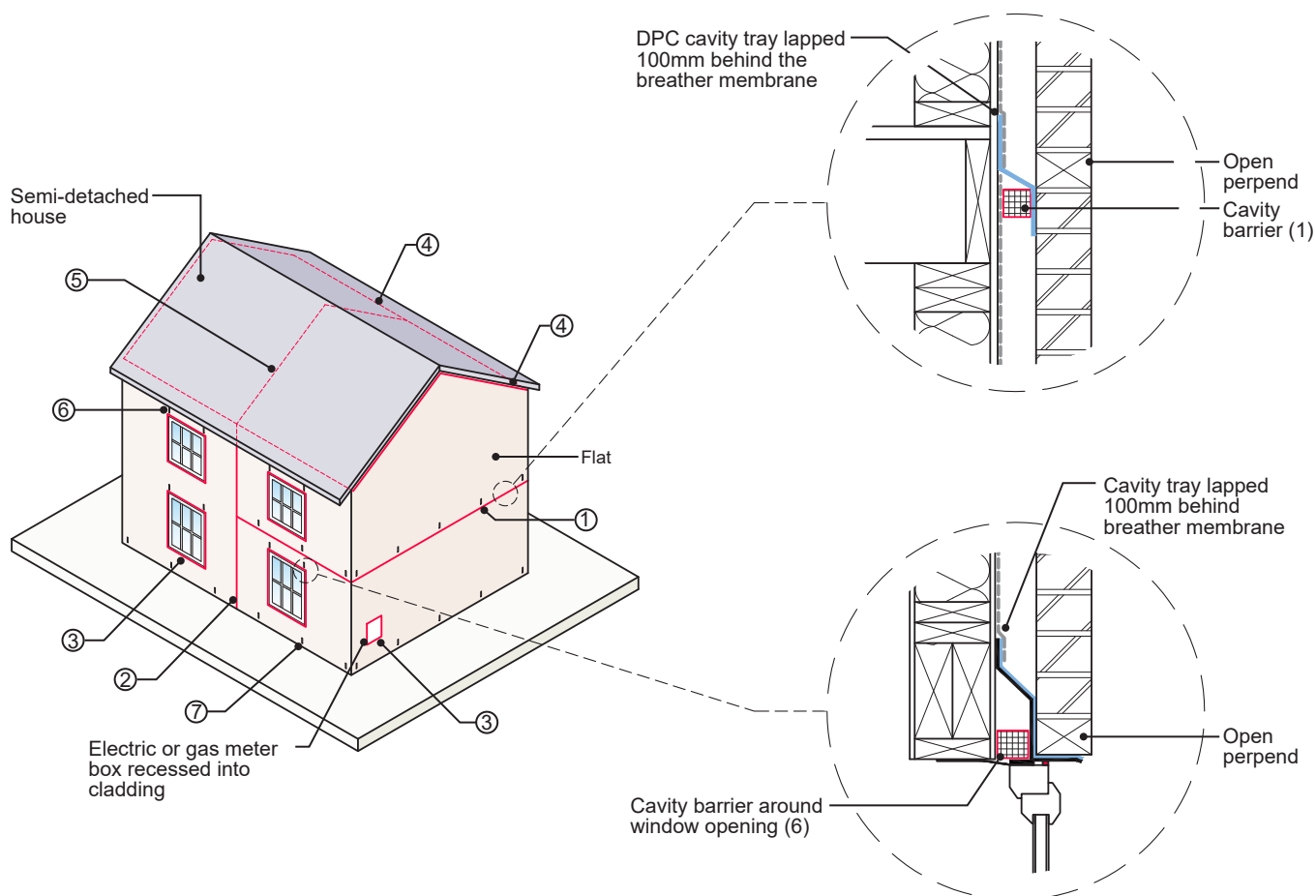
- Be of a suitable material.
- Specified and installed within the scope of the test certification and/or the third party product conformity certificate.
- Be installed in accordance with the manufacturer's recommendations.
- Be suitable for the location they are installed.

Where cavity barriers are required by statutory regulations, their specification, positioning and installation should satisfy the requirements of the Building Regulations.

#### Locations of cavity barriers and open perpend within the external wall

##### Notes

- Lightweight cladding systems will require a cavity barrier along the bottom of the cavity.
- Cavity barriers may also be required between walls and floors within the building, consult National Regulations for further guidance.



1. Cavity barriers are required at the junction of party floors and external walls (flats).
2. Cavity barriers are required at the junction of the external wall and the party wall.
3. Cavity barriers are required around the edges of all openings.
4. Cavity barriers are required at eaves and verge.
5. Cavity barriers/firestopping at the head of the party wall.
6. Open perpend over openings installed at maximum 900mm centres, with at least two over each opening.
7. Open perpend installed at maximum 1350mm centres to drain and ventilated external wall cavity.

## Cavity barrier installation

Cavity barriers should be installed:

- So they fully close the cavity by friction fitting for the designed cavity width.
- Backed by solid timber studs, rails or floor joist at least 38mm wide.
- In accordance with manufacturer or independent certifier's guidance.
- So they are mechanically fixed to rigid construction (for both vertical and horizontal positions).

Where insulation is placed outside of the timber frame and where a cavity barrier is required, it must be fixed back to the timber frame structure.

## Specification

Where vertical cavity barriers are required, they should be continuous for the full height of the wall and extend below DPC level.

Where horizontal cavity barriers are provided they must be tested for the scenario and have an third party product conformity certificate. A cavity tray should be installed directly above a horizontal cavity barrier and lapped up at least 100mm behind the breather membrane (except at eaves and verges).

Note: Lightweight cladding systems may require a cavity barrier along the bottom of the cavity. This may not be necessary however where a horizontal batten is present at the bottom of lightweight cladding systems.

## Materials

Cavity barriers may be constructed from:

- Steel at least 0.5mm thick.
- Timber at least 38mm thick.
- A proprietary mineral wool product which has an appropriate third party product conformity certificate.
- Calcium silicate, cement-based or gypsum-based board at least 12mm thick.
- An independently assessed and certified proprietary product.

Timber cavity barriers should be protected from cladding by the use of a DPC. The cavity face of the barrier should be left uncovered to allow drainage and ventilation of the timber frame system. The use of timber cavity barriers around openings allows for effective sealing to be installed between them and the opening frame.

### 6.2.21 Forming weather resistant openings

Openings within the timber framed wall shall be designed and constructed to prevent the passage of moisture to the inside of the building. Particular attention shall be paid to:

- Detailing around reveals.
- Window sill detailing.
- Thermal performance and thermal bridging.
- Differential movement.

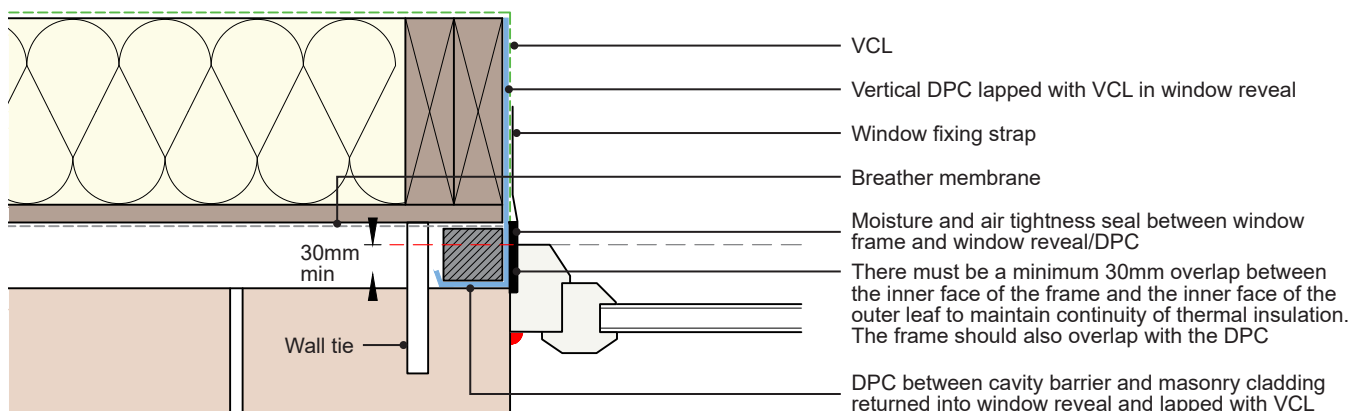
Openings shall also be designed and constructed to maintain fire and acoustic performance.

## Detailing around reveals

A DPC should be provided between the cavity barrier and external cladding which is returned into window reveal and lapped with VCL. Where no DPC is used, breather membrane should be lapped with internal VCL.

There must be a minimum 30mm overlap between the inner face of the window/door frame and the inner face of the outer leaf to maintain continuity of thermal insulation. The frame should also overlap with the DPC.

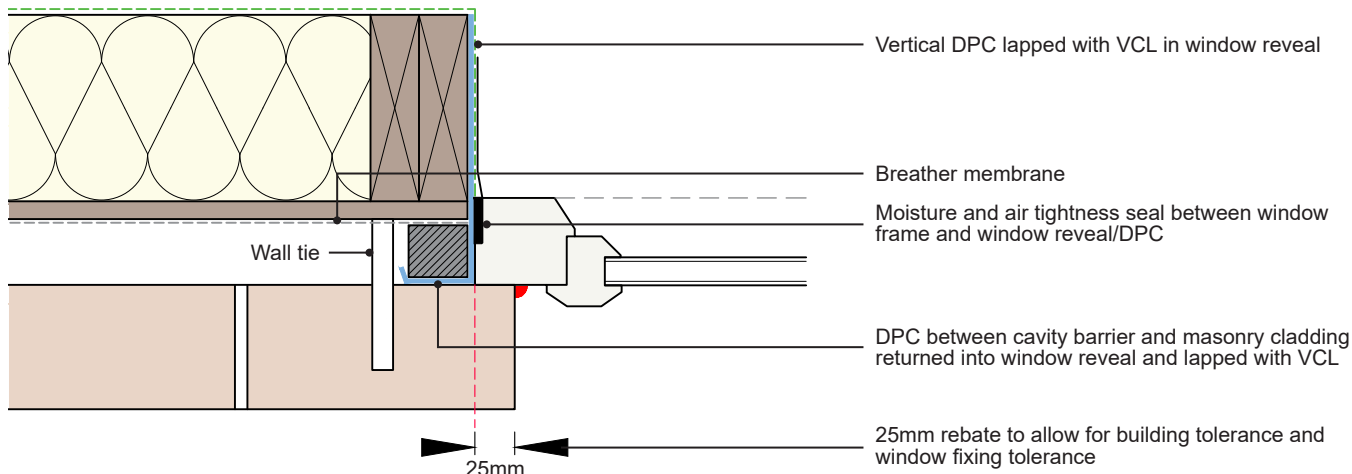
### Typical window reveal detail (normal exposure)



### Checked rebates

Checked (rebated) reveals are required in Scotland and in any areas of very severe exposure in England and Wales. The frame should be set back behind the outer leaf and should overlap.

For further information on external windows and doors please refer to the 'External Windows and Doors' section.

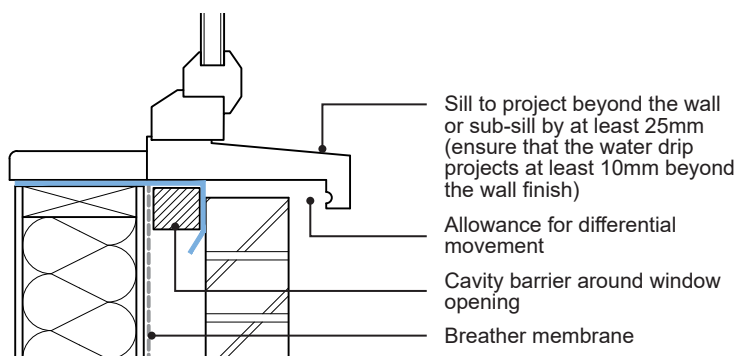


### Thermal performance and thermal bridging

Detailing around openings should avoid thermal bridging and interstitial condensation. To avoid these issues, detailing should consider the following:

- The element being installed into the opening will have a minimum thermal performance.
- Junction between the window/door frame and the opening also has a thermal performance value assigned to it (psi value) designs may incorporate insulated reveals.
- The gaps between the timber frame wall and the element being installed into the opening may include the use of air sealing tapes, compressible seals or EPDM to promote thermal performance and continuity, weather tightness and air tightness.

### Window sill detailing



Note: Internal linings have not been shown for clarity. A service void with additional insulation may be specified.

### Differential movement

Materials should be chosen to provide an effective weather tight seal dependent on whether they are to be subjected to compression, expansion, or shear forces around openings. The weathertight seals around the openings should be checked once the maximum design differential settlement has occurred to ensure a weathertight seal is maintained.

### Application of sealants

The use sealants around openings may not provide the required performance in areas of high movement. Specifiers should consult with manufacturer's for further guidance on performance in areas of compression, shear and expansion.

## 6.2.22 Cavity trays and their ancillary components

Cavity trays and their ancillary components shall be suitable and durable for their intended purpose and be provided to prevent moisture entering the home. The following should be taken into account:

- Specification
- Locations
- Drainage and ventilation
- Stop ends
- Installation of stepped cavity trays

### Specification

Cavity trays should:

- Meet the requirements of BS EN 14909.
- Comply with the relevant Building Regulations.
- Have an appropriate third party product conformity certificate confirming suitability for use as a cavity tray.
- Rise at least 150mm from the outer to the inner leaf, be self-supporting or fully supported and have joints lapped and sealed.

Cavity trays should be proprietary preformed cavity tray systems at stepped and lower storey abutments, complicated junctions and around corners in low rise masonry walls.

Cavity trays should lap behind the breather membrane by at least 100mm to deflect moisture away from the sheathing. Cavity trays should be robustly fixed to the to a suitable substrate as detailed in the third party product conformity certificate.

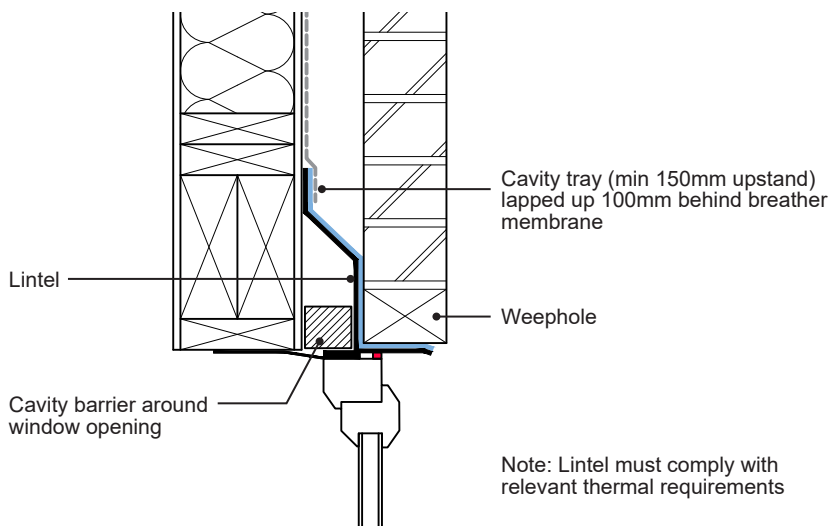
Please note: Polyethylene DPCs should not be used as a cavity tray. Please refer to 'Appendix C' for further guidance.

### Locations

Cavity trays should be provided in the following locations:

- Above all openings and interruptions likely to direct rain water across the cavity such as window and door openings, rectangular ducts, lintels and recessed meter boxes.
- Above horizontal cavity barriers.
- Above cavity insulation that is not taken to the top of the wall, unless that area of wall is protected by impervious cladding e.g. where a spandrel is provided cold pitched roof.
- Continuously above lintels where openings are separated by short piers.
- Directly above openings that are under a compartment floor with a cavity barrier and cavity tray already present.

### Cavity tray and lintel



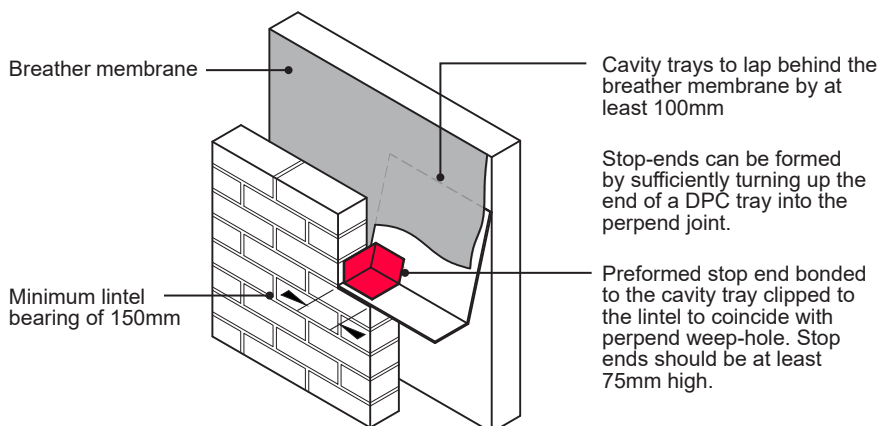
The detailing of the cavity tray will depend on the cladding type. For further information on masonry cladding, please refer to 'External Walls – External Masonry Walls' section.

### Drainage and ventilation

Where cavity trays are provided there should be provision to drain moisture from the cavity with the use of cavity vents. Cavity vents should also be provided to promote ventilation of the timber frame (minimum 500mm<sup>2</sup>/m run of wall). Cavity vents should prevent the ingress of moisture, insects or vermin.



### Stop end to cavity tray



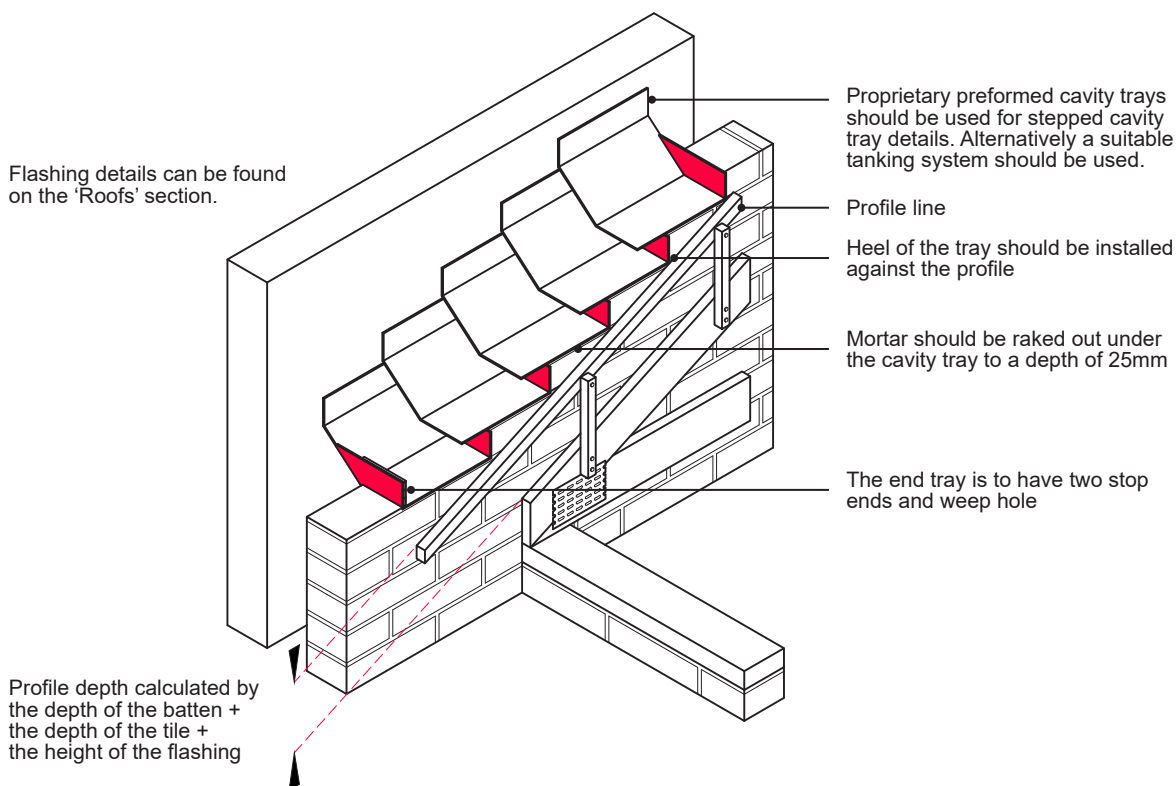
### Installation of stepped cavity tray

Stepped cavity trays are required at all pitched (stepped) roof abutments with external walls, e.g. attached garages or staggered terraces.

Preformed rigid cavity trays should be used for stepped cavity tray details. Stepped cavity trays to lap behind breather membrane by at least 100mm. Additional measures may be needed to ensure the breather membrane adequately laps the tray to prevent moisture ingress behind the stepped cavity tray.

Where preformed rigid cavity trays are specified, they should be specified and installed to take account of differential movement between the timber frame and external cladding.

A lead cover flashing should be linked into the cavity tray (lapped in below). Flashing details can be found in the 'Roofs' section.



## 6.2.23 Claddings

External claddings for the timber frame building shall be durable and fixed back to structural timber as per the Engineers specification whilst maintaining a drained and vented cavity.

Claddings supported on the timber frame should be connected to it on vertical treated timber battens, or a carrier system, to form a drained and ventilated cavity to all areas of the external timber frame wall. These should be fixed into structural timber not just through the sheathing and to the Engineer's specification.

Please refer to the 'External Walls – External Masonry Walls' section where masonry cladding is specified.

For additional guidance on claddings supported on timber frame please see the 'External Walls - Render' and 'External Walls - Claddings' section.

For guidance on cavity barriers, please refer to the requirements within this section.

## 6.2.24 Calculating differential movement

The designer shall calculate the anticipated differential movement between the timber frame and other elements of construction to ensure the structural and weatherproof performance of the building is maintained.

Differential movement should account for shrinkage of the timber frame and any thermal expansion and moisture relation movement of the external cladding material.

Differential movement will therefore effect detailing such as:

- Windows and doors.
- Balconies and Juliet balconies.
- Rigid services e.g. copper gas and water pipes, dry risers, internal downpipes, SVP's and cable trays.
- Openings for services.
- Eaves and verges.
- Parapets.
- Cavity wall ties.
- Battens across floor zones.
- Junctions for mixed cladding designs.
- Lift shafts and stair wells of mixed construction.

The rates applied to shrinkage of the timber frame and thermal expansion/moisture related movement must be clearly stated in the design and specifications provided. For further details on applicable rates the relevant manufacturer's should be contacted.

Construction joints designed for differential movement should:

- Accommodate the expected amount of shrinkage or expansion safely.
- Provide a weather resistant and durable joint.
- Be protected with a cover strip where the movement joint is in excess of 35mm.

If fillers or seals are to be installed into differential movement gaps their fully compressed dimension, considering the area of the seal and force required to compress it, must be added to calculated gap size.

Materials should be chosen to provide an effective weather tight seal dependent on whether they are to be subjected to compression, expansion, or shear forces.

Gap sizes should allow for anticipated differential movement while allowing for drainage and ventilation requirements. Insect infestation should be avoided by using screens to cover gaps exceeding 4mm.

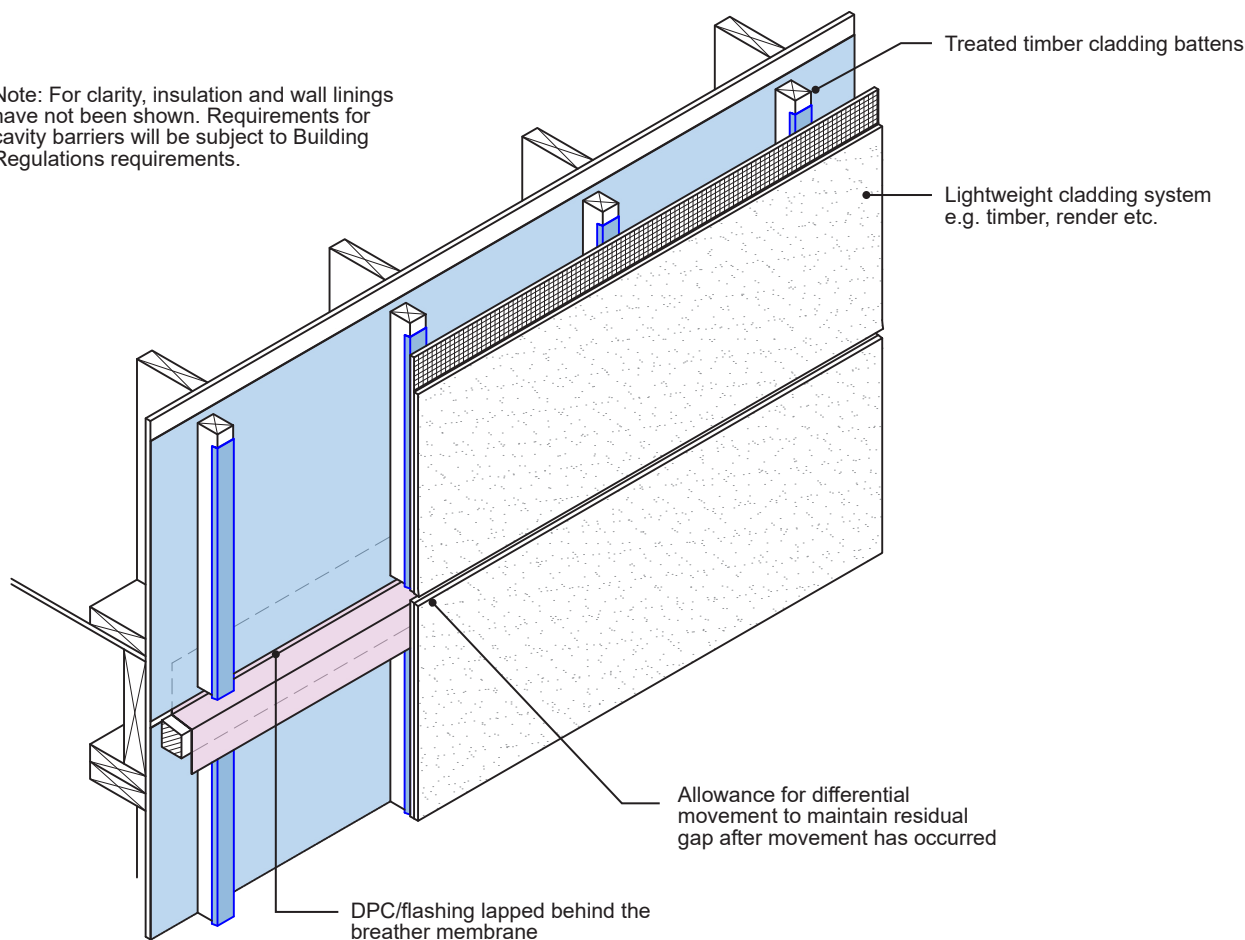
### Lift shafts, stairwells and steel posts

Lift shafts and stairwells of mixed construction, and steel posts will require site specific calculations to work out the anticipated differential movement with the timber frame.

### Differential movement at floor zone with cladding supported on timber frame

Vertical timber battens or other rigid cladding support systems should not span over the floor zones of timber frame buildings. Gaps should be provided to accommodate anticipated differential movement and the compressed size of any filler. Movement should be calculated individually for each floor zone using the formula of 1mm for every 38mm of horizontal cross grain timber.

Note: For clarity, insulation and wall linings have not been shown. Requirements for cavity barriers will be subject to Building Regulations requirements.



For additional guidance on claddings supported on timber frame please see the 'External Walls - Claddings' section 'of the Technical Manual.

### 6.2.25 Services

Where services pass through the timber frame panel they shall be specified and installed to:

- Ensure the structural integrity of the timber frame panel is unaffected.
- Prevent moisture ingress.
- Allow for differential movement where applicable.

Any penetrations to the timber frame panel be fully considered in the design in order to avoid unintended removal or alteration of structural timbers.

Where services pass through the timber frame panel they should be designed to prevent moisture transfer to the timber frame. Penetrations services such as flues and vents should include noggings to facilitate any enclosing cavity barriers and protected with a cavity tray.

Rigid services require specific detailing when passing horizontally or vertically through the timber frame panel to allow for differential movement, this should be calculated by the timber frame designer in line with the guidance in this section and provided to the relevant service installer to allow for appropriate installation details.

All service penetration should be carried out to maintain acoustic performance. The following should be taken into account:

- Seal gaps between timber frame wall and the element being installed into the opening.
- The element being installed into the opening may have a minimum acoustic requirement.

## Introduction

This section provides guidance on meeting the performance requirements for open light gauge steel frame (LGSF) panels which are manufactured off-site under factory conditions. For guidance on closed panel LGSF systems, please refer to the 'MMC Systems' section.

### 6.3.1 Compliance

The design, specification and erection of Light Gauge Steel Frame panels shall meet the performance requirements of this section.

### 6.3.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the performance requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. SCI stage 1 certificate, or evidence of a third party system approval (UKAS or equivalent).
2. Evidence of an ISO 9001 Quality management system covering the manufacturing of the panels including the material supply chain.
3. A full set of detailed drawings, including:
  - a. Plan layouts indicating dimensions.
  - b. Elevations with dimensions shown.
  - c. Junction details showing position of DPCs, cavity trays, other building elements such as roofs, floors etc.
  - d. Detailed drawings showing base rail levels in relation to external ground levels for all elevations.
4. Details of proposed breather membranes and VCLs to be used.
5. Engineers drawings, calculations and fixing schedules for each connection made on site (e.g. framing, sheathing, structural connections, membranes etc.) including size, type, number, spacing, method of fixing. Details of the corrosion protection of the fixing should also be provided.
6. Details relating to the securing and fixing of the panels to the substructure and between panels.
7. Details relating to the galvanisation coating of the frame, taking consideration of the anticipated exposure rating and potential aggressive meteorological environments.
8. Details of proposed cavity barriers including location, materials and technical assessments (third party product conformity certificate).
9. Details of any cladding material fixed back to the LGSF including type, size and location of fixings. Where masonry cladding is present on the external leaf, details of wall tie and movement joint provision.
10. Where insulation in the external wall makeup are to be fitted on site we would require details of proposed insulation to be used.
11. A condensation risk analysis should be provided for the external wall makeup.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 6.3.3 Structural design requirements

Load bearing LGSF panels shall:

- Meet the requirements of relevant standards.
- Be durable.
- Safely support and transmit intended loads to the foundations without undue movement.

A comprehensive full structural design specification and supporting calculations for each house type on the proposed project should be provided.

The structural design, specification and supporting calculations should be in accordance with the relevant parts of BS EN 1993 with dead, imposed, wind and snow loads calculated in accordance with:

- BS EN 1991-1-1
- BS EN 1991-1-3
- BS EN 1991-1-4

Please note we do not accept LGSF systems which rely on racking resistance of the sheathing board. Engineers Design Philosophy must clearly identify how lateral stability will be achieved by the steel frame design. This Engineers Design Philosophy should confirm that the stability system can resist the full horizontal wind and notional loadings, without any assistance from the sheathing board.

Wall panels may provide resistance to racking forces using one or more of the following techniques:

- Internal bracing.
- Cross flat bracing.
- Rigid frame action.

### 6.3.4 Certification

LGSF systems shall be provided with an SCI stage 1 certificate, or evidence of a third party system approval (UKAS or equivalent).

In addition to the SCI stage 1 certificate or third party system approval:

- A valid ISO 9001 Quality Assurance Certification (or equivalent) held by the Manufacturer, covering the manufacture of their product/ system should be provided.
- The manufacturer should demonstrate compliance with BS EN 1090 for factory production control and provide a declaration of performance certificate.

Please note, actual wall makeup, components, individual products used for the external waterproof, thermal and fire resistant envelope, are outside the scope of the SCI Stage 1 assessment. These elements will still need to meet the requirements of this Technical Manual.

### 6.3.5 Independent Engineer verification

An independent Engineer with suitable experience and PI insurance shall review the site specific design and calculations in accordance with the stage 1 SCI certificate.

The Engineer should review the site specific details and provide confirmation to the Warranty provider where requested that the structural design meets the site specific design and all relevant structural standards.

### 6.3.6 LGSF protection against corrosion

There shall be adequate protection against corrosion for all LGSF elements.

Steel and fixings should be suitable for the design and adequately protected against corrosion. Galvanised strip steel should be designated grade S280GD to 450GD to BS EN 10346.

All light gauge steel frame framing:

- Should be only used in warm or hybrid construction - including floors, walls, pitched roofs, flat roofs and terraces.
- Must be protected from the external conditions with the use of appropriate wall and roofing membranes.
- Must be located entirely above DPC level and a minimum 150mm above external ground level, the use of a masonry foundation kerb upstand may be an appropriate method to achieve this.
- Walls, upper floors and pitched roof framing, should be pre-galvanised in accordance with BS EN 10346 with a minimum 275g/m<sup>2</sup> zinc coating (Z).
- Ground floor joists and ring beams in such floors should be pre-galvanised to 450g/m<sup>2</sup> zinc coating (Z).
- Positioned below the waterproofing layer of a flat roof, balcony or terrace should be pre-galvanised to a minimum 600g/m<sup>2</sup> zinc coating (Z).
- Where level access requirements result in the floor joists, ring beams and base rails etc. being less than 150mm above external ground level, then these elements should be pre-galvanised to 600g/m<sup>2</sup> zinc coating (Z). Level access arrangements should be kept to a minimum and no more than 15% of the external perimeter of an individual building (e.g. a single plot in a row of terraced homes).

### 6.3.7 Gas protection system

Where a gas protection system is required (e.g. gas membranes) it shall:

- Be specified in accordance with relevant standards.
- Not impede on the drainage requirements of the LGSF system.
- Be installed to manufacturers recommendations.

Where a gas barrier is required it should be specified and installed by suitably qualified persons.

Please refer to the 'Ground Conditions – Managing Ground Contaminants' section for further guidance.

## 6.3.8 Site preparation and substructure detailing

The substructure shall be correctly set out to receive the LGSF system. LGSF panels shall also be securely fixed to the substructure as per the Engineers specification.

### Tolerances

For accurate erection of the frame the following tolerances are required at the level of the base of the wall frame:

- Length of wall frame: +/-10mm in 10m.
- Line of wall frame: +/-5mm from outer face of plate.
- Level of base of wall frame: +/-5mm over complete wall line.

Some packing may be needed to achieve the required tolerances.

### Anchoring

The LGSF system should be anchored to a suitable substrate to resist both lateral movement and uplift in accordance with the Engineers design and specification.

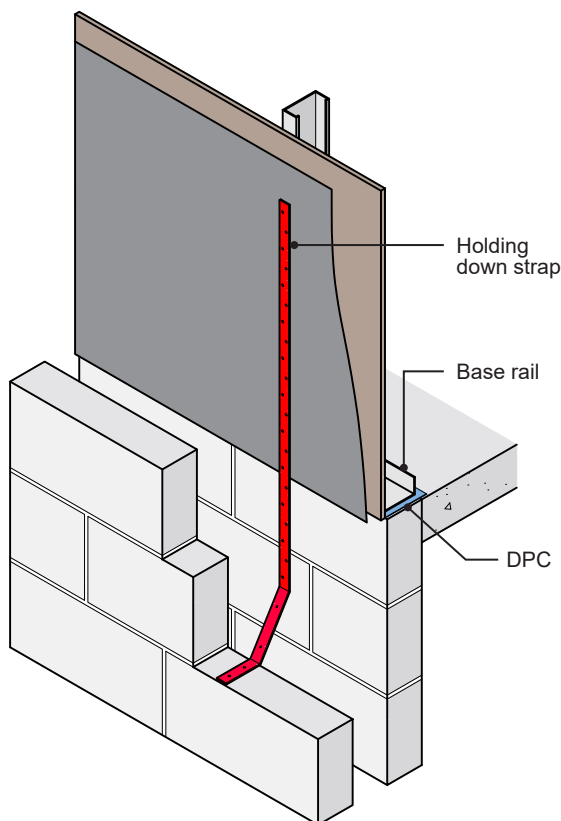
Where gas membranes are specified, they should not be punctured. Where puncturing is unavoidable the gas membrane should be appropriately sealed in line with the gas membrane manufacturers recommendations.

### Holding down straps

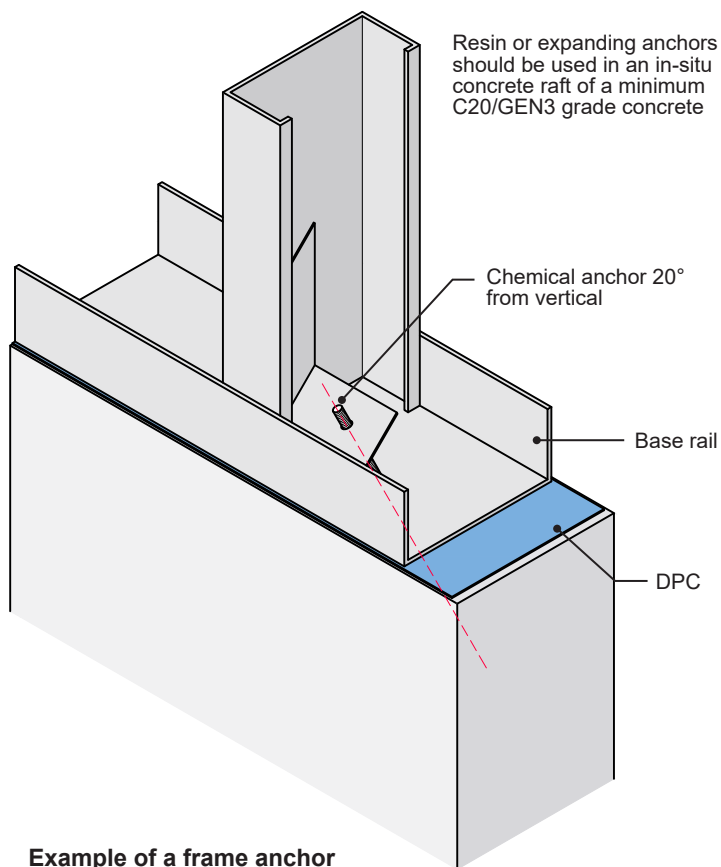
If stainless steel straps are used, they should be grade 1.4301 steel to BS EN 10088 and isolated from the studs with neoprene gaskets or similar. Non stainless connections should be isolated from the straps with suitable grommets and washers.

### Frame anchors

Bolt down frame anchors should be specified and installed as per the Engineers design and specification.



Example of a holding down strap

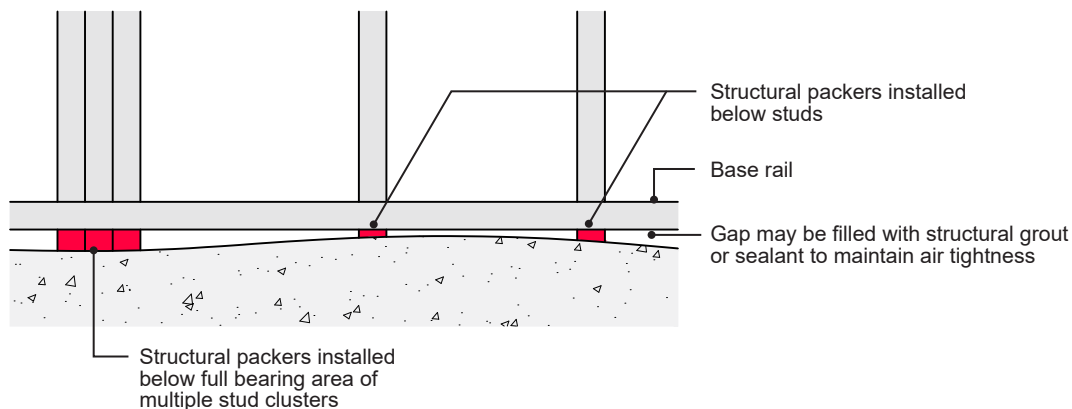


Example of a frame anchor

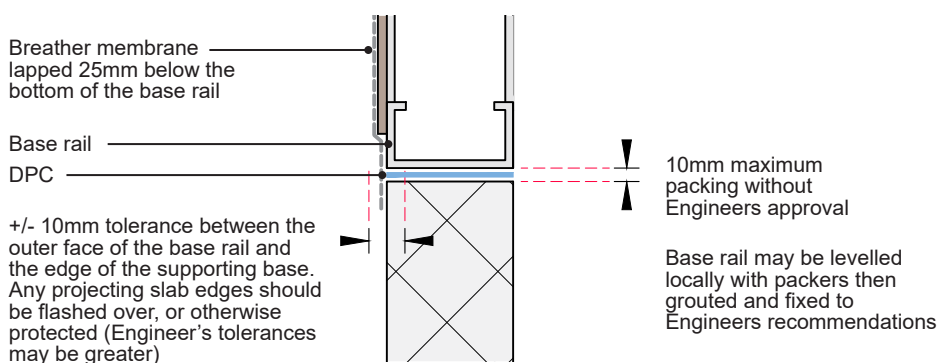
### Packing under the steel frame

Structural shims or grout may be required under the steel frames to level them and transfer vertical load. Longer frame to foundation fixing may be needed to allow for the size of the gap.

- Less than 10mm; pack under each steel with pre-galvanised steel shims.
- 10mm-20mm; pack under each steel with steel shims and grout over length of the base rail.
- Over 20mm; refer to the frame designer.

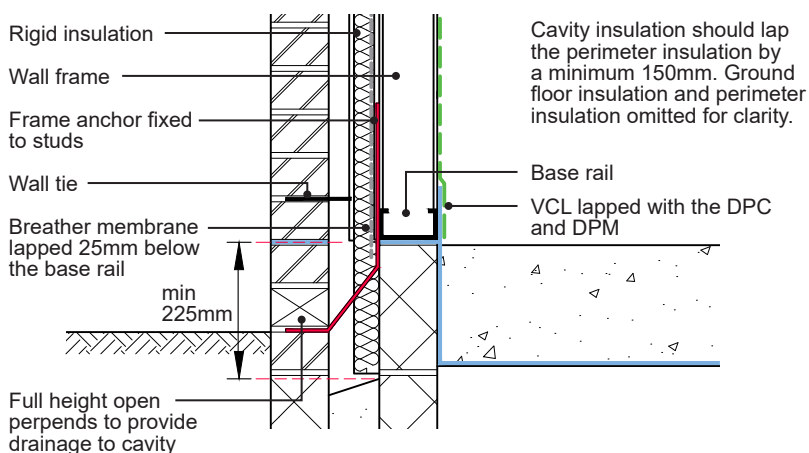


### Base rail positioning with the substructure



### DPC and DPM detailing

The oversite DPM should be attached to the side of the slab and returned under the DPC on which the frame is placed. The DPC/DPM detail requires careful attention to prevent the cavity being bridged and providing a ledge for mortar droppings.



Note: Internal linings have not been shown for clarity. A service void may be specified.

## 6.3.9 Location of frame above ground level

The LGSF shall be located above DPC level and a minimum 150mm above external ground level except where level access arrangements are required.

The use of a masonry foundation kerb upstand may be an appropriate method to having the LGSF 150mm above external ground level.

It is recommended that the inner leaf DPC is turned up approximately 30mm above the screed to protect the bottom of the studs from construction moisture and spillage, and weep-holes are provided at 900mm centres to drain cavities at ground level.

### Level access requirements

Where level access requirements result in the floor joists, ring beams and base rails etc. being less than 150mm above external ground level, then these elements should be pre-galvanised to 600g/m<sup>2</sup> zinc coating (Z). Level access arrangements should be kept to a minimum and no more than 15% of the external perimeter of an individual building (e.g. a single plot in a row of terraced homes).

## 6.3.10 Light gauge steel frame panels

LGSF panels shall be designed and installed to support and safely transmit loads to the substructure without undue movement.

The wall panel usually consists of a head rail, base rail (sole plate) and possibly horizontal noggins at mid-height, together with vertical wall studs. The following shall be taken into account:

### Tolerances

Framed walls should be accurately aligned, plumb, level without twist and securely fixed to adjacent elements. Vertical installation tolerances are:

- +/-15mm in overall height of wall 3 storey, **or**
- +/-10mm in overall height of wall 2 storey, **or**
- +/-5mm in storey height (approx. 2.5m).

Please refer to the 'Tolerances' section of this for further guidance.

### Lintels

Lintels should be provided within LGSF panel over openings. They should safely support the applied loads, be of the correct size, and have adequate bearing.

Openings in LGSF panels should have lintels which are supported off of studs where one or more studs is cut or displaced to form an opening. Additional studs may be required to provide support to the lintel or to provide additional fixing points for wall ties, cladding or wall linings.

Lintels are not required where an opening falls between studs.

For guidance on steel and concrete lintel provision in external masonry cladding, please refer to the 'External Walls – External Masonry Walls' section.

### Connections and fixings

The design should detail how joints between the wall panels and other elements are to be securely fixed:

- To the structure.
- To adjacent panels.
- To the floors and roof.

Recommended site connections include self-drilling, self-tapping screws or 10mm-12mm diameter grade 4.6 bolts. Welding is not recommended on-site. Workmanship should comply with BS 8000: 5.

### Movement joints

Non-load bearing walls should not bridge movement joints in the main structure. A movement joint should be constructed between the frame and any chimney flue or lift shaft to prevent load transfer.

### Holes and notches

Cutting holes in steel frame for services on-site is not recommended without approval from the steel frame designer. Holes, penetrations and cuts should be carried out in factory environments in accordance with the structural design. Holes should be fitted with grommets.

### Accommodation of deflection

Infill walls should accommodate anticipated deflection within the primary frame.



### 6.3.11 Structural sheathing boards

Structural sheathing boards shall be of a suitable material, strength and durability.

Structural sheathing boards should be compatible with the LGSF.

#### Materials

Structural sheathing board materials may be any of the following:

- Orientated strand board (OSB). OSB should be grade 3 or 4 in accordance with BS EN 300.
- Plywood. Plywood should be at least Class 2 or 3 Structural in accordance with BS EN 636.
- Cement bonded particle board in accordance to BS EN 634.
- Non timber based boards or other board material must have a suitable third party product conformity certificate which is acceptable to us.

All wood-based panel products should comply with BS EN 13986: Wood-based panels for use in construction characteristics, evaluation of conformity and marking.

Please note:

- We do not accept the use of MgO boards.
- The selection of materials for the structural sheathing boards should satisfy the relevant Building Regulations in respect to fire safety.

#### Fixings

The sheathing board shall be fixed to the LGSF studwork in strict accordance with the board manufacturers' specification and Engineer's fixing schedule. Fixings should be specified for strength and long term durability for the anticipated exposure condition.

### 6.3.12 Breather membrane

Breather membranes shall be installed to protect the LGSF system and sheathing board from moisture whilst allowing water vapour from within the frame to pass into the cavity. The following shall be taken into account:

- Specification of the membrane
- Positioning
- Lapping
- Fixing
- Exposure of the breather membrane

#### Specification

Breather membranes should:

- Have an appropriate third party product conformity certificate.
- Have a vapour resistant to less than 0.6MNs/g (0.12 Sd) when tested in accordance with BS EN ISO 12572 using the set of conditions C and using five test specimens.
- Be a minimum Class W2 or better in accordance with BS EN 13859-2.
- Be a minimum Class W1 in areas of very severe exposure, where liquid water penetration of the cladding is anticipated or where the membrane is likely to be left exposed during construction.
- Be UV resistant in accordance with BS EN 13859-2 where the cladding does not exclude UV exposure (e.g. such as open jointed cladding panels).
- Be capable of resisting water penetration.
- Be durable to resist site damage when wet.
- Be self-extinguishing.
- Be securely fixed to protect the outside face of the framed structure with austenitic stainless steel staples.
- Be trimmed to leave 25mm lap below the base rail.
- Be repaired if damaged.
- Have the location of the LGSF studs clearly marked on the outer face of the breather membrane to ensure that cladding fixings are installed into the LGSF studs.

#### Positioning

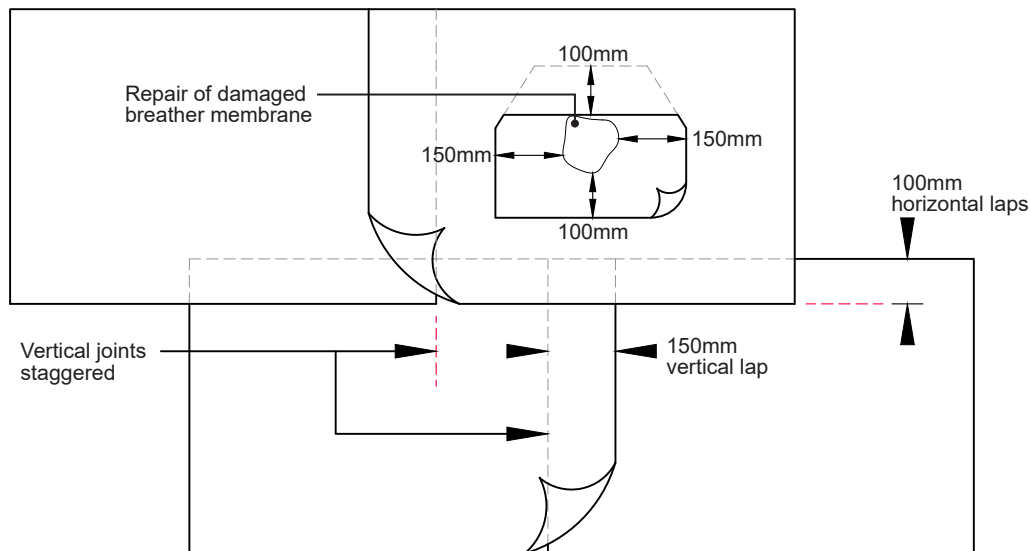
Breather membranes must be placed on the external face of the sheathing board to help provide weather protection to the sheathing board and the structural frame during construction. Any penetrations such as bracketry or fixings should be appropriately sealed as per the membrane manufacturer's instructions.

A breather membrane may also be required on the external face of the insulation which is in the cavity zone where required by the insulation manufacturer or third party product conformity certificate.

A breather membrane must always be installed irrespective of the external sheathing board product.

## Lapping

Breather membranes should be lapped by a minimum of 100mm at horizontal joints, and a minimum of 150mm at vertical joints. Vertical joints should be staggered at regular intervals where possible. The breather membrane should be lapped to deflect moisture away from the framed structure (upper layers over lower layers).



## Fixing

Breather membranes should be fixed using austenitic stainless-steel staple nails at the following centres:

- Horizontal
  - Panel centres – 600mm max
  - Horizontal membrane joint - 150mm
  - Head and base of panels – 150mm
- Vertical
  - 300mm centres vertically (may be increased to a maximum of 500mm when verified with the third party product conformity certificate).
  - Vertical membrane joint – 150mm
  - Ends of panel – 150mm
- Around openings – 150mm

If breather membranes are trimmed flush with the edges of wall panels, additional strips of breather membrane, at least 300mm wide, should be supplied and site fixed over panel junctions.

## Exposure of the breather membrane

In situations where open jointed claddings are used, **and/or** the breather membrane is left exposed during construction for a duration which exceeds what the manufacturer recommends (or what the third party product conformity certificate for the breather membrane states):

- The performance of the breather membrane should be based on artificial aged behaviour in accordance with BS EN 13859-2.
- A ventilated tarpaulin (or similar protective sheeting) should be used where there is an expected period of heavy rainfall followed by freeze thaw conditions.
- Where the cladding is not open-jointed (render board, brick cladding etc.) performance should be based on artificial aged behaviour in accordance with BS EN 13111.

### 6.3.13 Thermal insulation

Thermal insulation shall be specified correctly and installed to avoid damp and interstitial condensation issues occurring within the wall makeup. The overall insulation value of the wall shall meet the requirements of relevant Building Regulations.

Thermal insulation should:

- Have a suitable third party product conformity certificate.
- Be of a suitable material and thickness to satisfy the regional Building Regulation requirements.
- Be fixed to the outside face of the steel studs to create a 'warm frame' construction.
- Retain a minimum 50mm clear cavity.
- Be covered with a breather membrane adjacent to the cavity where required by the insulation manufacturer or third party product conformity certificate for the insulation.

External walls should be subject to U-Value and condensation risk calculations. A wall build up will be considered satisfactory if there is no calculated risk of surface or interstitial condensation at any time of the year.

Special consideration should be given to condensation risk where non-breathable insulation products are installed on the outside of the steel frame structure.

Where the condensation risk has been assessed and shown to be negligible additional insulation may be placed between the studs. The additional insulation should be placed in contact with the studs to minimise air gaps and prevent local condensation.

### Joins between foil faced insulation boards

Joins between the foil faced external insulation boards must not be taped as this forms a vapour control layer on the cold side of the insulation.

Where the insulation manufacturer requires the joins to be taped, the tape must be of a type as recommended by the insulation manufacturer, breathable to allow water vapour to move freely and resist water penetration.

Where the insulation board has an integral foil facing on one side only, the insulation should be fixed so the foil is facing towards the cavity side.

### Thermal bridging

Insulation should be continuous at all junctions and all voids within the wall panel should be insulated to ensure thermal continuity is maintained and any small gaps which cannot be insulated effectively should be avoided.

#### 6.3.14 Air and vapour control layer (AVCL)

AVCL's shall be specified and installed to restrict the passage of air and water vapour from within the home into the Light Gauge Steel Frame.

An AVCL is a moisture vapour-resistant material located on, or near, the warm side of the thermal insulation. Its purpose is to restrict the passage of moisture vapour through the structure of the wall and mitigate the risk of interstitial condensation.

### Specification

The AVCL may take the form of:

- A vapour control plasterboard.
- A minimum 125 micron thick (500 gauge) polythene sheet.
- A proprietary vapour control membrane product which has an appropriate third party product conformity certificate.

### Criteria for a condensation risk analysis

For Warranty purposes, the boundary conditions for a condensation risk analysis should be as follows:

- 60% relative humidity.
- External temperature -2°C.
- Internal temperature 21°C.

Where external temperatures are considered to fall below -2°C due to exposure or geographical locations, lower temperatures should be used based upon climatic data within relevant standards.

### Installation

A sheet membrane (polythene or proprietary) VCL should be:

- Securely fixed to and cover all areas of the LGSF external walls, including all base rails, head binders, and lapped/sealed fully into window/door reveals. The VCL should be Fixed at 250mm centres to the top and bottom of the frame.
- Lapped and sealed by at least 100mm at joints. Joints in the VCL should occur over studs, rails or noggins and be mechanically fixed.
- Lapped and sealed over studs, rails or noggins.
- Sealed around service penetrations.
- Lapped and sealed with DPM/DPC at the junction with the ground floor/foundation by a minimum of 100mm.
- Made good where damage as occurred to the VCL.

Vapour control plasterboard should be:

- Fixed in accordance with the plasterboard manufacturer's installation guidance.
- Tightly cut and fitted around service penetrations.
- Discarded if the vapour control backing is damaged.
- Junctions, joints and penetrations (switches and sockets for example) should be appropriately detailed to ensure the vapour resistivity is not adversely comprised.

### Notes

- The AVCL should not be installed until the building is weather tight.
- Small holes in the AVCL should be sealed with a suitable self-adhesive tape. If a proprietary membrane is being used, the manufacturer's proprietary sealing tape should be used. Larger holes should be re-covered to lap over adjacent studs and rails.

## 6.3.15 Internal wall linings

The internal wall lining shall provide an adequate surface to receive the intended finish required by the design. Supporting evidence will be required, where the wall lining is intended to perform additional functions such as:

- Racking resistance.
- Fire resistance.
- Acoustic performance.

Wall linings are typically:

- Gypsum plasterboard.
- Fibre reinforced gypsum board.
- Cement bonded particle board.

Lining materials should satisfy all relevant performance criteria, e.g. fire resistance, acoustic performance and have a relevant third party product conformity certificate.

Moisture resistance linings should be specified in high moisture environments (e.g. bathrooms).

Please note: we do not accept the use of MgO boards.

## 6.3.16 Fire resistance

LGSF walls shall have adequate fire resistance in accordance with the relevant Building Regulations. Supporting test evidence to an appropriate standard shall be made available upon request.

### Fire performance of openings

All openings including doors, windows, flues and ventilation ducts, should also be designed and constructed to maintain fire performance. The following should be taken into account:

- Internal reveals require equal fire resistance to the rest of the structure.
- Window fixing straps should not compromise the integrity of any fire-resistant reveal linings.
- Cavity barriers should be installed in the external wall cavity around the perimeter of openings. They must be mechanically fixed to rigid construction (for both vertical and horizontal positions).
- If profiled steel lintels are used as cavity barriers, triangular gaps behind lintels, which occur at each end, should be closed with careful positioning of adjacent cavity barriers.

## 6.3.17 Provision of cavities

LGSF external walls shall be provided with a drained cavity which resists the passage of moisture to the inside of the home and prevents interstitial condensation.

LGSF external wall panels should be provided with a cavity between itself and the external cladding.

### Minimum cavity widths for different cladding types

| External leaf                  | Minimum cavity width |
|--------------------------------|----------------------|
| Masonry                        | 50mm                 |
| Render on un-backed lath       | 50mm                 |
| Render on backed lath or board | 25mm                 |
| Timber                         | 19mm                 |
| Tile hanging                   | 25mm                 |

### Cavity drainage

All external wall cavities should be adequately drained to resist the passage of moisture to the inside of the home.

### Ventilation requirements for rainscreen cladding systems

Adequate ventilation should be provided at the head and base of rainscreen cladding systems where required by the manufacturer (or the third party product conformity certificate) of the rainscreen cladding system.

### 6.3.18 Cavity barriers

Cavity barriers shall be durable and must not adversely affect the structure of the external wall or the performance of the weatherproof envelope.

Where required by statutory regulations, cavity barriers shall:

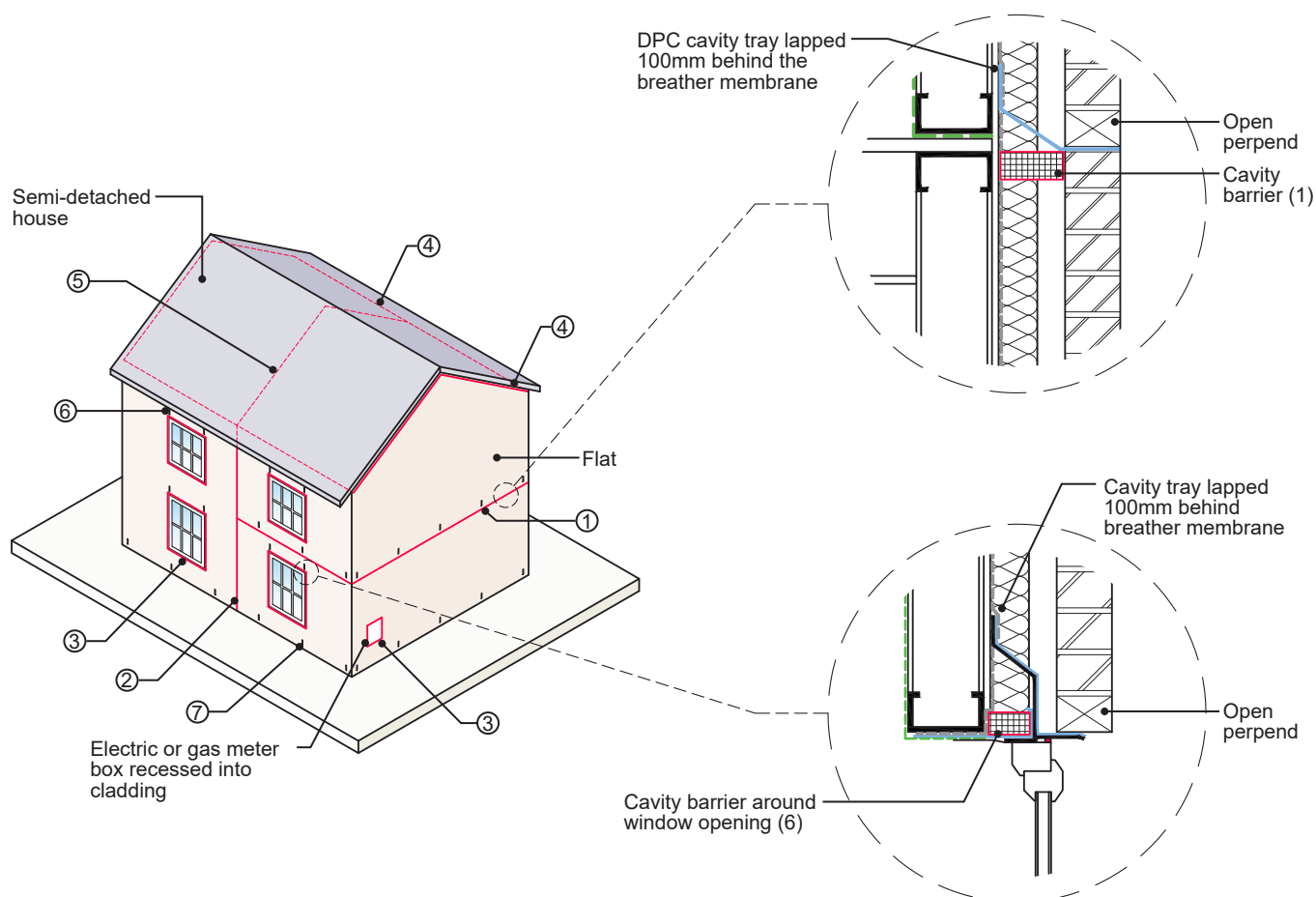
- Be of a suitable material.
- Specified and installed within the scope of the test certification and/or the third party product conformity certificate.
- Be installed in accordance with the manufacturer's recommendations.
- Be suitable for the location they are installed.

Where cavity barriers are required by statutory regulations, their specification, positioning and installation should satisfy the requirements of the Building Regulations.

#### Locations of cavity barriers and open perpend within the external wall

##### Notes

- Lightweight cladding systems will require a cavity barrier along the bottom of the cavity.
- Cavity barriers may also be required between walls and floors within the building, consult National Regulations for further guidance.



1. Cavity barriers are required at the junction of party floors and external walls (flats).
2. Cavity barriers are required at the junction of the external wall and the party wall.
3. Cavity barriers are required around the edges of all openings.
4. Cavity barriers are required at eaves and verge.
5. Cavity barriers/firestopping at the head of the party wall.
6. Open perpend over openings installed at maximum 900mm centres, with at least two over each opening.
7. Open perpend installed at maximum 1350mm centres to drain and ventilated external wall cavity.

## Cavity barrier installation

Cavity barriers should be installed:

- So they fully close the cavity by friction fitting for the designed cavity width.
- Backed by LGSF studs, rails or floor joists.
- In accordance with manufacturer or independent certifier's guidance.
- So they are mechanically fixed to rigid construction (for both vertical and horizontal positions).

Where insulation is placed outside of the LGSF frame and where a cavity barrier is required, it must be fixed back to the LGSF structure.

## Specification

Where vertical cavity barriers are required, they should be continuous for the full height of the wall and extend below DPC level.

Where horizontal cavity barriers are provided they must be tested for the scenario and have an third party product conformity certificate. A cavity tray should be installed directly above a horizontal cavity barrier and lapped up at least 100mm behind the breather membrane (except at eaves and verges).

Note: Lightweight cladding systems may require a cavity barrier along the bottom of the cavity. This may not be necessary however where a horizontal batten is present at the bottom of lightweight cladding systems.

## Materials

Cavity barriers may be constructed from:

- Steel at least 0.5mm thick.
- Timber at least 38mm thick.
- A proprietary mineral wool product which has an appropriate third party product conformity certificate.
- Calcium silicate, cement-based or gypsum-based board at least 12mm thick.
- An independently assessed and certified proprietary product.

### 6.3.19 Forming weather resistant openings

Openings within the LGSF walls shall be designed and constructed to prevent the passage of moisture to the inside of the building. Particular attention shall be paid to:

- Detailing around reveals
- Thermal performance and thermal bridging

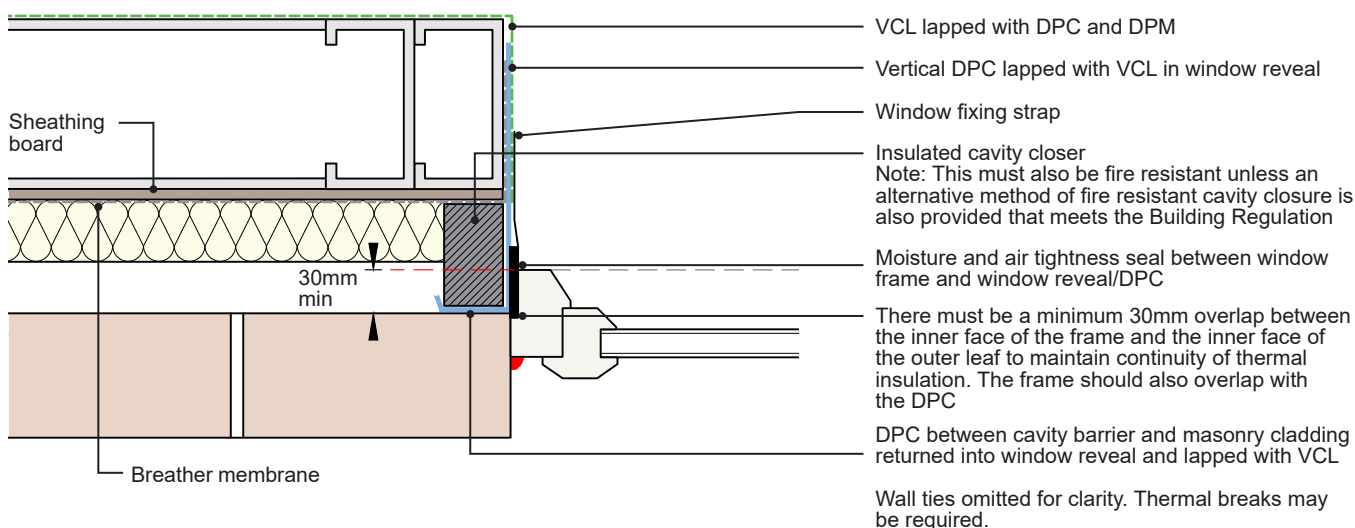
Openings shall also be designed and constructed to maintain fire and acoustic performance.

## Detailing around reveals

A DPC should be provided between the cavity barrier and external cladding which is returned into window reveal and lapped with VCL. Where no DPC is used, breather membrane should be lapped with internal VCL.

There must be a minimum 30mm overlap between the inner face of the window/door frame and the inner face of the outer leaf to maintain continuity of thermal insulation. The frame should also overlap with the DPC.

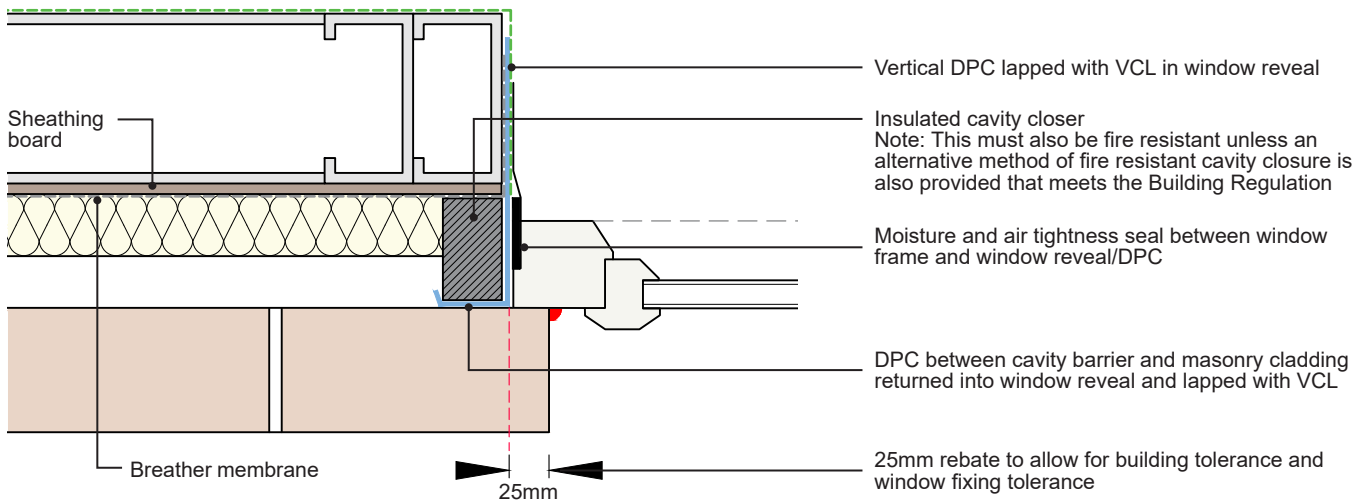
### Typical window reveal detail (normal exposure)



### Checked rebates

Checked (rebated) reveals are required in Scotland and in any areas of very severe exposure in England and Wales. The frame should be set back behind the outer leaf and should overlap.

For further information on external windows and doors please refer to the 'External Windows and Doors' section.

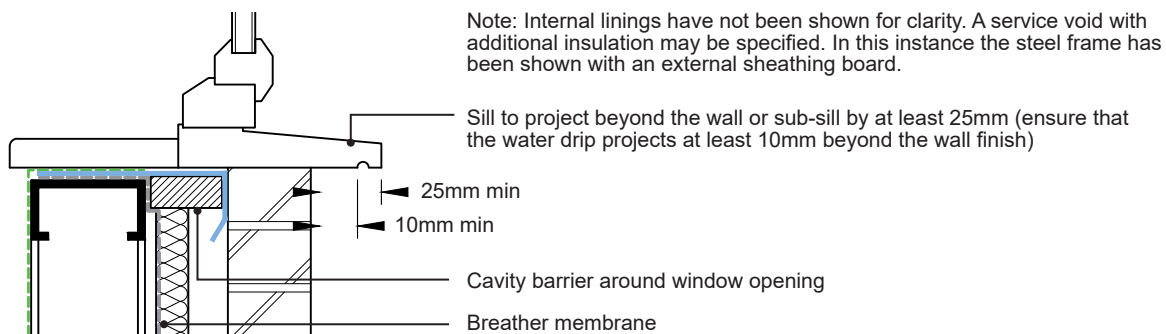


### Thermal performance and thermal bridging

Detailing around openings should avoid thermal bridging and interstitial condensation. To avoid these issues, detailing should consider the following:

- The element being installed into the opening will have a minimum thermal performance.
- Junction between the window/door frame and the opening also has a thermal performance value assigned to it (psi value) designs may incorporate insulated reveals.
- The gaps between the LGSF wall and the element being installed into the opening may include the use of air sealing tapes, compressible seals or EPDM to promote thermal performance and continuity, weather tightness and air tightness.

### Window sill detailing



### 6.3.20 Cavity trays and their ancillary components

Cavity trays and their ancillary components shall be suitable and durable for their intended purpose and be provided to prevent moisture entering the home.

### Specification

Cavity trays should:

- Meet the requirements of BS EN 14909.
- Comply with the relevant Building Regulations.
- Have an appropriate third party product conformity certificate confirming suitability for use as a cavity tray.
- Rise at least 150mm from the outer to the inner leaf, be self-supporting or fully supported and have joints lapped and sealed.

Cavity trays should be proprietary preformed cavity tray systems at stepped and lower storey abutments, complicated junctions and around corners in low rise masonry walls.

Cavity trays should lap behind the breather membrane by at least 100mm.

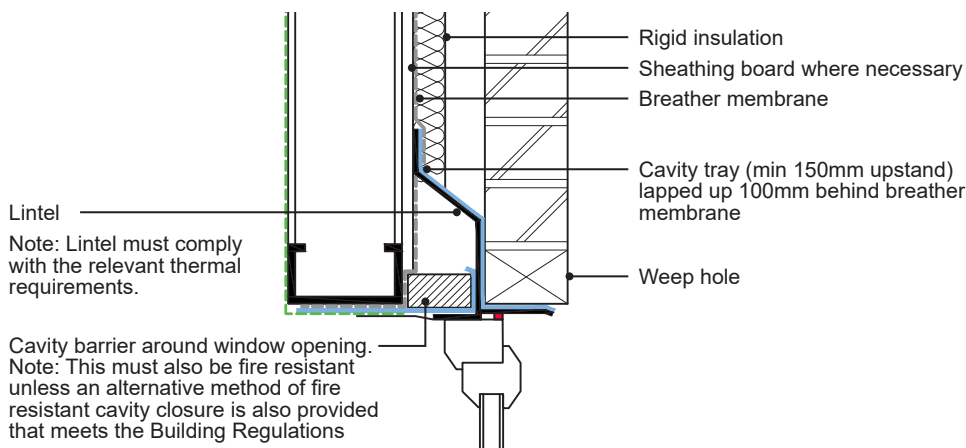
Please note: Polyethylene DPCs should not be used as a cavity tray. Please refer to 'Appendix C' for further guidance.

## Locations

Cavity trays should be provided in the following locations:

- Above all openings and interruptions likely to direct rain water across the cavity such as window and door openings, rectangular ducts, lintels and recessed meter boxes.
- Above horizontal cavity barriers.
- Above cavity insulation that is not taken to the top of the wall, unless that area of wall is protected by impervious cladding e.g. where a spandrel is provided cold pitched roof.
- Continuously above lintels where openings are separated by short piers.
- Above openings where the lintel supports a brick soldier course.
- Directly above openings that are under a compartment floor with a cavity barrier and cavity tray already present.

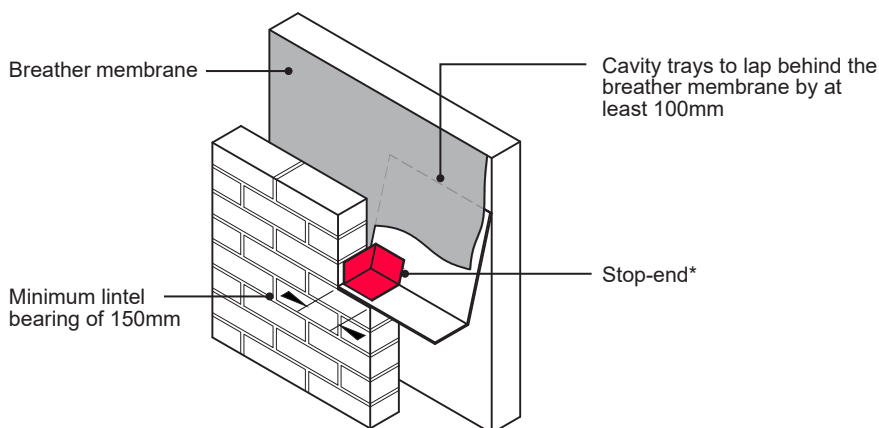
## Cavity tray and lintel



## Drainage and ventilation

Where cavity trays are provided there should be provision to drain moisture from the cavity with the use of cavity vents. Cavity vents should prevent the ingress of moisture, insects or vermin.

## Stop end to cavity tray



\*Stop-ends need to be bonded to the cavity tray material or clipped to the lintel, so that a stop to the structural cavity of at least 75mm high is provided. Normally, the stop-end is located to coincide with the nearest perpendicular to the end of the cavity tray.

Stop-ends can be formed by sufficiently turning up the end of a DPC tray into the perpendicular joint. Surplus mortar should be removed from cavities and wall ties cleared of mortar droppings and debris as the work proceeds.

Cavity trays should rise at least 150mm from the outer to the inner leaf, be self supporting or fully supported and have joints lapped and sealed.

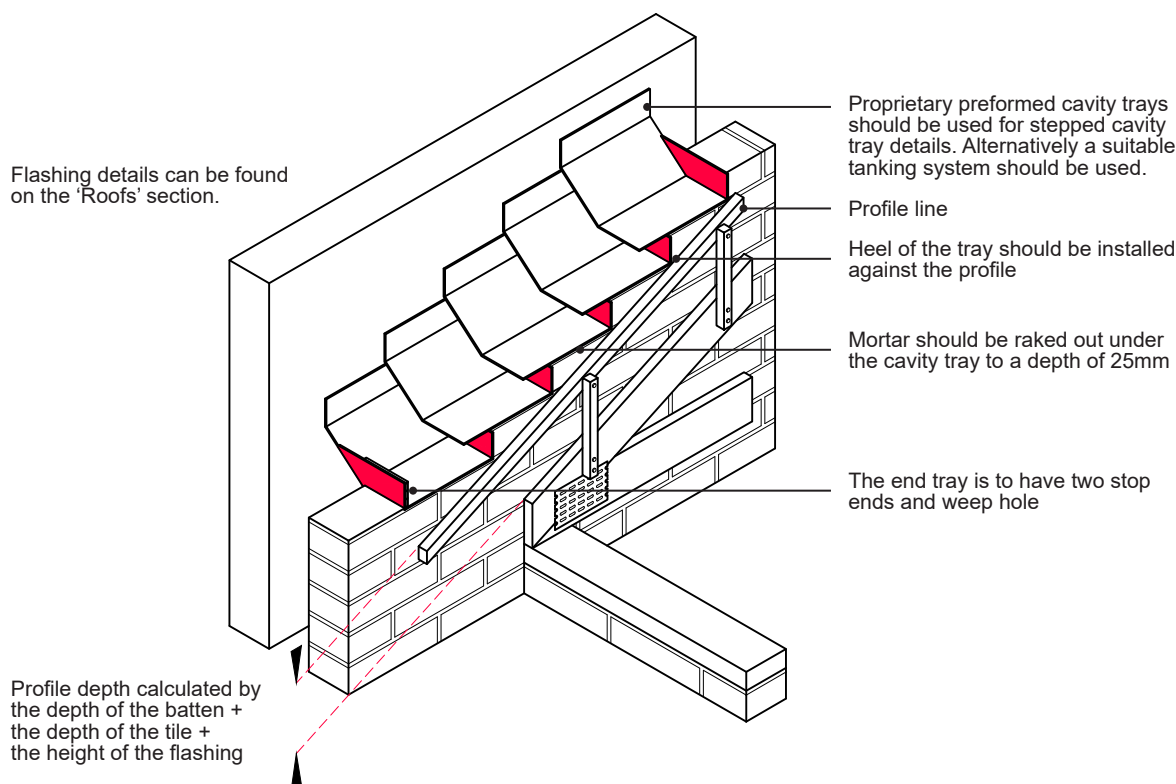


### Installation of stepped cavity tray

Stepped cavity trays are required at all pitched (stepped) roof abutments with external walls, e.g. attached garages or staggered terraces.

Preformed rigid cavity trays should be used for stepped cavity tray details. Stepped cavity trays to lap behind breather membrane by at least 100mm. Additional measures may be needed to ensure the breather membrane adequately laps the tray to prevent moisture ingress behind the stepped cavity tray.

A lead cover flashing should be linked into the cavity tray (lapped in below). Flashing details can be found in the 'Roofs' section.



#### 6.3.21 External claddings

External claddings for the LGSF building shall be durable and fixed back to structural steel as per the Engineers specification whilst maintaining a separating cavity.

Exterior claddings should be compatible with the steel frame.

Claddings supported on the LGSF should be connected to it on a carrier system, to form a separating cavity to all areas of the external wall. These should be fixed into structural steel not just through the sheathing and to the Engineer's specification.

For further information on the provision of cavities, please refer to the guidance within this section.

Please refer to the 'External Walls – External Masonry Walls' section where masonry cladding is specified.

For additional guidance on claddings supported on LGSF please see the 'External Walls - Render' and 'External Walls - Claddings' section.

### 6.3.22 Services

Where services pass through the LGSF panel they shall be specified and installed to:

- Ensure the structural integrity of the LGSF panel is unaffected.
- Prevent moisture ingress.

Any penetrations to the LGSF panel be fully considered in the design in order to avoid unintended removal or alteration of structural timbers.

Where services pass through the LGSF panel they should be designed to prevent moisture transfer to the LGSF or to the inside of the building. Service penetrations such as flues and vents should have cavity barriers around and be protected with a cavity tray.

All service penetration should be carried out to maintain acoustic performance. The following should be taken into account:

- Seal gaps between timber frame wall and the element being installed into the opening.
- The element being installed into the opening may have a minimum acoustic requirement.

## Introduction

This section provides guidance on meeting the performance requirements for factory and site made render applied to a variety of substrates. The guidance within this section should be read in conjunction with the following sections:

- External Walls – External Masonry Walls
- External Walls – Timber Frame
- External Walls – Light Gauge Steel Frame
- MMC Systems

### 6.4.1 Compliance

Rendering shall meet the performance requirements of this section.

### 6.4.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

#### Pre-bagged render

1. A full set of construction drawings detailing the areas to be rendered, location of movement joints and DPCs and subsequent construction details. Drawings must show presence of weep holes to all elevations.
2. Manufacturer's technical information relating to the application and suitability of render to be used on proposed substrates. This should include details on render thickness in accordance with the exposure zone. The specification should also identify the measures proposed to control movement within the back ground substrate and clearly identify the provision of movement joints and any additional reinforcements.
3. Copies of the manufacturer CE/UKCA Marking and declaration of performance relating to the proposed render.
4. Details and classification of render boards where they are proposed (including third party product conformity certificates).
5. Specifications, method statements, etc. relating to the application of renders around services, openings, movement-joints, etc.
6. Ancillary items forming part of the render system (e.g. render beads, stop-ends, etc.).

#### Site made render\*

1. A specification 'Manual' of the proposed design, preparation and application of the render for the proposed project in accordance with BS EN 13914 – 1. The manual should also provide a specification of the render in accordance with BS EN 13914 – 1. This should include details on render thickness in accordance with the exposure zone. The specification should also identify the measures proposed to control movement within the back ground substrate and clearly identify the provision of movement joints and any additional reinforcements.
2. A quality assurance document detailing how quality assurance will be maintained on site in regards to material storage, mixing and application.
3. A full set of construction drawings detailing the areas to be rendered, location of movement joints and DPCs and subsequent construction details. Drawings must show presence of weep holes to all elevations.

\* Site made renders are only acceptable on well-prepared masonry substrates where strict control over workmanship can be demonstrated and the correct selection of materials can be assured.

Site made render solutions will not be acceptable on projects where the render is to be applied on the following substrates:

- Render board.
- Render carriers.
- Hollow clay brick /block units.
- Insulated concrete formwork (ICF).

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 6.4.3 Weather conditions

Local weather conditions shall be taken into account when rendering.

There should be consideration for the anticipated weather conditions when rendering in wet, cold or hot conditions.

#### Wet

- The background substrate should not be saturated.
- Render which is curing should be appropriately protected from heavy rainfall.
- Downpipes (or temporary downpipes) should be provided to prevent the substrate or recently rendered walls from becoming saturated.
- Where specialist preparation coats are required they should be as per the render system manufacturers recommendations.

## Cold

- The background substrate should not show signs of frost or should not be saturated.
- Air temperatures should be 2°C and rising.

## Hot

- Render which is curing should not be directly exposed to strong sunlight.
- Lightly spray render with clean water to prevent rapid drying.

### 6.4.4 Site exposure rating to wind driving rain

The design and materials used, shall be suitable for the site specific exposure location.

For further information on determining the exposure for the site location please see 'Appendix C'.

For exposure zones where the wind driven rain is expected to be more than 75 litres per m<sup>2</sup> checked reveals will be required. In addition a site specific render manufacturer's specification will be required and the render manufacturers' approved contractor should be used.

### 6.4.5 Background substrate suitability

The background substrate should be prepared appropriately and be suitable for the intended purpose.

For Warranty purposes, Render is not considered completely 'waterproof' and some water seepage is expected through it to the substrate or cavity. Render is only considered to contribute to the 'weather resistance' of an external wall, rather than providing an impermeable barrier. Therefore, all substrates must be constructed to prevent moisture from reaching internal finishes.

## Masonry

This guidance should be read in conjunction with the 'External Walls – Masonry Cavity Walls' section.

For masonry substrates the masonry should be adequately prepared and be of a thickness which would resist damp ingress to the internal finishes based on the recommendations of PD 6697 for the given exposure zone.

Masonry should be free from dust, loose particles, efflorescence, and organic growth. Masonry walls should be suitably prepared in line with the render manufacturer's specification.

Adhesion of rendering is determined by suction of the background. Suction may be effected by the moisture content of masonry at any given time. Keys may be provided naturally or artificially and should be regularly spaced over the whole surface and as per the render manufacturer's recommendations.

Where S1 bricks are used, the render mix should resist sulfate.

For the purpose of Warranty:

- Render on an external leaf of clay bricks (F2, S1 or F1, S1 designation bricks BS EN 771) in severe or very severe exposures is not permitted where the cavity is to be fully filled with insulation.
- Direct rendering is not acceptable on high absorption materials e.g. lightweight blockwork, autoclaved aerated concrete blocks, common brick and/or smooth dense substrates e.g. engineering bricks as the moisture can be extracted by the substrate from the wet render which affects its curing and bonding capability.

### Masonry outer leaves on framed structures

Where render is applied to masonry outer leaves to timber frame or light gauge steel frame structures, a cavity and breather membrane to protect the framed structure should be provided in accordance with the 'External Walls – Timber frame' and 'External Walls – Light Gauge Steel Frame' sections.

## Boards on framed structures

### Third party product conformity certificate

The 'render system', including the render (only pre bagged and blended render will be acceptable) and render board, should hold a suitable third party product conformity certificate.

### Trained operatives

The render system should only be installed by the render manufacturers trained operatives. Evidence of this should be provided to the Warranty surveyor upon request.

### Protection of the framed structure

A 25mm cavity must be maintained between the render system and framed structure. The cavity should be drained and ventilated for timber framed structures and only drained for light gauge steel frame structures. The framed structure should be protected by a breather membrane.

For further guidance on framed structures please refer to the 'External Walls - Timber Frame' or 'External Walls – Light Gauge Steel Frame' sections.

**Fixing of render boards**

Render boards should be fixed in accordance with the manufacturers recommendations and the site specific location, consideration should be given to:

- Anticipated wind load.
- Pull-out strength.
- Pull through resistance.
- Anticipated movement.

The fixing specification should be checked by an Engineer to ensure it's suited for the site specific conditions and location.

When using external render board you should:

- Fix with the manufacturer's recommended non-corrosive fixings and in accordance with the manufacturer's installation details, ensuring the vertical board joints are staggered and do not follow directly in line with window, door reveals and other openings.
- Gaps between boards should be provided in accordance with the manufacturers recommendations however, care should be taken to ensure there are no excessive gaps between the boards and appropriate weather seals are incorporated against walls and frames.
- Ensure the boards are cut neat and square and the screw heads are recessed just below the surface.
- Fixing battens and rails should be installed vertically and not block drainage paths. Battens should be either 25mm x 38mm or 50mm x 50mm, preservative treated (BS 8417 or equivalent, hazard class 2). Fixings and preservatives should be compatible.
- Battens on Timber frame structures should be fixed to each stud with annular ring nails of length at least twice the batten thickness plus the sheathing thickness. Nails should be hot dipped galvanised stainless steel or equally durable.

**Cavity barriers**

Cavity barriers in external wall voids should be provided in accordance with the relevant Building Regulations. For further guidance on cavity barriers please refer to the 'External Walls - Timber Frame' or 'External Walls – Light Gauge Steel Frame' sections.

**Metal render carrier systems**

The carrier system must be Stainless steel in accordance with EN 10088-1 (Austenitic steel) or Zinc coated steel in accordance with EN ISO 16120-2 and EN 10346. Where sited in a coastal location a higher grade A4 stainless steel should be used (please see 'Appendix B' of this Technical Manual).

For metal lathing, these should be a proprietary product with a third party product conformity certificate non-corrosive mesh system and must be fully installed in accordance with the mesh system manufacturer to vertical battens at the stud centres.

**ICF**

For Warranty purposes a render directly applied to an ICF structure to provide a weather resistant cladding will not be acceptable and alternative solutions must be made.

For further guidance on ICF, please refer to the 'Modern Methods of Construction' section.

**External Wall Insulation systems (EWIS's)**

Where render is to be applied to an EWIS, the guidance in this section should be read in conjunction with the guidance on EWIS's in the 'External Walls – Cladding' section.

5-6mm is considered the minimum finished thickness of render for applications of specialist insulated render systems. The render thickness will need to be increased where structures are located in very severe weather rating locations, or within coastal locations and a specialist manufacturer's specification will be required to support this.

The combined system must be installed as per manufacturer's recommendations and may require the insulation to be keyed and mesh reinforcement may be required in the base coat.

**6.4.6 Accommodating for movement**

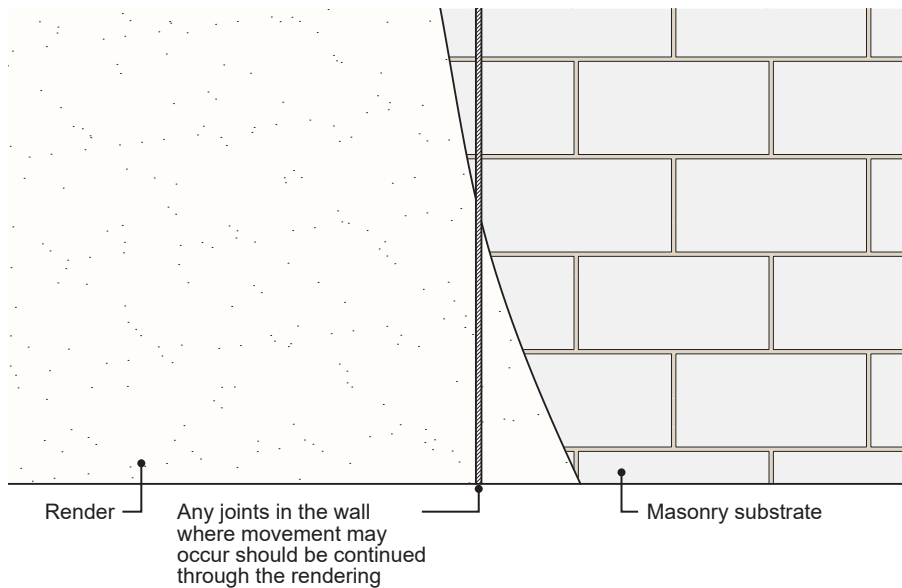
Rendered walls shall be detailed to accommodate any movement in the render system & the background substrate.

**Masonry**

Movement joints which are specified in the masonry wall, shall be carried through the render system, be weather tight and not align with any openings.

For any given wall elevation where there is a mix of masonry e.g. brickwork external leaf lower level with a rendered block upper level, the requirement of a full height movement joint should be based on the shorter spacing requirement e.g. for the blockwork at 6m not brickwork at 12m.

For detailed guidance on movement joint provision for masonry walls, please refer to the 'External Walls – External Masonry Walls' section.



## Dissimilar materials

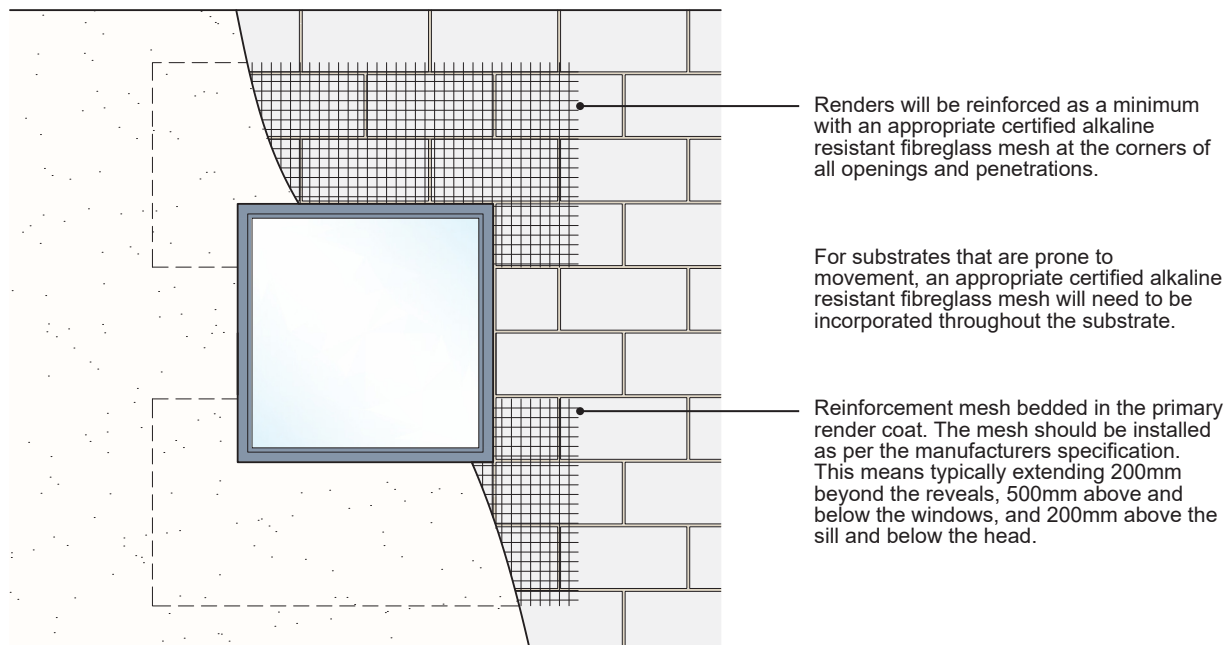
When rendering occurs over dissimilar materials (which have different densities), precautions should be taken to control differential movement between both of the substrates. The render should:

- Be stopped at appropriately formed movement joints, **or**
- Have austenitic stainless steel mesh reinforcement carried across the joint.

## Bed joint reinforcement

Bed joint reinforcement should conform to BS EN 845-3 and be provided in the first two courses above and below any opening with the reinforcement projecting 600mm beyond the opening. Ensure that the reinforcement is continuous and joints lapped in accordance with the manufacturer's requirements (generally 450 - 500mm laps and continued around corners). Specialist corner units are likely to be required.

## Mesh reinforcement



## Timber frame

Where renders spans across an intermediate floor zone in timber frame construction, allow for differential movement due to timber shrinkage by incorporating a movement joint.

Vertical movement joints should be provided at the required intervals. The actual spacing and position of the joints will be determined by the shape of the area to be rendered and generally vertical movement joints should be provided at maximum 5m centres.

### Metal carrier systems

Large uninterrupted areas of cementitious based rendering on metal lathing should be divided by movement joints into panels at intervals of approximately 5m. The actual spacing and position of the joints will be determined by the shape of the area to be rendered. The panels should have a maximum aspect ratio of 3:1 and maximum intervals of approximately:

- For timber backgrounds, 5m horizontally and every storey height.
- For all other backgrounds, 5m horizontally and vertically.

### 6.4.7 Render specification

The render specification shall be compatible with the background substrate and be designed to minimise the risk of de-bonding, cracking or crazing.

### General requirements

Renders installed between pedestrian level and 6.0m above ground level will be designed to accommodate higher maintenance and impact loads in accordance with Table 2 of BS 8200.

Rendering should have a maximum vertical and horizontal deviation from flatness of  $\pm 4$ mm in 5m, and is measured in a similar way to straightness on plan and plumb of masonry. See the 'Tolerances' section for further information.

### Factory made render

Factory made render should satisfy the requirements of BS EN 13914-1 for the design and application. The render should also be CE/UKCA marked in accordance with BS EN 998-1 or BS EN 15824.

Factory made renders should be applied in accordance with the manufacturer's recommendations.

Avoid applying a thin base coat and a thicker top coat, as this could cause the render to delaminate from the base coat.

Single coat factory made renders in sheltered and moderate exposure zones should be between 15-20mm depending on the background substrate. The render manufacturer's recommendations should be followed for severe and very severe exposure zones.

### Site made render

Site made renders are only acceptable on well-prepared masonry substrates where strict control over workmanship can be demonstrated and the correct selection of materials can be assured.

Where site made render is proposed, a detailed specification should be provided and should include the following:

- Detail specification including information of background suitability, movement control, render mix details, use of any admixtures. The specification should satisfy BS EN 13914 – 1.
- Quality assurance details for materials storage and mixing of the render.
- A full set of construction drawings.

Render mix and specification should be compatible with the background. Ensure the render being used is suitable for the substrate and is not too strong.

### Render thickness

The number of coats required will depend on the background substrate and site specific exposure conditions.

The render should have a total finished thickness of not less than:

- 16mm for sheltered and moderate exposure zones.
- 20mm for severe and very severe exposure zones.

Avoid applying a thin base coat and a thicker top coat, as this could cause the render to delaminate from the base coat.

### Quality assurance

The on-site quality control of site made renders is an important aspect to prevent premature failure of the render system.

The QA process should identify the following:

- The suitable storage of the materials on site.
- Only potable water should be used for mixing render.
- Mix ratio should be controlled by volume or weight – Relying on shovels of sand and cement is not acceptable.
- Mechanical mixing only is acceptable, renders should not be hand mixed.
- Additives should not be used unless specified – additives should be appropriately measured in accordance with the specification and manufacturer's instructions.
- Only products specifically designed as mortar additives will be acceptable.

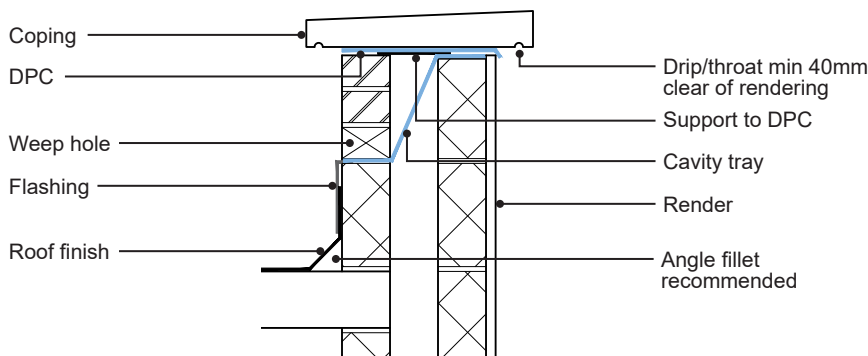
### Ashlar detailing

Where render is specified to provide an ashlar detailing effect it should have a site specific design to ensure durability of the render is maintained.

## 6.4.8 Detailing

Detailing of the render and the external wall should resist the passage of moisture to the inside of the home.

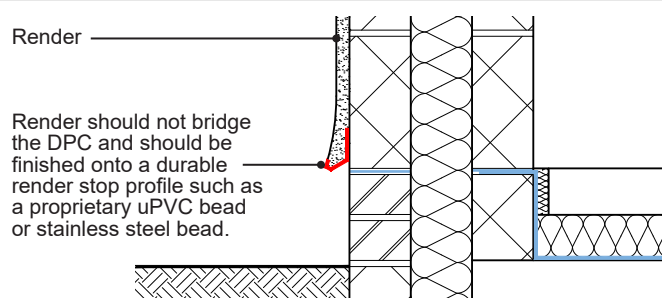
### Parapet wall detail



### Render and DPC levels

Render should not bridge the DPC, however, where this is unavoidable, the following precautions should be taken:

- Render specified below DPC must only be considered if the render manufacturer provides a site-specific specification or where site made render is used, a strong mix (M4) that is sulfate resisting should be used.
- Renders / boards to be used within 150mm of the adjacent ground level, to have a third party product conformity certificate for use in this location.
- There should be appropriate drainage installed along the perimeter or the ground should fall away from the building.
- Adjacent ground surfaces should not promote splashing.

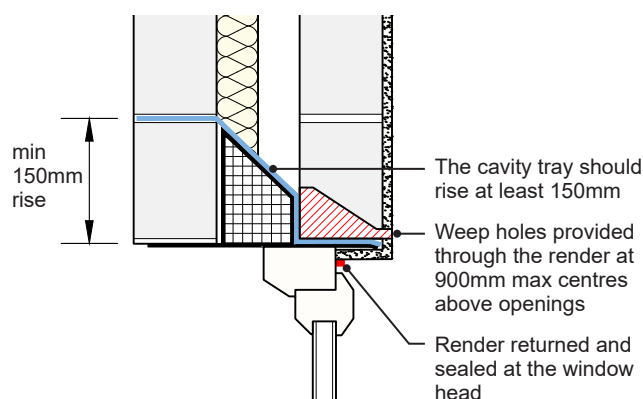


### Weep holes and render

For Warranty purposes, weep holes should always be provided to rendered masonry walls in the following circumstances:

- Where cavity trays are specified. Weep holes should be provided at no more than 900mm centres.
- From the concrete cavity infill at ground level.
- For timber framed buildings to provide drainage and ventilation (open perpend should be used).

For further guidance on weep holes, please refer to the 'External Walls – External Masonry Walls' and 'External Walls – Timber Frame' sections.



### Window sill detailing

Window and door sills should project beyond the wall finish or sub-sill by at least 25mm. The water drip should project at least 10mm beyond the wall finish.

### Abutment detailing

Where rendered walls abut against other elements of construction, appropriate detailing should be specified to prevent moisture passing behind the render or entering the inside of the home.

### Ancillary components

Stop beads and render stops should be austenitic stainless steel or PVC. Beads and stops should either be adhesive fixed in accordance with the manufacturer's recommendations or mechanically fixed with fixing which are appropriate for the environment. Long runs of stainless steel beads should be avoided due to their potential expansion. In coastal locations UPVC or marine grade stainless steel must be specified.



## Introduction

This section provides guidance on meeting the performance requirements for the following cladding types:

- Curtain walling systems
- Rainscreen cladding systems
- Timber cladding boards
- Mock Tudor cladding
- Vertical tiling and slating
- Brick slip cladding systems
- External Wall Insulation systems

The following definitions apply to curtain walling and rainscreen cladding systems:

- Curtain wall - A curtain wall cladding system consists of a prefabricated or site assembled frame with infill panels and glazing. Curtain walling systems supports no loads other than its own weight and the environmental and imposed forces which act upon it.
- A rainscreen cladding system consists of a multi-layer construction of materials which is designed to provide a barrier to the weather. The typical build-up would consist of:
  - An outer skin of panels (i.e. the rainscreen).
  - A drained and vented cavity.
  - A backing wall.

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  - An outer skin of panels (i.e. the rainscreen).
  - A drained and vented cavity.
  - A backing wall.

The above cladding systems should be fixed back to a suitable substrate/backing wall and as such, the guidance within this section should be read in conjunction with the following sections:

- External Walls – External Masonry Walls
- External Walls – Timber Frame
- External Walls – Light Gauge Steel Frame
- MMC Systems

### 6.5.1 Compliance

The design, specification and installation of external wall claddings shall meet the performance requirements of this section.

### 6.5.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

#### For all cladding systems

1. Full set of drawings including locations of cladding applications for each elevation and section details showing the external wall makeup.
2. Façade specification and/or full manufacturer's specification.
3. Bracket and fixing specification for the cladding system including the fixing type, size, spacing and method of fixing to the substrate. Site specific structural calculations of the brackets and fixings for the project are to be provided for the cladding system. Details of corrosion protection and how bi-metallic corrosion is to be mitigated should also be provided.
4. Details of any technical assessment (third party product conformity certificates) and/or test data.
5. Evidence the cladding system satisfies the Building Regulations in relation to their fire resistance.
6. Details of proposed cavity barriers to be used including materials, period of fire resistance (in compliance with the project fire strategy), test data for the system including any test data of penetrations through a barrier (e.g. brick shelf support angle brackets), plans and elevations detailing the locations of the barriers in the façade and vertical and horizontal section details at all interfaces.

In addition, the following should also be provided for the following cladding types:

#### Curtain walling and rain screen cladding systems

1. Details of proposed on site testing regimes

## Timber cladding boards

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1. Where timber cladding/boarding is proposed, a specification of the timber to be used should be provided to confirm it has a minimum service life of at least 25 years. Details of preservative treatment used (if any) to BS8417 should also be provided.

## Brickslip cladding systems

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1. Detailed specification of all materials to be used within the brickslip system build-up.
2. Details of material specification for the brick slips with evidence the brick slips satisfy the requirements of BS EN 771.
3. Third party product conformity certificates for brickslip systems.

## External wall insulation systems

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1. Details of any technical assessment (third party product conformity certificate) for the entire EWI system including the cladding or render to be used on the external face. The certificate must clarify which type of wall substrate the EWI system has been assessed.
  - a. For coastal environments and areas of severe and very severe wind driven rain exposures, the technical assessment for the EWI system must explicitly confirm the system is suitable for use in a coastal environment or severe/very severe wind driven rain exposure.
2. A full manufacturer's specification for the installation of the system to the substrate must be provided.
3. The manufacturer or Engineer should provide a fixing specification for the insulation boards. This should be site specific and must detail type, spacing and method of fixing to the substrate. On-site pull out testing and a report confirming fixing type and length to satisfy the design loads including safety will be required in accordance with the Construction Fixings Association.
4. Where adhesive is used to fix insulation boards back to the substrate, a technical assessment (third party product conformity certificate) must be provided for the adhesive.
5. Specification and detailing of:
  - a. How external fixtures (such as downpipes, satellite dishes and other ancillary fittings) are to be fixed back to the substrate (not just the EWI system).
  - b. Materials to be used for sleeving of service penetrations where required.
  - c. Interface detailing for window and door reveals to avoid interstitial condensation.
  - d. DPCs, cavity trays, flashings etc.
6. A condensation risk analysis should be provided for the external wall makeup.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

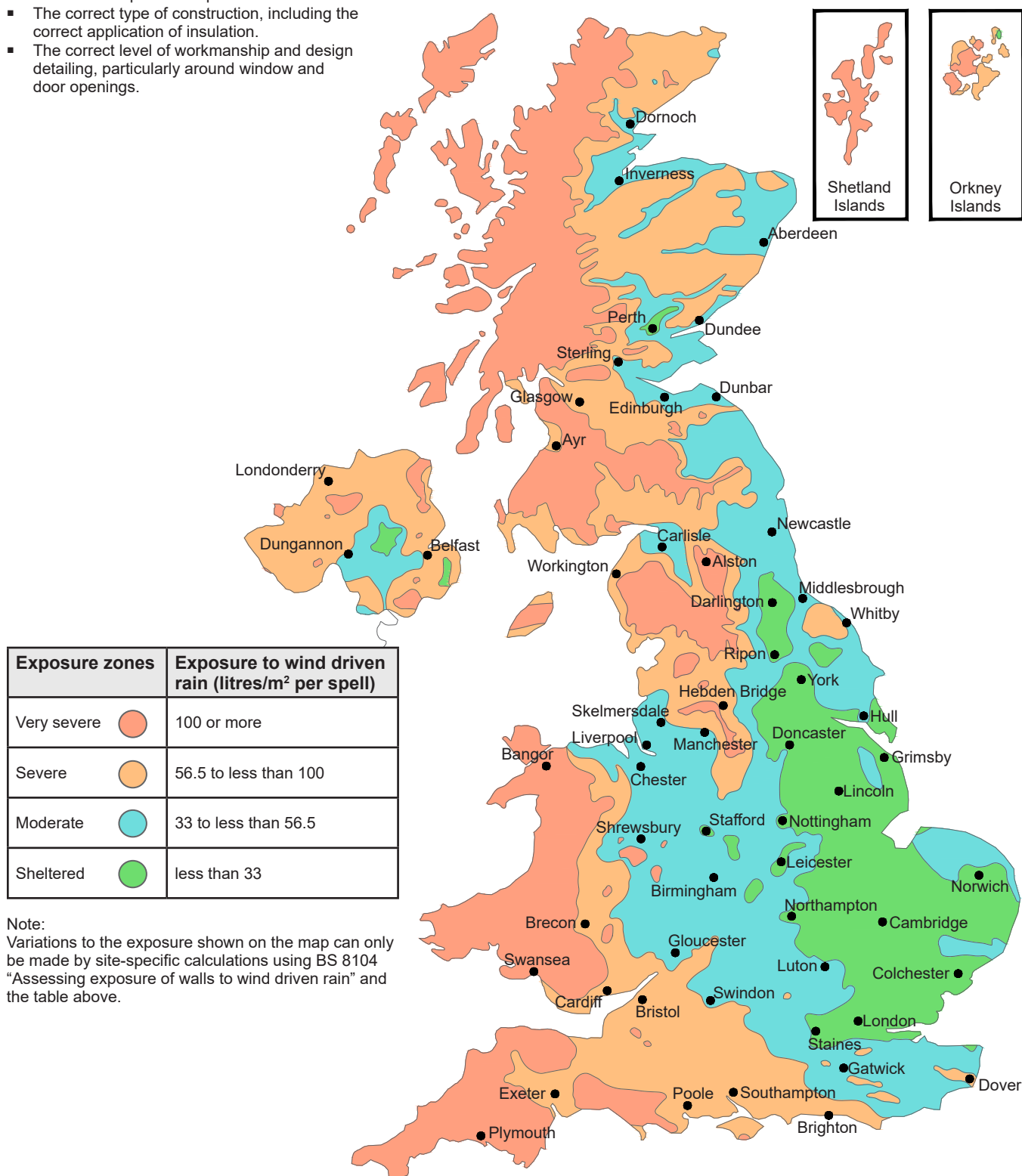
### 6.5.3 Wind driven rain exposure requirements for all cladding types

External wall and cladding systems shall be suitable for the wind driven rain exposure rating specific to the project.

In all situations, external walls and cladding systems must be suitable for the wind driven rain rating specific to the project.

To ascertain the risk relating to wind-driven rain, the following should be determined:

- The exposure to wind-driven rain, using the wind driven rain exposure map.
- The correct type of construction, including the correct application of insulation.
- The correct level of workmanship and design detailing, particularly around window and door openings.



For further information on determining the exposure for the site location please see BS 8104 and BR 262 for further guidance.

## 6.5.4 Fire resistance

All cladding systems shall have adequate fire resistance in accordance with the relevant Building Regulations. Supporting test evidence to an appropriate standard shall be made available upon request.

## 6.5.5 Cavity barriers

All cladding systems shall incorporate cavity barriers where required by regional Building Regulations. Cavity barriers shall be durable and must not adversely affect the structure of the external wall or the performance weatherproof envelope.

Where required by statutory regulations, cavity barriers shall:

- Be of a suitable material.
- Specified and installed within the scope of the test certification and/or the third party product conformity certificate.
- Be installed in accordance with the manufacturer's recommendations.
- Be suitable for the location they are installed.

The completed system should incorporate cavity barriers and firestops and resist the spread of fire in accordance with the relevant Building Regulations and project fire strategy requirements. Their specification, positioning and installation should also satisfy the requirements of the Building Regulations.

Cavity barriers should be mechanically fixed to rigid construction (for both vertical and horizontal positions) in accordance with the manufacturer's recommendations. Open state barriers are not suitable for vertical arrangements.

## Curtain walling systems

Where curtain wall members run uninterrupted past floor slabs and partition walls, consideration must be given to the chimney effect allowing hot smoke or fire bypassing the slab edge fire barrier in a fire situation. Any fire stopping product should be tested to BS EN 1364-4 for fire stop testing in curtain walls and CWCT TN 98.

## Rainscreen cladding systems

The cavity behind a rainscreen is deemed to be a moist zone and materials selected must not corrode, deteriorate or affect the performance of the cavity barrier during its design life. Horizontal cavity barriers must allow for drainage and ventilation in the rainscreen cavity and a gap of 50% of the cavity width must be retained in front of the open state cavity barrier.

## Decorative cladding on external cavity masonry walls

Cavity barriers are required behind decorative cladding such as timber boarding which is constructed on the outside of an external cavity masonry wall.

## 6.5.6 Certification and testing for curtain walling and rainscreen cladding systems

Curtain walling and rainscreen cladding systems shall have adequate testing and certification to satisfy our Warranty requirements.

### Certification

Curtain walling and rainscreen cladding systems should have a third party product conformity certificate confirming satisfactory assessment and comply with the requirements of the CWCT Standard for Systemised Building Envelopes, including parts 1-8.

The collation of individual testing of components does not provide an overall performance of the cladding system or backing wall.

The CWCT Standard provides detailed guidance on performance and testing which should be adhered to.

### Testing requirements

#### Off site testing requirements for curtain walling systems

In addition curtain wall system will have either been:

- Tested and provided with a classification given in BS EN 13830, or
- If the curtain walling is of a custom design, it should be tested to an appropriate standard of CWCT sequence A or B testing when tested at a test pressure of at least 600 pascals by an independent UKAS accredited test facility to ensure that the system meets or exceeds the weather performance classification for the building taking into account the design parameters and project location.

At a test pressure of 600 pascals, an air infiltration rate no higher than 1.5m<sup>3</sup>/hr/m<sup>2</sup> for fixed glazed panels is permissible.

**Pull out testing for curtain walling systems**

Pull-out or destructive testing of anchors should be carried out in accordance with BS 5080 and the Construction Fixings Association Guidance Note, Procedure for Site Testing Construction Fixings.

The number of fixings to be assessed must be agreed on a project by project basis. In addition, if there are varying types of fixings then each type should be tested. If the fixing is the same but the structure varies, then each type of structure should be tested.

BS 5080 requires 5 tests per type, however if a very large project is proposed, this could be increased to give more assurance of installation, e.g. every floor, one per side (e.g. North / East/ South/West). The scope and number of tests must be agreed with the Warranty surveyor at the commencement of the project, to allow sufficient time for testing to be planned in advance and made available to the Warranty surveyor when completed.

**Site water testing for rainscreen and curtain walling systems**

Site water testing of penetrations to critical joints should be carried out by a UKAS accredited testing company in accordance with CWCT test methods. This is required to check to site workmanship of the building envelope as constructed. Areas and method of testing is to be agreed prior to construction. See CWCT Technical Note 41 and 102 for guidance.

Where testing fails, the cause and remedial action should be implemented and advised to the Warranty surveyor and additional checks to be carried out to determine whether the failure is local or a system issue in accordance with CWCT TN 101. If it is a system issue, remedial work to the façade must be carried out prior to further testing is carried out, to demonstrate the remedial solution is effective.

Additional testing may be required for developments over 6 storeys. For further information, our Major Projects Team should be consulted.

**6.5.7 Durability of all cladding systems**

All cladding systems shall have an adequate durability as outlined within our guidance.

Primary components (those that are not easily replaceable) should have a service life not less than 60 years.

Secondary components e.g. those that are easily replaced / accessible and do not require substantial dismantling of the system should have a service life of not less than 25 years. For secondary components, repairs can be easily undertaken as part of planned maintenance programme in place during the service life of the cladding.

**6.5.8 Load transfer for curtain walling and rainscreen cladding systems**

Curtain walling and rainscreen cladding systems and their associated ancillary components shall safely transfer loads back to the building structure and shall allow for movement without causing damage to the cladding system or building fabric.

Dead and live loads should be transferred safely to the building structure without undue permanent deformation or deflection of any component.

Imposed loads should be calculated in accordance with BS EN 1991. Movement should be accommodated without any reduction in performance.

Fixings and supports should be designed to accommodate specified loads. This must consider the structure it is being fixed to and the product manufacturer's recommendations.

**6.5.9 Resistance of water penetration for curtain walling & rainscreen cladding systems**

Curtain walling and rainscreen cladding systems shall be designed and constructed to resist the passage of moisture to the inside of the home and be appropriate for the exposure.

**Curtain walling systems**

The completed curtain wall system should resist the passage of water to the inside of the building allowing free drainage, not trapping water and should have:

- External and internal air and water seals.
- Drained and ventilated glazing rebates.

**Rainscreen cladding systems**

Rainscreen systems require adequate drainage and ventilation in accordance with CWCT standards for systemised building envelopes. At the head and base of a rainscreen cavity, a minimum of 5000mm<sup>2</sup>/m of ventilation must be provided. Ventilation gap must not be less than 10mm high (a continuous 10mm gap will provide 10,000mm<sup>2</sup> ventilation). Drainage must be provided at the base of the rainscreen system. The functional drainage gap must not be less than 10mm.

Cavity trays are required at the base of rainscreen façades to direct water away from the building to prevent the risk of water ingress.

## Minimum cavity widths

Cavity widths are determined by the joint type:

- Sealed / closed = 25mm
- Baffled = 38mm
- Open = 50mm
- Labyrinth = 38mm

## Sealants

Sealants should be specified in accordance with BS 6213 or BS EN 15651 and the performance determined by BS EN 11600 and the manufacturer's recommendations.

### 6.5.10 Bimetallic corrosion for curtain walling and rainscreen cladding systems

The risk of bimetallic corrosion shall be checked as early as possible and avoided by the isolation of dissimilar metals.

### 6.5.11 Specific requirements for curtain walling systems

Curtain walling systems shall be design and installed to ensure an adequate service life is achieved.

CE/UKCA marking is to be provided for all curtain walling covered by EN 13830.

## Surface and interstitial condensation

The system should be designed to minimise the risk of surface and interstitial condensation by the use of thermal breaks and a continuous vapour control layer.

## Sound transfer

The system should be designed to resist the passage of airborne and impact sound within the building with particular attention given to through wall, vertical and horizontal flanking transmission at:

- The edges of separating floors and the interface with the facade.
- The outer edges of separating walls and the interface with the facade.
- The outer edges of partition walls and the interface with the facade.
- The junctions with roof constructions and parapets and the interface with the facade.

Where curtain wall members run uninterrupted past floor slabs and partition walls, consideration must be given to structure-borne sound (impact sound) through the system.

## Electrical installations and lightning protection

The system should comply with BS 7671 requirements for electrical installations for electrical continuity and earth bonding, where it is required to form part of a lightning protection system it must be designed to comply with the requirements of BS 6651.

## Fixings

Fixings should be specified in accordance with the manufacturer's recommendations and be installed to the correct torque setting. Fixings should be of a suitable material and have an adequate durability for the environmental condition.

Fixings and finishes to curtain walling must consider the location and corrosion category to ensure corrosion is avoided. Aluminium components must be robustly isolated from cementitious products to mitigate corrosion.

## Other considerations

The curtain wall system should not include materials liable to infestation attack by micro-organisms, fungi, insects or vermin.

Packing of brackets to achieve surface tolerance is only permitted in accordance with the manufacturer's recommendations, and shall not exceed the maximum depth stated in the designer's calculations.

All packers for brackets supporting or restraining the curtain wall must be metal. All dead load packers to windows and doors must be suitable to transfer the load.

### 6.5.12 Specific requirements for rainscreen cladding systems

Rainscreen cladding systems shall be design and installed to ensure an adequate service life is achieved.

#### Pressure moderation

Cavities should be closed within 300mm of corners to reduce the effect of wind pressure in line with clause 2.2.6.1 of the CWCT Standard for Systemised Building Envelopes.

#### Insulation fixing - combustible fixing

Where insulation is fixed to a backing wall, a minimum of one non-combustible fixing per 1m<sup>2</sup> or per insulation batt (whichever is the lesser) should be provided in addition to the other fixings.

#### Impact damage

Rainscreen panels are generally lightweight and vulnerable to impact damage. The rainscreen must be able to resist impacts without causing safety hazards. Testing and classification to CWCT Technical Note 75 and 76 may be required to demonstrate the rainscreen's material impact performance.

#### Tolerances

Design should allow for the line, level, plumb and plane of the completed rainscreen cladding to be within the acceptable tolerances of:

- Line: +/-2mm in any one storey height or structural bay width, and +/-5mm overall.
- Level: +/-2mm of horizontal in any one structural bay width, and +/-5mm overall.
- Plumb: +/-2mm of vertical in any one structural bay width, and +/-5mm overall.
- Plane: +/-2mm of the principle plane in any one storey height or structural bay width, and +/-5mm overall.

#### Sheathing boards

Where sheathing boards are specified, they should satisfy the requirements as set out in the 'External Walls ' Timber Frame' and External Walls – Light Gauge Steel Frame' sections.

#### Seals

All penetrations in the façade including windows, doors, ductwork etc. must be sealed to the structure and external sheathing board with EPDM or suitable alternative. The sealing membrane must have adequate test data suitable for the project specific wind load and proposed substrate compatibility.

### 6.5.13 Timber cladding boards - durability and specification

Timber cladding boards have an adequate durability.

Timber and boards for exterior use should be of a durable species, with sapwood excluded, or preservative treated by pressure impregnation using preservatives suitable for use in hazard Class 3 in compliance with BS 8417, or equivalent.

Timber cladding boards should have a minimum service life of at least 25 years. Further guidance on the durability of timber is provided in 'Appendix C - Materials, Products, and Building Systems'.

Where finishes are applied to timber boarding, they should be a translucent or opaque penetrating vapour permeable stain or paint, rather than a film coating type e.g., oil-based paint or varnish.

Timber boarding should be at least 16mm thick, and allowance for moisture movement in boarding should be achieved by making tongues, joints or overlaps at 10% of the board width or 20mm, whichever is greater.

### 6.5.14 Timber cladding boards - cavity requirements

A cavity shall be present between the timber cladding and substrate which resists the passage of moisture to the inside of the home.

Timber boarding should be battened off the supporting background to provide a minimum 19mm cavity for draining and venting board.

Battens should be a minimum of 38mm wide, preservative treated and at maximum 600mm centres. Battens on timber frame should be fixed to each stud (and not to the sheathing) with annular ring nails of length at least twice the batten thickness plus the sheathing thickness (or plain shank nails of length 2.5 times the batten thickness plus the sheathing thickness).



## 6.5.15 Timber cladding boards - fixings requirements

Timber cladding boards shall be securely fixed back to the substrate with fixings which are appropriate for the environment and site specific conditions.

Boards should be fixed to battens by face or secret nailing with annular ring nails at least 2.5 times the board thickness. In addition, all of the following conditions should be satisfied:

- Use double battens to support abutting boards. Batten should extend the full width of the boards either side.
- Pre-drill fixing points at board ends to prevent splitting.
- For boards 100mm and wider, use two fixings per board at every batten.
- On boards under 100mm in width, use one centrally placed fixing.
- Use two fixing points per board where they cross a support batten.
- Position fixing 25% in from each side and a minimum of 20mm in at board ends and pre-drill to avoid splitting where necessary.
- All fixings should finish flush with the surface and should not be punched or countersunk.

All metal fixings must be from corrosion resistant materials such as stainless steel (austenitic grade), hot dipped galvanised (BS7371:6 min) copper, silicon bronze or high performance coated steel. The following should not be used for any metal fixings: aluminium, electro plated steel or brass. Galvanised nails should not be used with Western Red Cedar.

The use of dissimilar materials in the same fixing point should be avoided to minimise the risk of galvanic corrosion.

When using timber species with high tannin or corrosive oil content such as Western Red Cedar, Douglas Fir and some hardwoods, stainless steel fixings should be used.

## 6.5.16 Timber cladding boards – differential movement

Where timber cladding boards are specified for timber frame construction, differential movement should be taken into account.

Where timber boarding or plywood spans across an intermediate floor zone in a timber frame construction, allow for differential movement caused through timber shrinkage by incorporating a movement joint.

For further information on differential movement with timber frame, please refer to the 'External Walls – Timber Frame' section.

## 6.5.17 Timber cladding boards – abutment details

Timber cladding boards shall be detailed to resist the passage of moisture to the inside of the home.

Abutments between cladding and other weather-resisting elements should be neatly made, weather tight and allow for differential movement. Workmanship should comply with BS 8000:5.

## 6.5.18 Mock Tudor cladding

Mock Tudor cladding shall be specified and installed:

- To ensure the service life and durability of the render is maintained.
- To ensure the timber achieves an adequate service life and is durable.
- To ensure the detailing resists the passage of moisture to the inside of the home.

Where mock Tudor cladding is proposed over a rendered substrate, the wall should be rendered in its entirety and the timber planted onto the render.

Where mock Tudor cladding is proposed the following recommendations should be followed:

- To minimise movement all timber, used for mock tudor cladding, regardless of species should be kiln dried.
- Timber should not be sealed against the render as this may trap moisture.
- To reduce the effects of warping it is better to fix the timber 'Pith out' which means any warping across the width of the timber the edges will be in the direction of the backing wall. Using only Quarter sawn timber will also help reduce this.
- Depending on the desired visual effect, timber thickness can range from 19-40mm max. 40mm is generally the maximum, as thicker timbers can exert higher forces when warping which can pull the fixings out.
- Due to the limited access, the back of the timber should be decorated/stained before it is fixed to the wall.
- When jointing mock Tudor cladding a butt joint is sufficient. Halved joints should be avoided, due to the potential to trap moisture and biscuit joints also avoided, as often the biscuit is also not durable enough.



### Specific to Oak

Where oak is specified, the fixings should not react with the timber or timber treatment, therefore stainless steel fixings are recommended.

With oak, there is a risk of extractive staining, where moisture will remove tannings from the oak and stain the render (particularly where light renders are used).

Please refer to 'Appendix C' for further guidance on the use of oak.

#### 6.5.19 Vertical tiling and slating

Vertical tiling and slating shall be specified and installed:

- To ensure service life and durability of the cladding is achieved.
- To ensure the detailing resists the passage of moisture to the inside of the home.

Plain tiles and, natural and fibre cement slates should satisfy the material specifications outlined in 'Roofs – Pitched roof coverings (tiles and slates)'.

Vertical tiling and slating should be fixed back to horizontal tiling battens (38mm x 25mm minimum). Special masonry fixings may be required.

Detailing should not interfere with window and door openings.

Cavity barriers are required behind decorative cladding such as vertical tiling and slating which is constructed on the outside of an external cavity masonry wall and where counter battens are used. Cavity barriers should not impeded on the ability of the cavity to be drained.

#### Vertical natural slate or fibre cement slates

- Slate-and-a-half should be used in alternate courses at internal and external corners and adjacent to openings.
- Use Code 3 lead soakers to weather internal and external corners.
- Fix slates by two nails and one rivet, and slate-and-a-half by three nails and two rivets.
- Code 4 lead cover flashings should be used above and below openings, in accordance with Lead Sheet Training Academy recommendations.

#### Vertical tiling with plain tiles

- Lead flashings and soakers should be used around openings, in accordance with Lead Sheet Association details.
- Use double course of tiles at eaves, by laying first course of eaves/tops tiles with course of full tiles laid over.
- At the top of a wall or under a sill, use a course of eaves/tops tile laid over a course of full tiles. Dress a Code 4 lead cover flashing over by 100mm.
- Use internal and external angle tiles at all 90° corners. Purpose-made 135° angle tiles are also available. For other angles, close mitre tiles and use Code 3 lead soakers.
- All tiles should be twice nailed.

Further guidance on tiles and slates can be found in the 'Roofs' section.

#### 6.5.20 Brickslip cladding systems

Brickslip cladding systems shall hold a valid third party product conformity certificate and be specified and installed:

- To ensure service life and durability of the cladding system and external wall makeup is achieved as outlined in the service life table within 'Appendix C'.
- To ensure the detailing resists the passage of moisture to the inside of the home.

#### Requirements for all brickslip cladding systems

The complete brickslip cladding system e.g. the slips, adhesive, backing boards and associated ancillary products such as clips and fixings must hold a valid third party product conformity certificate.

Where adhesive is used the brickslip must have a full bond that covers the entire surface area of the brickslip. Spot bonding should be avoided.

The substrate must be appropriately prepared as per the system manufacturer's instructions.

The design and fixing of the slip system must be in strict accordance with the third party product conformity certificate with any adhesion tests, pull out tests and saturation / freeze / thaw testing completed satisfactorily as per the requirements of the certificate.

Where cavity barriers are required behind the brick slip system, they must be appropriately selected, suitable for use and be aligned with the compartment wall and floor and be provided around openings.

Pointing mortars should be chosen and installed as per the system manufacturer's instructions. Traditional sand and cement mortar should be avoided. Lime based mortars should be used instead to aid in thermal expansion and settlement.

Any systems utilising clips, strapping, screws, etc. must used in a coastal location within 500m of the shoreline must be Grade A4 stainless steel.

Any fixings of ancillary rainwater goods, satellite dishes, clothes lines, hanging baskets and similar items must go through the slips and into the substrate to ensure adequate fixing.

## Brick slip material specification

Brickslips facings can be adhered to a variety of materials and substrates, the brick slips should meet the following requirements:

- Masonry units (such as clay, calcium silicate, concrete and natural stone) should must confirm to BS EN 771 and have UKCA markings.
- Agglomerated stone - slabs and tiles for wall finishes to BS EN 15286 and have UKCA Marking (Artificial stone).
- Accelerated weathering test data for the specific brick proposed must be provided. The full brick (prior to cutting to 25-28mm) must be tested by UKAS test laboratory for Hygrothermal testing, conditioning to ETAG 034, Freeze/thaw to EN 772-22 and tensile testing to BS EN 1015-12.

In all circumstances, we can only accept F2/S2 bricks complying with EN 771.

## Masonry cavity walls

Where slips are to be bonded onto masonry walls, the following must be also be considered:

- The substrate which the slip is to be attached to must achieve the desired weather resistance from the wind driven rain exposure map as if the slip was not to be installed and in strict accordance with the weather resistance requirements of the Building Regulations.
- The cavity width must satisfy the requirements of PD6697 and the 'External Walls – External Masonry Walls' section.
- Slips must not bridge the damp proof course. The damp proof course must extend through the slip to the outside face of the slip cladding.
- Movement joints in the substrate must be installed in strict accordance with the Technical Manual and extend through the decorative slip cladding.
- Cavity trays must be present, as per the requirements of the Technical Manual.
- Weep holes must be installed, as per the requirements of the Technical Manual and extend through the decorative slip cladding.
- Where checked reveals are required (very severe exposure zone), the design must be assessed and deemed compliant. The check must be formed by the masonry substrate not slips or render. Windows must be sealed prior to the slip installation.

## Brickslip cladding on framed construction with a backing board or as a rainscreen cladding system

Where a brickslip cladding system is specified for either a timber framed or light gauge steel framed building, the timber and light gauge steel frame construction should satisfy the requirements of either:

- External Walls – Timber Frame
- External Walls – Light Gauge Steel Frame

In addition, the following must also be considered for the brickslip cladding system:

- The framed structure (backing wall) must be water tight and protected with a suitable breather membrane.
- The brick slip cladding system should be able to resist impacts without causing safety hazards. Testing and classification to CWCT Technical Note 75 and 76 may be required to demonstrate the impact performance.
- The third party product conformity certificate must confirm the cladding system can provide the necessary weather resistance.
- A drained cavity, which is ventilated where required, must be provided in accordance with the 'External Walls – Timber Frame' and 'External Walls – Light Gauge Steel Frame' sections.
- Where the brickslip cladding system spans across an intermediate floor zone in a timber frame construction, allow for differential movement caused through timber shrinkage by incorporating a movement joint.
- MgO boards are not acceptable for Warranty use.

## Insulated Concrete Formwork (ICF)

Where a brickslip cladding system is specified for ICF, ICF construction should satisfy the requirements of the 'Modern Method of Construction' section. The following must also be satisfied:

- The third party product conformity certificate must confirm the cladding system can provide the necessary weather resistance.
- There must be a drained and vented cavity between the ICF and cladding system.
- The brick slip system must be secured back to the concrete core of the ICF.

If the project location is situated in a wind driven rain exposure zone exceeding that stated in the third party product conformity certificate, the certificate holder must seek agreement with the Warranty provider prior to any installation.

## Brickslips on external wall insulation (EWI)

Where Brickslips are specified as a part of an EWI system, the guidance for both brickslip cladding systems and external wall insulation systems within this section should be followed.

## Brickslips on lintels

Brick slips used in conjunction with either concrete, steel or lightweight (SIP) lintels, must hold a valid third party product conformity certificate covering the lintels, adhesive and slip system as a whole.

### Brickslips on chimneys

All GRP chimneys must either:

- Hold a valid third party product conformity certificate confirming a minimum service life of 25 years and be deemed acceptable to the Warranty provider, **or**
- The GRP chimney manufacturer must be a current 'Accredited Member for the Production of GRP Brick Slip Chimneys' from the 'Construction Glass fibre Manufacturers Association'. Please refer to the 'Chimneys and Flues' section for further guidance.

### 6.5.21 External wall insulation systems

External Wall insulation systems shall be specified and installed to ensure service life and durability of the external wall makeup is achieved whilst ensuring the detailing resists the passage of moisture to the inside of the home.

In addition to the following guidance, EWI systems should satisfy the relevant Building Regulations in relation to fire resistance and fire spread.

### Background substrate suitability

#### Masonry wall

The masonry wall should be designed and constructed to provide adequate resistance to water penetration without the EWI system being present. This can be identified by reference to either BS 5628-3 or PPD 6697, depending on the wall thickness and site exposure.

#### Framed structures

The following should be satisfied for where EWI systems are specified on framed structures such as timber frame and light gauge steel frame:

- A 15mm cavity must be provided. The cavity should be drained and vented for timber frame structures and be drained for LGSF structures.
- For the purposes of Warranty, cavities should be located between the outermost insulation and cladding system proposed as a part of the third party product conformity certificate.
- A breather membrane must be specified to protect the structural frame.
- Breather membranes and AVCL's must be appropriately lapped at reveals.

For further guidance on framed structures, please refer to the 'External Walls – Timber frame' and 'External Walls – Light Gauge Steel Frame' sections.

### Specification

#### Third party product conformity certificate

A valid third party product conformity certificate is required for the entire EWI build up including the cladding or render on the external face. Components outlined within the certificate should not be replaced on site.

The third party product conformity certificate may state the EWI system will only 'contribute towards' the weather resistance of the wall i.e. not give full weather resistance. Therefore the guidance for background substrate suitability should be followed.

The third party product conformity certificate may also state the EWI provides a means to 'improve' the thermal performance of the external wall construction. Therefore any proposed installation must account for the overall thermal performance of the wall construction and the provision of a cavity to meet our Warranty requirements.

#### Loads

The dead and live loads should be transferred safely to the building structure without deformation or deflection of any component.

#### Fixing requirements

Insulation boards should be fixed in accordance with the manufacturers requirements. The density of proprietary fixings should be designed on a site specific basis by an Engineer. This generally consists of a minimum of 5 fixings per full insulation board / 8m<sup>2</sup> with additional fixings to corners and reveals.

On-site pull out testing and a report confirming fixing type and length will be required in accordance with the Construction Fixings Association and made available to the Warranty surveyor.

Where the support of the system is via a horizontal rail system, calculations to demonstrate the system can withstand the design load are required.

If the fixing for the insulation boards are to pierce a breather membrane, a site specific installation guide must be provided from either the EWI manufacturer, breather membrane manufacturer or frame manufacturer (timber or light gauge steel frame) detailing how this should be completed without compromising the effectiveness of the breather membrane.

A minimum of one non-combustible fixing per 1m<sup>2</sup> or per insulation batt, whichever provides the greater number should be provided in addition to the other fixings.

Dot and dab method of fixing using adhesives is not acceptable on masonry substrates. A full coat of approved adhesive (often the manufacturer's adhesive base coat) must be applied across the full face of the substrate with a tooled finish as per the manufacturer's specifications.

For coastal environments and areas of severe and very severe wind driven rain exposures the third party product conformity certificate for the

EWI system must explicitly confirm the complete the system is suitable for use in a coastal environment or severe/very severe wind driven rain exposure. Furthermore, all external metals must have suitable corrosion protection for the intended environment. Further guidance can be found in 'Appendix C - Materials, Products, and Building Systems'. For further information please see 'Appendix B' of our Technical Manual which provides further guidance on additional requirements for developments within coastal locations.

## Suitability of insulation and condensation risk analysis

The insulation type for the structure and application should be suitable for the intended purpose and, when required, should be keyed to receive the desired base coat and reinforcement.

The insulated render system should be designed to minimise the risk of interstitial condensation and the effects of thermal bridging.

A condensation risk analysis should be carried out in accordance with BS 5250 to ensure the building fabric meets the relevant Performance Requirement. If a vapour control layer is required then this must be installed to the warm side of the insulation and the type must be approved and suitable for the application.

Providing a condensation risk analysis doesn't negate the need for thorough and robust checks on the design, workmanship and materials by the site management team and installers.

Particular attention should also be given to detailing around DPC level to ensure that there are no thermal breaks between the wall and floor construction and that any products used below DPC are suitable and accredited for use in that location.

## Window and door openings

Insulation boards should be present around the window and door reveals and care should be taken to ensure there are no breaks in the insulation line.

A continuation of the breather membrane and Vapour Control Layer (VCL) must be catered for around the window and door reveals where the EWI is applied to a framed substrate.

Allowance must also be made to ensure window cills adequately project beyond the finished surface of the EWI system to ensure any throating is correctly positioned clear of the finish.

Drainage deflection beads should be incorporated into the system to deflect water present in the drainage cavity around openings, other penetrations or items that block the drainage cavity.

## DPC, flashings, cavity trays and weep holes

- The EWI system must not bridge any horizontal damp proof course.
- Where cavity trays are installed e.g. over openings or roof abutments, provision for draining the cavity tray will be required through the system as well as the correct construction of any flashing.
- Weep holes should be clear and functioning correctly (i.e. not blocked by the EWI system).

## Movement joints

Movement within the EWI system should be accommodated without any reduction in performance and should be constructed in accordance with the manufacturer's details. Movement joints in the backing substrate should be mirrored through the EWI system and formed in accordance with the EWI manufacturer's recommendations.

## External fixtures

All fixings, down pipes, rainwater pipes, cables, fence posts, external light fittings, satellite dishes and other ancillary fittings and fixtures should be temporarily removed to enable the easy application of the insulated render system. Once the EWI system has been installed, the external fixtures can be installed into the substrate construction (not solely fixed to the EWI).

In addition the following should be observed:

- Temporary downpipes should be provided. Avoid allowing the temporary downpipes to spill water over the substrate or EWI system.
- If required reset all drainage gully's to accommodate the insulation system thickness.
- Flues, ventilation pipes, water pipes etc should be appropriately sleeved and fully sealed in accordance with the system manufacturer's recommendations.
- If required ensure that any gap around the window and door frames is correctly sealed against rain penetration before application of the insulated render system.

## Impact resistance

EWI systems should be able to resist impacts without causing safety hazards. Testing and classification to CWCT Technical Note 75 and 76 may be required to demonstrate impact performance.

## Installation

The EWI system must be installed by an approved installer from the EWI manufacturer. Evidence of the installer being approved should be provided to the Warranty surveyor before works start on site. When installing the EWI system, the following should be observed:

- Protection must be provided when applying the insulation boards in rain or other inclement weather; to avoid trapping moisture in the system.
- Vented cavities should not be blocked, nor should any weep holes.
- Timber supports or blocks should not be used within the EWI system.
- Detailing at window and door reveals should be checked to ensure appropriate trims are provided.
- Ensure the cavity barriers at compartment wall, floor locations and around openings are correctly installed and effective in a fire situation.

### 6.6.1 Compliance

The design, specification and construction of parapet walls shall meet the performance requirements of this section.

### 6.6.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of all proposed materials to be used in the construction of the parapet wall, including but not limited to:
  - a. Details of proposed coping or capping.
  - b. Details of DPC material to be used under coping or capping.
  - c. Details of material to be used for supporting the DPC under the coping or capping.
  - d. Details of cavity tray to be used.
2. A full set of detailed drawings including section details and the dimensions of the parapet wall.
3. Manufacturer or Engineer should provide a site specific fixing specification for the coping or capping. This should detail type, size, spacing and method of fixing to the substrate. Details of corrosion protection should also be provided where applicable.
4. Details of any technical assessment (third party product conformity certificates) for any components used for the construction of the parapet wall.

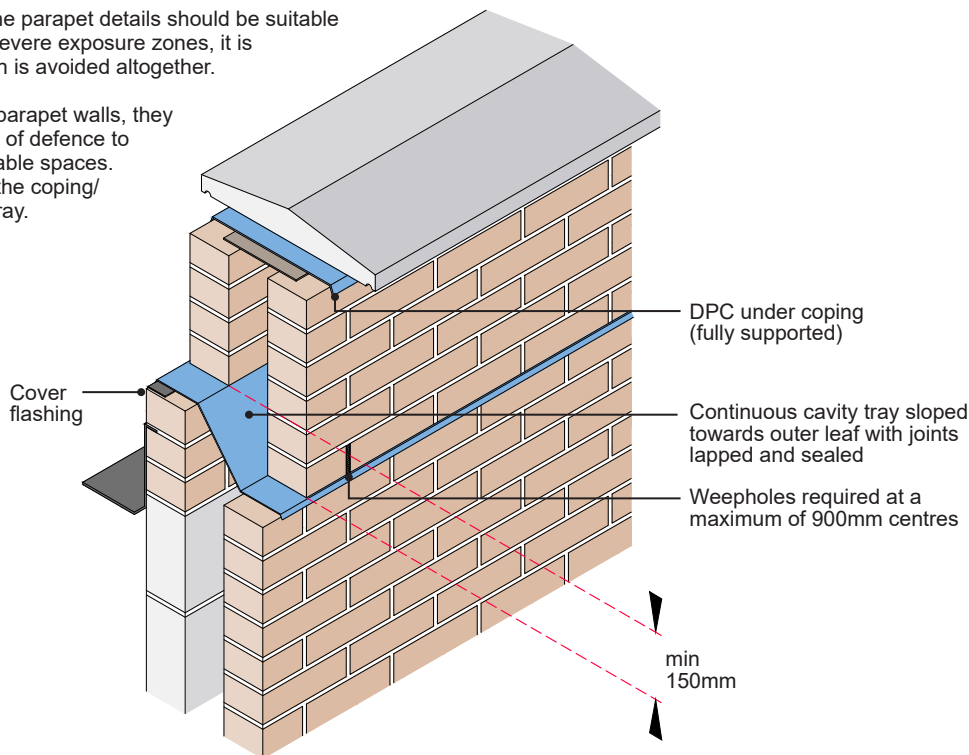
The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 6.6.3 Material suitability and protection against water ingress

The materials used in the construction of the parapets walls shall be suitable for the location and exposure. Parapet walls should be detailed to prevent moisture ingress to the inside of the home.

The materials used in construction of the parapet details should be suitable for the location and exposure. In very severe exposure zones, it is recommended that parapet construction is avoided altogether.

Due to the inherent exposed nature of parapet walls, they should be specified with at least 3 lines of defence to protect against moisture entering habitable spaces. The 3 lines of defence should include, the coping/ capping, supported DPC and a cavity tray.



### 6.6.4 Structural stability

Parapet walls shall be designed (by an Engineer) and constructed to be structurally stable and resist all associated loads. Parapet walls shall also satisfy the relevant requirements of the Building Regulations.

## 6.6.5 Copings and cappings

Copings and cappings shall be specified to:

- Prevent rainwater entering the cavity or the inside of the home.
- Protect the top of the parapet.
- Shed rainwater clear of the surfaces beneath.

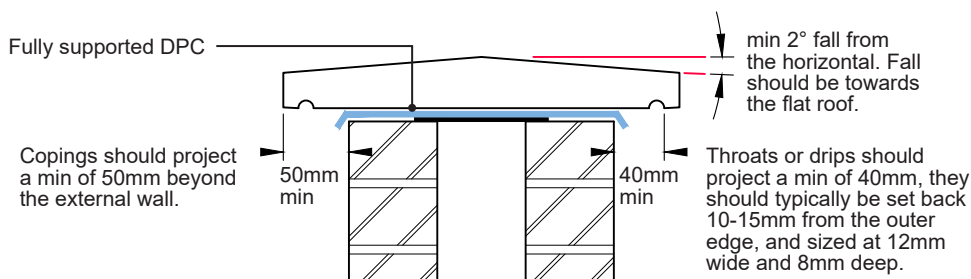
### Copings

All copings and cappings should be of a suitable material specification for the position and exposure conditions, be laid on a fully supported DPC and have a sufficient projection (with a drip) from the parapet wall under.

Copings should:

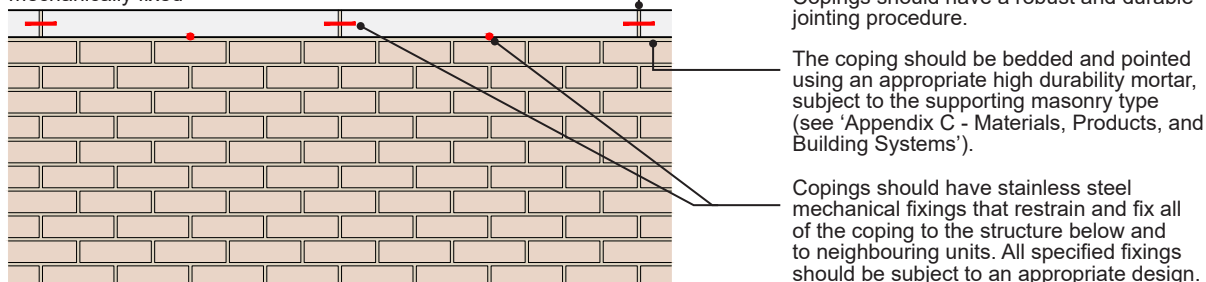
- Be frost resistant.
- Be mechanically fixed.
- Incorporate weather tight detailing to junctions with other elements of structure e.g. coping terminations abutting perpendicular walls.

Vertical movement joints in the supporting structure below should be carried through the parapet and copings. DPCs and cavity trays must be continuous at the movement joint. In addition there should be consideration for the coping manufacturer's requirements for the provision of movement of the coping itself (e.g. thermal expansion).



### Fixing of copings onto horizontal parapets

All copings should be mechanically fixed

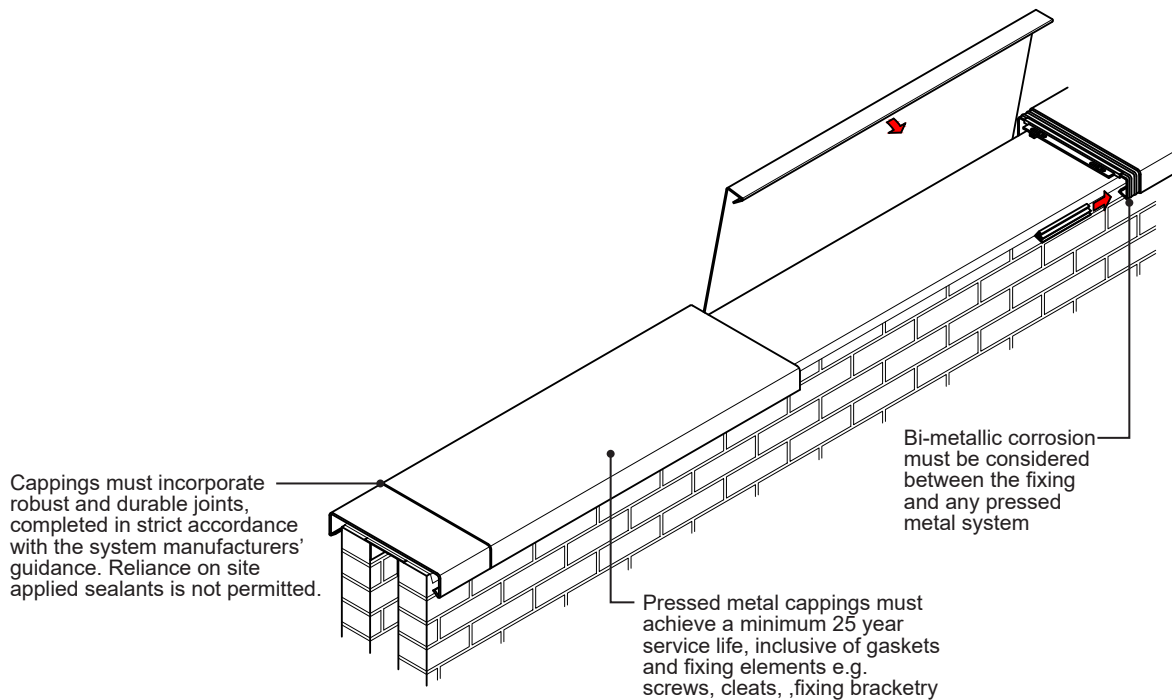


### Pressed metal cappings

The following should be satisfied for pressed metal cappings:

- They should be suitably durable for the exposure conditions and any potentially aggressive environments (coastal locations, industrial zones, etc.) Pressed metal cappings must achieve a minimum 25 year service life, inclusive of gaskets and fixing elements e.g. screws, cleats, fixing bracketry.
- Bi-metallic corrosion must be considered between the fixing and any pressed metal system.
- Aluminium capping systems must not be installed in contact with copper or its alloys, or the runoff from them.
- Aluminium cappings should not be bedded into mortar or concrete.
- They should be 'once weathered' and incorporate pre-formed drip provision within their profile. Typically, the coping will discharge water to the inside e.g. towards the balcony, terrace or flat roof.
- They should incorporate robust and durable joints, completed in strict accordance with the system manufacturers' guidance. For the purpose of Warranty provision, reliance on site applied sealants is not permitted.
- Where the specified system relies on overlapping sections or joints that utilise an anti-capillary methodology e.g. drainage gaps at joints, the developer must prove and demonstrate through testing that sufficient weather tightness can be achieved.
- They should be secured to the wall. The preferred method is the use of concealed bracketry, fixings and gaskets which avoids the need for penetrations through the capping.
- The pull-out resistance of the fixings must be checked for wind uplift by an Engineer. Adhesive bonding of pressed metal copings alone is not considered acceptable for Warranty purposes.
- They should be designed to accommodate movement e.g. thermal expansion and contraction – notably at external and internal corners. Typically aluminium requires an allowance of approximately 1mm per linear meter for movement.
- Achieve a minimum overlap of 75mm at any lead soaker, lead upstand or secret gutter location. Consideration must be given to bi-metallic corrosion occurring between the pressed metal work, lead work and associated fixings.





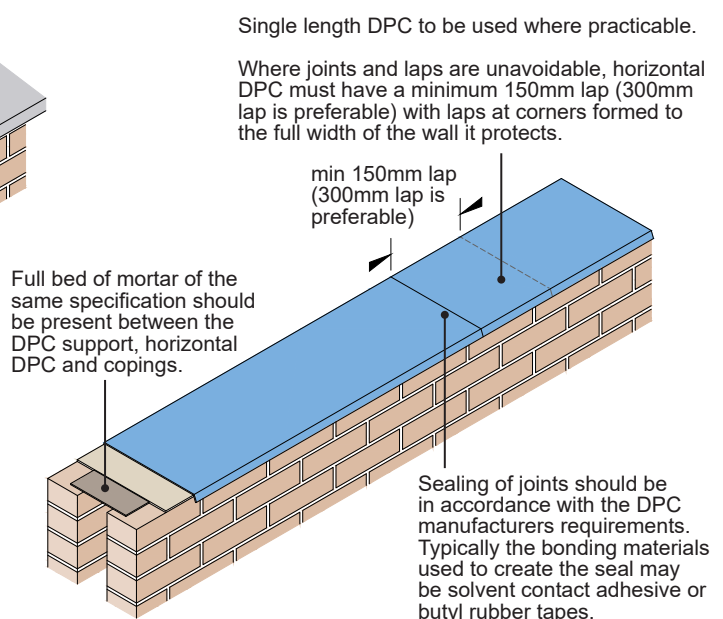
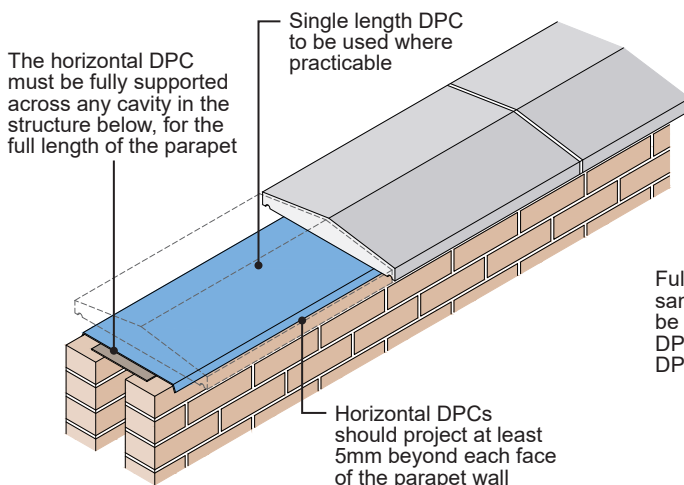
### 6.6.6 Fully supported horizontal DPCs

Fully supported horizontal DPC's shall be of a suitable material specification and detailed to prevent water ingress into the structure below.

The fully supported horizontal DPC should:

- Be of suitable material specification with particular attention to mortar bond.
- For pressed metal cappings, the horizontal DPC should be laid and secured in line with the guidance issued by the pressed metal coping system manufacturer.
- Any penetrations through the horizontal DPC e.g. from coping stone fixings, balustrades, balcony guarding, etc., must be fully sealed to prevent penetrating moisture, using working practices and suitably durable sealant material recognized by the manufacturer of the DPC system as acceptable and compatible.

Manufactured DPC pre-formed cloaks are preferred where complex shapes are created by penetrations such as wind post penetrations, etc.



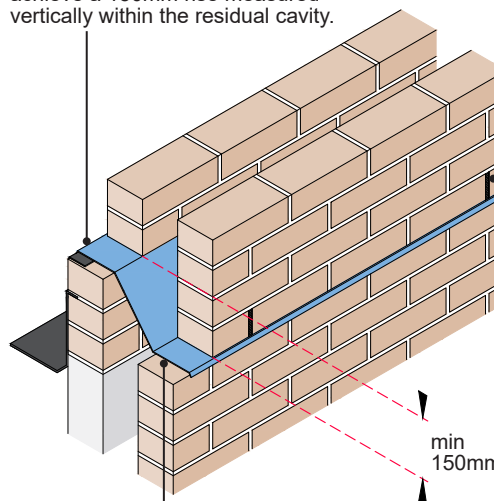
## 6.6.7 Cavity trays

Cavity trays shall be of a suitable material specification with an appropriate third party product conformity certificate and be detailed to direct any water ingress to the outside of the cavity.

The following should be satisfied for cavity trays:

- The cavity tray should be of suitable material specification. Materials attaining the correct bond performance should be specified and this should be checked against a third party product conformity certificate as suitable in situations of minimal load.
- Proprietary self-supporting cavity trays should be used; flexible cavity trays should be avoided.
- Where flexible cavity trays are used, evidence of how they are to be continuously supported should be provided.
- When securing to framed construction e.g. timber frame, surface fixing must be done in strict accordance with manufacturers guidance and materials e.g. bonding materials, fixing strips.
- Fixing to insulation boards alone must be avoided and the cavity tray will require to lap with any breather membrane on the frame construction.
- Cavity trays must be formed with minimal joints, as far as practicable. Where joints and laps are unavoidable, laps should be formed and fully sealed in accordance with the manufacturers' guidance. Preformed cloaks should be used for complex geometry and obstructions.
- Horizontal cavity trays in parapets may form a slip plane, this should be taken into account by the designer with for example the introduction of additional wall ties.

Cavity trays must be securely fixed to maintain their position and achieve a 150mm rise measured vertically within the residual cavity.



Weep holes must be incorporated at a max 900mm centres

Where cavity tray material passes through any masonry leaf, it must be sandwiched between even beds of wet mortar, receiving at least one further course of masonry units on mortar to achieve the required bond.

## 6.6.8 Raking parapets

Raking parapets shall be appropriately detailed to prevent water ingress to the inside of the home or cavity.

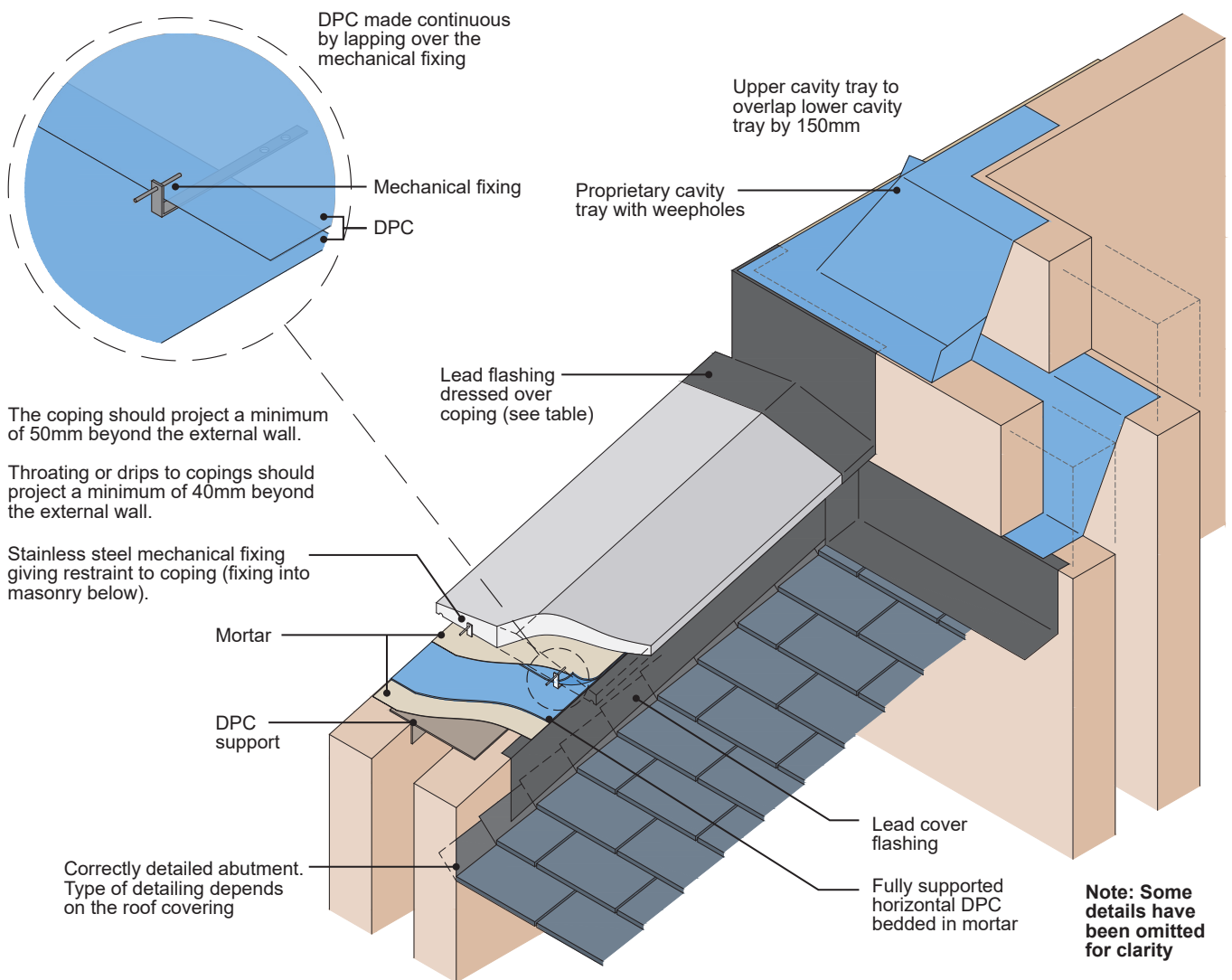
In addition to the other guidance in this section, the following should be considered for raking parapets:

- Joints in the DPC are not permitted on raking parapets. Where dual pitched roofs are encountered, an allowable overlap will occur at the transfer from one plane to another e.g. the ridge. This exception must have a minimum 150mm sealed overlap (300mm lap is preferable).
- Where the wall upstand above the roof line is relatively short e.g. 150-300mm, any lead flashings used to weatherproof the junction must dress underneath the DPC arrangement and be secured in place prior to the horizontal DPC installation. The lead flashing must sit on the horizontal portion of the wall by 25-30mm.
- As an alternative to a DPC material being used, a lead detail could be adopted. In such a cases installation must be in accordance with the Lead Sheet Training Academy guidance and the guidance within the 'Roofs' section with regards the execution of flashing details.
- Where pressed metal capping sections are being used, the DPC must hold a valid third party product conformity certificate where horizontal DPCs do not form part of the installation. This documentation must prove and demonstrate weather tightness of the installed system to a point deemed acceptable to the Warranty provider.

The amount of lead lapping on to the coping should be in accordance with the table shown below.

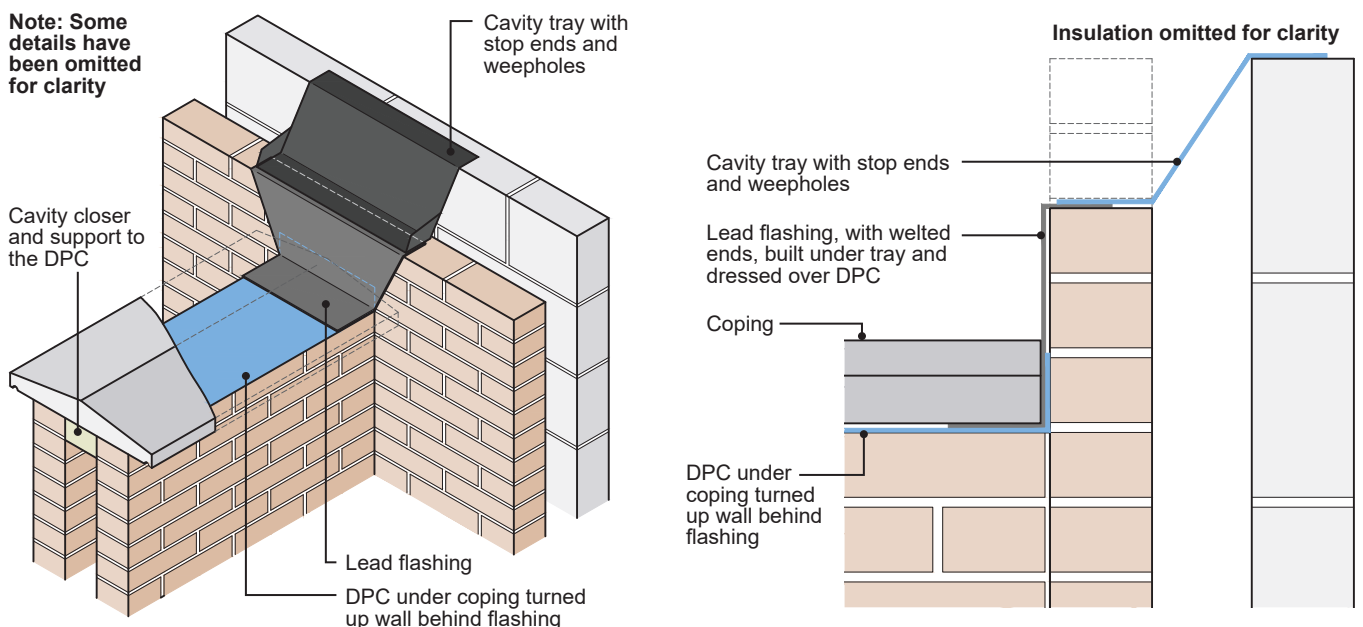
| Minimum lap of the flashing with the coping/roof covering                                                                                                                                                                 |                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Pitch of roof                                                                                                                                                                                                             | Cover of lead flashing on coping/roof |
| 30°                                                                                                                                                                                                                       | 150mm                                 |
| 20°                                                                                                                                                                                                                       | 220mm                                 |
| 15°                                                                                                                                                                                                                       | 290mm                                 |
| Note: <ul style="list-style-type: none"> <li>▪ For pitches over 30°, a min lap of 150mm should be provided.</li> <li>▪ In areas of severe/very severe exposure, the vertical upstand should increase to 100mm.</li> </ul> |                                       |





### 6.6.9 Parapet wall and external wall junction

Where a parapet wall abuts an external wall, the junction should be detailed to prevent water ingress to the inside of the home.



## 6.6.10 Chute detailing

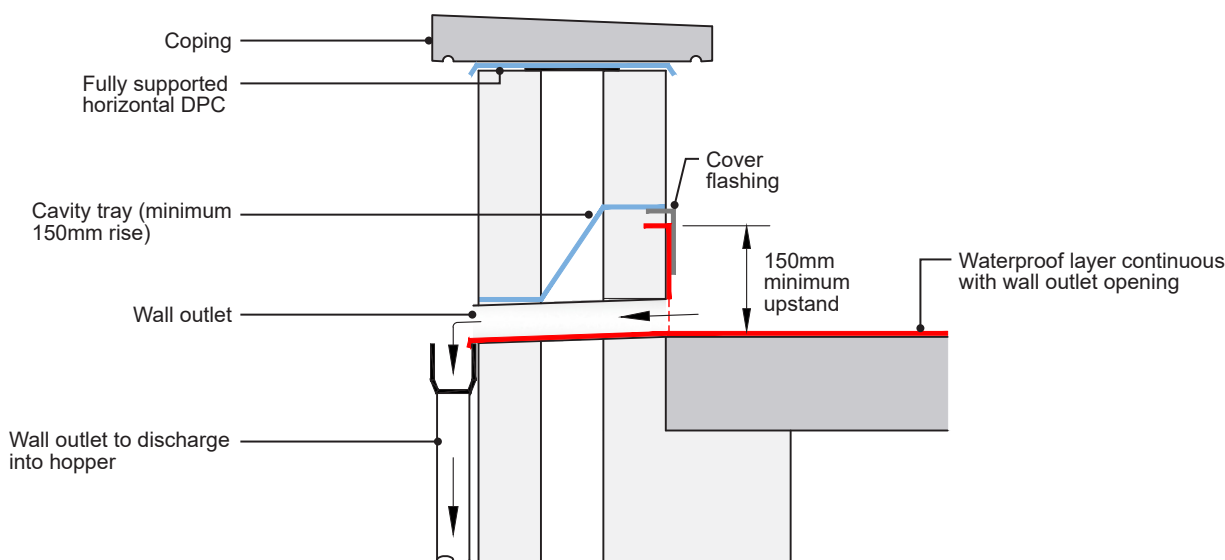
Where chutes are specified, it should direct rainwater to a suitable outfall whilst not impeding on the effectiveness of other waterproofing elements of the parapet wall.

Where a chute penetrates a parapet:

- It must not impede the effectiveness of the cavity tray, flashing or any other waterproofing elements of the parapet.
- The number, size and positioning of the chutes must be designed to BS EN 12056-3 taking local rainfall intensities into account.
- Differential movement should be taken into account for both the chute and the hopper where the chute passes through timber frame construction. Please refer to the 'External Walls – Timber Frame' section for further guidance on differential movement.

Notes:

- Cavity tray requires a 150mm rise, weep holes and stop ends.
- 150mm upstand also required for upstand.
- Drawing shows a generic wall build up.



## 6.6.11 Parapet detailing for framed structures

Parapet walls for framed structures shall be adequately detailed to be structurally stable and prevent water ingress to the inside of the home.

### Structural stability

The parapet shall be structurally stable and capable of accommodating foreseeable loads and differential movement and shall be designed by an Engineer.

### Preventing water ingress

Parapets should resist water ingress by adopting 3 line of defence:

- The capping.
- Supporting DPC, or waterproof membrane where the parapet is fully encapsulated.
- A cavity tray.

To protect the inside face of the parapet, the waterproofing system applied to the roof shall either:

- Full encapsulate the parapet and be continuous with the capping detail, **or**
- Be combined with an impervious cladding system which if fixed to the inside face of the parapet.

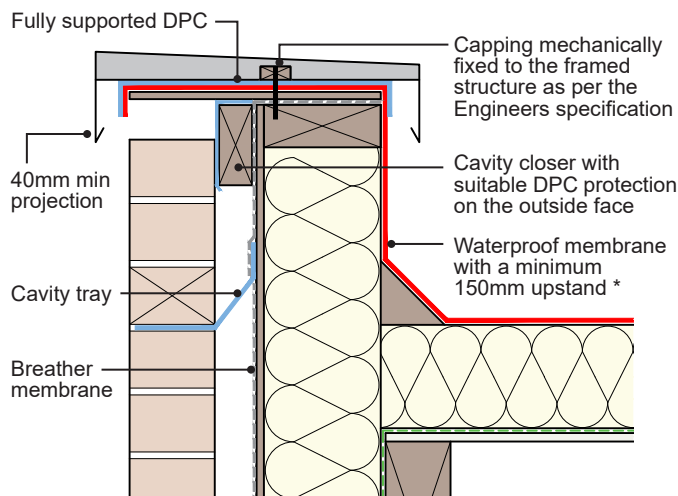
In all situations, the waterproofing situation should have a third party product conformity certificate which confirms it can be used in that scenario. In addition, a site specific fixing specification should be provided by the manufacturer or an Engineer.

### Lightweight proprietary capping

The waterproofing of Parapets for framed structures should incorporate a lightweight proprietary capping which should be mechanically fixed back to the framed structure in a manner which does not impede on the waterproofing.

The capping should be suitable for the exposure and anticipated wind loading. The Engineer should provide specification for the fixing of the lightweight proprietary capping. If the capping is secret fixed, each capping piece should be provided with at least 2 security fixings.

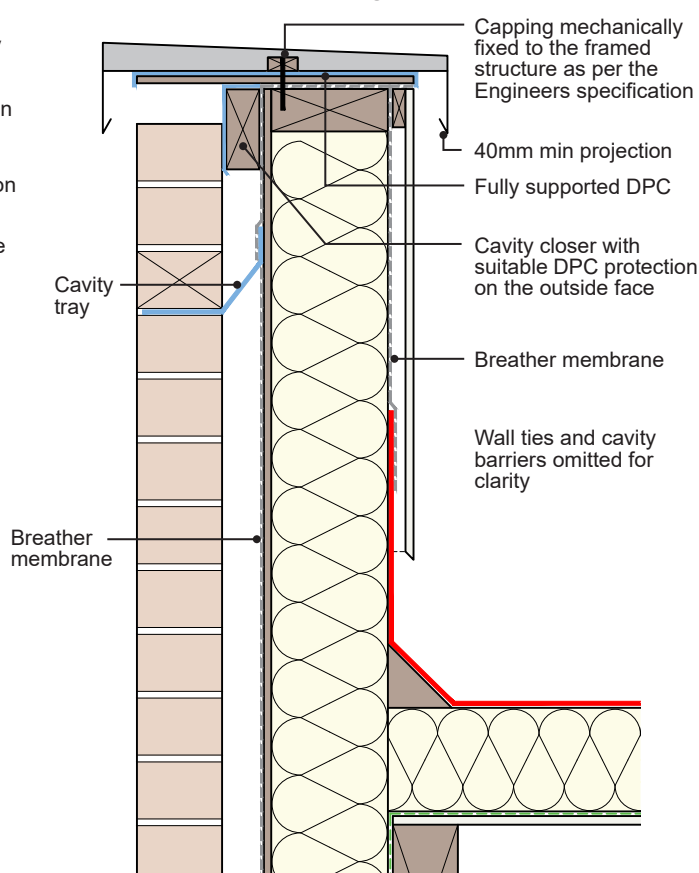
**Typical detail of a waterproofing membrane fully encapsulated parapet**



\*Subject to the membrane manufacture specification.

Wall ties and cavity barriers omitted for clarity.

**Typical detail of the internal face of the parapet being protected by both a waterproof membrane and impervious cladding**



### 6.6.12 Terrace guarding and balustrade systems

Guarding and balustrade systems shall:

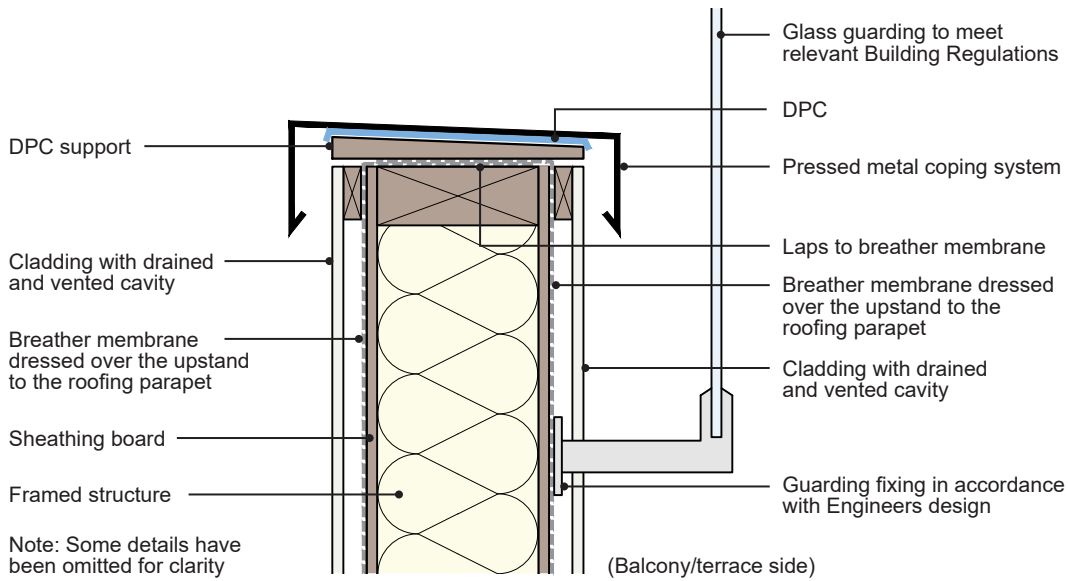
- Be designed to resist horizontal forces.
- Fixed back to the structure in accordance with the design.
- Have a fixing specification that does not create weak spots for water ingress to the inside of the home.
- Be specified and installed to prevent cold bridging.

#### General guidance

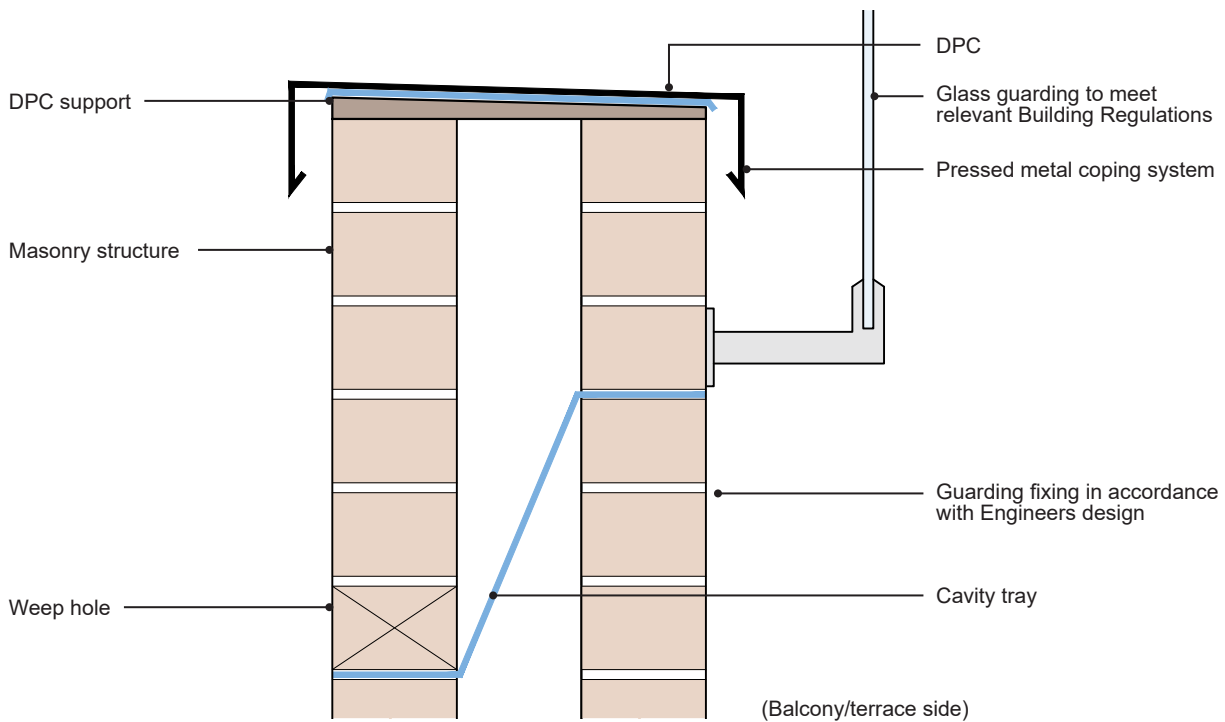
Where terrace guarding or balustrade systems are specified, the following should be taken into account:

- Any guarding should ideally be mounted to the sides of the parapets, either internally or externally via face fixings into the parapet wall and not through the coping. This should be the preferred method as it prevents creating weak spots for water ingress.
- The copings weathered upper surface, projection and drainage function must be uninterrupted and unhindered by guarding provisions e.g. glazing channels which are recessed into and divide coping provisions should be avoided.
- Where this cannot be avoided, and any guarding over a coping arrangement is in continuous contact, the free drainage of the coping should not be impeded. In such instances, coping arrangements must incorporate a fall away from the obstruction to any outside edge.
- Where the guarding incorporates proprietary glazing and framing profiles, drainage provisions from glazing channels must be provided and kept free from obstruction. Particular attention should be paid to sealant pointing used where such profiles are in continuous contact with the upper surface of a coping system, as this area can often restrict drainage when incorrectly executed.
- Where the guarding, over a coping arrangement, is in continuous contact with the coping fixings which penetrate the coping arrangement, the fixings must only pass through a self-sealing butyl tape. Reliance on silicone is not acceptable.
- Guarding incorporating elements of glazing may need to be heat soak tested to BS EN 14179-1.

## Framed structure



## Masonry structure



## Introduction

This section provides guidance on meeting the performance requirements for Gable spandrel panels. Gable spandrel panels can be used as a continuation of the internal skin of masonry cavity blockwork.

### 6.7.1 Compliance

The design, specification and construction of gable spandrel panels shall meet the performance requirements of this section.

### 6.7.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full set of detailed drawings, including:
  - a. Plan layouts indicating dimensions.
  - b. Elevations with dimensions shown.
  - c. Detailing around junctions such as with masonry walls, ceiling lines or at ridges.
2. Engineers drawings, calculations and fixing schedules for each connection made on site.
3. Details of any cladding material fixed back to the spandrel panel including type, size, location of fixings provision of cavities. Where masonry cladding is present on the external leaf, details of wall tie and movement joint provision.
4. Location and method of how vertical and lateral restraint is to be provided, and its interaction with the roof structure.
5. Details of proposed cavity barriers including location, materials and technical assessments (third party product conformity certificate).

### 6.7.3 Structural design

Gable end spandrel panels shall be appropriately designed by an Engineer to accommodate loads identified within the design.

The following should be taken into account:

- Design and loads.
- Timber strength class and grading.
- Timber durability and preservative treatment.

## Design and loads

Gable spandrel panels should be designed in accordance with BS EN 1995-1-1. The panels must be designed to:

- Resist wind loadings acting on the end walls and also loads applied by the claddings.
- Withstand all applied vertical and horizontal loads, on a site by site basis.

## Timber strength class and grading

BS EN 338 should be used by the designer to determine the suitable strength class for structural timber components.

All structural timber should be:

- Machine graded to BS EN 14081 or, visually graded to BS 4978 for softwoods or BS 5756 for hardwoods.
- Dry graded.
- Marked in accordance with BS EN 14081.

All load-bearing solid timber studs, rails, binders and sole plates should be of a minimum dry graded C16.

## Timber durability and preservative treatment

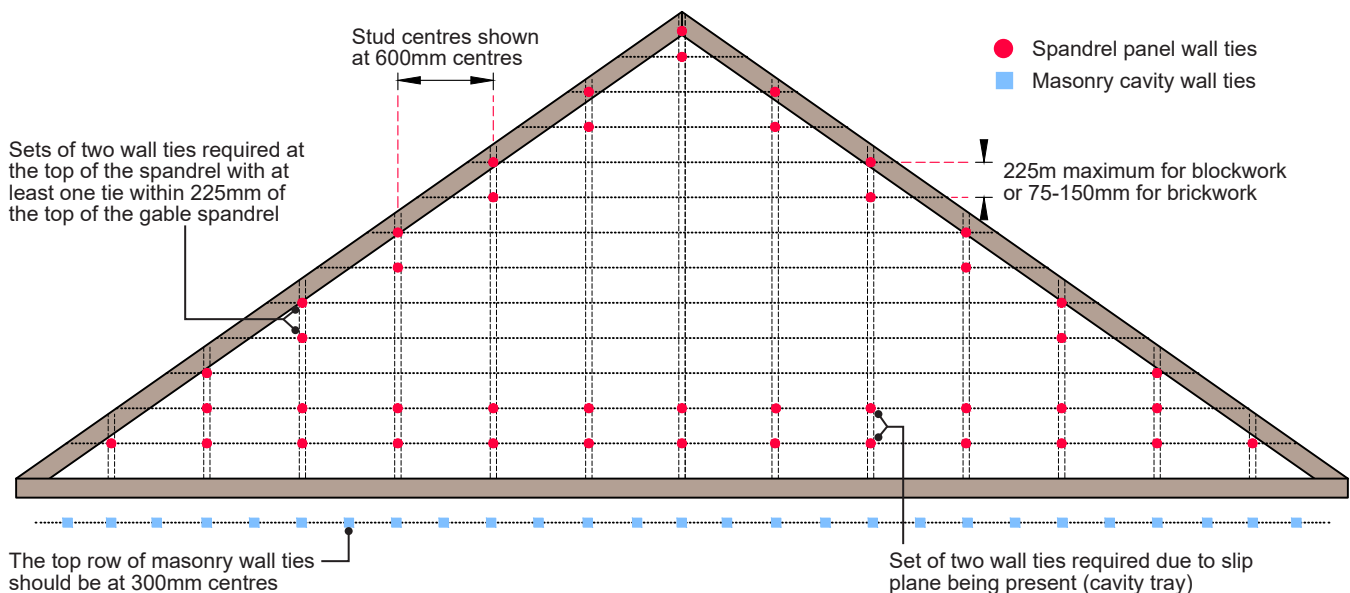
Timber and joinery used in the construction shall either have adequate natural durability or be preservative treated against fungal decay and insect attack with the preservative treatment being in accordance with BS 8417.

BS 8417 provides information to establish the appropriate type of treatment according to the particular element and conditions of use. Tables 1 to 3 of BS 8417 must be referred too to identify 'Use classes', 'Service Factor code' and durability class of wood for the desired service life.

#### 6.7.4 Wall tie locations

Where masonry cladding is specified, wall ties shall be of the correct type and be suitable for the intended purpose and location. Wall ties shall be spaced as per the Engineers specification and site specific conditions.

Wall ties between the spandrel panel and brick or block outer leaf should have the ties fixed into the timber vertical studs of the spandrel panel. The spacing of wall ties should be increased at the top of the wall and where a potential slip plane is present (horizontal cavity trays at the base of the spandrel panel).



### 6.7.5 Restraint requirements

The lateral restraint of the panels, shall be designed by an Engineer to withstand all applied vertical and horizontal loads on a site by site basis to suit the structural requirements of each project.

Gable spandrel panels shall also have adequate vertical restraint in accordance with the Engineers design.

Spandrel panels require lateral restraint at rafter level and along the base of the panel. Lateral restraint could be provided by:

- Timber members (e.g. the longitudinal bracing secured to the spandrel with timber ledgers/noggings), fixed into at least two studs within the panels.
- Metal restraint straps fixed to the panel and to noggings, or timber bracing fixed across the trusses.

Gable spandrel panels must resist wind loads acting on the gable end walls and loads transferred from elsewhere e.g. from the roof structure, bracing etc. These loads are transmitted through the panel from the roof structure, bracing etc. via lateral restraints.

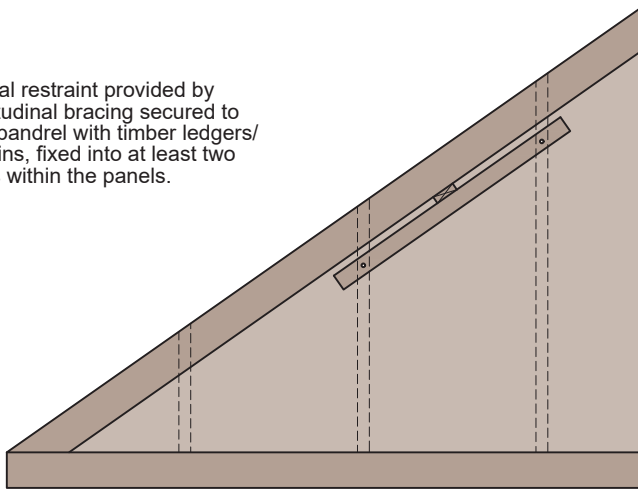
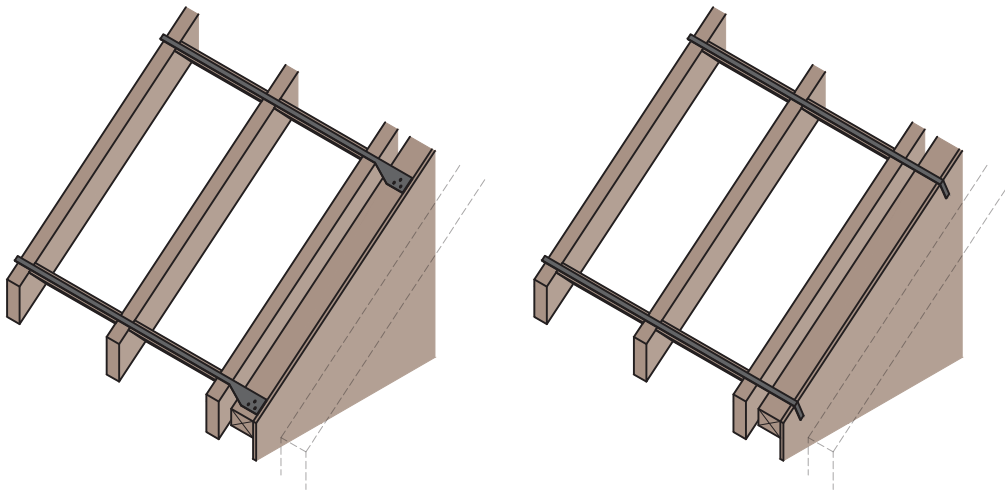
The restraint of the panels, should be designed by an Engineer to withstand all applied vertical and horizontal loads, on a site by site basis to suit the structural requirements of each project. The design and supporting calculations should be provided to the Warranty surveyor.

Other points to consider:

- Intermediate restraint may also be necessary for larger panels.
- Restraint straps should be located at a minimum 2m centres and should pass at least 3 trusses.
- A timber blocking piece is typically required between the truss and spandrel panel.
- Restraint strap to be fixed to a panel stud, with fixings capable of resisting a minimum 8kN force (based on restraint straps at maximum centres).

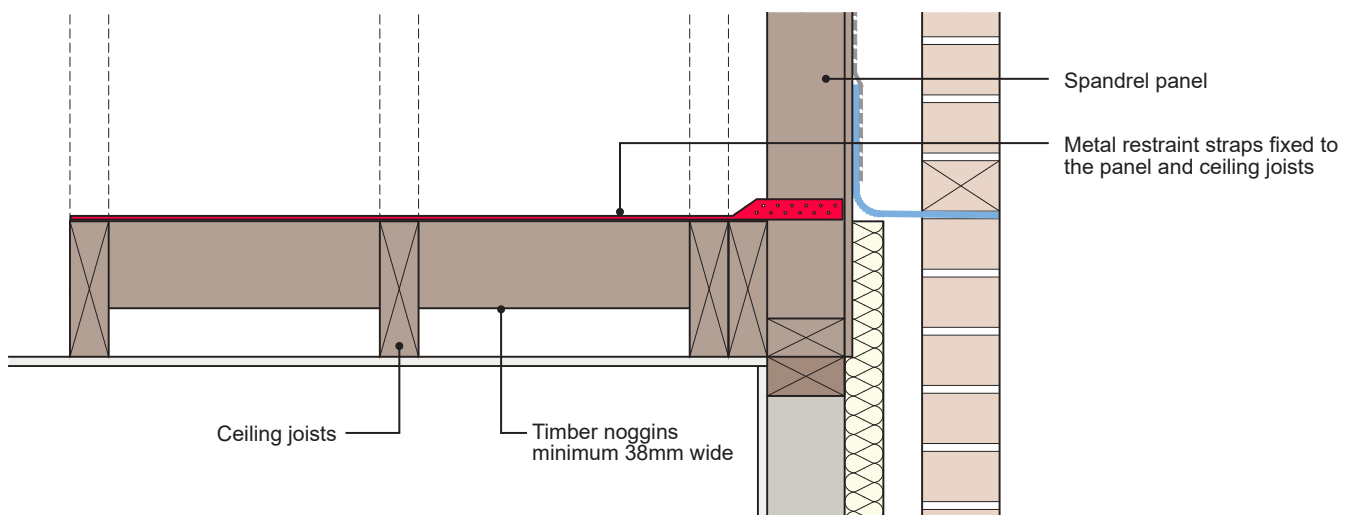
**Lateral restraint provided by longitudinal bracing**

Lateral restraint provided by longitudinal bracing secured to the spandrel with timber ledgers/noggins, fixed into at least two studs within the panels.

**Metal restraint straps fixed to the panel and to noggings****Low level lateral restraint**

At low level, lateral restraint is required along the ceiling joists.

Where the blockwork wall extends above the ceiling joists, lateral restraint is required for both the masonry wall and at the base of the spandrel panel.



## Vertical restraint

Gable spandrel panels should also be fixed to the head of the masonry wall. This can be achieved with the use of vertical restraint straps at centres specified by the designer. These are typically placed at a minimum of 1200mm centres and face fixed to coincide with stud positions. The strap length should ensure a minimum of two fixings into the panel framework and three fixings into the blockwork, into a minimum of 2 blocks.

### 6.7.6 Providing a drained and vented cavity

Gable spandrel panels shall be provided with a drained and vented cavity which:

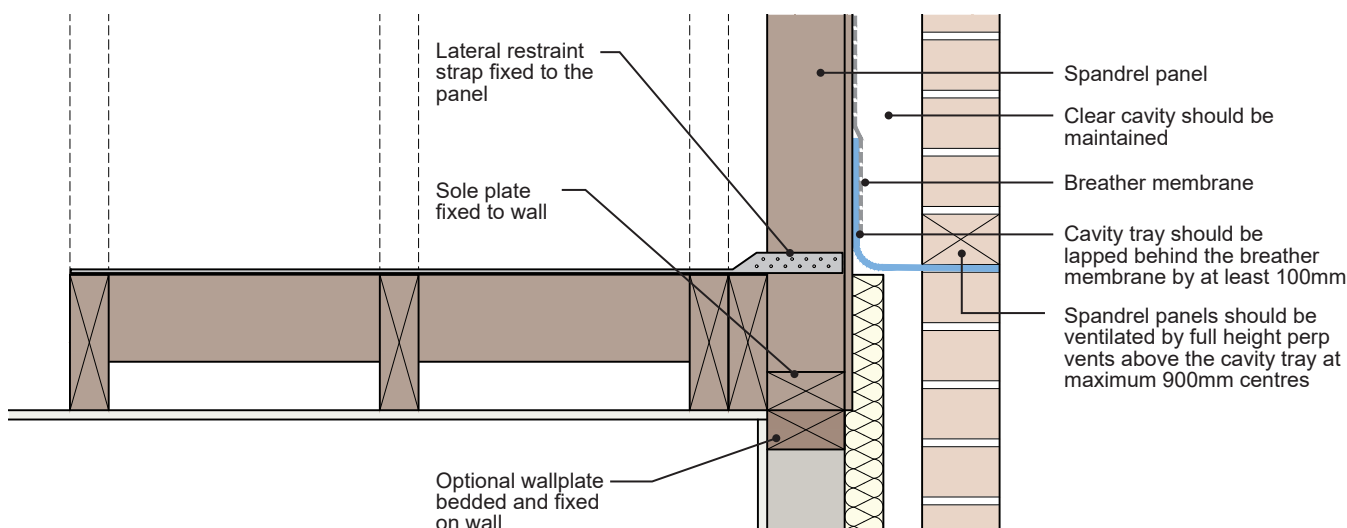
- Resists the passage of moisture to the inside of the home, **and**
- Prevents interstitial condensation.

Gable spandrel panels must incorporate a sheathing board, breather membrane and maintain a minimum of a 50mm clear cavity. Full fill cavity insulation with not be acceptable for Warranty as this prevents the spandrel panel frame from being able to dry out. The stud positions should be clearly marked on the breather membrane to assist in correct installation and positioning of wall ties.

Where blown full fill insulation is being used in the masonry cavity wall, there should be a way of ensuring:

- The insulation does not deform the cavity tray at the base of the spandrel panel.
- The insulation does not spread into the spandrel panel cavity frame area.
- This may be achieved by incorporating a non-deformable cavity closure or a rigid preformed cavity tray.

Horizontal cavity trays at the base of the spandrel may create a potential slip plane, the designer should take this into account or the guidance on wall tie locations on this page may be followed.



### 6.7.7 Fire considerations

The design of the panel shall achieve compliance with the Building Regulations in regards to fire resistance and fire spread.





# 7.

## Internal Walls

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### Contents

|     |                                                     |     |
|-----|-----------------------------------------------------|-----|
| 7.1 | Masonry                                             | 202 |
| 7.2 | Timber Stud                                         | 206 |
| 7.3 | Metal Stud                                          | 211 |
| 7.4 | Spandrel Panels                                     | 215 |
| 7.5 | Fire Resistance, Cavity Barriers, and Fire Stopping | 219 |

## Introduction

This section provides guidance on meeting the performance requirements for internal masonry walls.

### 7.1.1 Compliance

The design and construction of internal masonry walls shall meet the performance requirements of this section.

### 7.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section. A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Floor plans indicating the positions of internal walls - load-bearing and non-load-bearing.
2. Specifications relating to the proposed construction of internal walls and formation of openings including lintels.
3. Site specific supporting calculations confirming design loading where required.
4. Details of proposed fire stopping and cavity barriers.
5. Details relating to service penetrations.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 7.1.3 Methods of supporting masonry internal walls

Masonry internal walls shall be adequately supported and safely transfer loads to the foundations.

Internal masonry walls should be supported on one of the following:

- A suitable foundation.
- Other masonry walls (wherever conceivable, the design of buildings should be such that the first floor masonry partitions are an extension of those on the ground floor).
- Structural concrete floors.
- Steel or concrete beams.

It may be necessary to use padstones at bearings where steel or concrete beams are to be used.

Masonry partitions should not be supported by timber joists or beams.

Allowance for the probable deflection of floors at the head of partitions is required to prevent the partition becoming load-bearing. Allowance should be given in the design for the relatively flexible nature of the timber and the rigid nature of masonry.

Walls and partitions that are supported off structural floors, should not be built directly off a compressible layer forming part of a floating floor system.

### 7.1.4 Structural design

Internal masonry walls shall:

- Meet the requirements of the Building Regulations for their structural design.
- Use masonry units which are suitable for the intended purpose and service life.
- Be adequately restrained at floors and roofs. Particular attention should be paid to location, type and method of restraint.
- Be appropriately bonded to external walls as specified by the designer.
- Have chases which do not impair on the structural integrity of the wall.

## Structural design

Internal masonry walls shall be designed in accordance with BS EN 1996-1-1.

## Masonry unit suitability

Masonry units should satisfy the relevant parts of BS EN 771.

The varying strengths of bricks and blocks mean that they have to be chosen in accordance with the proposed use of the building. The recommended strengths of bricks and blocks to be used in buildings up to three storeys high are found in 'Appendix C - Materials, Products, and Building Systems' and the relevant Building Regulations.

## Lateral restraint

Lateral restraint is to be provided for load-bearing walls and separating walls at each floor level and the ceiling level below a roof.

Lateral restraint of walls can be provided by lateral restraint straps at 2m centres, restraint type joist hangers or other forms of restraint proven by an Engineer.

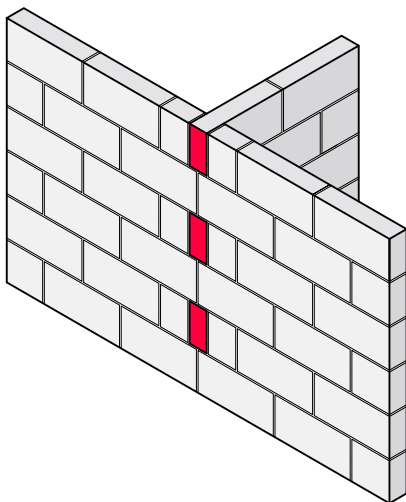
For further guidance on lateral restraint, please refer to the 'External Walls – External Masonry Walls' section.

## Bonding

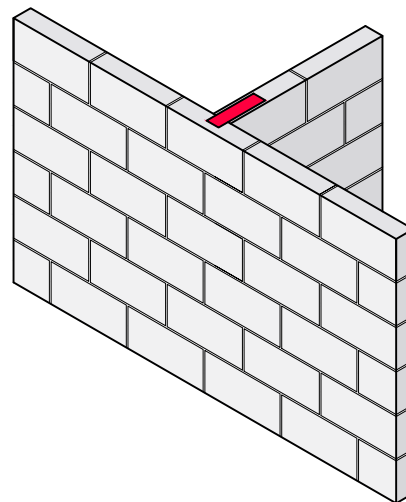
Where a separating wall abuts an external wall, they may be tied or bonded together. Tied joints should be formed using expanded metal strip, wall ties or equivalent fixings, at maximum 300mm vertical centres.

Where the external wall cavity needs to be closed at the junction with the separating wall with a flexible cavity stop, but not if the cavity is fully filled with built-in insulation (where permitted).

### Block bonding internal walls to inner leaf



### Block bonding internal walls to inner leaf using ties



## Chases in internal masonry walls

Chases in masonry walls for service pipes and cables should be avoided. Where unavoidable, chases should:

- Only be made in solid masonry (not hollow blocks).
- A horizontal chase must not exceed 1/6 the thickness of the single leaf.
- A vertical chase must not exceed 1/3 the thickness of the wall.
- Electric sockets should be staggered either side of a party wall.

### 7.1.5 Beams and lintels

Beams and lintels shall safely support the applied loads, be of the correct type and size, and be suitable for the location.

Beams and lintels shall be satisfactory for their purpose. Concrete and steel lintels should be appropriate for use in masonry walls. Support for masonry should not be provided by timber lintels.

Items to be taken into account include:

- Loads and spans are in accordance with the manufacturer's recommendations.
- Wall and cavity thicknesses.
- Bearing capacity of the masonry supporting the lintel or beam.
- Lintels should comply with BS EN 845-2 where steel or concrete lintels are used.

Lintels should not:

- Have masonry overhang the lintels by more than 25mm.
- Be supported on short lengths of cut blocks or make-up pieces.
- Have concrete loads applied before the brickwork is full bedded as per the lintel manufacturer's requirements.

Steel beams should be designed by an Engineer and should have appropriate fire resistance to meet the requirements of the relevant Building Regulations.

Where steel beams and columns are used on a project in a coastal location, please follow the requirements for additional corrosion protection 'Appendix B - Coastal Locations'.

### Minimum bearing lengths of lintels

Lintels should extend beyond each end of openings in masonry as follows:

| Span       | Minimum length of bearing |
|------------|---------------------------|
| Up to 1.2m | 100mm                     |
| Over 1.2m  | 150mm                     |

- Steel lintels should comply with the manufacturer's installation guidance.
- Where structurally necessary, provide padstones under the bearings of lintels and beams.
- Beams and lintels should bear on a full masonry unit.
- Non-load bearing partitions shall have acceptable strength and be adequately supported.

### 7.1.6 Detailing for non-load bearing internal masonry walls

Internal non-load bearing masonry walls shall be appropriately detailed to take account of any deflection in floors or roofs.

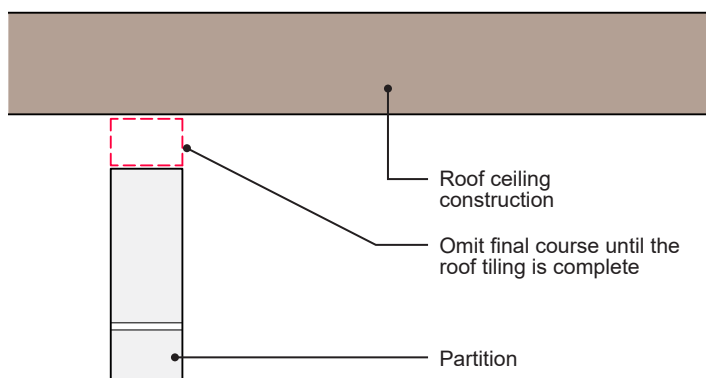
#### Deflection heads in internal masonry wall under a floor structure

Site specific designed deflection allowances should be clearly defined by those designing the floor structure. The building designer should clearly indicate walls that are suitable for structural loading and walls that are not.

This should be factored into the design of any internal non-load bearing partitions, and head restraint details must correspond with identified and expected deflection limits. A corresponding deflection head design should be provided prior to commencement of any construction of internal non-load bearing walls.

#### Internal masonry wall and roof structure deflection

It is advisable to erect non-load bearing walls after the roof tiling has been completed thus allowing deflection to take place under dead load, thereby reducing the risk of cracking appearing in the ceiling finishes. If partitions are of brick or block, then alternatively the final course can be omitted until roof tiling has been completed.



### 7.1.7 Horizontal DPCs

Horizontal DPCs shall be suitable for their intended purpose and be provided to prevent moisture rising or entering the home.

Where an internal wall is built off a foundation continuity of the DPM must be achieved.

The internal wall should have a DPC, which is at least the width of the internal wall and linked with the DPM by a minimum of 100mm.

## 7.1.8 Sound insulation

Suitable materials with adequate thickness and densities shall be specified to provide the required resistance to the transmission of sound.

Internal separating walls should, where necessary, meet the requirements of the relevant Building Regulations in relation to the resistance of sound and sound testing requirements.

Internal masonry partitions should have a minimum density of 600kg/m<sup>3</sup> and finished both sides with 13mm of plaster.

### Wall ties for cavity separating walls

To provide structural stability, the two leaves of a masonry cavity separating wall should be tied together.

Sound transmission across the cavity should be limited by the type of tie and spacing.

Ties should be specified in accordance with the system designer's recommendations for separating walls. The type of tie and spacing should limit sound transmission across the cavity.

To limit sound transmission, metal tie straps should be:

- No more than 3mm thick.
- Fixed below ceiling level.
- Spaced at least 1.2m apart horizontally.

Thicker ties, fixed at ceiling level or more closely spaced, will increase sound transmission through the cavity.

## 7.1.9 Thermal insulation of internal walls between heated and unheated areas

Internal separating walls shall be adequately insulated to prevent undue heat loss from heated areas of the building to unheated areas.

Internal walls separating heating and unheated areas of the dwelling shall have adequate thermal insulation to satisfy the thermal requirements of the Building Regulations. Designers should provide adequate information to demonstrate this.

## Introduction

This section provides guidance on meeting the performance requirements for traditional internal timber stud walls.

### 7.2.1 Compliance

The design and construction of internal timber stud walls shall meet the performance requirements of this section.

### 7.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section. A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Floor plans indicating the positions of internal walls - load-bearing and non-load-bearing.
2. Specifications relating to the proposed construction of internal walls and formation of openings including lintels.
3. Site specific supporting calculations confirming design loading where required.
4. Details of proposed fire stopping and cavity barriers.
5. Details relating to service penetrations.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 7.2.3 Methods of support for timber partitions

Timber partitions shall be adequately supported and safely transfer loads to the foundations.

Load-bearing timber internal walls are to be designed to provide support and transfer loads to foundations safely and without undue movement.

Walls and partitions are to be supported by the structural floor, only if the material is specifically manufactured for that purpose; it is not to be supported by a floating floor that incorporates a compressible layer.

Extra noggins or joists should be specified where stud partitions or proprietary plasterboard partitions are supported by a timber floor, unless it can be shown that the deck can transfer the load without undue movement. Allowance for the probable deflection of floors at the head of partitions is required to prevent the partition becoming load-bearing.

Head and sole plates should consist of single length members fixed to the building structure at no less than 600mm centres.

Partitions should be located on double joists when parallel to floor joist span and nailed to 50mm x 50mm noggins fixed between ceiling joists at 600mm centres when parallel to ceiling joist span. For short lengths of partitions (1.2m maximum), blocking between joists at 600mm centres may be used. Intersecting head and sole plates should be skew nailed together.

Timber members should be fixed together with a minimum of two 75mm long x 2.65mm diameter nails. Proprietary partitions of plasterboard, strawboard or other material must be detailed and constructed in accordance with the manufacturer's recommendations.

Walls and partitions that are supported off structural floors, should not be built directly off a compressible layer forming part of a floating floor system.

### 7.2.4 Structural design

Timber stud walls shall be designed to be durable and safely transfer loads.

The structural design of load-bearing timber walls should be in accordance with BS EN 1995-1-1.

Structural timber should be specified according to the strength classes, e.g. C16 or C24. Where partitions are placed onto concrete ground floors a DPC should be provided directly below regardless of if there is a DPM beneath the slab.

Load-bearing partitions should be designed by an Engineer.

Timber studs should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure in accordance with BS 8417.

Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.

## Timber stud construction

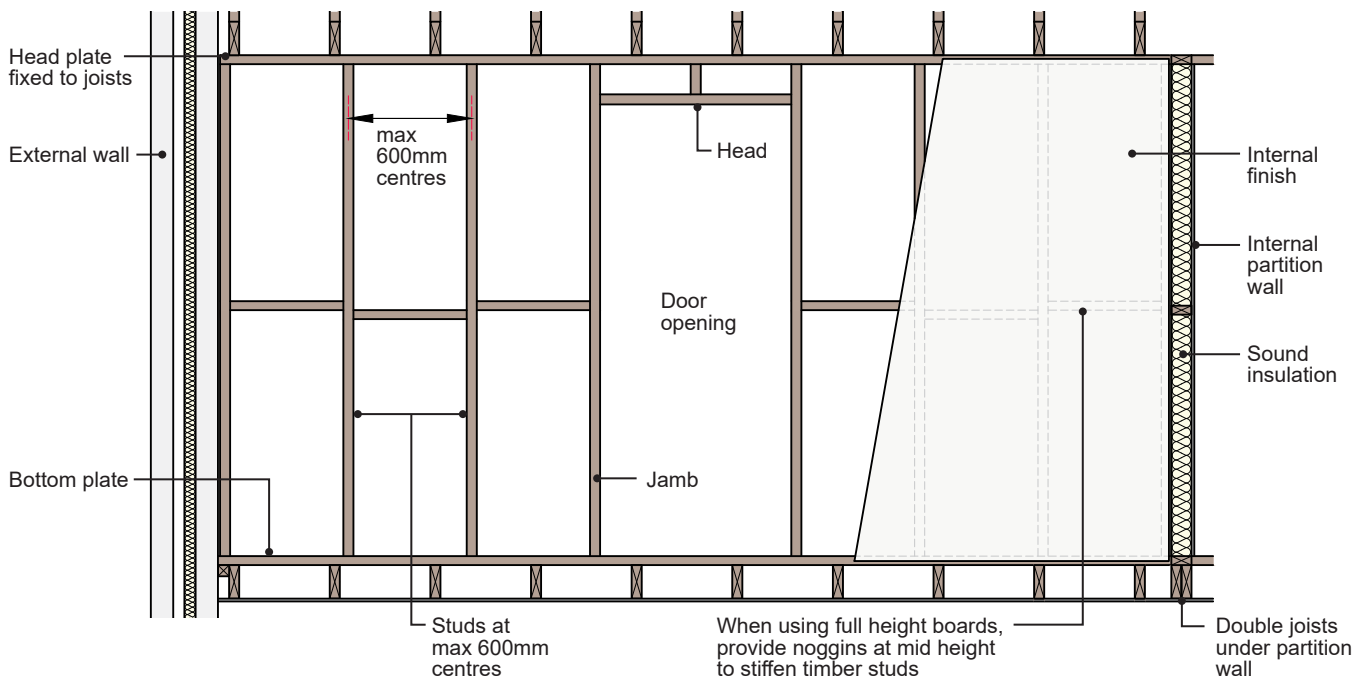
The following partition constructions are satisfactory:

- Loading bearing timber stud partitions using studs, sills and head plates nominally 75mm x 38mm.
- Non load bearing timber stud partitions using studs, sills and plates nominally 63mm x 38mm.<sup>1</sup>
- Maximum 450mm spacing for 9.5mm boards.
- Maximum 600mm spacing for 12.5mm-20mm boards.

<sup>1</sup> Stud partitions should be no less than 38mm wide and no less than 63mm thick (up to a maximum partition height of 2.4m), and 89mm thick up to a maximum partition height of 3m. However, in order to accommodate tolerances for plasterboard fixing, a minimum width of 44mm is recommended.

Partitions should be robust and form a smooth, stable, plane surface to receive decoration:

- Supporting members should be accurately spaced, aligned and levelled.
- The tolerance of horizontal straightness of a partition should be +/-10mm over a 5m length.
- The deviation in vertical alignment of a partition in any storey height should be +/-10mm.
- Timbers supporting plasterboard should be regularised and have a moisture content not greater than 20% at the time of erection (lower moisture contents can reduce incidents of nail popping and other effects of shrinkage).

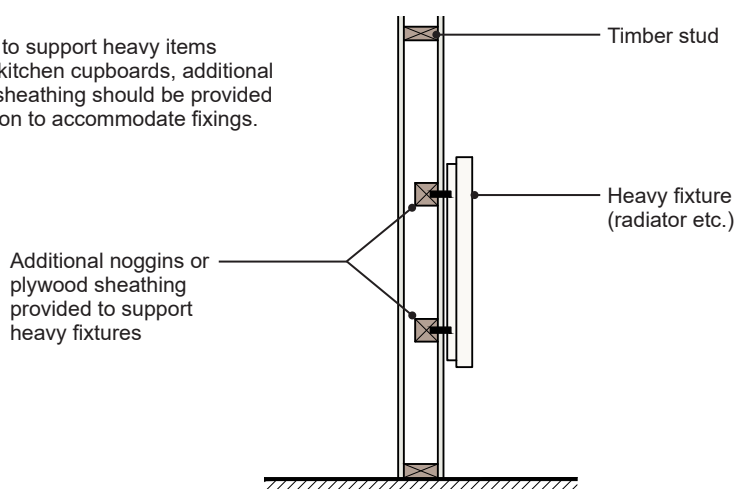


## The use of oak in the wall construction

Green oak, air dried (seasoned)/kin dried oak is not acceptable in the external wall construction, frame, window/door construction, internal wall or roof constructions, regardless of whether it forms part of the weather proof envelope or not. Projects incorporating such oak will not be acceptable for Warranty cover except where described in 'Appendix C - Materials, Products, and Building Systems' of this Technical Manual.

## Support of heavy fixtures

Where partitions are to support heavy items such as radiators or kitchen cupboards, additional noggins or plywood sheathing should be provided within the stud partition to accommodate fixings.





### 7.2.5 Lintels

Lintels shall safely support the applied loads, be of the correct type and size, and be suitable for the location.

A lintel and cripple studs are to be provided to any opening other than where the stud spacing is not affected. Traditionally, multiple studs will be used to support multiple joists.

Where internal walls are made-up of panels, structural continuity is to be maintained, for example through the use of a continuous top binder.

Framing joints need to be secured with a minimum of two nails per joint.

Where lintels are specified, items to be taken into account include:

- Wall thicknesses.
- Bearing capacity of the wall construction supporting the lintel.
- Loads and spans are in accordance with the manufacturer's recommendations.

### 7.2.6 Detailing of non load bearing walls

Internal non-load bearing walls shall be appropriately detailed to take account of any deflection in floors or roofs.

Site specific designed deflection allowances should be clearly defined by those designing the floor structure. The building designer should clearly indicate walls that are suitable for structural loading and walls that are not.

This should be factored into the design of any internal non-load bearing partitions, and head restraint details must correspond with identified and expected deflection limits. A corresponding deflection head design should be provided prior to commencement of any construction of internal non-load bearing walls.

### 7.2.7 Horizontal DPCs

Horizontal DPCs shall be suitable for their intended purpose and be provided to prevent moisture rising or entering the home.

Where partitions are placed onto concrete floors a DPC should be provided directly below regardless of if there is a DPM beneath the slab.

### 7.2.8 Plasterboard specification

The internal wall lining shall provide an adequate surface to receive the intended finish required by the design. Supporting evidence will be required, where the wall lining is intended to perform additional functions, such as:

- Racking resistance,
- Fire resistance, or
- Acoustic performance.

Plasterboard should be to BS EN 520 or BS EN 15283 and be 9.5mm thick for stud spacing up to 450mm or be 12.5mm or thicker for stud spacing up to 600mm. In high humidity environments (such as bathrooms), moisture resistant plasterboards should be specified.

#### Plasterboard joints and fixings

Supports for plasterboard should be designed so that the following span limits are not exceeded.

| Board thickness | Timber support centres | Intermediate noggins required? |
|-----------------|------------------------|--------------------------------|
| 9.5mm           | 400mm                  | No                             |
|                 | 450mm                  | Yes                            |
| 12.5mm          | 400mm                  | No                             |
|                 | 450mm                  | No                             |
|                 | 600mm                  | Yes                            |
| 15mm            | 600mm                  | No                             |

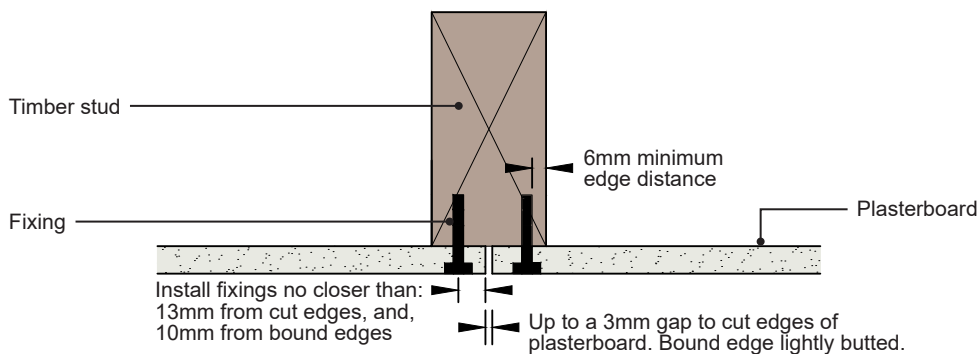
When fixing plaster boarding:

- Fix with decorative side out to receive joint treatment or a skim plaster finish.
- Lightly butt boards together and never force boards into position.
- Install fixings no closer than 13mm from cut edges and 10mm from bound edges.
- Position cut edges to internal angles whenever possible, removing paper burrs with fine sandpaper.
- Stagger horizontal and vertical board joints between layers by a minimum of 600mm.
- Locate boards to the centre line of framing where this supports board edges or ends. Fix to timber studs using dry-wall screws.
- When dry lining, plasterboard can be fixed to walls using adhesive dabs or by screwing to timber battens.

Note: Where adhesive dabs are used, the plasterboard manufacturer's recommendations must be followed.

Alternatively, a proprietary wall system can be used, providing it has a full third party product conformity certificate. Gaps between boards should not exceed 3mm and consideration should be given to sealing all gaps to improve building air tightness.

## Fixing of plasterboard to studs at joint positions



### 7.2.9 Plastering specification

Plastering shall provide an adequate surface to receive the intended finish required by the design.

The design, preparation and application of Internal plastering should be in accordance with BS EN 3914-2.

This guidance covers all plastered finishes to walls and ceilings. The workmanship of plastered finishes should be applied to a certain standard to receive a suitable decorative finish. It should be durable enough to prevent surface cracking and, if applicable as part of the whole element, meet the required levels of fire and sound insulation in accordance with current Building Regulations.

## Substrate and background

Plasterwork should be applied to suitable substrates. The substrate may also require additional sealing or bonding agents, in accordance with the requirements set out in BS 8481.

Where the background has a mix of varying materials, e.g. blockwork and brickwork, expanded metal should be provided to prevent differential movement in the plaster finish.

## Plaster mixes

Plaster mix ratios should be in accordance with manufacturer's recommendations and be appropriate for the intended use.

## Minimum plaster thickness

The thickness of plaster will vary depending on the evenness of the substrate. The finished element must meet the tolerances identified, and be of a suitable quality so that a decorative finish can be applied. Please refer to the 'Tolerances' section for further guidance.

## Plastering of plasterboard walls

Plasterboard walls should be skimmed to provide a suitable and durable finish. A minimum of one coat is required.

### 7.2.10 Sound insulation

Suitable materials with adequate thickness and densities shall be specified to provide the required resistance to the transmission of sound.

Internal separating walls should, where necessary, meet the requirements of the relevant Building Regulations in relation to the resistance of sound and sound testing requirements.

**7.2.11 Thermal insulation of internal walls between heated and unheated areas**

Internal separating walls shall be adequately insulated to prevent undue heat loss from heated areas of the building to unheated areas.

Internal walls separating heating and unheated areas of the dwelling shall have adequate thermal insulation to satisfy the thermal requirements of the Building Regulations. Designers should provide adequate information to demonstrate this.

## Introduction

This section provides guidance on meeting the performance requirements for internal metal stud walls.

### 7.3.1 Compliance

The design and construction of internal metal stud walls shall meet the performance requirements of this section.

### 7.3.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Floor plans indicating the positions of internal walls - load-bearing and non-load-bearing.
2. Specifications relating to the proposed construction of internal walls and formation of openings including lintels.
3. Site specific supporting calculations confirming design loading where required.
4. Details of proposed fire stopping and cavity barriers.
5. Details relating to service penetrations.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 7.3.3 Method of supporting partitions

Metal stud partitions shall be adequately supported and safely transfer loads to the foundations.

Walls and partitions are to be supported by the structural floor only if the material is specifically manufactured for that purpose; it is not to be supported by a floating floor that incorporates a compressible layer.

Extra noggins or joists should be specified where stud partitions or proprietary plasterboard partitions are supported by a timber floor, unless it can be shown that the deck can transfer the load without undue movement.

Allowance for the probable deflection of floors at the head of partitions is required to prevent the partition becoming load-bearing.

Head and sole plates should consist of single length members fixed to the building structure at no less than 600mm centres.

Partitions should be located on double joists when parallel to floor joist span and nailed to 50mm x 50mm noggins fixed between ceiling joists at 600mm centres when parallel to ceiling joist span. For short lengths of partitions (1.2m maximum), blocking between joists at 600mm centres may be used. Intersecting head and sole plates should be fixed in accordance with the manufacturer's recommendations.

Proprietary partitions of plasterboard, strawboard or other material must be detailed and constructed in accordance with the manufacturer's recommendations.

### 7.3.4 Metal stud specification

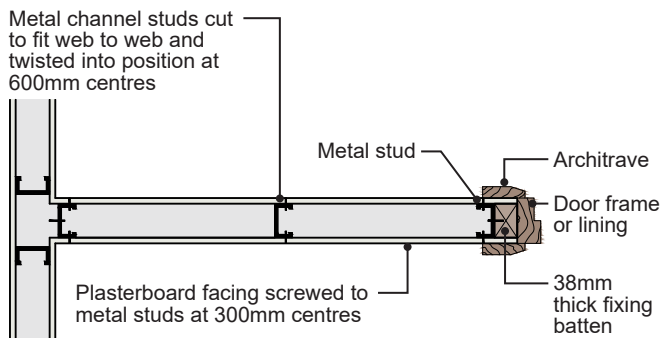
The construction of internal metal studs shall ensure adequate durability and desired service life is achieved.

There are a number of proprietary systems on the market. This traditionally consists of U-shaped channels that act as ceiling (head), base plates (tracks) and the vertical studs.

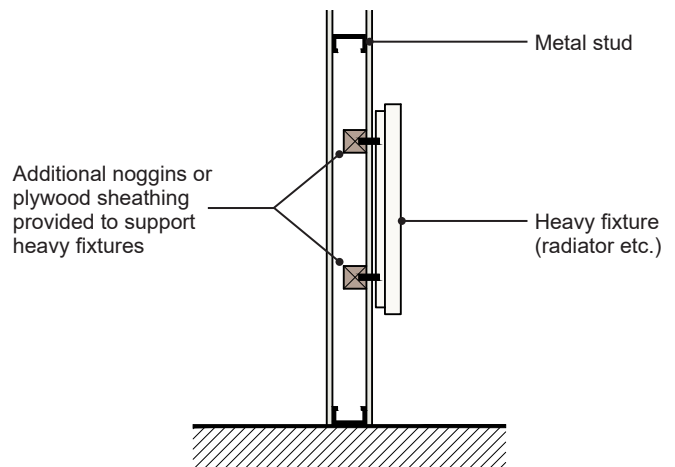
Installation should always be carried out in accordance with the manufacturer's instructions.

Plasterboard coverings are screw-fixed to the metal studs, with the perimeter studs/tracks generally being mechanically fixed to the surrounding walls, ceilings and floors.

It may be necessary to provide earth-bonding to the metal stud system.

**Metal stud partition (plan)****Support of heavy fixtures**

Where additional loads will be applied to the walls e.g. radiators or kitchen cabinets, these may require additional strengthening support as per the manufacturer's guidance.

**7.3.5 Lintels**

Lintels shall safely support the applied loads, be of the correct type and size, and be suitable for the location.

Openings in LGSF panels should have lintels which are supported off of studs where one or more studs is cut or displaced to form an opening. Additional studs may be required to provide support to the lintel or to provide additional fixing points for wall ties, cladding or wall linings.

Lintels are not required where an opening falls between studs.

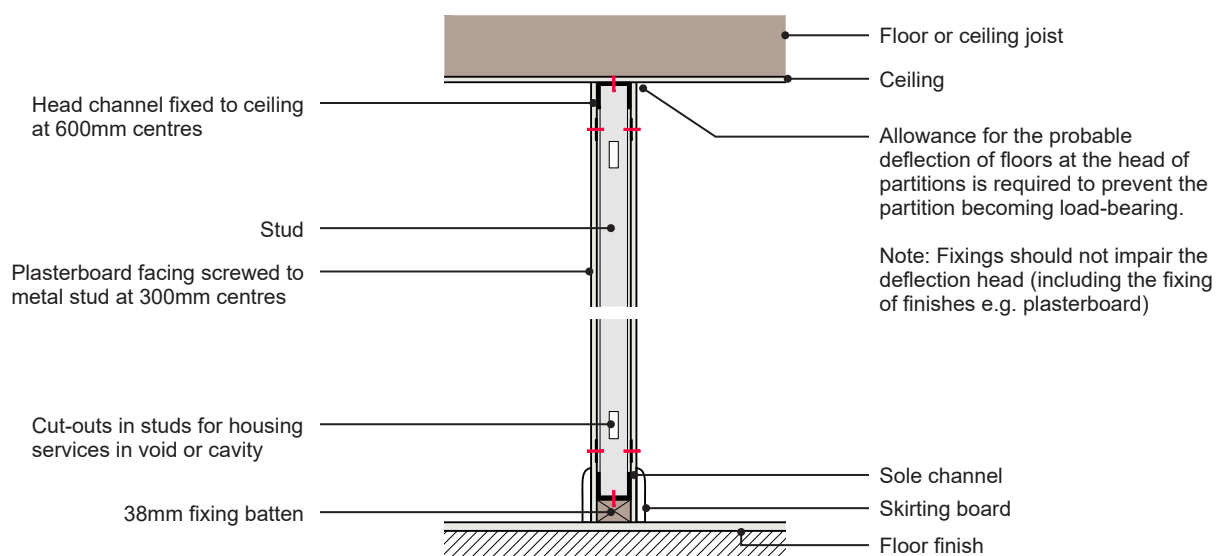
**7.3.6 Deflection heads for non-load bearing walls**

Where required, non-load bearing walls shall have site specific designed deflection head detailing. Any designs should account for:

- Type of floor structure
- Expected loads/deflection limits
- Type of wall
- Type of connection

Site specific designed deflection allowances should be clearly defined by those designing the floor structure. The building designer should clearly indicate walls that are suitable for structural loading and walls that are not.

This should be factored into the design of any internal non-load bearing partitions, and head restraint details must correspond with identified and expected deflection limits. A corresponding deflection head design should be provided prior to commencement of any construction of internal non-load bearing walls.



## 7.3.7 Horizontal DPCs

Horizontal DPCs shall be suitable for their intended purpose and be provided to prevent moisture rising or entering the home.

Where partitions are placed onto concrete floors a DPC should be provided directly below regardless of if there is a DPM beneath the slab.

## 7.3.8 Plasterboard specification

The internal wall lining shall provide an adequate surface to receive the intended finish required by the design. Supporting evidence will be required, where the wall lining is intended to perform additional functions, such as:

- Racking resistance,
- Fire resistance, or
- Acoustic performance.

Plasterboard should be to BS EN 520 or BS EN 15283 and be 9.5mm thick for stud spacing up to 450mm or be 12.5mm or thicker for stud spacing up to 600mm. In high humidity environments (such as bathrooms), moisture resistant plasterboards should be specified.

### Plasterboard joints and fixings

Supports for plasterboard should be designed so that the following span limits are not exceeded.

| Board thickness | Timber support centres | Intermediate noggins required? |
|-----------------|------------------------|--------------------------------|
| 9.5mm           | 400mm                  | No                             |
|                 | 450mm                  | Yes                            |
| 12.5mm          | 400mm                  | No                             |
|                 | 450mm                  | No                             |
|                 | 600mm                  | Yes                            |
| 15mm            | 600mm                  | No                             |

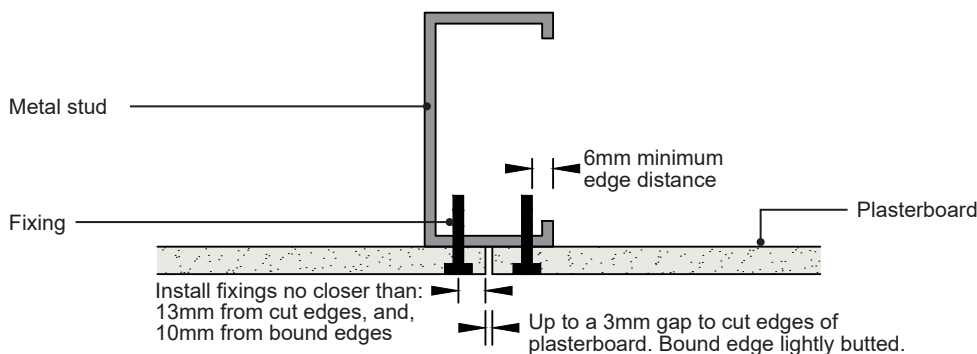
When fixing plaster boarding:

- Fix with decorative side out to receive joint treatment or a skim plaster finish.
- Lightly butt boards together and never force boards into position.
- Install fixings no closer than 13mm from cut edges and 10mm from bound edges.
- Position cut edges to internal angles whenever possible, removing paper burrs with fine sandpaper.
- Stagger horizontal and vertical board joints between layers by a minimum of 600mm.
- Locate boards to the centre line of framing where this supports board edges or ends.
- Fix metal studs using dry-wall screws.
- When dry lining, plasterboard can be fixed to walls using adhesive dabs or by screwing to metal battens.

Note: Where adhesive dabs are used, the plasterboard manufacturer's recommendations must be followed.

Alternatively, a proprietary wall system can be used, providing it has a full third party product conformity certificate. Gaps between boards should not exceed 3mm and consideration should be given to sealing all gaps to improve building air tightness.

### Fixing of plasterboard to studs at joint positions



### 7.3.9 Plastering specification

Plastering shall provide an adequate surface to receive the intended finish required by the design.

The design, preparation and application of Internal plastering should be in accordance with BS EN 3914-2.

This guidance covers all plastered finishes to walls and ceilings. The workmanship of plastered finishes should be applied to a certain standard to receive a suitable decorative finish. It should be durable enough to prevent surface cracking and, if applicable as part of the whole element, meet the required levels of fire and sound insulation in accordance with current Building Regulations.

#### Substrate and background

Plasterwork should be applied to suitable substrates. The substrate may also require additional sealing or bonding agents, in accordance with the requirements set out in BS 8481.

Where the background has a mix of varying materials, e.g. blockwork and brickwork, expanded metal should be provided to prevent differential movement in the plaster finish.

#### Plaster mixes

Plaster mix ratios should be in accordance with manufacturer's recommendations and be appropriate for the intended use.

#### Minimum plaster thickness

The thickness of plaster will vary depending on the evenness of the substrate. The finished element must meet the tolerances identified, and be of a suitable quality so that a decorative finish can be applied. Please refer to the 'Tolerances' section for further guidance.

#### Plastering of plasterboard walls

Plasterboard walls should be skimmed to provide a suitable and durable finish. A minimum of one coat is required.

### 7.3.10 Sound insulation

Suitable materials with adequate thickness and densities shall be specified to provide the required resistance to the transmission of sound.

Internal separating walls should, where necessary, meet the requirements of the relevant Building Regulations in relation to the resistance of sound and sound testing requirements.

### 7.3.11 Thermal insulation of internal walls between heated and unheated areas

Internal separating walls shall be adequately insulated to prevent undue heat loss from heated areas of the building to unheated areas.

Internal walls separating heating and unheated areas of the dwelling shall have adequate thermal insulation to satisfy the thermal requirements of the Building Regulations. Designers should provide adequate information to demonstrate this.

## Introduction

This section provides guidance on meeting the performance requirements for Spandrel panels. Spandrel panels can be used as a continuation of the internal skin of masonry cavity blockwork. The guidance within this section relates to where spandrel panels are specified:

- on a party wall between two buildings, **or**
- on a compartment line within a building.

For guidance on gable spandrel panels, please refer to the 'External Walls' section.

### 7.4.1 Compliance

The design, specification and construction of the spandrel panel shall meet the performance requirements of this section.

### 7.4.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full set of detailed drawings, including:
  - a. Plan layouts indicating dimensions.
  - b. Elevations with dimensions shown.
  - c. Detailing around junctions such as with masonry walls, ceiling lines or at ridges
2. Engineers drawings, calculations and fixing schedules for each connection made on site.
3. Location and method of how vertical and lateral restraint is to be provided.
4. Details of proposed cavity barriers including location, materials and technical assessments (third party product conformity certificate).
5. Details of how the spandrel panel achieves the required fire resistance in accordance with the Building Regulations and any supporting test evidence.
6. Details of how the spandrel panels are to achieve the required acoustic requirements in accordance with the Building Regulations.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 7.4.3 Structural design

Party wall spandrel panels shall be appropriately designed by a suitable qualified person to accommodate loads identified within the design.

Where party wall spandrel panels have any additional structural functions, it shall be appropriately designed by a suitable qualified person.

The following should be taken into account:

- Design and loads.
- Timber durability and preservative treatment.
- Timber strength class and grading.
- Spandrel panel construction.

## Design and loads

Spandrel panels should be designed in accordance with BS EN 1995-1-1 with relevant loads should be taken into account as a part of the overall design.

### Timber strength class and grading

BS EN 338 should be used by the designer to determine the suitable strength class for structural timber components.

All structural timber should be:

- Machine graded to BS EN 14081 or, visually graded to BS 4978 for softwoods or BS 5756 for hardwoods.
- Dry graded.
- Marked in accordance with BS EN 14081.

All load-bearing solid timber studs, rails, binders and sole plates should be of a minimum dry graded C16.



### Timber durability and preservative treatment

Timber and joinery used in the construction shall either have adequate natural durability or be preservative treated against fungal decay and insect attack with the preservative treatment being in accordance with BS 8417.

BS 8417 provides information to establish the appropriate type of treatment according to the particular element and conditions of use. Tables 1 to 3 of BS 8417 must be referred too to identify 'Use classes', 'Service Factor code' and durability class of wood for the desired service life.

### Spandrel panel construction

Spandrel panels are generally a softwood structural frame with head and soleplates with vertical studs at 600 centres. The typical section sizes are 47mm x 72mm where joints are plated and 38mm x 89mm where joints are nailed. The designer should provide supporting calculations for the design of the spandrel panel upon request.

### Weather protection

Any impervious weather protection should be removed sufficiently to allow the panels to breathe.

## 7.4.4 Restraint requirements

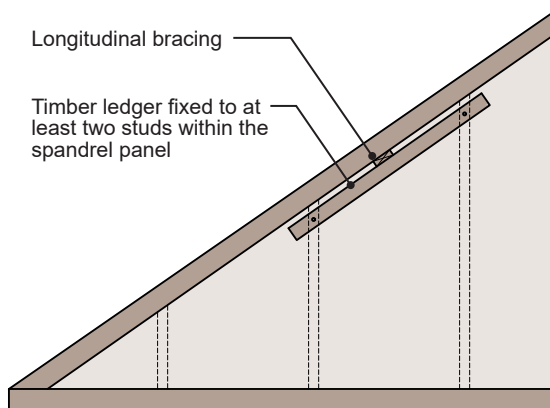
Spandrel panels shall have adequate vertical and lateral restraint in accordance with the design.

### Lateral restraint of the spandrel panel at roof level

The spandrel panel should be restrained at roof level this should be on both sides of the panel and should be in accordance with the design typically at 2m centres. Common methods of achieving this are:

- Fixing a timber ledger to the face of the spandrel panel to at least 2 vertical studs and fixing a timber (or lateral bracing) to the top of the timber ledger, which extends back over a minimum of three trusses at 2m centres, **or**
- Using restraint straps at 2m centres (this may commonly need to be increased to 1.8m centres to coincide with the vertical studs) fixed to vertical studs within the panel and extending back over three trusses, these straps should be supported by noggins in between the truss. The restraint should not impair the fire resistance of the panel.

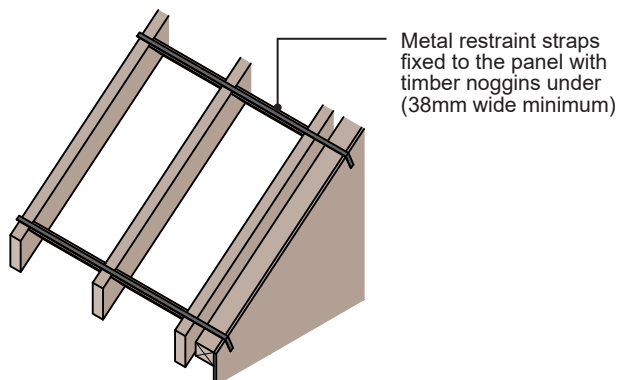
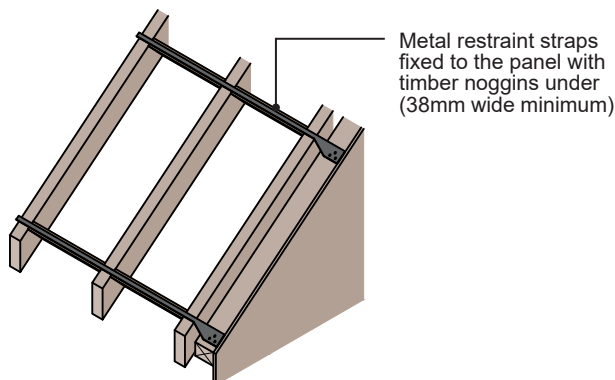
### Lateral restraint of the spandrel with the use a timber ledger and lateral bracing



Head restraint may be achieved through timber bracing. Requirements for the spandrel panel head restraint are as follows:

- Lateral bracing at a maximum 2m centres.
- Minimum bracing section 25mm x 100mm, fixed using 2mm x 3.35mm x 65mm galvanised wire nails to top edge of the timber ledger.
- Timber ledger minimum section 45mm x 72mm and minimum length 900mm.
- Timber ledger screw-fixed with minimum 100mm long screws to at least two vertical studs within the panel.
- Lateral bracing should be fixed to a minimum of three trusses (note: 3.1mm machine nails may be used in lieu of 3.35mm standard wire nails).

### Lateral restraint of the spandrel with the use a restraint strap



Head restraint may be achieved through metal restraint straps. Requirements for the spandrel panel head restraint are as follows:

- Lateral bracing to be fitted at apex and along rafters and ceiling joists maximum two-metre centres (no more than 1.25m centres for dwellings over three storeys or over two storeys in Scotland).

- Minimum 38mm x 63mm noggings fixed between at least three trusses.
- Metal restraint strap fixed to noggings with eight 3.75mm x 30mm square twisted nails evenly spaced.
- End of metal restraint strap to be screw-fixed to studwork within spandrel with minimum 50mm-long screws.

## Restraint requirements for party wall spandrel panels at low level

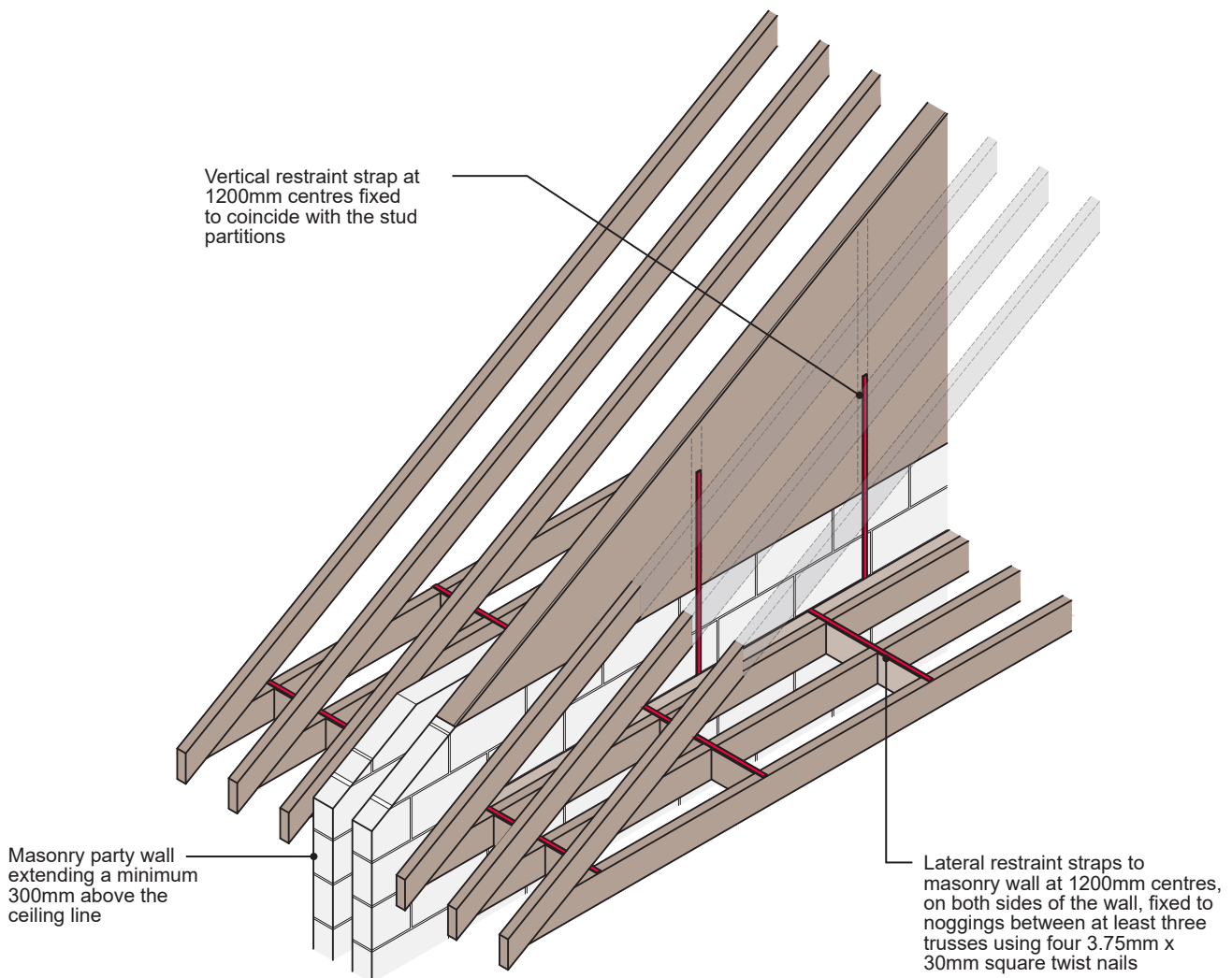
### Vertical restraint strap requirements

Party wall spandrel panels should be fixed to the head of the masonry wall, this can be achieved with the use of vertical restraint straps at centres specified by the designer. These are typically placed at 1200mm centres and face fixed to coincide with stud positions. The strap length should ensure a minimum of two fixings into the panel framework and three fixings into the blockwork, into a minimum of 2 blocks.

### Lateral restraint of the masonry wall

In addition, lateral restraint straps are required to the masonry wall at 1200mm centres on both sides of the wall. The lateral restraint straps should be fixed to noggings between at least 3 trusses using four 3.75mm x 30mm square twist nails.

The blockwork should provide continuous support for the panel.



### 7.4.5 Fire resistance

Spandrel panels on a party or compartment wall shall have adequate fire resistance in accordance with the relevant Building Regulations. Supporting test evidence to an appropriate standard shall be made available upon request.

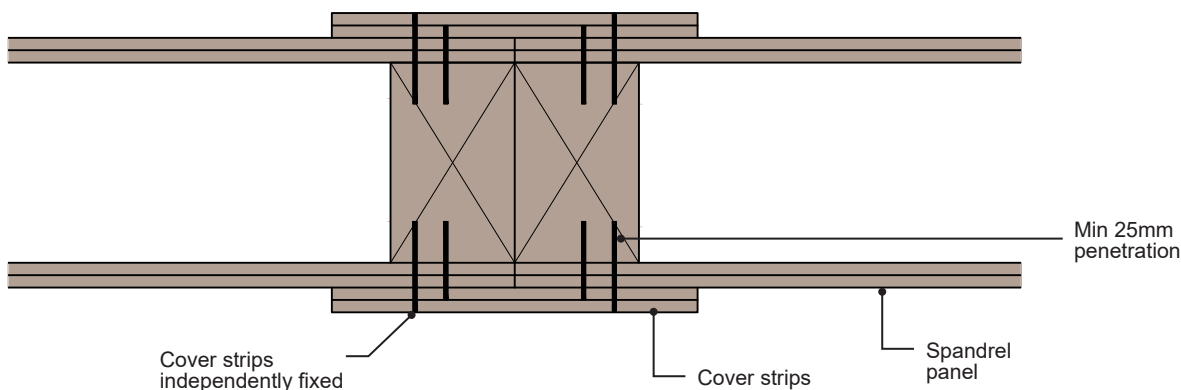
Fire resistance should be provided on a site-by-site basis; however generally for party walls a minimum of 60 minutes fire resistance from both sides is required. Plasterboard should be fixed at a minimum of 300 centres with plasterboard screws, the screws should penetrate a minimum of 25mm into the timber studs, and joints of the plasterboard should be over timber studs or noggings and staggered.

Fire stopping should be provided above the panel between the roofing membrane and in between the battens, the fire stopping should continue into the boxed soffits. Where the spandrel panel is sat on a masonry wall fire stopping is required between the panel and the wall.

In the case of a fire the party wall the spandrel panels should be designed to remain in place should one side of the roof structure be burnt away, as a result party wall spandrel panels should be restrained from both sides.

Party wall spandrel panels for ease of handling may consist of a number of panels, it is important that these panels are suitably jointed as not to impair the required fire resistance of the panel.

### Spandrel panel connections



- Joints should be backed by timber.
- Where panels are butt jointed, a cover strip should be fitted. The correct lapping must be to the manufacturer's requirements to achieve adequate fire resistance. Generally, the cover strip should be a minimum of 150mm wide.
- The cover strips should provide the same fire resistance as the rest of the wall. Each cover strip should be independently fixed and the joints of the cover strip should be staggered.
- Fixings should penetrate the timber by a minimum of 25mm.

### 7.4.6 Acoustic requirements

Spandrel panels shall meet the relevant Building Regulations in relation to acoustic requirements.

In a cold roof where masonry party walls are used in conjunction with a single piece panel, the masonry walls should extend a minimum of 300mm above the ceiling line and incorporate a suitable cavity closer to close the cavity.

## Introduction

This section provides guidance on meeting the performance requirements for fire resistance, cavity barrier and fire stopping requirements for all internal walls.

### 7.5.1 Compliance

The fire resistance of internal walls and, specification and installation of cavity barriers and fire stopping shall satisfy the performance requirements of this section.

In all circumstances, the fire resistance of internal walls and, specification and installation of cavity barriers and fire stopping should be in accordance with the relevant Building Regulations.

### 7.5.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of proposed cavity barriers including:
  - a. Specification of materials.
  - b. A third party product conformity certificate and/or test reports. This should include details of the period of fire resistance the cavity barrier achieves in relation to the site specific requirements and requirements of the relevant Building Regulations.
  - c. Plans and elevations showing positioning of cavity barriers.
2. Details of proposed fire stopping, including:
  - a. Specification of materials.
  - b. A third party product conformity certificate and/or test reports. This should include details of the period of fire resistance the cavity barrier achieves in relation to the site specific requirements and requirements of the relevant Building Regulations.
3. Plans showing period of fire resistance for all internal walls.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 7.5.3 Fire resistance

Where required, all internal walls shall have adequate fire resistance in accordance with the relevant Building Regulations. Supporting test evidence to an appropriate standard (e.g. BS EN 1365-1) shall be made available upon request. This may include, but not limited to, walls separating an integral garage from the dwelling and internal walls separating stairwells.

## Fire resistance

All internal, separating and compartment walls should have the fire resistance required by the Building Regulations which should be supported by relevant supporting test evidence from the manufacturer.

Compartment walls that are common to two or more buildings should run the full height of the building in a continuous vertical plane and should be continued through the roof space.

Where a compartment wall meets another external wall or floor junction fire resistance should be maintained.

Please refer to the 'Garages' section for further information for walls separating an integral garage from the dwelling.

## Openings for pipes in separating elements

Pipes which pass through fire separating elements (unless in a protected shaft) shall:

- Have an approved proprietary sealing system that has a UKAS accredited test to prove it will maintain the fire resistance of the wall. Note: It should only be installed as per the test requirements, **or**
- Where an approved proprietary sealing system is not used; the pipes penetrating the fire separating element should be restricted in diameter to a maximum size shown in the relevant Building Regulations and fire stopping used around the pipe, **or**
- A sleeving system with a maximum 160mm internal diameter is used as specified in the relevant Building Regulations.

## Electrical sockets in timber and metal stud party walls

Electrical sockets within the timber and metal stud party walls should be avoided where possible, where this is not possible the fire and sound resistance of the walls should be maintained.

Sockets should not be installed back-to-back in timber or metal stud party walls. Please see the 'Electrical Services' section for further guidance.

**Recessed electrical accessories**

Where timber or metal stud walls have fire resistant linings with recessed electrical accessories (such as sockets or switches for example), the wall construction shall maintain the same period of fire resistance as required by Regional Building Regulations.

Where passive fire protection products (e.g. intumescent putty pads) are specified, they must have suitable and relevant fire test evidence or a third party product conformity certificate to confirm of its suitability in the proposed scenario.

Where recessed electrical accessories are to be installed without the use of additional passive fire protection products, suitable and relevant fire test evidence shall be provided confirming no additional protection is required.

In all instances, where recessed electrical accessories are specified, installation should be in accordance with the Building Regulations.

**Fire doorset**

Where an internal wall is required to fulfil a fire resisting function, any fire doorset installed in it must maintain the period of fire resistance of the internal wall and the following must be satisfied:

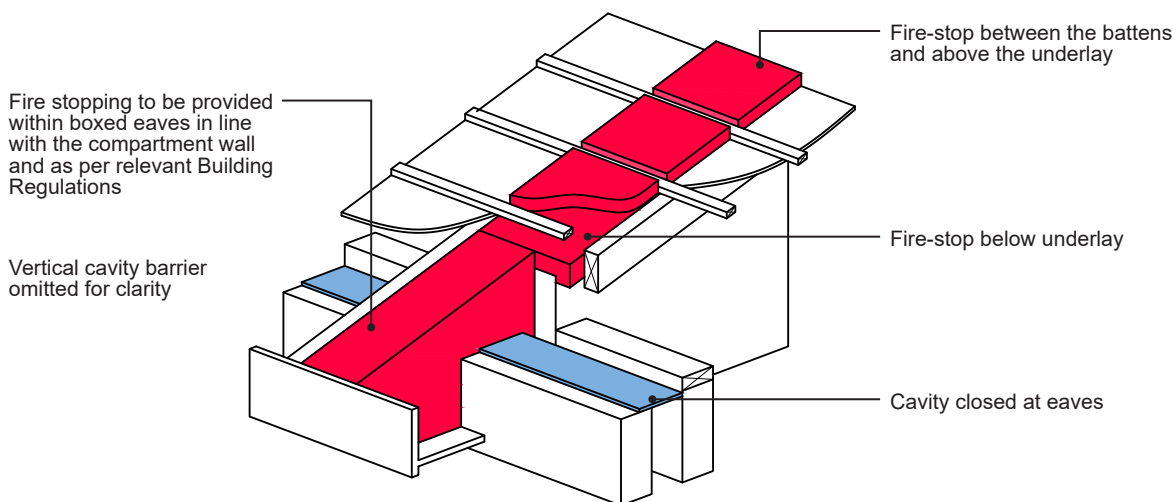
- The fire door and frame must be installed as a combined tested fire doorset (as defined in the Building Regulations) and not made from either different untested components or components from different products which were not tested together.
- Proof of fire test performance to be available to demonstrate meeting the requirements of the relevant Building Regulations.
- Suitable approved linear gap sealing systems must be utilised to protect the frame and supporting construction gap. These should be applied subject to the conditions contained in the relevant fire test certification.
- Whilst some gaps between the fire door frame and opening may be present, they should be kept to a minimum and be no greater than the gaps stipulated in the fire test certification. Expanding fire foam which has relevant testing and certification may be used to seal gaps up to 10mm.
- The fire doorset must be installed as per manufacturer's instructions and the test certificate criteria.

Fire doorsets between a dwelling and attached/integral garage must be half-hour fire resisting, be fitted with a self-closer and also meet the above requirements.

Note: For guidance on gaps under non-fire internal doors, please refer to the 'Tolerances' section.

**Fire stopping**

Fire stopping should be provided in accordance with the relevant Building Regulations. The designer should take account of how movement within the building may effect the performance of fire stopping. The manufacturer of the fire stopping should be contacted for further information.

**Fire stopping at roof level between party walls**

Fire stopping should be provided in accordance with the relevant Building Regulations.

- Party/separating walls should be finished 25mm below the top of the rafter line and a soft fire-resistant packing, such as mineral wool, should be used to allow for movement in roof timbers and prevent distortion of the roof tiles.
- The fire stopping should be continuous to eaves level and a provided within the boxed eaves in line with the compartment wall and as per relevant Building Regulations.

## 7.5.4 Cavity barriers

Cavity barriers shall be durable and must not adversely affect the structure of the internal wall or the performance weatherproof envelope.

Where required by statutory regulations, cavity barriers shall:

- Be of a suitable material.
- Specified and installed within the scope of the test certification and/or the third party product conformity certificate.
- Be installed in accordance with the manufacturer's recommendations.
- Be suitable for the location they are installed.

Cavity barriers should be specified and installed in line with relevant regional Building Regulations.

### Materials

Cavity barriers may be constructed from:

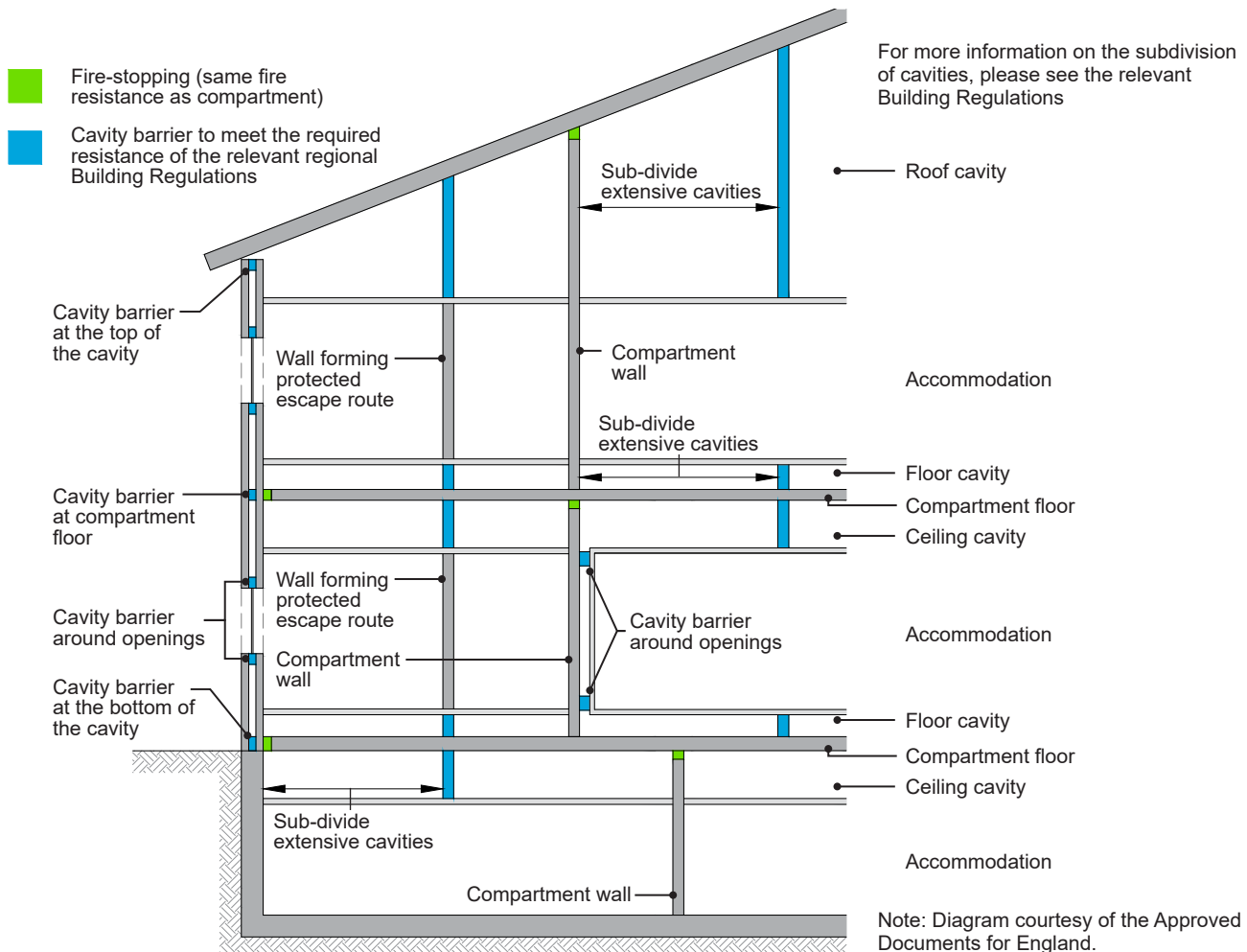
- Steel at least 0.5mm thick.
- Timber at least 38mm thick.
- A proprietary mineral wool product which has an appropriate third party product conformity certificate.
- Calcium silicate, cement-based or gypsum-based board at least 12mm thick.
- A proprietary product with an appropriate third party product conformity certificate.

### Cavity barrier installation

Cavity barriers should be installed:

- So they fully close the cavity by friction fitting for the designed cavity width.
- Backed by solid timber studs, rails or floor joist at least 38mm wide.
- In accordance with manufacturer or independent certifier's guidance.
- So they are mechanically fixed to rigid construction (for both vertical and horizontal positions).

### Locations for cavity barriers and fire stopping



**7.5.5 Additional requirements compartment floors, walls, and roof junctions to flats and apartments with a floor 4.5m or more above the ground**

Compartment floors, walls, and roof junctions to flats and apartments with a floor 4.5m or more above the ground shall have fire stopping and cavity barriers completed by a third party approved Contractor, or have a suitable quality assurance process provided to evidence the installation of the fire stopping and cavity barriers. This is applicable to all floor levels of a building that has a floor 4.5m above the lowest external ground level.

It is not the intention to enhance the requirements of the Building Regulations, but more to ensure that the statutory requirements are applied correctly to the construction. It is therefore deemed that the requirements of the regional Building Regulations will also meet the requirements of this guidance.

**Design information**

Drawings showing the lines of compartmentation and the lines of fire-resisting construction should be provided to the Surveyor and the Builder. The drawings should also give the required level of fire resistance for each element. Drawings to show the position of cavity barriers should be provided, and the specification of cavity barriers included.

The design details must also show the correct level of fire resistance for the building, in accordance with Part B of the Building Regulations or Section 2 of the Scottish Building Standards, depending on region.

**Materials**

All materials used to form a fire barrier must have a relevant third party product conformity certificate or be CE marked in accordance with the Construction Products Regulations. The materials must be installed in accordance with the manufacturer's instructions and recommendations.

**Installation**

The fire stopping material or cavity barriers should be installed by a person who is deemed competent to install such products. A competent person is deemed to be a third party approved contractor specialising in fire stopping and passive fire protection.

Where intumescent paints are used to provide the required level of fire protection, certification confirming that the paint applied will achieve the correct level of fire protection is required.

# 8.

## External Windows and Doors

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### Contents

|            |                                                                               |     |
|------------|-------------------------------------------------------------------------------|-----|
| <b>8.1</b> | General Requirements                                                          | 224 |
| <b>8.2</b> | Additional Requirements for External uPVC Window and Door Frames              | 232 |
| <b>8.3</b> | Additional Requirements for External Timber Window and Door Frames            | 234 |
| <b>8.4</b> | Additional Requirements for External Aluminium & Steel Window and Door Frames | 237 |
| <b>8.5</b> | Additional Requirements for Vertically Stacked Coupled Window Assemblies      | 240 |
| <b>8.6</b> | Additional Requirements for External Bi-fold Doors                            | 243 |



## Introduction

This section provides guidance on meeting the performance requirements for all types of external windows and doors. The guidance within this section should be read in conjunction with the other sub-sections within this section and the 'External Walls' section.

### 8.1.1 Compliance

External windows and doors shall meet the performance requirements of this section.

### 8.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Evidence that the external windows and doors are suitable for the site exposure e.g. a manufacturers declaration of performance for the site.
2. Evidence of certification confirming weather-tightness rating as detailed within BS 6375.
3. Evidence of UKCA marking in accordance with UK Construction Production Regulation.
4. Details of external window and door fixing will be required.
5. Details of sealing around the frame will need to be confirmed.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 8.1.3 Weathertightness and operational loads

External windows and doors shall be designed and specified to have adequate weathertightness. External windows and doors shall resist the passage of moisture to the inside of the home.

## Weathertightness performance classification

External windows and doors (both factory made and bespoke) should have adequate: air permeability, watertightness and wind resistant in accordance with BS EN 14351-1. For low-rise housing, BS 6375-1 may be used to determine the weathertightness performance classifications for the site exposure conditions.

Wind load calculations should be calculated in accordance all relevant parts of BS EN 1991 to determine the exposure category.

External bay, oriel and dormer windows require particular care in detailing and fitting so that they are stable, weather tight and reasonably air tight. Roof lights should be proprietary components, fixed within prepared openings in accordance with the manufacturer's instructions and have effective weather sealing.

### 6 storeys and above

For developments that are 6 storeys and above, the test pressure should be at least 25% of the design wind load for weathertightness. For further information, advice should be sought from our Major Projects Team.

Additional requirements of CWCT Technical Note 95 also apply for developments that are 6 storeys and above.

## Operational loads

External windows and doors should have sufficient strength to withstand operational loads. Characteristics and classes of performance should be in line with the relevant class of window or doorset as defined in Annex A of BS 6375-2.

### 8.1.4 Control of condensation

External windows and doors shall be constructed and installed to ensure resistance to the effects of condensation forming on the surface of the frames, the glazing and at junctions with the surrounding building fabric.

To ensure that condensation does not occur and give rise to mould growth, external windows and doors must be:

- Thermally efficient to the level identified within the guidance of the relevant Building Regulations.
- Detailed and constructed to ensure continuity of insulation and avoidance of thermal bridges at lintels, sills and jambs.
- Detailed to be contributing to the requirements of airtightness, providing appropriate seals between frame sections, opening lights and at junctions with surrounding fabric e.g. housing window boards into frames to prevent the opportunity for air leakage.

## 8.1.5 Ventilation

Windows and roof lights shall be designed and constructed so that they offer, where necessary, sufficient natural ventilation.

Where windows and roof lights are designed to contribute to the ventilation of a room, they should comply with the relevant Building Regulations requirements. Please also refer to the 'Ventilation and Extraction' section of the Technical Manual.

## 8.1.6 Ironmongery

Ironmongery and hinges shall be suitable for the location and intended purpose.

Ironmongery and hinges should be suitable for the relative exposure of the building, please also refer to 'Appendix B' for guidance on coastal locations.

Ironmongery should allow window and doors to be operated readily and easily by the user.

## 8.1.7 Security

The design and specification of external doors and windows which provide access into a dwelling or into a building containing a dwelling, shall satisfy the requirements of the relevant Building Regulations to ensure the system is classified and tested to the appropriate burglar resistance class.

The following should be taken into account:

- The frames of secure external doorsets and windows should be mechanically fixed to the building structure in accordance with the manufacturer's tested specifications.
- Where an external doorset is installed in a lightweight framed wall, a resilient layer should be incorporated to reduce the risk of anyone breaking through the wall to access the locking systems. The resilient layer should be for the full height of the door and 600mm either side of the doorset, 9mm timber sheathing or expanded metal may be used.
- Any glazing which if broken in an attempt to gain access to the locking device on a door must be a minimum class of P1A in accordance with BS EN 356:2000.
- A means of caller identification should be provided at the main door to the dwelling to allow means of seeing callers. The same external doorsets should also have a securely fixed door chain or door limiter fitted.
- The external doors and windows should be manufactured to a design that has been shown by tests to meet the security requirements of PAS 24.

## Secondary access doors

Secondary access doors such as those listed below should also satisfy the above.

- Vehicular garage doors.
- Pedestrian garage doors for attached garages.
- Communal entrance doors.
- Side or rear secondary access doors.

## 8.1.8 Installation

External windows and doors shall be installed to:

- Be appropriately mechanically fixed to the building fabric,
- Resist the passage of moisture to the inside of the home, and
- Not impede on the structural stability of the external wall.

External windows and door frames should be installed so that:

- They are appropriately fixed back to the building fabric in accordance with the manufacturer's recommendations and our requirements within the following sections:
  - External Windows and Doors - Additional Requirements for External UPVC Window and Door Frames
  - External Windows and Doors - Additional Requirements for Timber Windows and Door Frames
  - External Windows and Doors - Additional Requirements for Aluminium and Steel Window and Door Frames
- They do not carry loads unless designed to do so.
- They are plumb and square and they satisfy the 'Tolerances' section.
- Draught seals are fitted to maintain airtightness.
- The masonry on the external side of vertical DPC should not be in contact with internal finishes.
- The window head is set back behind the edge of the cavity tray.
- The frame to wall junction is weather tight and reasonably air tight.

- Where checked rebated reveals are provided, the frame should be set back behind the outer leaf and should overlap it. In other areas of exposure, the frame should be set back at least 30mm and overlap the DPC.
- Distortions of doors should be minimized by not locating radiators or other heaters close to doors.
- The reveal should be protected throughout its width by a continuous DPC. The width of the DPC should be sufficient to overlap/be fixed to the frame and fully protect the reveal. Alternatively, an insulated finned cavity closer with a third party product conformity certificate may be used.
- Proprietary materials with a third party product conformity certificate should be used to close cavities at window and door openings. They should also be installed in accordance with the manufacturer's recommendations.

Workmanship should follow the recommendations of BS 8213-4.

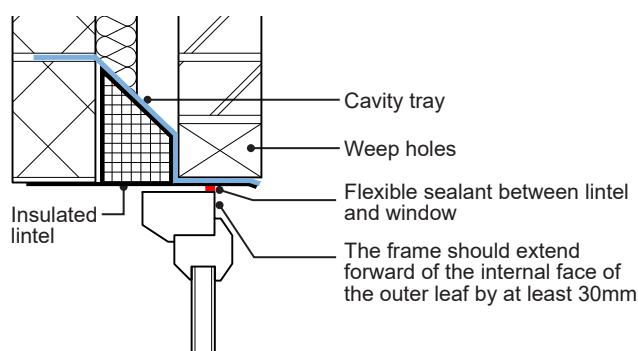
For further guidance on forming weather resistant openings, please refer to the following sections:

- External Walls – External Masonry Walls
- External Walls – Timber Frame
- External Walls – Light Gauge Steel Frame

### Typical details

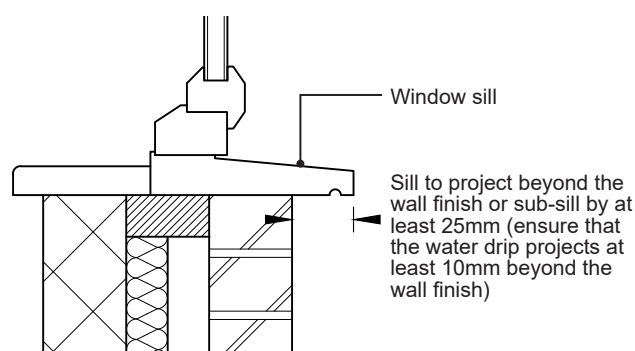
These illustrations show accepted practice for forming weather resistant openings and may not indicate the full extent of insulation requirements to meet relevant Building Regulations.

#### Typical vertical section through an external window head



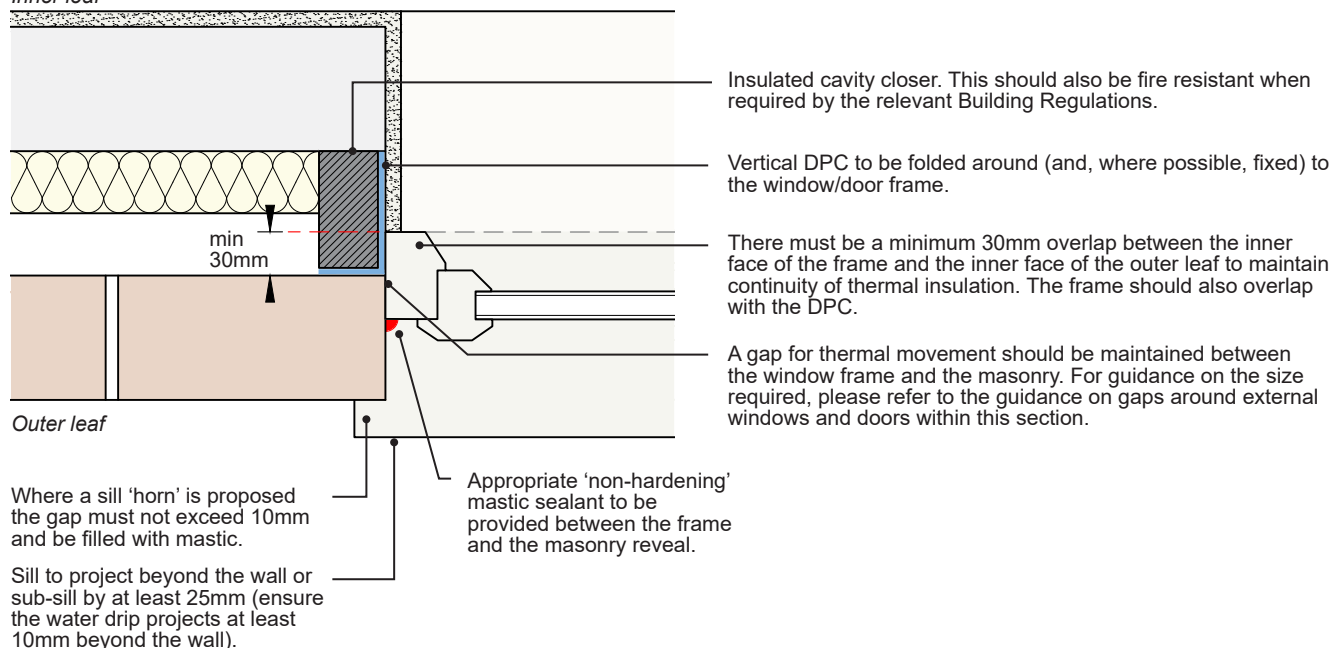
Lintel must comply with relevant thermal requirements.

#### Typical vertical section through an external window sill

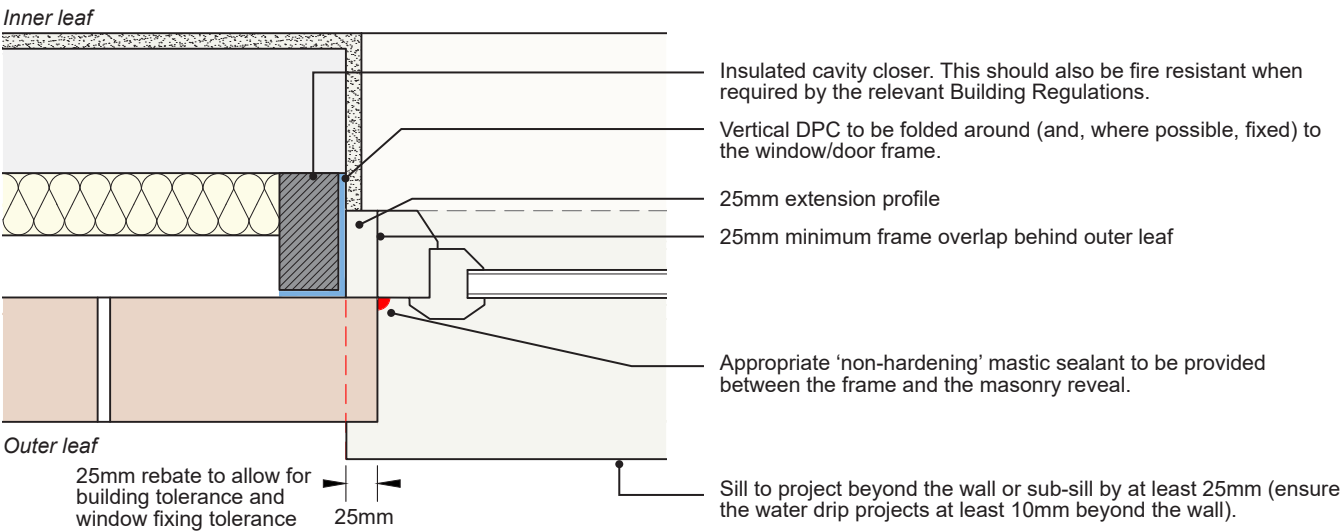


#### Typical external window reveal detail (normal exposure)

Inner leaf



## Checked rebate window frame detail



When installing window/door frames in a checked rebate, allow for the frame to be deeper:

- To accommodate the 25mm rebate, **and**
- To allow for opening lights to open clear of the masonry/render.

For more information on checked rebates, please refer to the 'External Walls' section.

### 8.1.9 Gaps around external windows and doors

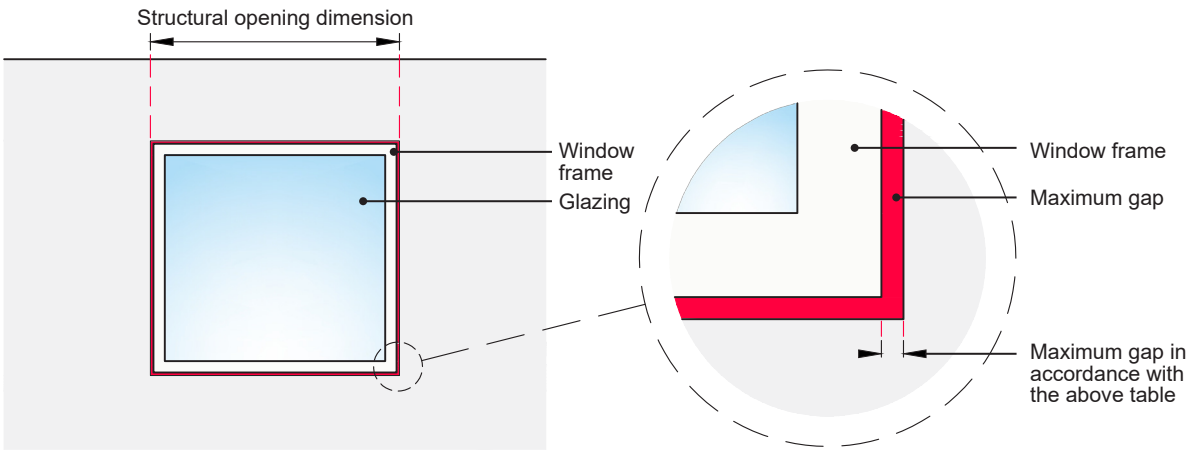
Gaps around external windows and doors shall be sized to allow for thermal movement and this will vary depending on the material of the frame.

#### Minimum gap sizes for Warranty

| Material         | Recommended gap per side for width of structural openings |              |              |
|------------------|-----------------------------------------------------------|--------------|--------------|
|                  | Less than 1.5m*                                           | 1.5m – 3.0m* | 3.0 – 4.5m** |
| Upvc – white     | 5mm                                                       | 5mm          | 7.5mm        |
| Upvc - non-white | 7.5mm                                                     | 7.5mm        | 11mm         |
| Timber           | 5mm                                                       | 5mm          | 5mm          |
| Steel            | 4mm                                                       | 5mm          | 6mm          |
| Aluminium        | 5mm                                                       | 5mm          | 7.5mm        |

Notes:  
 \* The maximum gap permitted for openings less than 3m should be 10mm.  
 \*\* For openings more than 3m, the maximum gap permitted should be 15mm.

For gaps greater than 5mm, a backing strip should be provided behind the sealant and the sealant should have a minimum depth of 6mm. External window and door frames should be installed in accordance with the manufacturer's instructions. For further guidance on wall openings, please refer to the 'External Walls' section.



## Sealants

Thermally insulating filling materials should be applied to the perimeter gap around the frames (such as PU foam, or impregnated tapes). Perimeter joints need to be continuously sealed on both the outside and the inside of the frames. Sealants should be appropriate to:

- The frame surface.
- The substrate material.
- Joint size and configuration.
- Anticipated joint movement.
- Anticipated weather exposure conditions.

Wet sealants (e.g. silicones) should be tested and classified in accordance with BS EN ISO 11600.

When using impregnated tapes, over-capping with a wet sealant is generally not required – manufacturer's instructions should be followed.

In situations where the sealant will rely on atmospheric moisture to begin curing then deep filling should be avoided.

When applying sealant:

- Apply against a firm backing, forcing it against the sides of the joint.
- It should not be applied to the backing as this restricts lateral movement of the joint.
- Any gaps greater than 6mm require a closed-cell oversized polyethylene (PE) foam backing rod to be included.
- A width to depth ratio of between 1:1 and 2:1 should be observed.
- When applying a fillet joint a minimum 6mm contact to non-porous, and 10mm to porous substrates should be achieved.
- Seal should be provided between any sill and frame.

For further guidance on the application of sealants around external windows and doors, please see BS 8213-4 Code of practice for the survey and installation of windows and external doorsets.

## Finishing trims

The use of proprietary surface fixed finishing trims e.g. D-moulds, should be undertaken only as part of a designed junction between external window and door framing and the surrounding opening.

For this purpose, surface finishing trims:

- Must be compatible with the materials used within the frame.
- Must be robust in their attachment.
- Must not be detrimental to the performance of the junction e.g. create thermal bridging.
- Must not impede the function or operation of the external window or any attached fittings e.g. obstructing trickle vents, framing drainage outlet.

The inclusion of finishing trims should not be considered as a means to:

- Achieve weather tightness, unless they are included within appropriate weather and water tightness testing conducted on the external window and door system.
- Extend frame dimensions where external windows are undersized for the opening. Only recognised sections that form part of the external window system can be used for this purpose e.g. proprietary or manufactured interlocking sections ('knockons'), or manufacturer led alterations using fixed sections (adhesively bonded planted sections).

### 8.1.10 Protection for falling

External windows and doors (including Juliet Balconies) shall provide adequate protection from falling where required by the relevant Building Regulations.

Where external window openings are formed less than 800mm from the finished floor level, permanent guarding should be provided to the opening in accordance with the design requirements specified in the relevant Building Regulations.

If external window openings are formed less than 800mm from the finished floor level, and there is no permanent guarding provided, and the glass is required to act as the barrier and provide containment to persons falling against it; the glass needs to be designed in accordance with the requirements of BS 6180. The designer shall determine the potential impact energy by establishing the perpendicular unhindered distance that could be travelled prior to impact.

In the absence of an assessment by a suitably qualified person, any glass which is required to provide containment must meet with BS EN 12600 Class 1(C)1.

For guidance on protection from falling and guarding for Juliet Balconies, please refer to the 'Roof Terraces and Balconies – Balconies' section.

### 8.1.11 Critical locations

Glazing in critical locations shall satisfy the relevant Building Regulations.

Glazing in external windows and doors in areas known as 'critical locations' needs to be given special consideration in order to prevent potential injury to people within or around the building.

These 'critical locations' are:

- In a door or in a side panel adjacent to a door where the glazing is within 300mm of the door and the glazing is situated between floor level and a height of 1500mm.
- In an internal or external wall or partition between floor level and a height of 800mm.

It is important that any glazing within these 'critical locations' should be either:

- Provided with permanent protection.
- In small panes.
- Robust.
- Break safely.

For further information on how the above can be achieved, please refer to the relevant Building Regulations.

Where safety glass is specified for use in critical locations, the glass should be marked with the following:

- Manufacturer's name.
- The standard number for the type of glass (e.g. BS EN 14449 laminated glass).
- The impact performance classification, e.g. 1, 2, 3 to BS EN 12600.

## 8.1.12 Insulated glass units

Insulated glass units (IGU) shall meet requirements of BS EN 1279 and be CE/UKCA marked.

Insulated glass units should have continuous dual seals; single seal units are not acceptable:

- Desiccant should be provided to spacer bars.
- Any glazing with an area greater than 1m<sup>2</sup> must have a drained and ventilated bottom bead with a minimum gap of 5mm between the edge seal of the insulated glass unit and the bottom channel of the frames glazing rebate.
- Glazing with an area less than 1m<sup>2</sup> may be solid bedded.
- UPVC frames and spacer bars should be stamped with BS 7412, 7413 and 7414.

Linseed oil glazing putty should not be used when the joinery is finished with vapour permeable paint or stain. Glazing putty should also not be used with organic solvent-based stains, the putty should be neatly finished to receive a protective paint coat.

Putty is not suitable for laminated glass and double-glazed units, the workmanship should be in accordance with BS 8000: 7. To ensure the compatibility of the whole glazing system is to a high level of workmanship and control, it is recommended that factory pre-glazed systems be installed in all external openings.

The window beads should suitably lap the external windows and doors to prevent premature degradation of the glazing unit. Glazing spacer bars must not project above the top of glazing beads and rebate where they can be affected by UV.

External glazing beads should be pinned at a maximum of 150mm centres (a maximum of 50mm from corners) or screwed at 200mm centres (maximum 50mm from corners).

The preferred method of installation for double-glazed units is either:

- Drained and ventilated frames, as recommended by the Glass and Glazing Federation (GGF), where possible this method should be adopted for external glazing.
- Solid bedding of units in 16mm-18mm deep frame rebates; 18mm rebates are recommended by the GGF to allow for tolerances. In all cases, sealants should not be sensitive to ultraviolet light. External glazing beads should be fixed at a maximum of 150mm centres, and the glazing bedded in non-setting putty. Louvre windows should not be used and double-glazing should be fixed and bedded as recommended by the GGF.

Fully bedded insulated glass units installations should only be accepted where glazing operations are carried out within a factory controlled environment with appropriate QA procedures as the extensive monitoring of sealant use on site is very difficult to execute.

All Safety glazing should have markings in accordance with BS 6262-4.

## 8.1.13 Glazing beads

Glazing shall be installed as per the manufacturer's guidance and any relevant standards.

Glazing beads should:

- Not be mitred but scribed to bead profiles at junctions.
- Have a wider bottom bead running the full width of the opening and projecting beyond the face of the frame to conceal the drainage provision. The bottom bead should have a 1:6 (11° angle) weathering slope on its top surface.
- Have an uppermost horizontal glazing bead that runs the full width of the opening to protect the top of the jamb beads on either side.
- Have side (jamb) beads that stop short of the bottom bead by 3mm – where the bottom bead has a 1:6 (11° angle) weathering slope on its top surface, the gap can be reduced at the glass face by cutting the ends of the side beads to a shallower pitch.
- Be securely fixed with pins or screws at a 200mm maximum spacing, starting at 50mm from corners to create compression of seal provided between the timber sections and the glass surfaces.

On site operations that incorporate site applied capping sealant on drained and vented glazing systems should be executed in strict accordance with the design and specification.

### 8.1.14 Nickel sulphide inclusions in glazing

Toughened glazing shall be heat soak tested in accordance with BS EN 14179-1.

In low-rise buildings which exceed three storeys in height, 100% of the toughened glazing used from the third storey upwards must be heat soak tested in accordance with BS EN 14179-1. The glass must be permanently marked in accordance with BS EN 14179-1 and substantiated evidence of heat soak testing must be disclosed for all effected panes.

Alternatively where toughened glazing does not exceed 50kg in weight and where there is safe and easy access to remove and replace the glazing without the need for access scaffolding or fall arrest equipment, a methodology statement of how this will be undertaken should be provided.

Please note: A storey is defined as the space between two consecutive floors or a floor and a roof. The number of storeys should be counted from the lowest external ground level.

### 8.1.15 Level access thresholds to the principle entrance

Where level access thresholds are required, detailing shall be in accordance with the relevant Building Regulations and demonstrate how the passage of moisture will be prevented from reaching the inside of the home, including:

- Threshold design.
- Ramps.
- Level access thresholds to timber frame structures.

Please see additional guidance in the 'Driveways and Paving' section.

#### Threshold design

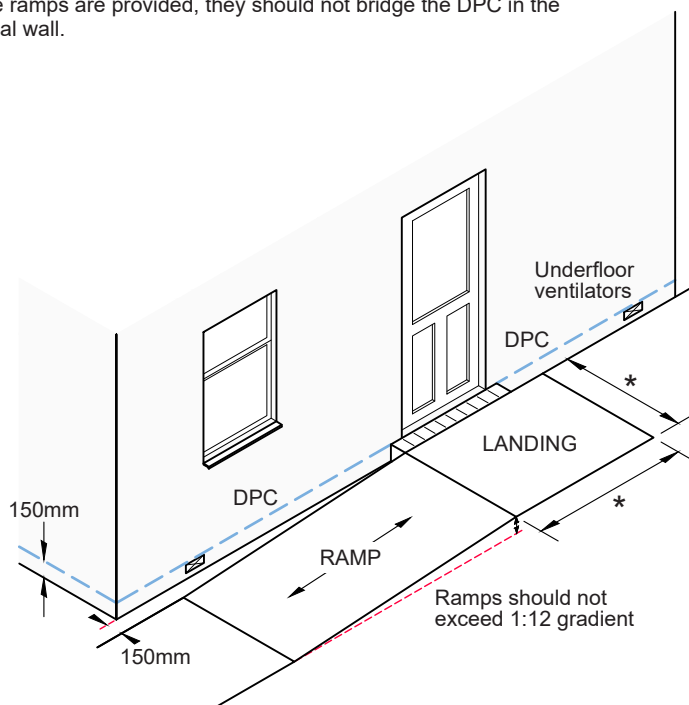
Thresholds and sills shall be at least 150mm above finished ground level. However, where a level (threshold) access is required, the general guidance in this section shall be followed ensuring a high level of supervision and workmanship together with the correct specification of materials and consideration to design, location, and exposure.

Wherever possible, locate the entrance door away from the prevailing weather and provide a storm porch. Where a drainage channel is provided, this must be connected to the storm drainage system to prevent flooding occurring and water ingress into the building.

It is recommended that a mat well be constructed within the entrance hall to accommodate the swing of the door without fouling the carpet and/or the proprietary door seal.

#### Ramps

Where ramps are provided, they should not bridge the DPC in the external wall.



\* See the Building Regulations for disabled ramp design and landing dimensions.

Ramps should not exceed 1:12 gradient. Where the outside ground levels slope towards the property, an effective gully system should be provided to prevent flooding, e.g. in front of garage doors.

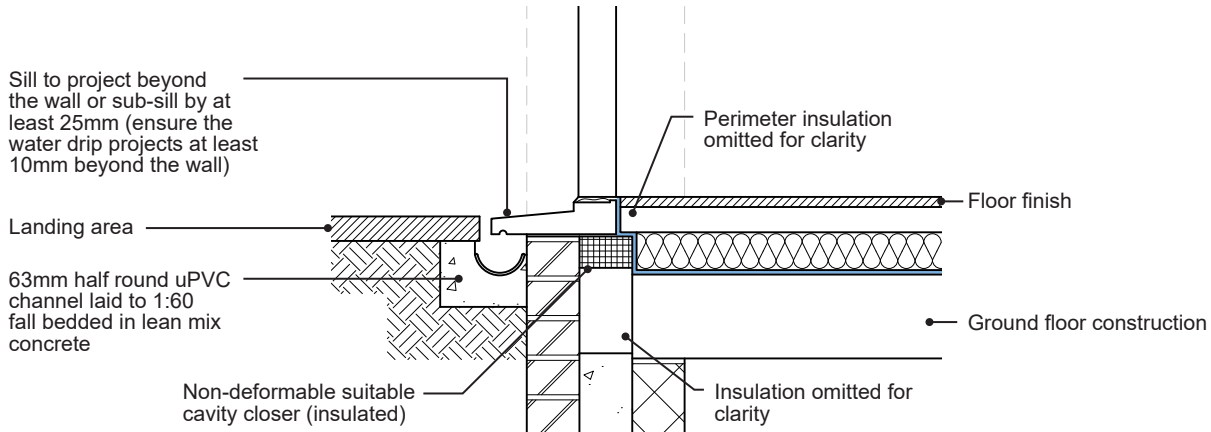


## Level thresholds timber frame structure

At the level threshold open perpend should be provided in close proximity to the timbers on each side of the door opening one brick course below the lowest timber. The open perpend must provide adequate ventilation of the external wall cavity, and drainage to disperse water that may penetrate the cladding.

## Typical level threshold

Please note, the drainage gully may be omitted where a canopy is provided.



### 8.1.16 Additional requirements for coastal locations

Where developments are within a coastal location, the requirements of 'Appendix B – Coastal Locations' should also be satisfied.

Further information on Warranty requirements within a coastal location can be found in 'Appendix B - Coastal Locations'.



## Introduction

This section provides guidance on meeting the performance requirements for external uPVC window and door frames and should be read in conjunction with the 'External Windows and Doors – General Requirements' and 'External Walls' sections.

### 8.2.1 Compliance

External windows and doors shall meet the performance requirements of this section.

### 8.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Evidence external uPVC window and door frames are of a suitable specification as detailed within this section.
2. Evidence of UKCA marking in accordance with UK Construction Production Regulation.
3. Details of External window and door fixings will be required.
4. Details of sealing around the frame will need to be confirmed.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 8.2.3 Specification

uPVC External windows and doors shall conform to relevant standards as listed in the guidance.

The design and construction of factory assembled uPVC external windows and doors should conform to the following relevant standards:

- BS 7412 - Specification for windows and doorsets made from unplasticized polyvinyl chloride (PVC-U) extruded hollow profiles
- BS EN 12608-1 - Unplasticized poly(vinyl chloride) (PVC-U) profiles for the fabrication of windows and doors. Classification, requirements, and test methods — Non-coated PVC-U profiles with light coloured surfaces
- BS EN 514 - Plastics. Poly(vinyl chloride) (PVC) based profiles. Determination of the strength of welded corners and T-joints

Non-factory assembled units and 'bespoke' units are also expected to meet the same standard.

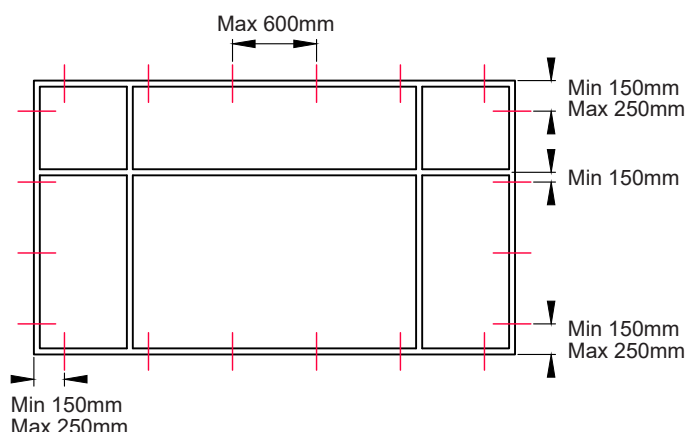
### 8.2.4 Fixings for external uPVC windows and doorsets

Frames shall be securely fixed to the surrounding structure within the structural opening in accordance with the manufacturer's instructions. If no instructions are provided, the following guidance may be used.

Frames should be fixed in accordance with the manufacturers recommendations or, if no instructions are given, with the following guidance:

#### Fixing locations for external uPVC windows and doorsets

All sides of the frame should be secured as follows:



- Corner fixings should be between 150mm and 250mm from the external corner.
- No fixings should be less than 150mm from the centre line of a mullion or transom.
- There should be a minimum of two fixings on each jamb and sill, with intermediate fixings at centres no greater than 600mm.
- If the head is fixed with polyurethane foam, then the fixings at the head may be as follows:
  - a. Frame width up to 1200mm - no fixings;
  - b. Frame width 1201mm to 2400mm - one central fixing;
  - c. Frame width 2401mm to 3600mm - two equally spaced fixings.

Note: These fixings do not apply to French doors, patio doors, or bi-fold doors. Manufacturers recommended fixing details should be followed.

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## Fixing type

Two methods of fixing are lug fixing, or through frame fixing. These can be used separately or as a combination.

Should be galvanised steel cramps or by non-corrodible screw fixings appropriate to the surrounding wall.

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## Fixing substrate penetration

Fixings should penetrate surrounding structure as per the following:

### Masonry

Fixings should penetrate the surrounding masonry structure by at least 40mm for external windows and 50mm for external doors.

### Timber frame

Fixings should penetrate into the surrounding timber frame by at least 25mm for all situations.

### Steelwork (maximum 2mm thick)

Fixings into a surrounding structure formed by steelwork which is a maximum of 2mm thick should be made with power driven hardened self-drilling screws or self-tapping screws (with pilot hole).

### Steelwork (greater than 2mm thick)

Fixings into a surrounding structure formed by steelwork which is greater than 2mm thick should be made either into pre-tapped holes with machine screws a minimum of 5mm diameter or with power driven hardened self-drilling screws.

Notes:

- Please refer to the lintel manufacturers' recommendations for making mechanical fixings to the underside of the lintel.
- Fixings should not be made into the insulated cavity closer.

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## Standards

### Design, specification, and manufacturing

- BS EN 514 Plastics. Polyvinyl chloride (PVC) based profiles. Determination of the strength of welded corners and T-joints.
- BS 7412 Specification for windows and doorsets made from unplasticized polyvinyl chloride (PVC-U) extruded hollow profiles.
- BS 6262 Glazing for buildings - Code of practice for safety related to human impact.
- BS 6375 Performance of windows and doors - Classification for weathertightness and guidance on selection and specification.
- Air permeability - BS EN 12207 - Classification & BS EN 1026 - Test method.
- Water resistance - BS EN 12208 - Classification & BS EN 1027 - Test method.
- Wind resistance - BS EN 12210 - Classification & BS EN 12211 - Test method.
- BS EN 1670 Building hardware. Corrosion resistance. Requirements and test methods.

### Installation

- BS 8213 Windows and doors - Code of practice for the survey and installation of windows and external doorset.
- BS 8000: 7 Workmanship on building sites. Code of Practice for glazing.

## Introduction

This section provides guidance on meeting the performance requirements for external timber window and door frames and should be read in conjunction with the 'External Windows and Doors – General Requirements' and 'External Walls' sections.

### 8.3.1 Compliance

External windows and doors shall meet the performance requirements of this section.

### 8.3.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Timber and other wood based materials need to comply with the relevant requirements of BS EN 942. Evidence of this needs to be provided to the Warranty surveyor.
2. Evidence that the external windows and doors are suitable for the site exposure e.g. a manufacturers declaration of performance for the site.
3. Evidence of certification confirming weather-tightness rating as detailed within BS 6375. External bespoke timber windows and doors that cannot provide a BS 6375 rating will need to be water tested as per CWCT Note 41.
4. Evidence of UKCA marking in accordance with UK Construction Production Regulation.
5. Details of external window and door fixing will be required.
6. Details of sealing around the frame will need to be confirmed.
7. External bespoke timber windows and doors must provide a detailed specification of the design, construction and durability of the proposed units. Bespoke timber windows will not be acceptable for use without prior approval from the Warranty surveyor.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 8.3.3 Specification

External timber windows and doors shall be of an adequate quality and be suitable for their intended purpose.

The design and construction of factory assembled External windows should satisfy BS 644.

Timber used for external joinery should be a species classified as suitable in BS EN 942 and preservative treated; if not, use a moderately durable species or better (sapwood excluded).

External joinery should be designed and constructed in accordance with the requirements of the following British Standards:

- BS 4787: 1 Internal and external wood door sets, door leaves and frames.
- BS 6375: 1 Performance of windows.
- BS 6262 Code of Practice for glazing for buildings.
- BS 644: 1 Wood windows.
- BS 8213: 1 Windows, doors and roof lights.

Workmanship should follow the recommendations of BS 1186: 2.

Non factory assembled units and 'bespoke' units are also expected to meet the same standard.

The moisture content of external timber windows and doors should not exceed 17% when installed.

## The use of Oak in external windows and doors

For the purpose of this section there are three types of oak considered:

- Green Oak - recently felled Oak with a moisture content typically between 60%-80%.
- Air Dried (seasoned) Oak - naturally stored Oak with a natural seasoning process moisture content up to 30%.
- Certified kiln dried oak - processed seasoned timber with a moisture content of 12% or less.

Green or air dried Oak is not acceptable for use when manufacturing external windows and doors.

Certified kiln dried Oak with a certified moisture content of 12%, is acceptable for the manufacturing of windows and doors, subject to the external joinery meeting the relevant British Standards for manufacturing/testing, as outlined in this section.

## Bespoke timber windows and doors

External bespoke timber windows and doors must have a detailed specification of the design, construction, and durability of the proposed units. Bespoke timber windows will not be acceptable for use without prior approval from the Warranty surveyor.

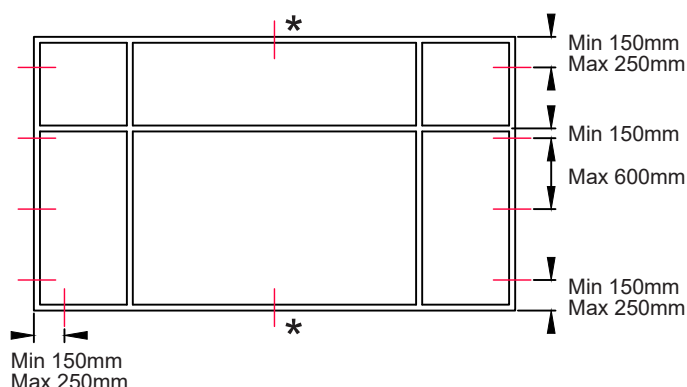
## 8.3.4 Fixings for external timber windows and doorsets

Frames shall be securely fixed to the surrounding structure within the structural opening in accordance with the manufacturer's instructions. If no instructions are provided, the following guidance may be used.

Frames should be fixed in accordance with the manufacturer's recommendations, or if no instructions are given, with the following guidance.

### Fixing locations for external timber windows and doorsets

All sides of the frame should be secured as follows:



- Corner jamb fixings should be between 150mm and 250mm from the external corner.
- Intermediate fixings should be at centres no greater than 600mm.
- There should be a minimum of two fixings on each jamb.
- On external windows and doorsets over 1800mm wide, central head and sub-sill fixings should be provided.

\*Additional fixing for windows and doorsets over 1800mm wide.

### Fixing type

Two methods of fixing are lug fixing, or through frame fixing. These can be used separately or as a combination.

Should be galvanised steel cramps or by non-corrodible screw fixings appropriate to the surrounding wall.

### Fixing substrate penetration

Fixings should penetrate surrounding structure as per the following:

#### Masonry

Fixings should penetrate the surrounding masonry structure by at least 40mm for external windows and 50mm for external doors.

#### Timber frame

Fixings should penetrate the surrounding timber framing by at least 25mm for all situations.

#### Steelwork (maximum 2mm thick)

Fixings into a surrounding structure formed by steelwork which is a maximum of 2mm thick should be made with power driven hardened self-drilling screws or self-tapping screws (with pilot hole).

#### Steelwork (greater than 2mm thick)

Fixings into a surrounding structure formed by steelwork which is greater than 2mm thick should be made either into pre-tapped holes with machine screws a minimum of 5mm diameter or with power driven hardened self-drilling screws.

Note: Fixings should not be made into the insulated cavity closer.

For further guidance on the installation of windows and doors, refer to BS 8213.

## 8.3.5 Decoration, treatment and protection of external timber windows and doors

External timber windows and doors shall be adequately decorated, treated and protected.

It is recommended that all external windows are pre-finished to ensure all parts of external timber windows and doors, including joints, are fully protected during the build process. Where this is not the case, the external windows and doors should be protected using appropriate weather resistant sheeting until paint finishes are applied.

Preservative-treated joinery cut or adjusted on-site should be brushed liberally with an appropriate and coloured preservative. Where the colour of the preservative will adversely affect the final appearance of the joinery, an appropriate clear preservative should be used.

Where a painted finish is proposed to the external window/door frame and opening units; the primer coat should be applied to all final exposed parts, including rebates prior to glazing installed or bottoms of external doors, or external windows.

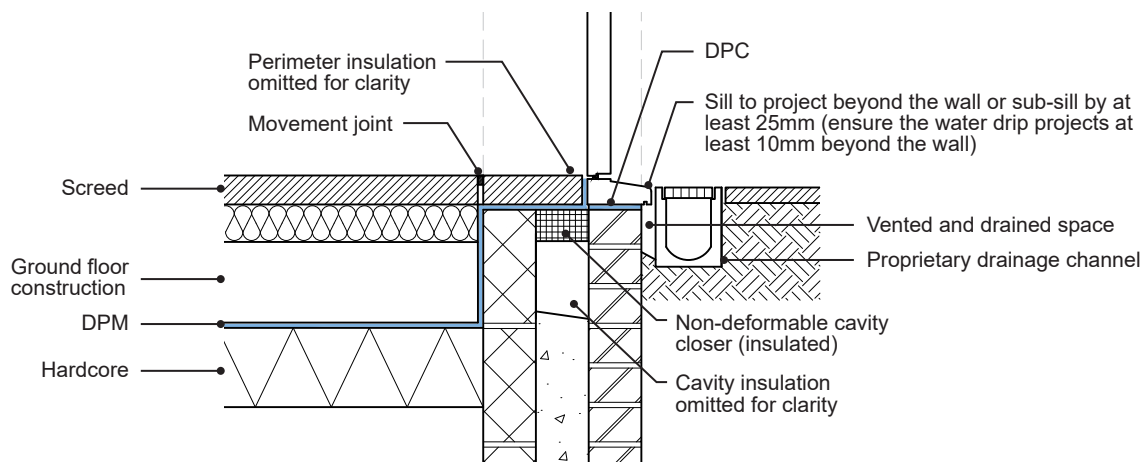
## 8.3.6 Detailing for timber sills

Timber sills shall be designed and constructed to prevent moisture ingress into the property and shall prevent early deterioration of the timber sill.

Timber sills should:

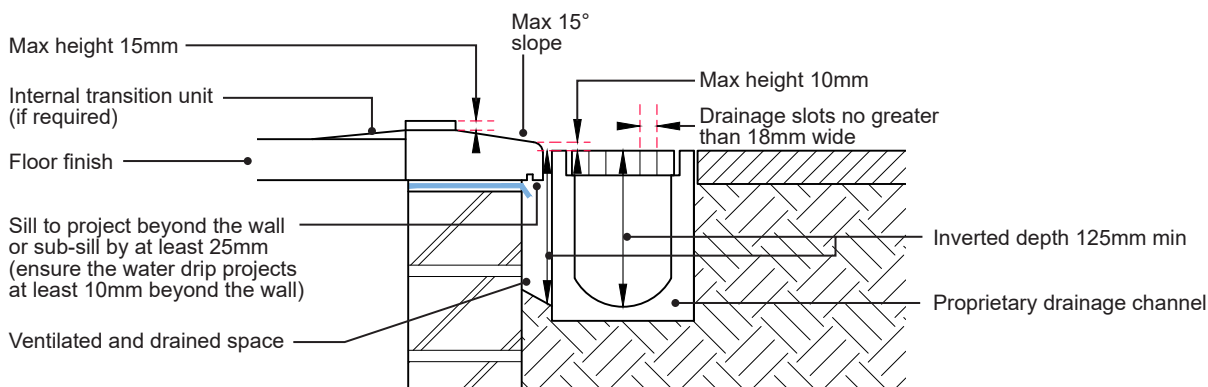
- Project at least 25mm from the building fabric.
- Have a vented and drained space below.

### Ground floor and timber sill typical detail



### Drained and vented void for timber sills

Where timber sills are installed, to prevent deterioration of the timber due to the risk of moisture ingress, a drained and vented void must be provided immediately in front of the sill (at least 125mm invert).



## Standards

### Design, specification and manufacturing

- BS 1186: 2 Timber for and workmanship in joinery - Specification for workmanship
- BS 644 Timber windows and doorsets. Fully finished factory-assembled windows and doorsets of various types
- BS 6375-1 Weather tightness
- Air permeability - BS EN 12207 - Classification & BS EN 1026 - Test method
- Water resistance - BS EN 12208 - Classification & BS EN 1027 - Test method
- Wind resistance - BS EN 12210 - Classification & BS EN 12211 - Test method
- BS 4787: 1 Internal and external wood door sets, door leaves and frames
- BS 6262 Code of Practice for glazing for buildings
- BS 8213: 1 Windows, doors and roof lights
- BS 942 Timber in joinery. General requirements
- BS 8417 - Preservation of wood; Code of practice
- BS EN 1670 Building hardware. Corrosion resistance. Requirements and test methods

## Introduction

This section provides guidance on meeting the performance requirements for external aluminium and steel window and door frames and should be read in conjunction with the 'External Windows and Doors – General Requirements' and 'External Walls' sections.

### 8.4.1 Compliance

External windows and doors shall meet the performance requirements of this section.

### 8.4.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Evidence external aluminium and steel window and door frames are of a suitable specification as detailed within this section.
2. Evidence that the external windows and doors are suitable for the site exposure e.g. a manufacturers declaration of performance for the site.
3. Evidence of certification confirming weather-tightness rating as detailed within BS 6375.
4. Evidence of UKCA marking in accordance with UK Construction Production Regulation.
5. Details of external window and door fixing will be required.
6. Details of sealing around the frame will need to be confirmed.
7. Details relating to the quality control processes for the procurement of metals, and the quality control processes of the factory where they are assembled.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 8.4.3 Specification

Aluminium and steel external windows and doors shall conform to relevant standards as listed in the guidance.

The design and construction of factory assembled aluminium and steel external windows and doors should conform to the following relevant standards:

- BS 4873 - Aluminium alloy windows and doorsets. Specification
- BS 6510 - Steel-framed windows and glazed doors. Specification

Non factory assembled units and 'bespoke' units are also expected to meet the same standards.

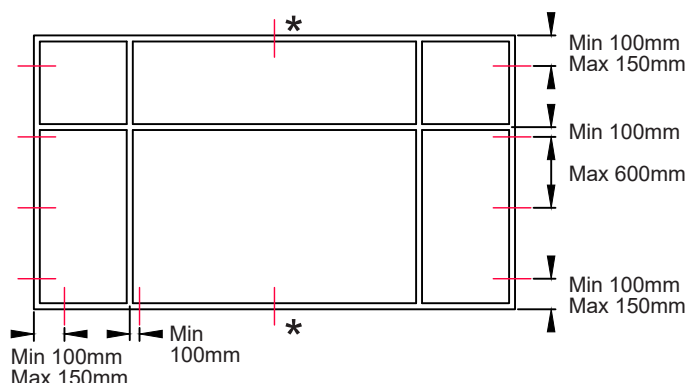
### 8.4.4 Fixings for external aluminium and steel windows and doorsets

Frames shall be securely fixed to the surrounding structure within the structural opening in accordance with the manufacturer's instructions. If no instructions are provided, the following guidance may be used.

Frames should be fixed in accordance with the manufacturers recommendations or, if no instructions are given, in line with the following guidance:

## Fixing locations for external aluminium windows and doorsets

All sides of the frame should be secured as follows:

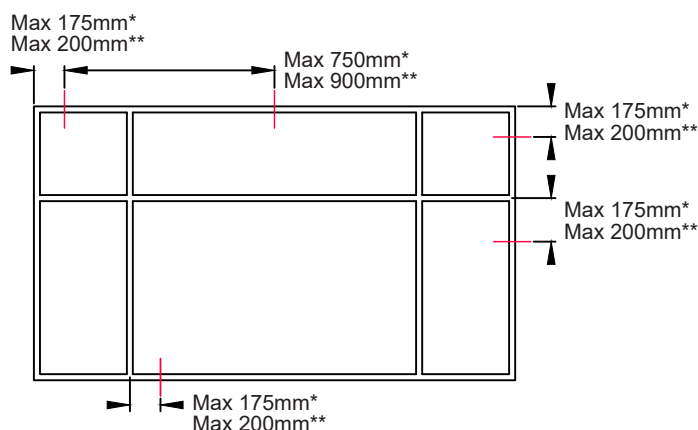


- Corner jamb fixings should be between 100mm and 150mm from the external corner.
- Fixings should be a minimum of 100mm from the centre line of a mullion or transom.
- Intermediate fixings should be at centres no greater than 600mm.
- There should be a minimum of two fixings on each jamb.
- On windows and doorsets over 1800mm wide, central head and sill fixings should be provided 100mm or more distant from any mullion that might coincide.

\*Additional fixing for windows and doorsets over 1800mm wide.

## Fixing locations for external steel windows and doorsets

All sides of the frame should be secured as follows:



\* Dimension for hot rolled sections

\*\* Dimension for cold rolled sections

**For steel frames of hot rolled solid section**

- Fixings should be a maximum of 175mm from corners.
- Intermediate fixings should be at centres no greater than 750mm.

**For steel frames of cold formed hollow section**

- Fixings should be a maximum of 200mm from corners.
- Intermediate fixings should be at centres no greater than 900mm.
- Intermediate fixings should be at centres no greater than 900mm.
- Either into pre-tapped holes with machine screws a minimum of 5mm diameter or with power driven hardened self-drilling screws.

### Fixing substrate penetration

Fixings should penetrate surrounding structure as per the following:

## Masonry

Fixings should penetrate the surrounding masonry by at least 40mm for external windows and 50mm for external doors.

## Timber frame

Fixings should penetrate the surrounding timber framing by at least 25mm for all situations.

**Steelwork (maximum 2mm thick)**

Fixings into a surrounding structure formed by steelwork which is a maximum of 2mm thick should be made with power driven hardened self-drilling screws or self-tapping screws (with pilot hole).

### Steelwork (greater than 2mm thick)

Fixings into a surrounding structure formed by steelwork which is greater than 2mm thick should be made either into pre-tapped holes with machine screws a minimum of 5mm diameter or with power driven hardened self-drilling screws.

Note: Fixings should not be made into the insulated cavity closer.

For further guidance on the installation of windows and doors, refer to BS 8213.

## 8.4.5 Powder coated aluminium protection

Where aluminium frames are powder coated, it shall maintain the durability of the frame and satisfy the requirements of BS EN 12206-1.

Aluminium frames to receive powder coating must be pre-treated to ensure good adhesion of the coating to the surface. Pre-treatment seals the surface of the aluminium and helps form a "key" for the powder coating to adhere to. It is necessary to remove all forms of contamination, the naturally forming oxide layer, and any deformation layer prior to applying the powder coating.

Pre-treatment of aluminium frames should not include the use of hexavalent chromium. The pre-treatment of components to be powder coated is covered within BS EN 12206-1.

Details should be made available for:

- Quality management system from recognised source (such as ISO 9001).
- Confirming that the operations will be completed in line with BS EN 12206-1.
- Pre-treatment to frames.
- Powder coating manufacturer and confirmation that the applicator is an approved installer with regular, up-to-date audit records.
- Third party guarantees (e.g. adhesion, colour, etc).
- Third party product conformity certificate (such as QUALICOAT, etc).
- Full specification details for the application, outlining why the proposed product is best suited for use.
- Necessary future maintenance.

### Durability

For external window and door frames in coastal locations the durability of the coating must take into account of aggressive environment conditions. Please refer to Appendix B for further guidance.

### Standards

#### Design, specification, and manufacturing

- BS 4873 Aluminium alloy windows and door sets
- BS 6510 Steel windows and doors
- BS 6375 Performance of windows and doors - Classification for weather tightness and guidance on selection and specification
- Air permeability - BS EN 12207 - Classification & BS EN 1026 - Test method
- Water resistance - BS EN 12208 - Classification & BS EN 1027 - Test method
- Wind resistance - BS EN 12210 - Classification & BS EN 12211 - Test method
- BS EN 1670 Building hardware. Corrosion resistance. Requirements and test methods

#### Installation

- BS 8213 Windows and doors - Code of practice for the survey and installation of windows and external doorsets



## Introduction

This section provides guidance on meeting the performance requirements for vertically stacked coupled window assemblies which for the purposes of Warranty, are more than one separate glazed panel and frame unit coupled together vertically in an external wall elevation.

The guidance within this section is limited to where coupled window assemblies are:

- Specified in low rise construction (Buildings of 5 storey or lower – including the ground floor level), **and**
- Coupled in a vertical position.

The guidance within this section should be read in conjunction with the rest of the applicable guidance in the 'External Windows and Doors' section and the 'External Walls' section.

### 8.5.1 Compliance

Vertically stacked coupled window assemblies shall meet the performance requirements of this section.

### 8.5.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A fully specified system for the coupled window assembly and this must include details of dual sealed coupling joints, seals, fixings and other ancillary components.
2. Evidence of CE/UKCA marking in accordance with UK Construction Product Regulation.
3. Details of proposed testing strategy as outlined within CWCT Note 41 and 102 are to be provided along with test report.
4. Evidence vertically stacked coupled window assemblies are of a suitable specification as detailed within in the 'External Windows and Doors – Additional requirements for external uPVC window and door frames' section and the 'External Windows and Doors – Additional requirements for external aluminium and steel window and door frames' section.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 8.5.3 Specification

Vertically stacked coupled window assemblies shall be part of a fully specified system and this must include details of:

- Dual sealed coupling joints,
- Seals,
- Fixings, **and**
- Other ancillary components.

Vertically stacked coupled window assemblies must be manufactured to the relevant standards outlined within this section. Timber coupled window and door assemblies are not acceptable for Warranty purposes.

Where vertically stacked coupled window assemblies are proposed, thermal breaks should be incorporated into the dual sealed coupling joints.

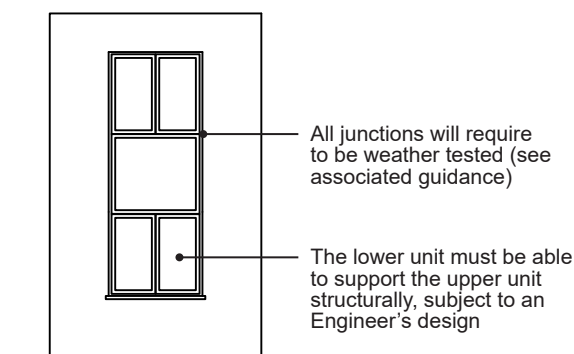
Vertically stacked coupled window assemblies need to be sealed at the edges and drained at the front to prevent water ingress at the edges.

### Dual sealed coupling joints

Where vertically stacked coupled window assemblies are specified, pre-fabricated dual sealed coupling joints should be used for creating a weathertight joint. A dual sealed coupling joints should include:

- Outer seals as the primary water barrier.
- Inner seals providing an air barrier and secondary water barriers. The air barrier must be fully continuous around the full perimeter of the window.
- A drained cavity to remove any water that by passes the outer seal. This should be detailed to prevent water entering parts of the structure which are not intended to becoming wet.

Inner seals within the coupling joint must be placed within the joint during the assembly operation and be suitable for the proposed detailing. Suitable inner seals include impregnated foam tapes or flexible polymer gaskets. Wet sealants should not be solely relied upon.



If sealants (internal or external) are inaccessible or not easy to replace, their service life should match the service life of the window system as a minimum.

All seals must be permanently flexible and resistant to weathering.

All external sealants must be easy to replace.

Fixing should allow for differential movement if in a timber framed building as well as suitability to join one frame to the other. Fixings must also meet the requirements of BS8213: 4 for spacing requirements with particular emphasis on the side and tops.

## 8.5.4 Testing

Vertically stacked coupled window assemblies shall have appropriate off-site and on-site testing.

### Off-site testing

Vertically stacked coupled window assemblies require off-site testing to BS EN 14351-1 and this must be for the complete coupled window assembly (with the dual sealed coupling joint in place), not just individual units.

Vertically stacked coupled window assemblies with higher levels of performance will be required for locations exposed to high levels of driving rain and this should be detailed by the system manufacturer.

Please note: individual units with a third party product conformity certificate may not cover a coupled window assembly scenario.

### On-site testing

Where vertically stacked coupled window assemblies are proposed, on-site testing of water penetrations to critical joints (such as dual sealed coupling joints) in accordance with CWCT test methods is required to check to site workmanship of the building envelope as constructed. Areas and method of testing is to be agreed with the Warranty surveyor prior to construction commencing. See CWCT Technical Note 41 and 102 for guidance.

Minimum requirements for on-site testing may be increased for areas subject to extreme weather conditions, exposed locations or coastal locations. The testing may also be increased where bespoke jointing systems are proposed as part of the construction.

### Testing requirements for developments that are 6 storeys and above

While the guidance within this section is predominantly for low rise developments, it should be noted for developments that are 6 storeys and over, developers and designers should consult with our Major Projects team for further advice. For testing the following will be required:

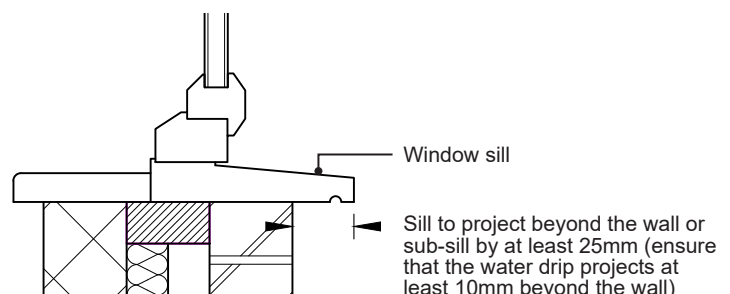
- A minimum performance of 600 pascals water tightness will need to be achieved for vertically stacked coupled window and door assemblies.
- Vertically stacked coupled window assemblies will need to comply with CWCT Technical Note 95.

## 8.5.5 Window sills and managing extra volume of rainfall due to increased glazing

The design and construction shall prevent moisture ingress to the inside of the property.

Vertically stacked coupled window assemblies may encounter an extra volume of rainfall due to the increase in the amount of glazing used in the window system. This should be taken into account with the window system to ensure rainfall is discharged away from the building and does not impact on the weatherproof envelope.

Vertically stacked coupled window assemblies must incorporate a sill which projects from the wall by at least 25mm. The water drip must project the wall by at least 10mm.



## 8.5.6 Structural integrity

Vertically stacked coupled window assemblies shall be designed to be able to appropriately transfer its self-weight and imposed loads to the supporting structure.

The project Engineer should verify the vertically stacked coupled window assembly is capable of supporting appropriate loads.

The frame of the window needs to be able to resist the wind load in deflection, alternatively, the joining component needs to provide support and contribute to the overall stiffness of the system in resisting deflection.

Where the vertically stacked coupled window assembly extends to more than one window in both directions, the joining component in one direction must span the full width or height of the assembly and will have to carry all the load at the junction(s) between the window frames. It will also have to support the ends of the joining components running in the transverse direction.

### **8.5.7 Accommodating movement**

Vertically stacked coupled window assemblies shall accommodate movement between the window system and the surround structure to ensure the structural and weatherproof performance of the building is maintained.

Gaps are required around external windows and doors to accommodate differences in movement between the window and the surrounding wall construction as specified in our 'External Windows and Doors – General requirements' section.

Where vertically stacked coupled window assemblies are specified however, the gap sizes between the frame and wall construction may need to be greater and this should be specified by the system manufacturer.

Vertically stacked coupled window assemblies should also accommodate for any movement due to shrinkage in the timber frame. For further information please refer to the 'External Walls – Timber frame' section.

Where a vertically stacked coupled window assembly extends across a horizontal movement joint (in a timber framed building with lightweight cladding for example), the design should allow for suitable jointing of the window assembly that will accommodate predicted structural movement whilst remaining weathertight and transferring loads to the building structure.

## Introduction

This section provides guidance on meeting the performance requirements for External Bi-fold doors. Where external bi-fold doors are specified, the guidance within this sub-section must be read in conjunction with the guidance within the rest of the 'External Windows and Doors' section.

### 8.6.1 Compliance

External bi-fold doors shall meet the performance requirements of this section.

### 8.6.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full specification of the external bi-fold door must be provided to the Warranty surveyor.
2. The designer must take thermal bridging into account. Details of how thermal bridging is to be mitigated must be provided to the Warranty surveyor.
3. Where external top hung bi-fold doors are specified, the Engineer must design and specify the lintel provision above the bi-fold doors.
4. The information to be provided in the other sub-sections within the 'External Windows and Doors' section must also be satisfied

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 8.6.3 Thermal bridging

The designer shall take thermal bridging into account. Details of how thermal bridging is to be mitigated shall be provided to the Warranty surveyor upon request.

The method of mechanically fixing the frames should not compromise the thermal performance or thermal breaks incorporated into the frames.

### 8.6.4 Level access thresholds

Where level access thresholds are specified, detailing shall resist the passage of moisture to the inside of the home.

Care must be taken for level access threshold detailing to ensure weather resistance is maintained. Falls in the external ground levels must be away from the building.

The sill must project a minimum 25mm (ensure the water drip projects at least 10mm beyond wall) into a channel drain which is laid to a 1/60 fall. Please refer to the 'External Windows and Doors – General Requirements' section for further guidance.

### 8.6.5 Bi-fold door installation

Where external bi-fold doors are specified, the manufacturer's guidance shall be followed to ensure structural stability, weather resistance and desired service life is achieved.

Care must be taken for level access threshold detailing to ensure weather resistance is maintained. Falls in the external ground levels must be away from the building.

The sill must project a minimum 25mm (ensure the water drip projects at least 10mm beyond wall) into a channel drain which is laid to a 1/60 fall. Please refer to the 'External Windows and Doors – General Requirements' section for further guidance.



# 9.

## Stairs

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### Contents

|     |                                     |     |
|-----|-------------------------------------|-----|
| 9.1 | General Requirements for all Stairs | 246 |
| 9.2 | Timber Stairs                       | 250 |
| 9.3 | Concrete and Steel Stairs           | 252 |

## Introduction

This section provides guidance on meeting the performance requirements for all stairs.

### 9.1.1 Compliance

The specification and construction of staircases shall meet the performance requirements of this section.

### 9.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Detailed specification relating to the construction of the stairs.
2. Planned details indicating proposed dimensions of stairs (such as dimensions of rise, goings, pitch, headroom, etc).
3. Proposed fixing details of stairs at strings, top and bottom of flights.
4. Structural calculations for concrete and/or steel stairs.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 9.1.3 Structural design

Staircases shall be properly supported and transmit loads to the supporting structure without undue movement, deflection or deformation.

Staircases shall satisfy the following standards:

- BS 585 Specification for stairs with closed risers for domestic use, including straight and winder flights and quarter or half landings
- BS EN 1992-1-1 Design of concrete structures
- BS EN 1993-1-1 Design of steel structures
- BS EN 14843:2007 Precast concrete products. Stairs
- BS 5395-1:2010 Stairs - Code of practice for the design of stairs with straight flights and winders
- BS 8000 Workmanship on construction sites

For further guidance on timber and reinforced concrete, please refer to 'Appendix C'.

Where bespoke materials are specified, they must be proven to be suitably durable and have a service life of at least 60 years.

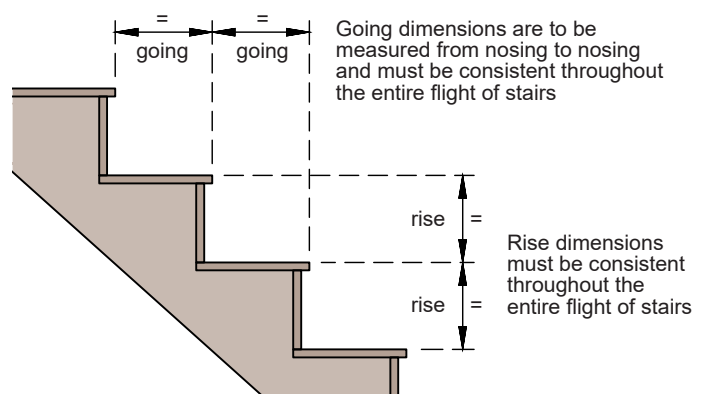
### 9.1.4 Stair design

Stairs shall be safe in use in relation to:

- Rise and going
- Tapered treads and winders
- Pitch
- Landings
- Handrails
- Guarding

#### Rise and going

- Must be consistent throughout the flight of the stairs.
- Each tread is to be level.
- Open risers are permissible in dwellings if the treads overlap by a minimum of 16mm and the steps are constructed in a manner so as to prevent a 100mm diameter sphere passing through them.
- Open risers are not permissible on common stairs.
- Allowance should be made for stair and floor finishes, ensuring that all risers are equal.



## England

|                      | Rise           | Going          |
|----------------------|----------------|----------------|
| Private Stair*       | 150mm to 220mm | 220mm to 300mm |
| Utility Stair        | 150mm to 190mm | 250mm to 400mm |
| General Access Stair | 150mm to 170mm | 250mm to 400mm |

\*For dwellings for external tapered steps and stairs that are part of the building the going for each step should be a min 280mm.

## Scotland

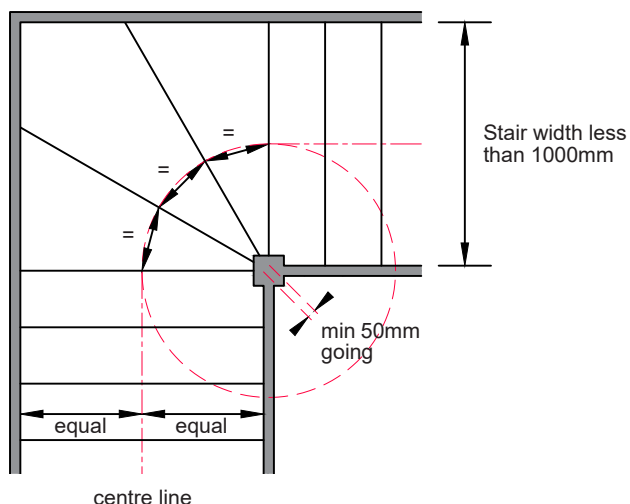
|               | Rise           | Going           |
|---------------|----------------|-----------------|
| Private Stair | 100mm to 220mm | 225mm (minimum) |
| Other         | 100mm to 250mm | 250mm (minimum) |

## Wales

|                           | Rise           | Going           |
|---------------------------|----------------|-----------------|
| Private Stair             | 155mm to 220mm | 245mm to 260mm  |
|                           | 165mm to 200mm | 223mm to 300mm  |
| Institutional/Assembly ** | 135mm to 180mm | 280mm to 340mm  |
| Other **                  | 100mm to 250mm | 250mm (minimum) |

\*\* Maximum rise for stairs providing access for disabled people should give reference to Approved Document M (Wales)

## Tapered treads and winders



This guidance is for tapered treads and winders less than 1000mm width. For where they are greater than 1000mm please see BS 5395-2.

- The centre line arc from the newel around the winder must consist of consistent going dimensions.
- Goings to winders around the newel must be a minimum of 50mm.

## Pitch

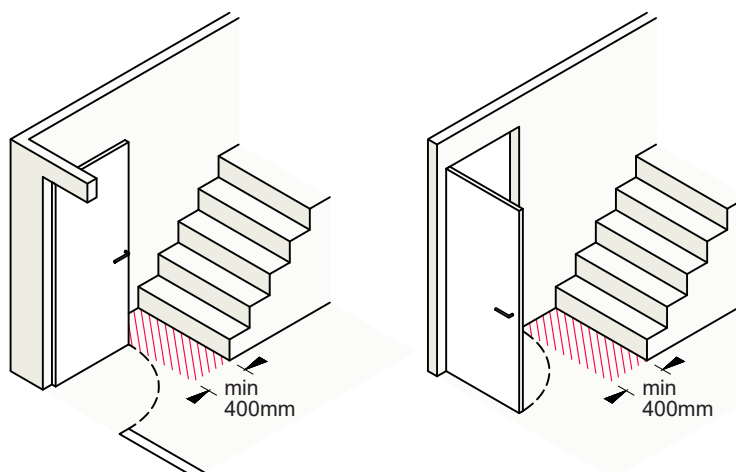
Staircases should be accurately located and fixed with the string at the correct angle, so that all treads are horizontal. The pitch should be suitable for the intended use in accordance with the relevant Building Regulations.

The maximum angle of pitch of a stairway should not exceed 42° for private stairs.

## Landings

Landings must be provided at the top and bottom of every flight and should meet the following:

- Landings should be level.
- The width and length of landing should be at least as great as the smallest width of the flight. For Scotland, landings should have an effective width of not less than the effective width of the stair flight it serves. The minimum length of a stair landing, measured on the centreline of travel, should be either 1.2m or the effective width of the stair, whichever is less.
- Landings shall be kept clear of permanent obstructions.
- Where a door swings across a landing at the bottom of a flight, a 400mm clearance must be provided between the landing and the door.
- Landings should be designed and constructed robustly.
- They should provide full support and secure fixings, for flights, newels, apron linings etc.





## Handrails

### Dwellings

- Handrails should be provided at a height of between 900mm to 1000mm (or 840mm to 1000mm in Scotland), measured above the pitch line of the stairs.
- Handrails will need to be continuous across intermediate landings and around winders.
- Handrails should be firmly secured and comfortable to grip, allowing the entire hand to grasp the rail.
- Where the staircase is greater than or equal to 1000mm width, then additional handrails will need to be provided on both sides.
- Handrails should be provided in a manner that reduces the risk of clothing being caught.

### Common stairs to flats

In addition to the above requirements, handrails in common stairs:

- Will need to be provided on each side of the flight, and continue a minimum of 300mm past the top and bottom nosings of the flight with ends returned into the wall or down to prevent “catching”.
- Handrails must be continuously graspable along their length; the handrails should have 50mm to 75mm clearance from any outside walls, yet be no further than 50mm from the face of the inside string.
- The handrail must have at least 50mm clearance under the bottom of the rail.
- Circular handrails are to have a diameter between 32mm and 50mm, whereas non-circular handrails must be 50mm wide and 39mm deep.
- Should be installed to reduce the risk of clothing being caught.

Please note, for the purposes of Warranty, common stairs are defined as a staircase serving more than one property.

## Guarding

The following points apply to dwellings only:

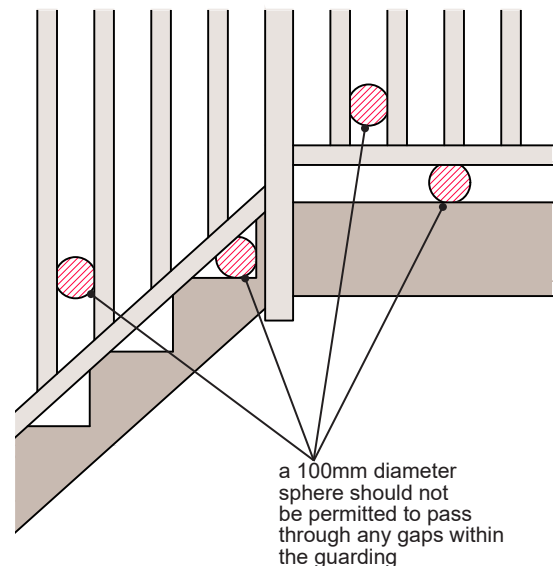
- Guarding to stairs, landings, ramps, and the edges of internal floors must be at least 900mm high (note, considerations for guarding heights at other locations, such as balconies will be covered within the appropriate sections).
- Guarding should be provided so as to prevent children climbing or being held fast; a 100mm diameter sphere should not be permitted to pass through any gaps within the guarding, including between the bottom of the guarding and the string of the stairs.
- Guarding will be required where there are changes in level greater than 600mm.

### Glazed guarding

Where glazing is specified in and around a staircase, the glazing should either:

- If broken on impact, break in a way which is unlikely to cause injury, **or**
- Resist impact without injury, **or**
- Be shielded or protected from impact.

Where toughened glazing is specified, 100% of toughened glazing should be formed and then heat soak tested in accordance with BS EN 14179-1. The glass must be permanently marked in accordance with BS EN 14179-1 and substantiated evidence of heat soak testing must be disclosed for all effected panes.



## 9.1.5 Lighting

Staircases shall be provided with adequate lighting.

Artificial light sources should be provided to all internal staircases and landings. Within a building, lighting to stairs should be controlled by two-way switching.

Automatic light-sensitive controls may be used in common areas, provided lights can also be two-way switched manually.

## 9.1.6 Construction of stairs

Staircases shall be installed to established standards of workmanship.

- If stairs are supplied for construction on site (or in kit form) then fixing instructions will need to be provided.
- The top nosing of the flight should finish flush with the surface of the flooring and adequately secured into place.
- The underside of the string can be cut so that the measurement from the top of the tread to the underside of the string is equal to the overall rise.
- Consideration should be given to differential movement within the setting-out, levels, and finishes (e.g. in timber framed buildings).
- The first rise of the staircase must be positioned so as to allow for any floor screed or other hard finish to ensure the rise is equal throughout the flight.

## 9.1.7 Protection of staircases

Staircases shall be adequately protected during construction to prevent damage.

- Staircases should be protected during the construction phase to prevent damage and marking.
- When storing staircases they must be stacked on bearers and suitably protected from the weather.
- Timber stairs should only be incorporated into the build once the unit is suitably weather tight.
- As timber staircases may be effected by residual moisture within a concrete floor, an isolating DPC should be provided directly below the timber staircase.

## 9.1.8 External stairs which form a part of the access route to the home

In addition to the guidance covering internal stairs:

- All external stairs must be constructed from masonry, concrete or metal.
- External lighting requirements must meet relevant Building Regulations.

## Introduction

This section provides guidance on meeting the performance requirements for timber staircases.

### 9.2.1 Compliance

The specification and construction of timber staircases shall meet the performance requirements of this section.

### 9.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Detailed specification relating to the construction of the stairs.
2. Planned details indicating proposed dimensions of stairs (such as dimensions of rise, goings, pitch, etc).
3. Proposed fixing details of stairs at strings, top and bottom of flights. See guidance within this section.
4. Details of balustrades and handrails to be used which must be securely fixed and robust.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 9.2.3 Additional requirements for timber staircases

Timber staircases shall be suitable for their intended purposes, durable and have an appropriate service life.

## Timber specifications

Timber staircases should be adequately durable or preservative treated against fungal decay and insect attack in accordance with 'Appendix C'.

## Wall string fixings

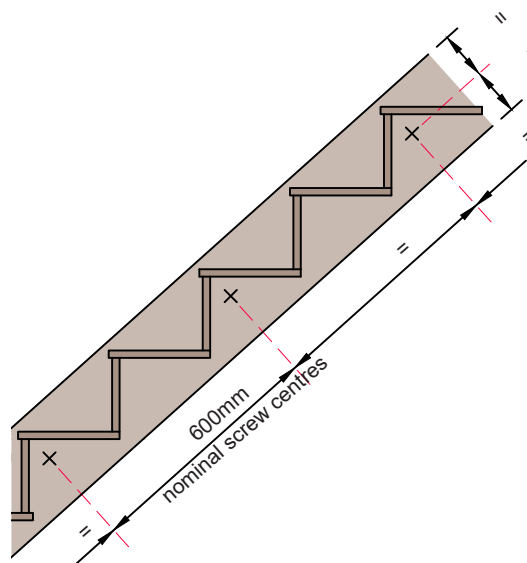
- Structural screws, UKCA/CE marked to EN 14592, should be used to secure wall strings to both timber stud and masonry walls. The screws should have a nominal diameter of 5mm and should be either self-drilling or fixed into pre-drilled holes. Each screw should have a minimum bearing of 50mm into the timber stud/ noggin, or the masonry wall.
- Wall plugs used in masonry walls should be at least 50mm long. Timber packing of adequate width to prevent the possibility of splitting should be fixed the full length of the string.
- Stair string fixing should begin with screws being provided beneath the top and bottom treads.

### String-wall gaps up to 40mm

Private (domestic) stair = Max 600mm centres  
General access (e.g. flats) = Max 300mm centres

### String-wall gaps exceeding 40mm

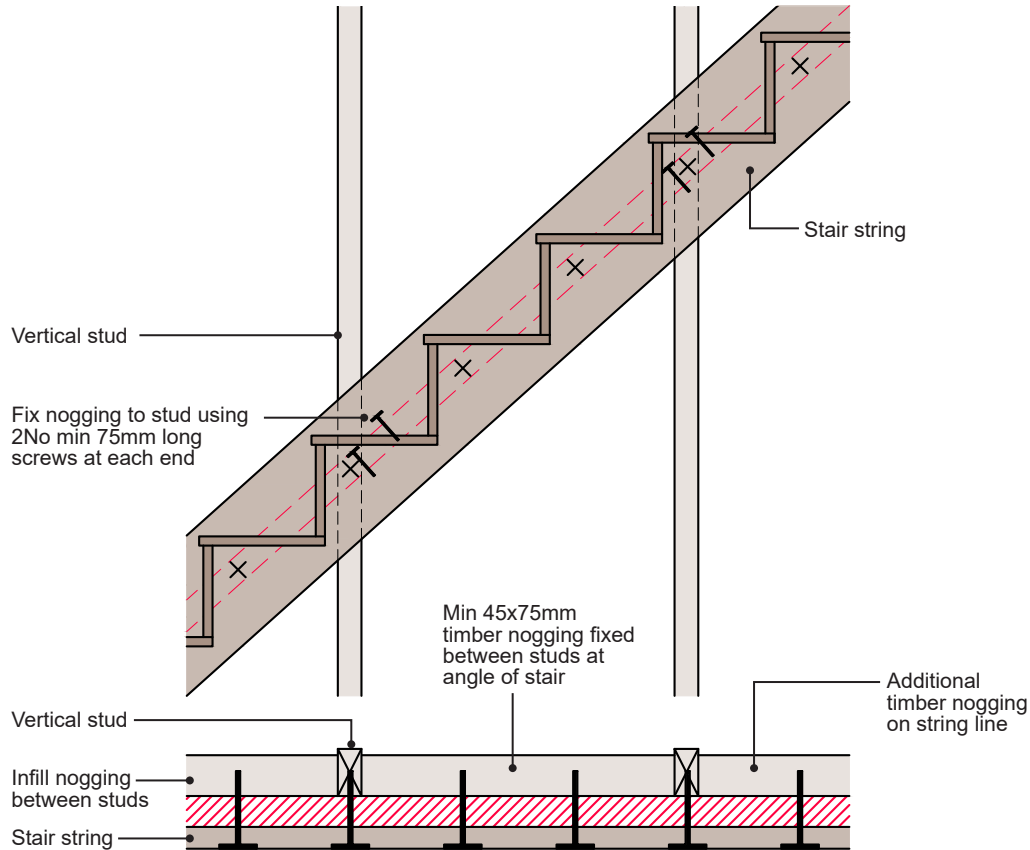
Private (domestic) stair = Max 300mm centres  
General access (e.g. flats) = Seek specialist advice from a Structural Engineer



## Fixing to timber studs

When fixing timber stairs to timber studs, either:

- Provide timber infill pieces between the studs following the intended line of fixings (nogginns should be at least 45x72mm and double fixed at each end using 75mm long screws), or
- Alternatively, provide additional vertical studs at 300mm centres to enable direct fixing of strings into the studs.



## Fixing to steel stud partitions

Fixing of stairs into steel partitions is not generally permissible unless confirmed by the steelwork designer – please refer to the 'External Walls - Light Gauge Steel Frame' section for further guidance.

## Introduction

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This section provides guidance on meeting the performance requirements for concrete and steel staircases.

### 9.3.1 Compliance

The specification and construction of concrete and steel staircases shall meet the performance requirements of this section.

### 9.3.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Detailed specification relating to the construction of the stairs.
2. Planned details indicating proposed dimensions of stairs (such as dimensions of rise, goings, pitch, etc).
3. Structural calculations for concrete and/or steel stairs.
4. Details of balustrades and handrails to be used which must be securely fixed and robust.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 9.3.3 Additional requirements for concrete and steel stairs

Concrete and steel staircases shall be suitable for their intended purposes, durable and have an appropriate service life.

## Precast concrete staircases

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- Manufacturer's design and calculations will be required for pre-cast concrete stairs.
- Engineer's design and calculations will be required prior to construction.
- Design should include depth of cover to proposed steelwork within the stair.
- Design should include proposed concrete mix design outlining strength and slump.
- In-situ concrete must be allowed to cure appropriately prior to shuttering being struck.
- Staircases must be adequately fixed in place in accordance with the Engineers specification to maintain stability.
- Weather and working conditions must be consistent with guidance for working with in-situ concrete provided in 'Appendix C'.
- Balustrading and guarding associated with the stair must either be grouted into preformed holes, or bolted to brackets cast into the stair.

## Steel staircases

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Engineer's design and calculation will be required for the proposed element.

Staircases must be adequately fixed in place in accordance with the Engineers specification to maintain stability.

# 10.

## Upper Floors

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### Contents

|             |                                                     |     |
|-------------|-----------------------------------------------------|-----|
| <b>10.1</b> | Timber Upper Floors                                 | 254 |
| <b>10.2</b> | Concrete Upper Floors                               | 272 |
| <b>10.3</b> | Fire Resistance, Cavity Barriers, and Fire Stopping | 282 |

## Introduction

This section provides guidance on meeting the performance requirements for the following types of timber upper floors:

- Traditional solid timber joists
- I-joists
- Metal web joists

Throughout this section, both I-joists and metal web joists will collectively be referred to as 'Engineered Joists'.

### 10.1.1 Compliance

The design, specification and installation of timber upper floors shall satisfy the performance requirements of this section.

### 10.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of proposed floor joists to be used including floor joist layouts and structural calculations (for engineered joists this should be provided from the joist manufacturer).
2. Where engineered joists are proposed, details of the manufacturer relevant accreditation (TRADA, STA, etc.). The accreditation must confirm the manufacturers has been assessed for the design of joists.
3. Details of proposed services to be constructed within the floor void.
4. Details of any proposed underfloor heating systems to be incorporated.
5. Details of insulation to be used within the floor construction.
6. The following should be provided for the structural floor boarding:
  - a. Details of the proposed structural floor boarding including evidence the boards are suitable for the intended purpose.
  - b. Details of the type, size, spacing and method of fixing the boards.
7. The following should be provided for the proposed plasterboard to be used:
  - a. Details of proposed plasterboards to be used; type of board, thickness, number of boards to create the layer.
  - b. Details of mechanical fixings of plasterboards.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 10.1.3 Structural design

Timber upper floors shall be durable and safely support and transmit intended loads to the supporting structure without undue movement.

## General requirements

All timber upper floors should have loads calculated in accordance with BS EN 1991-1-1.

### Deflection

For timber upper floors, designers and Engineers must observe our tolerance requirements for levelness and deflection limits of floors. Please refer to the 'Tolerances' section for further guidance.

There may be an instance where a joist might be designed to meet permissible deflections within a relevant British Standard; however, our tolerance requirements will take precedence.

## Traditional solid timber joists

### Specification

BS EN 338 should be used by the designer to determine the suitable strength class for the traditional solid timber joists.

All traditional solid timber joists should be:

- Machine graded to BS EN 14081 or, visually graded to BS 4978 for softwoods or BS 5756 for hardwoods.
- Dry graded.
- Marked in accordance with BS EN 14081.

**Sizing**

For advice on sizing of certain timber members of floors, the Designer should refer to the following sources:

- Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings. Published by BM TRADA. Note: Reference should be made to the version of the BM TRADA document current at the time of construction of the floor/ceiling or roof.
- BS 8103-3, Structure design of low rise buildings, Code of Practice for timber floors and roofs for dwellings.
- BS EN 1995, Eurocode 5 design of timber structures. General. Common rules and rules for buildings.

**Engineered joists**

Engineered joists should be designed in accordance with BS EN 1995, Eurocode 5 design of Timber Structures. General: Common rules and rules for buildings. Engineered joists should be appropriately UKCA / CE marked and comply with ETAG 011 or have an appropriate third party product conformity certificate.

**10.1.4 Storage and protection of timber joists**

Timber joists shall be appropriately stored and protected on site so as to not effect the performance or durability of the timber joists.

Timber upper floors should be protected from the elements and supported on suitable bearers over a free draining surface. Levels of exposure, which are more severe than those encountered during a normal uninterrupted build programme should be addressed by the provision of suitable protection.

**10.1.5 Installation and workmanship**

Timber joists shall be installed in a manner which does not affect their durability or performance.

Where Engineered joists are specified, their installation shall also be in accordance with the manufacturer's recommendations and the site specific specification.

All workmanship shall satisfy the 'Tolerances' section.

It is essential that joists are not overloaded during construction. Joints in joists should only be in place over a load-bearing support, or the joint be designed by an Engineer.

**Levelling**

Floors should be level in accordance with the 'Tolerances' section.

Where hard packing is proposed to ensure the floor is level, it should be specified in accordance with the Engineers specification or Engineered joist manufacturer's recommendations. Loose or soft packing should not be used.

**Bearing on supporting structure**

The floor joists must be laid reasonably level and onto suitable solid and level bearings.

Minimum bearing for timber joists:

| Type of timber joist                                  | Minimum bearing |
|-------------------------------------------------------|-----------------|
| Traditional solid timber joist on masonry wall        | 90mm            |
| Traditional solid timber joist on a timber wall plate | 75mm            |
| I-Joist                                               | 90mm            |
| Metal web joist                                       | 90mm            |

**Bearing on joist hangers**

Where joist hangers are specified to support timber joists, the end bearing should be in accordance to an Engineers design and hanger manufacturer's recommendations. Additional fixings may also be required to secure joist ends into the hanger.

Joists should be restrained at supports using tightly fitted strutting.

**Notching and drilling****Traditional solid timber joists**

Requirements for notching and drilling of solid timber joists can be found in BS 8103, TRADA span tables, BS EN 1996 and PD 6693 – 1.



This guidance is for joists up to 250mm deep, notching and drilling for joists exceeding this depth should be designed by the Engineer.

- Notches should be made in between  $0.1$  and  $0.2 \times$  span. Notches should be no deeper than  $0.15 \times$  depth of the joists in this area e.g. for a 250mm deep joist, the maximum notch depth should not exceed 35mm.
- Holes should be drilled on the centre line of the joist. Holes should be between  $0.25$  and  $0.4 \times$  the span. Holes should be a maximum diameter of  $0.25 \times$  the joists depth and kept apart by at least  $3 \times$  the diameter. The maximum hole diameter should not exceed 65mm.

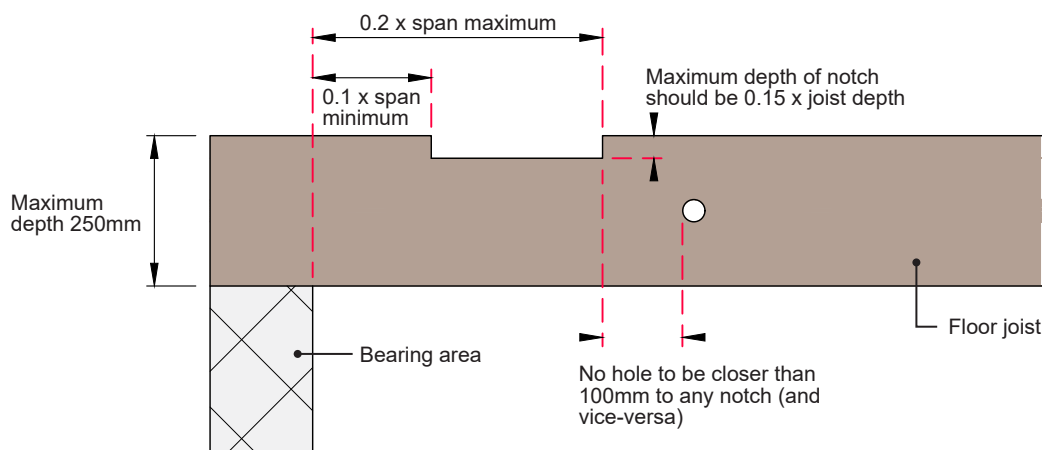
Note: Notches and holes should be a minimum of 100mm apart.

The table below gives an indication of the areas in a joist which are suitable for notching and drilling.

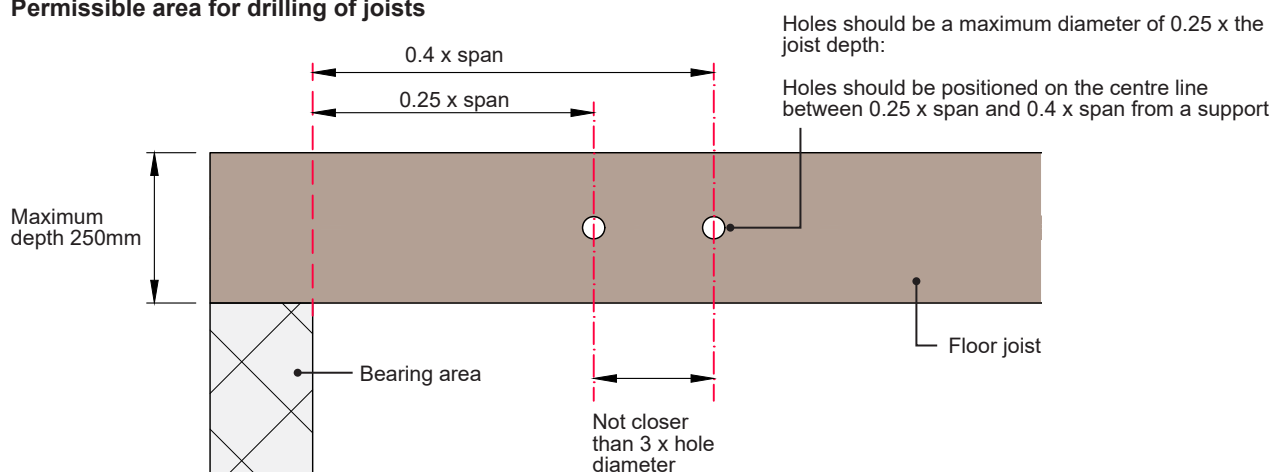
### Typical permissible zones for notching and drilling of solid timber joists

| Span | Notches to be taken out only within these zones |      | Holes only to be drilled within these zones |      |
|------|-------------------------------------------------|------|---------------------------------------------|------|
| 1.5m | 0.15m                                           | 0.3m | 0.375m                                      | 0.6m |
| 2.0m | 0.2m                                            | 0.4m | 0.5m                                        | 0.8m |
| 2.5m | 0.25m                                           | 0.5m | 0.625m                                      | 1m   |
| 3m   | 0.3m                                            | 0.6m | 0.75m                                       | 1.2m |
| 3.5m | 0.35m                                           | 0.7m | 0.875m                                      | 1.4m |
| 4m   | 0.4m                                            | 0.8m | 1m                                          | 1.6m |
| 4.5m | 0.45m                                           | 0.9m | 1.125m                                      | 1.8m |
| 5m   | 5m                                              | 1m   | 1.25m                                       | 2m   |

### Permissible area for notching of joists

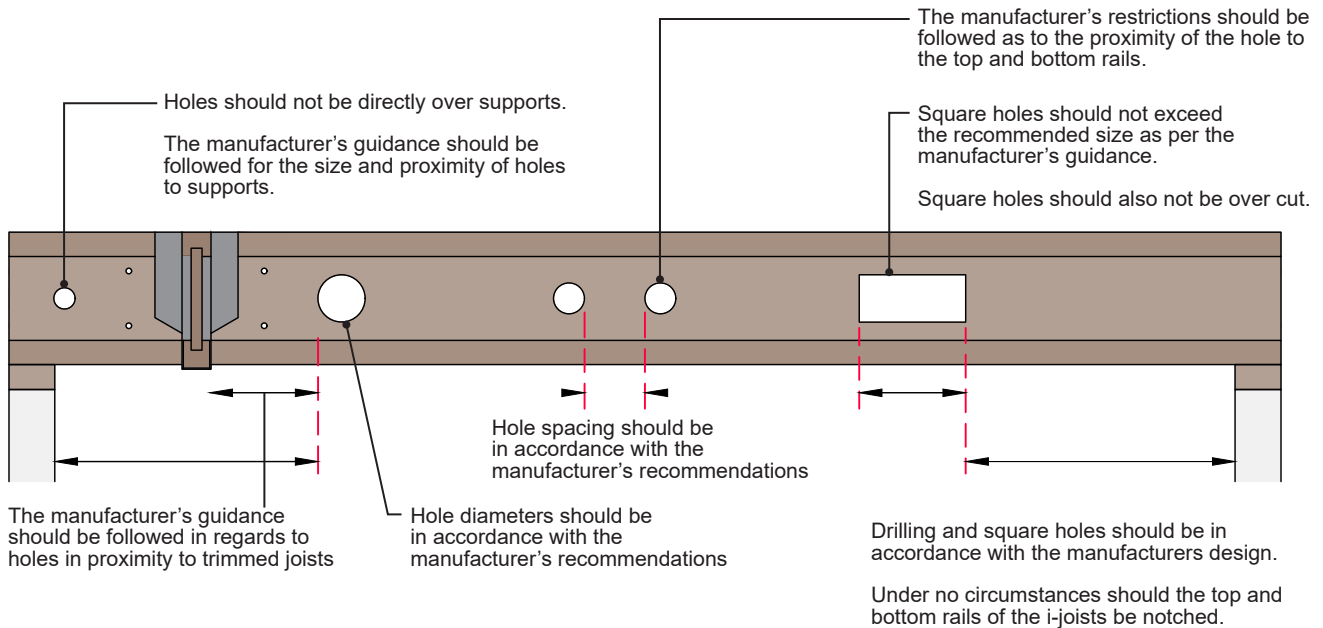


### Permissible area for drilling of joists



## I-Joists

I-joists should be notched and drilled in accordance with the manufacturer's recommendations.



## Support of light-weight non-load bearing partitions

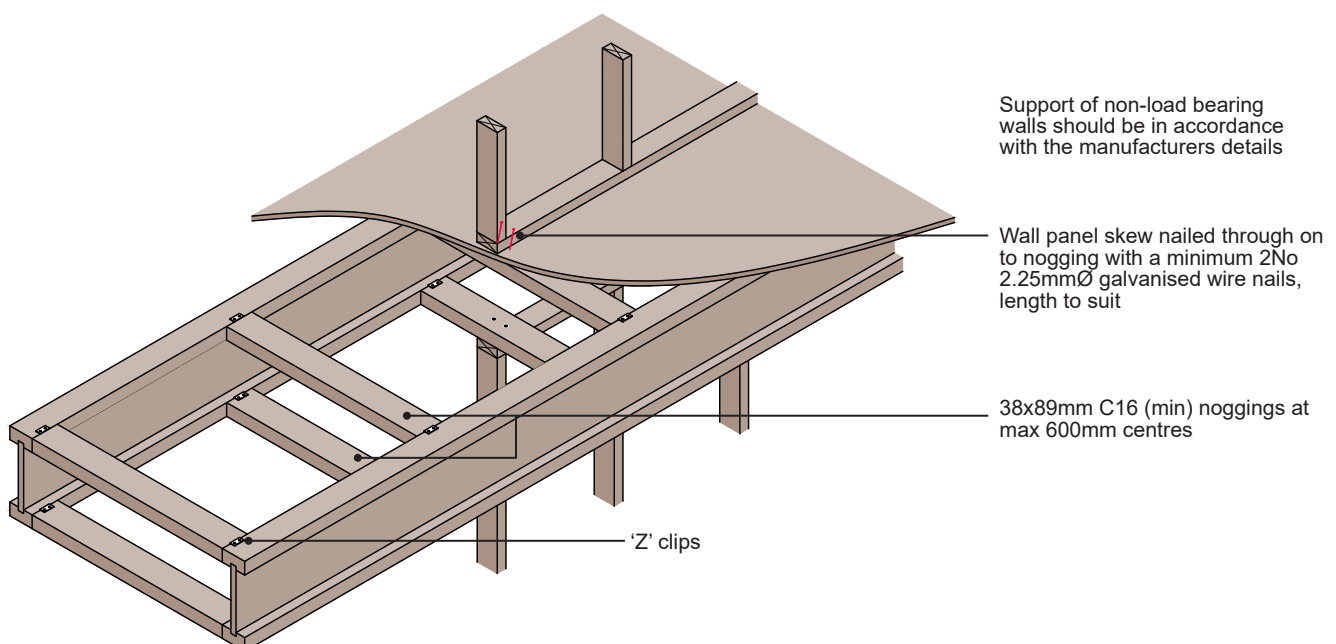
Where light weight non load bearing partition are parallel to the joists, they should be suitably supported with in accordance with the design. Sole plates should be fixed to the nogginns or joists.

Where traditional solid timber joists or Engineered joists run parallel to non-load bearing partitions above:

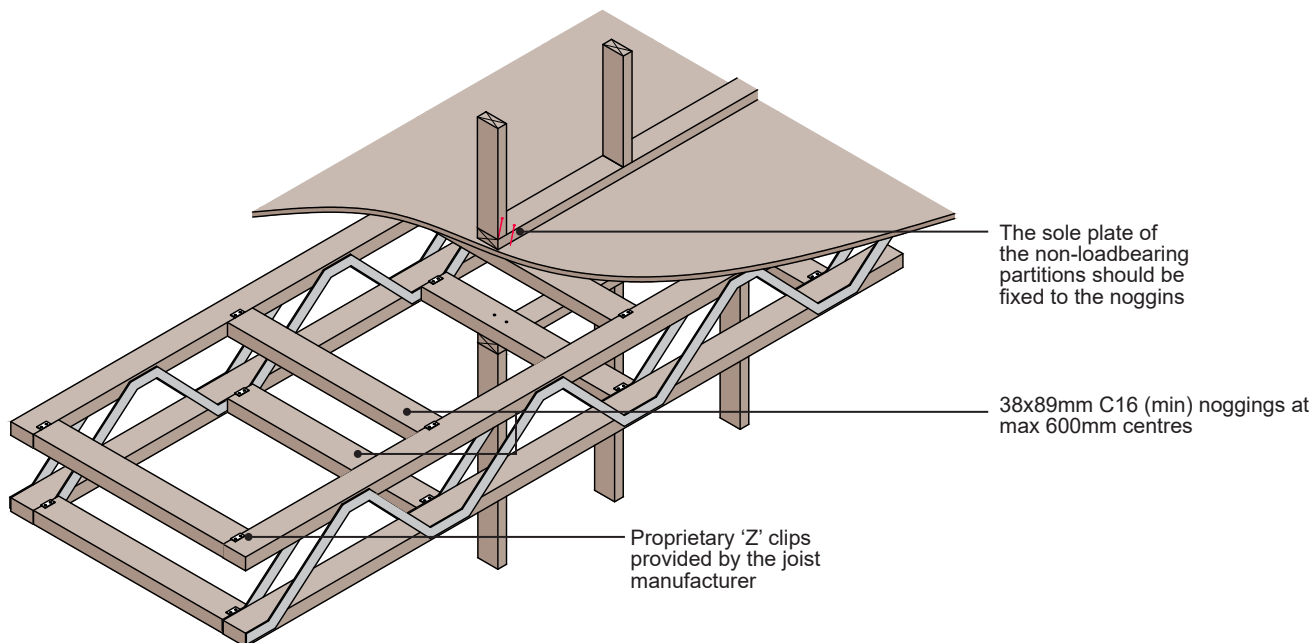
- The joists should be positioned centrally below the non load bearing partitions. Double or triple joists should be provided in accordance with the Engineers design, **or**
- The partition should be supported by nogginns or bearers fixed to joists in accordance with the Engineers specification or Engineered joist manufacturer's specification.

In all circumstances, where engineered joists are specified, the joist manufacturers specification should be followed.

## I-Joists supporting non-load bearing partition on nogginns



### Metal web joists supporting non-load bearing partition on nogginns



### General detailing for traditional solid timber joists

#### Floor joists bearing on to masonry walls

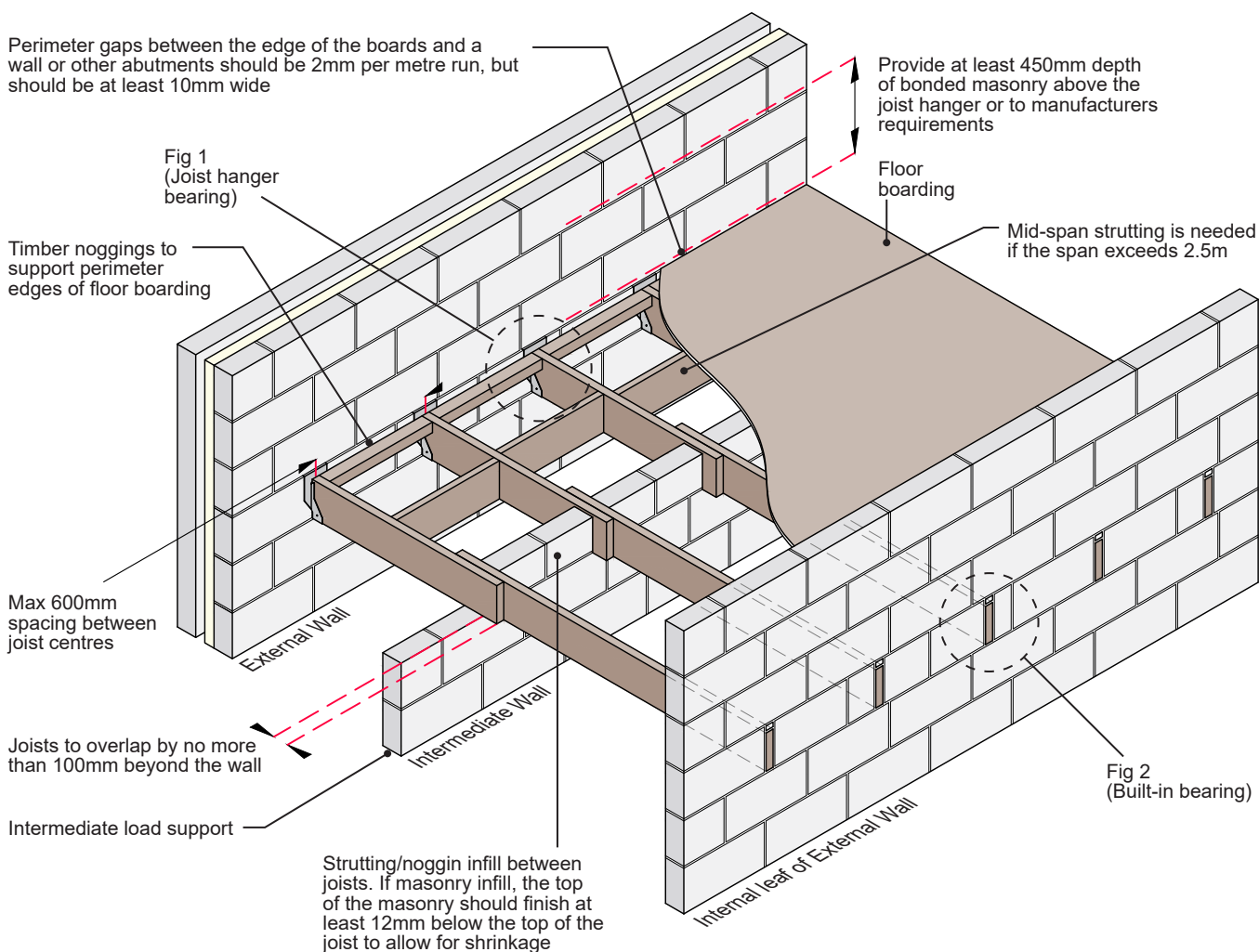


**Fig 1 Joist hanger bearing**

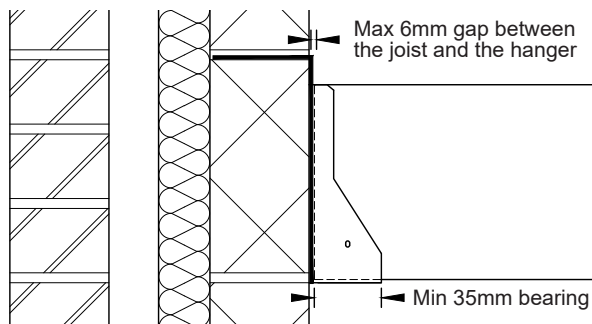
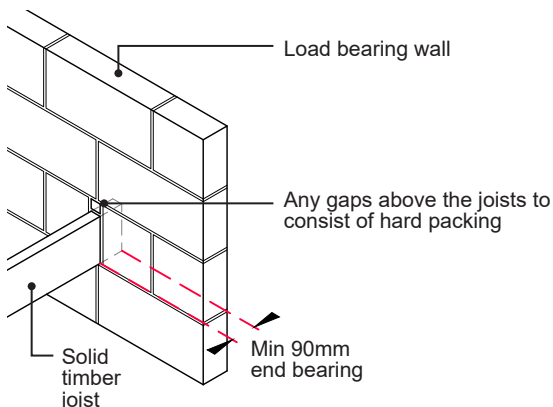


**Fig 2 Built-in bearing**



**Floor joists bearing on to a timber frame**

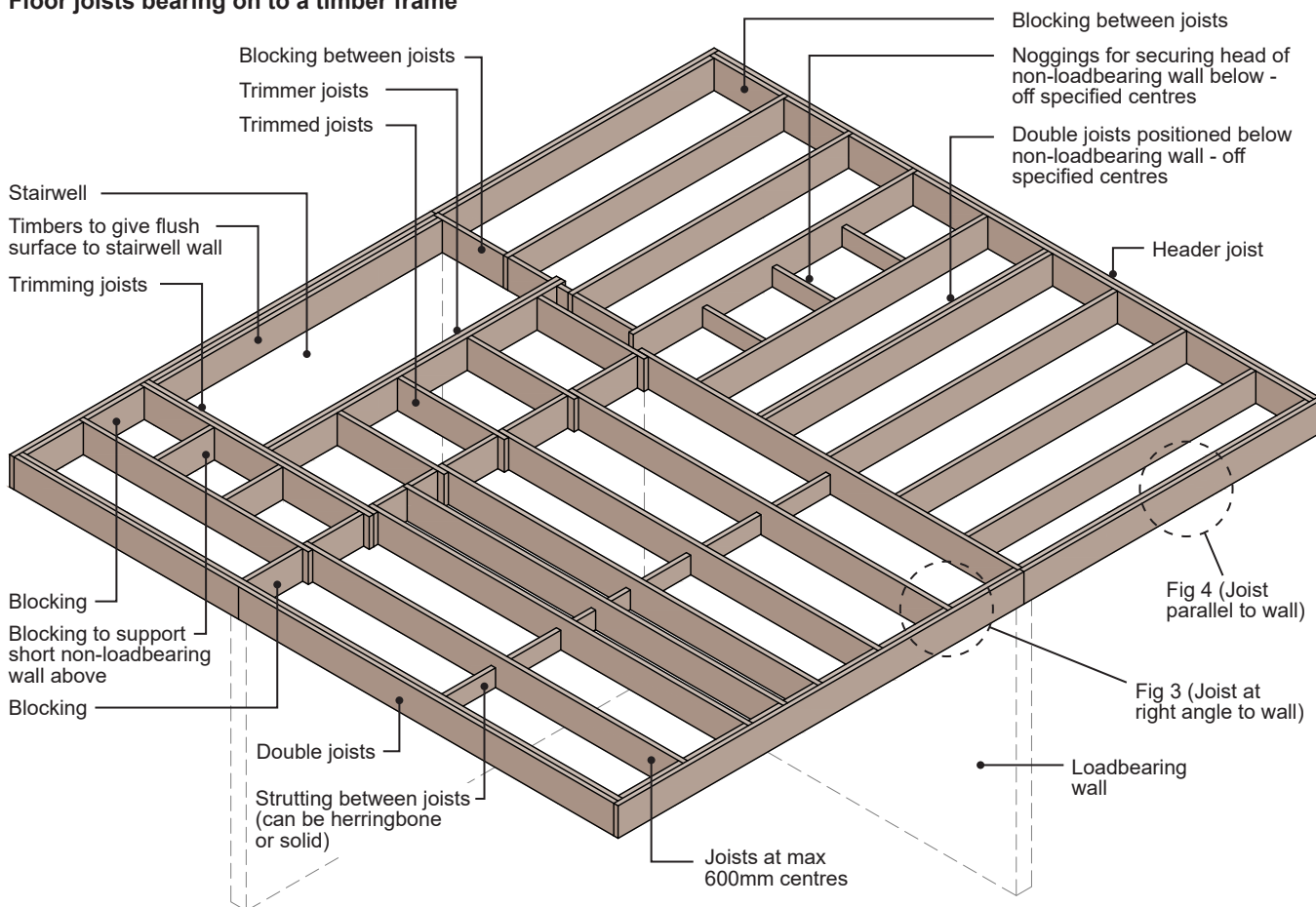


**Fig 3 Joist at right angle to wall**

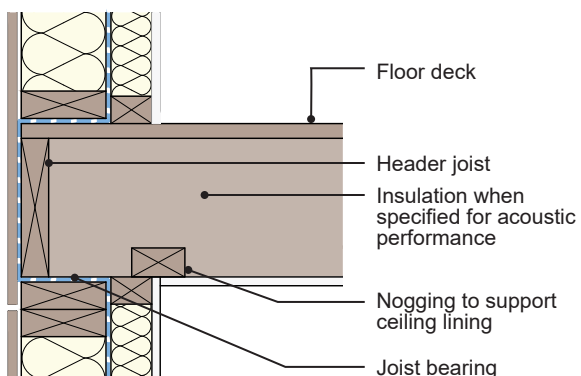
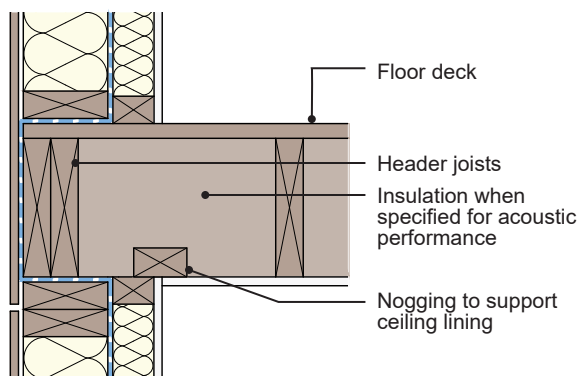


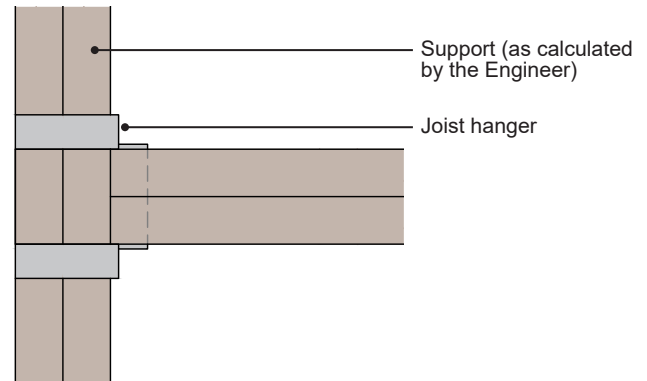
**Fig 4 Joist parallel to wall**



### Typical trimming detail (plan)

Double joists should be bolted together at 600mm centres using minimum 10mm diameter bolts with large washers that will prevent the bolt head and nut from penetrating the joist. It is recommended that the bolting of double joists is along the centre line of joists. Suitably sized trimmer joists shall be provided around floor openings.

Trimmed openings may be needed around staircase openings and chimneys. Solid trimmed joists may be supported using either joist hangers or a structurally designed connection; timber trimmers around openings should consist of at least two members and be designed by the Engineer.



### General detailing for I-Joists

#### I-joists bearing on to masonry walls

Perimeter gaps between the edge of the boards and a wall or other abutments should be 2mm per metre run, but should be at least 10mm wide

Top flange restraint: Noggins securely fixed with manufacturers specified clip

Centres of i-joists to be to the manufacturers specification. Max 600mm spacing

Joist hangers to support both the top and bottom flanges of the i-joist

Web stiffener

Intermediate wall support: Short sections of i-joist used between the main i-joists with web stiffeners inserted

Provide at least 450mm depth of bonded masonry above the joist hanger or to manufacturers requirements

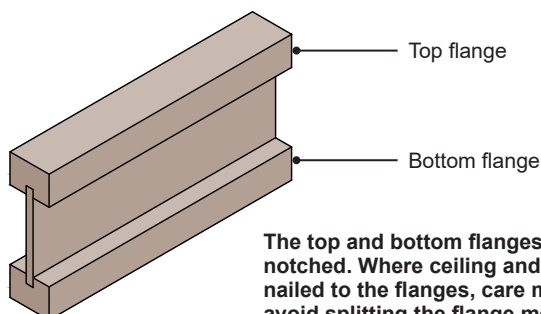
Floor boarding

Fig 5 (Joist hanger detailing)

Proprietary stiffeners to be used in web void where i-joist is built in to the internal wall (or where built in to the inner leaf of the cavity wall)

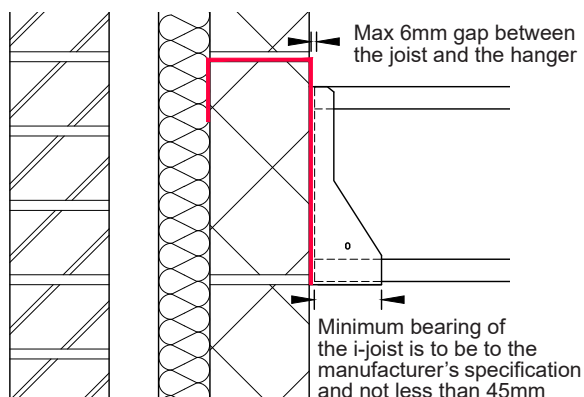
I-joists are not suitable for building in to a solid external wall

#### Top and bottom flange



The top and bottom flanges **must not** be notched. Where ceiling and floor boards are nailed to the flanges, care must be taken to avoid splitting the flange member.

**Fig 5 Joist hanger detailing**



Where hangers are specified they should be either:

- Full depth of the joist and restrain top flange, **or**
- At least 0.6 x depth of the joist and have web stiffeners specified for the full depth of the joist (to both sides of the web).

## I-joists bearing on to a timber frame

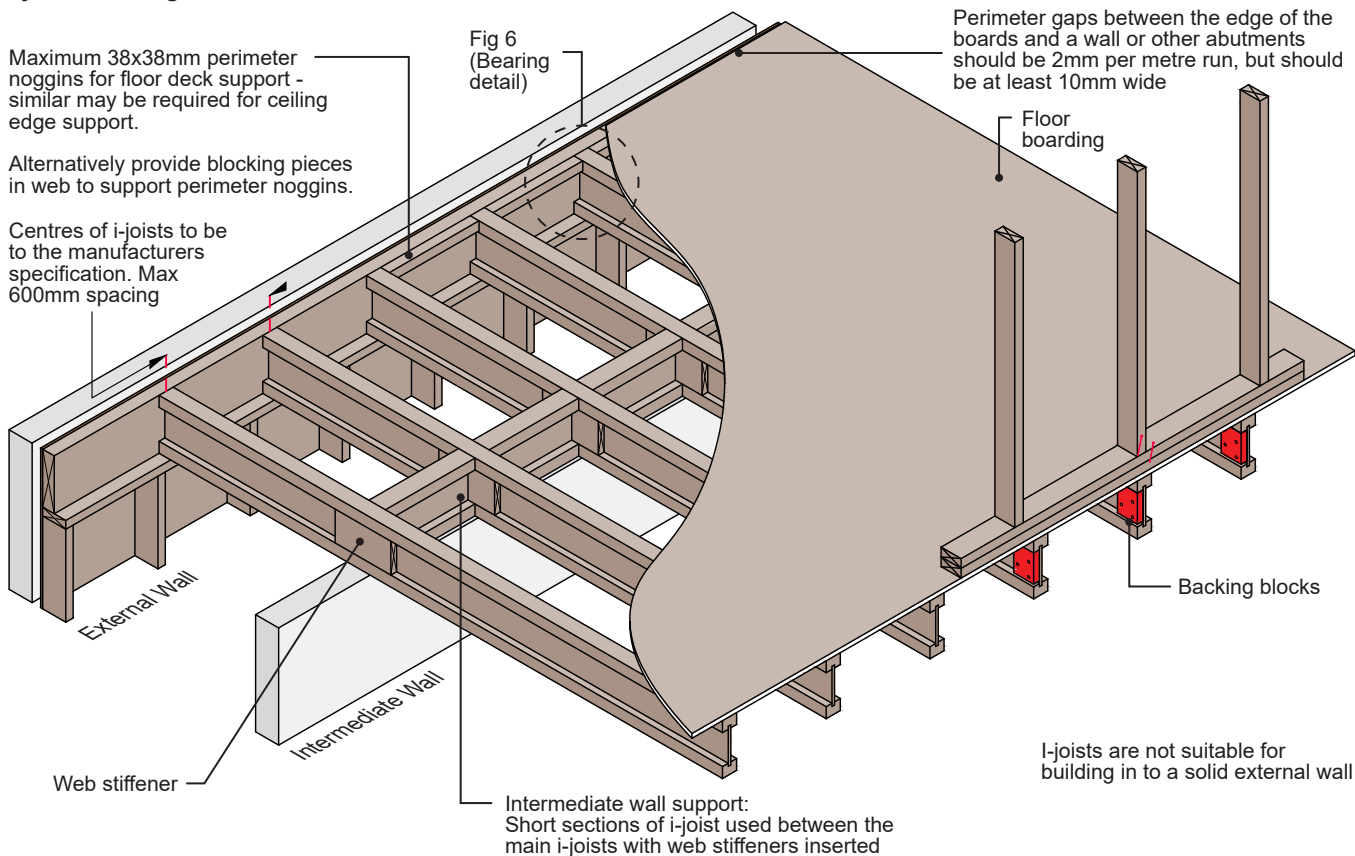
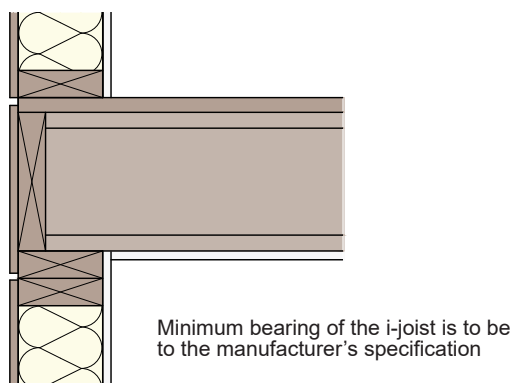
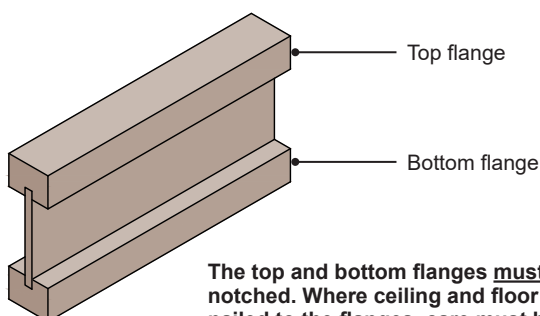


**Fig 6 Bearing detail**



## Top and bottom flange



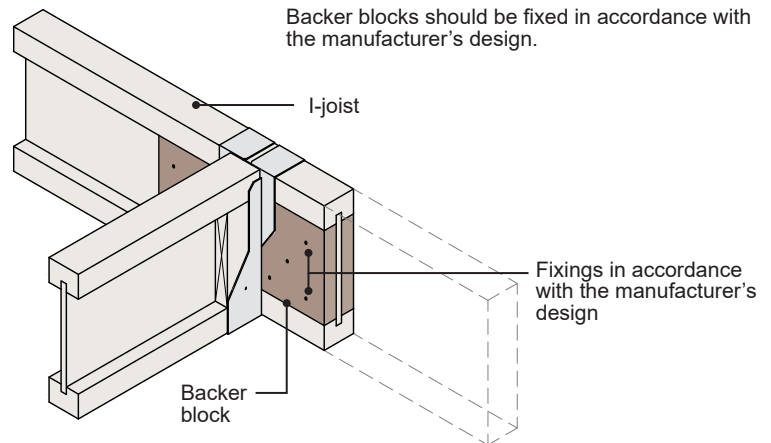
The top and bottom flanges **must not** be notched. Where ceiling and floor boards are nailed to the flanges, care must be taken to avoid splitting the flange member.



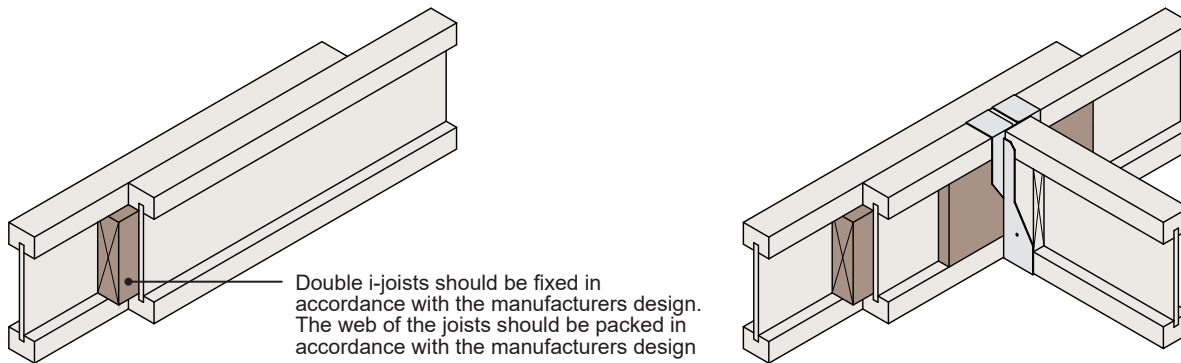
### Backer blocks

Trimmed openings may be needed around staircase openings and chimneys. Solid trimmed joists may be supported using joist hangers. Timber trimmers around openings should consist of at least two members and be designed and installed in accordance with the manufacturer's instructions. Where an I-joist is faced fixed to another I-joists backer blocks should be provided on both sides of the web of the trimmer.

Fixing of I-joists should be in accordance with the Engineers design and specification. A timber filler block should be installed between I-joists.

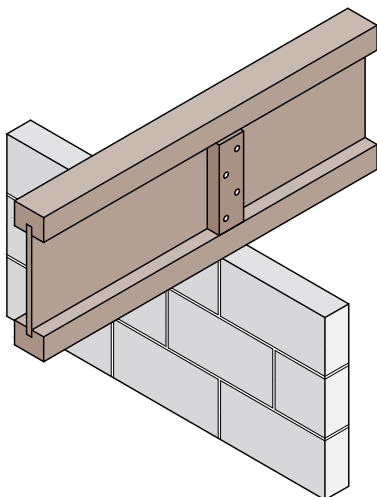


### Fixing of multiple I-joists



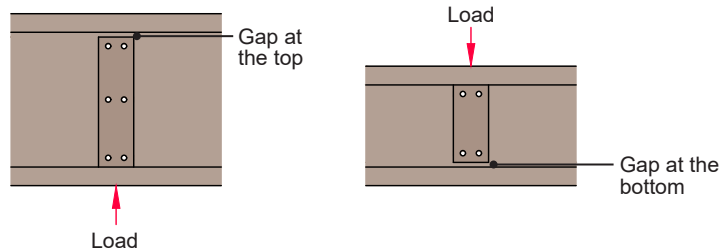
### Building in of I-joists over internal walls

To reduce shrinkage, all mortar should be adequately dry and solidly packed in, but it should not be packed up tight to the underside of the top flange. Before the floor decking is fixed, all continuous joists must be packed down to the intermediate bearing wall.



Additional blocking should be installed in accordance with the manufacturer's instructions.

Generally a gap is required at the top or bottom of the packing, dependent on the direction of the load. Generally if the load comes from the bottom e.g. bearing on an internal wall the gap should be at the top. If the load is from the top the gap should be provided at the bottom.



The backing blocks should be fixed in accordance with the manufacturers design. Generally, backing blocks on deeper joists require a higher number of fixings.

## General detailing for metal web joists

### Metal web bearing on to masonry walls

Perimeter gaps between the edge of the boards and a wall or other abutments should be 2mm per metre run, but should be at least 10mm wide

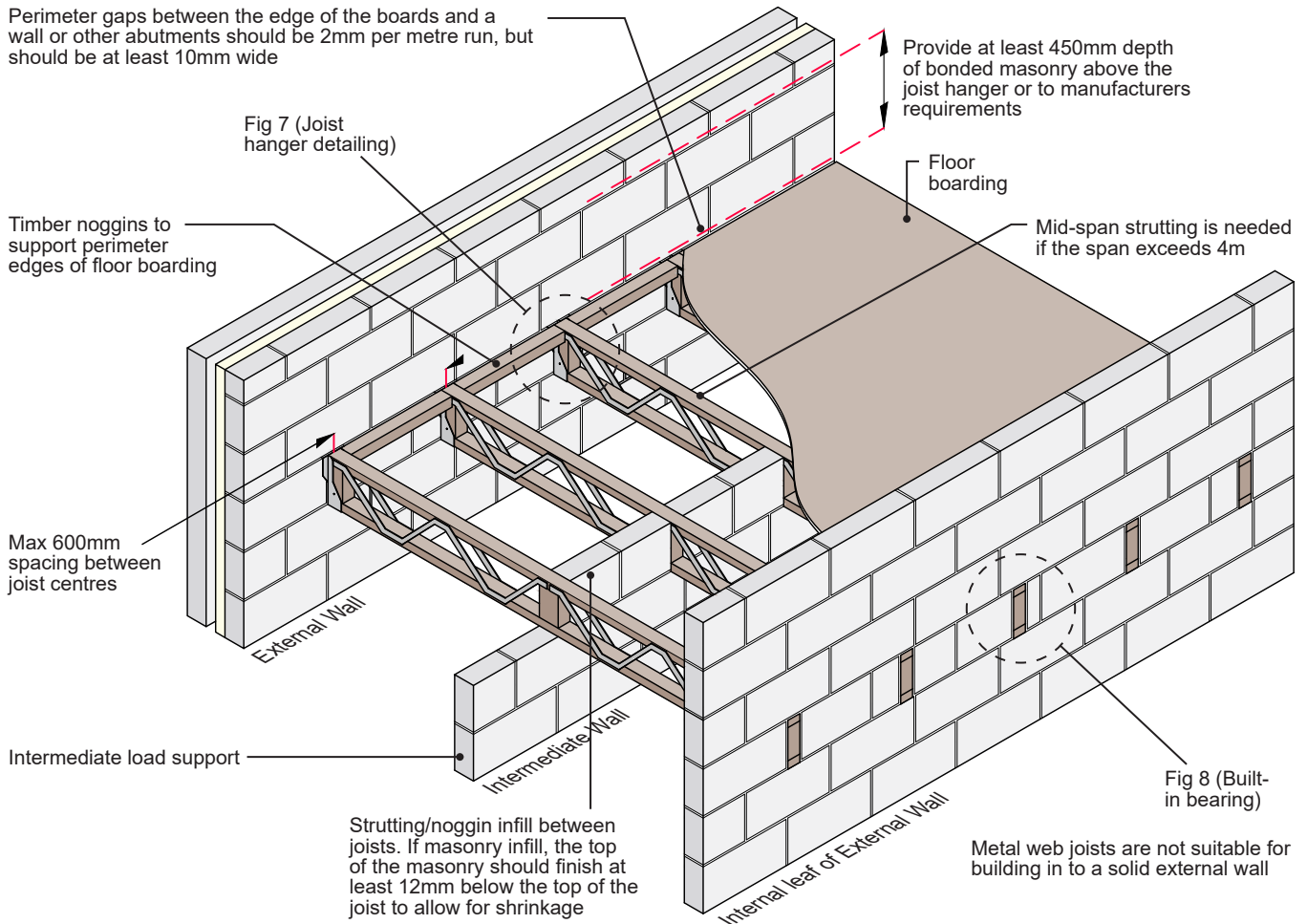
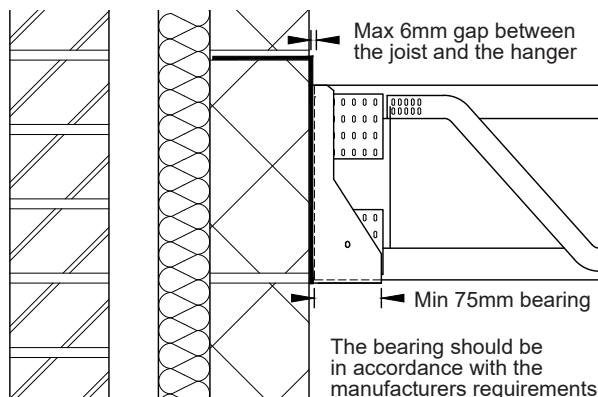
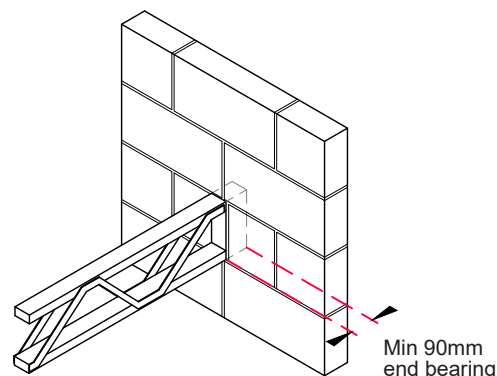


**Fig 7 Joist hanger detailing**



Hangers should be full depth of the joist and provide restraint to the top flange. Alternatively, there should be an alternative means of providing restraint to the top flange of the joist. Timber uprights should be fixed between the top and bottom flanges.

**Fig 8 Built-in bearing**





### Metal web bearing on to a timber frame

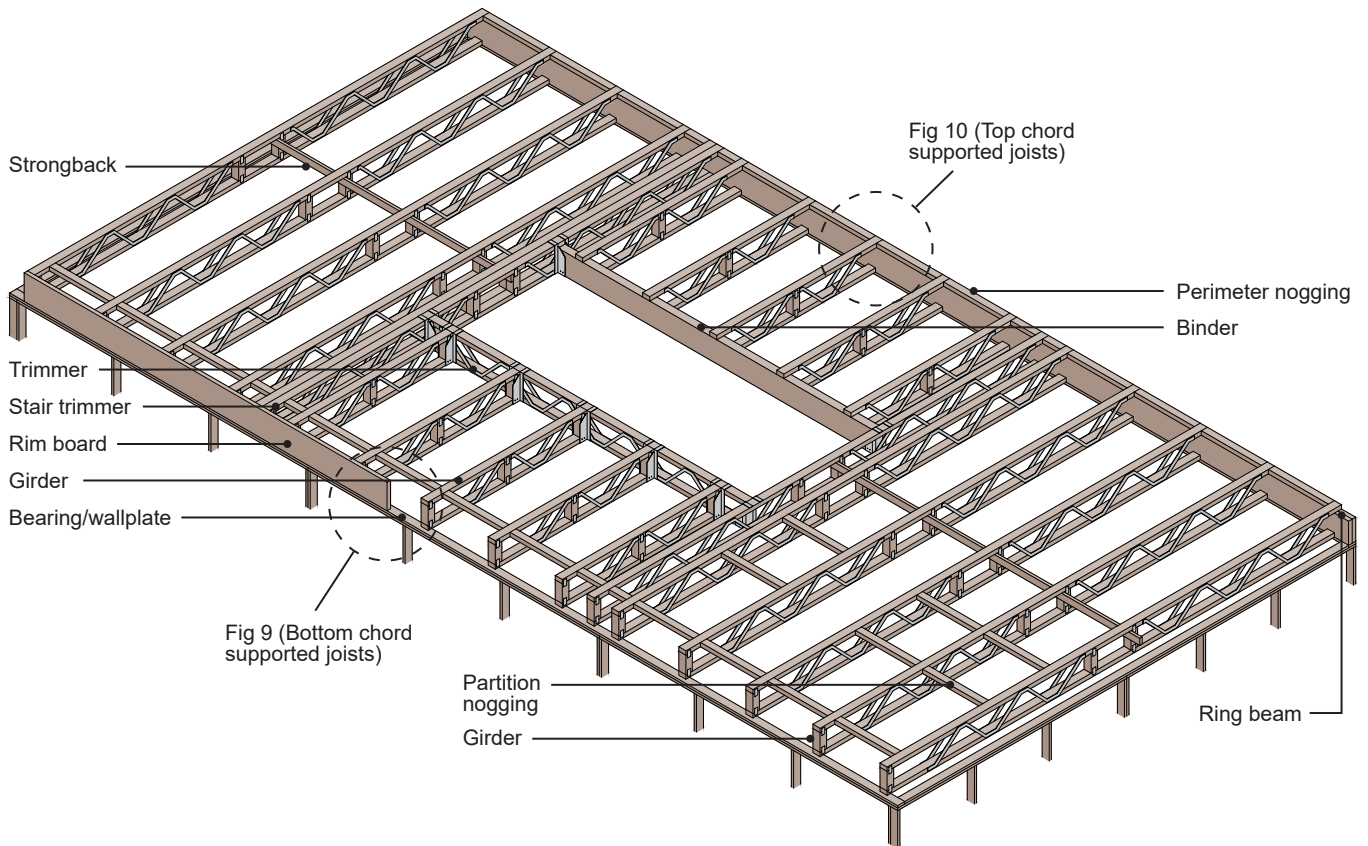
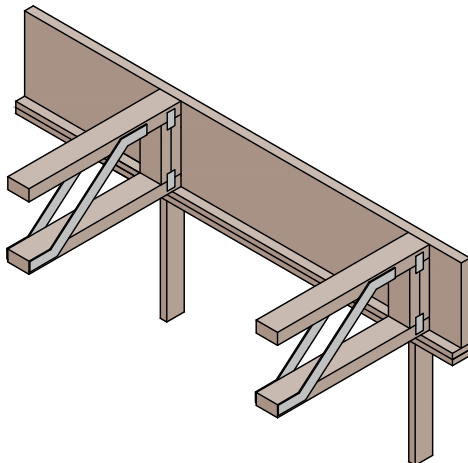


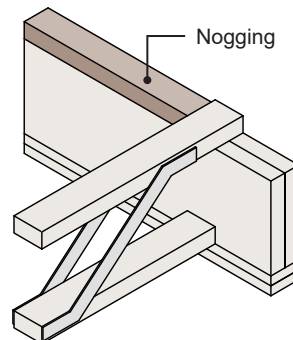
**Fig 9 Bottom chord supported joists**



Traditional arrangement - bottom chord supported joists on normal height panels.

The rim board around the outside closes off the floor zone. Solid timber blocking in between the joists provides support for the panel above.

**Fig 10 Top chord supported joists**

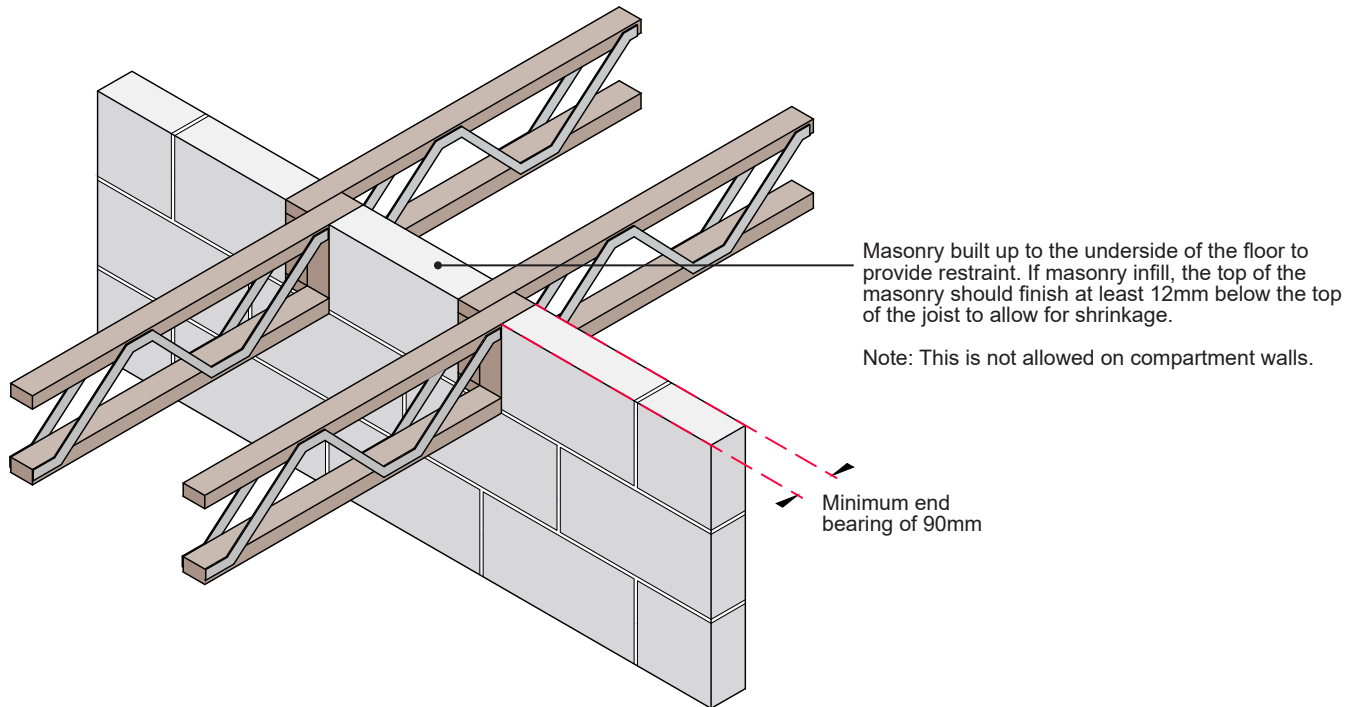


Standard height panel - top chord supported joist.

Solid noggins on top of the rim board in between the joists to provide support for the panel above.

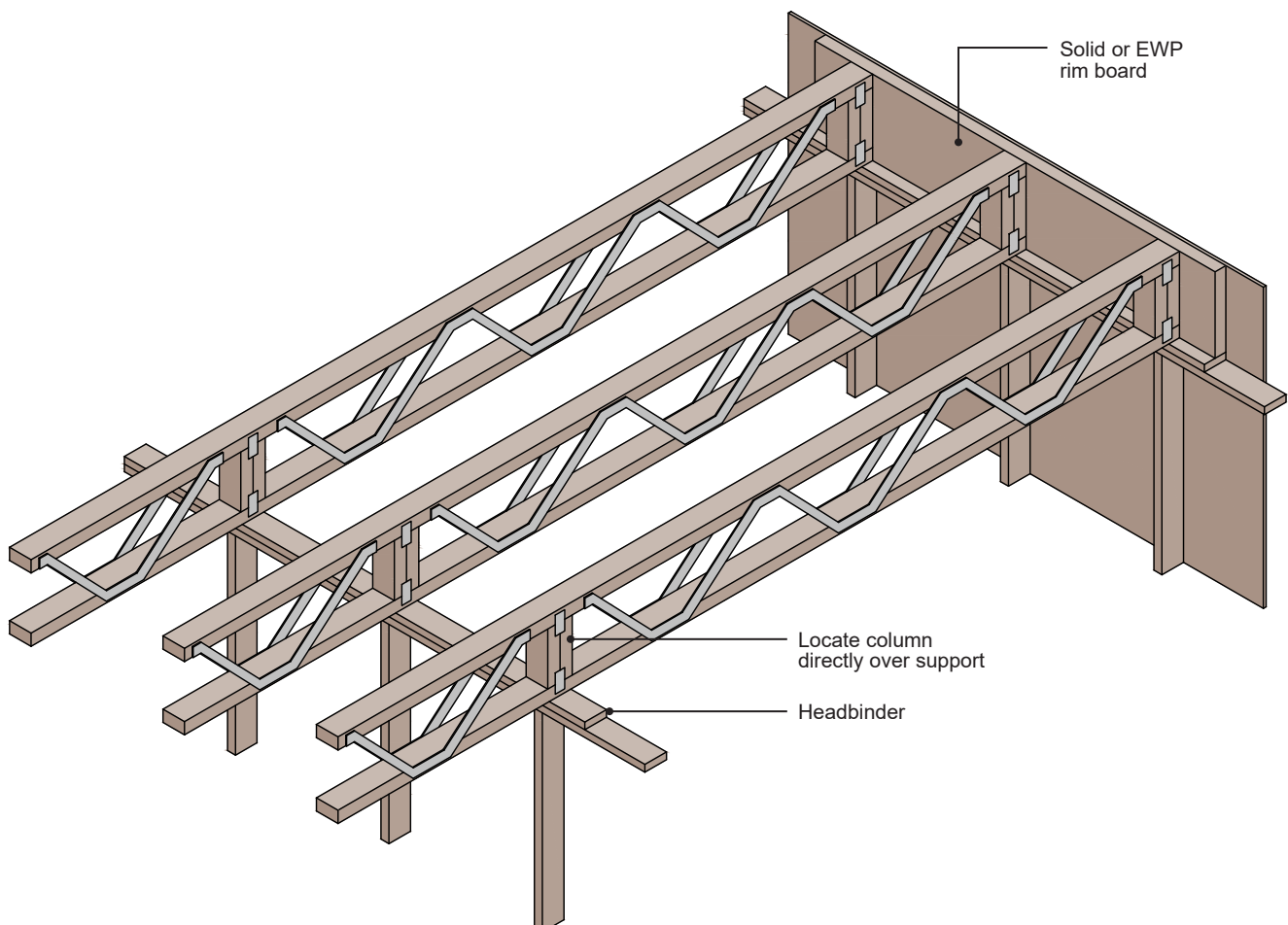
The floor decking will typically extend to the back of the noggins/end of the joist to tie the panels in with the floor.

## Metal web joists supported on load bearing masonry internal wall



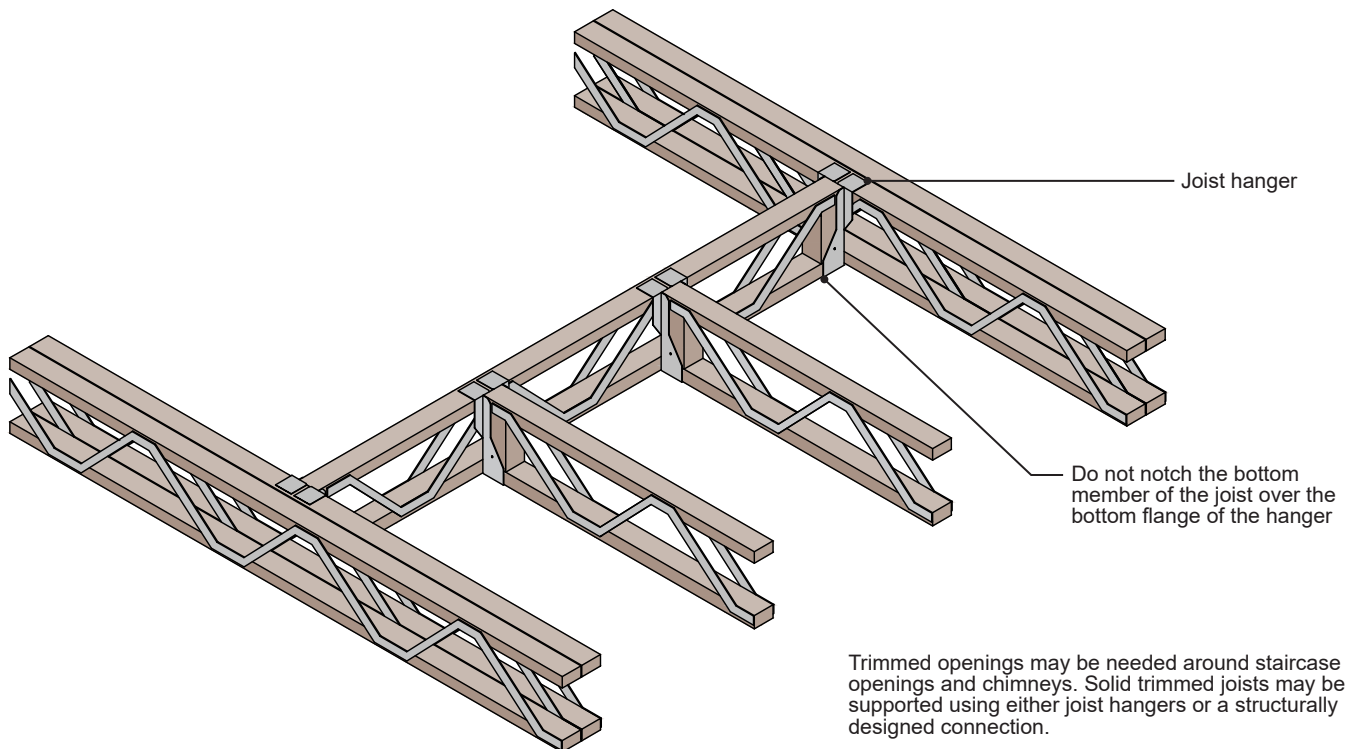
## Metal web joists supported on load bearing timber internal wall

Example of metal web joists bearing on intermediate load bearing wall. Column within the metal web joist should be located directly over the support. In accordance with the manufacturers design.



**Typical trimming detail**

Double joists should be fixed as per the manufacturer's design, this can be with a proprietary clip or fixed at specified centres with fixings provided by the manufacturer. It is important to ensure that the work on site is in accordance with the manufacturer's design.

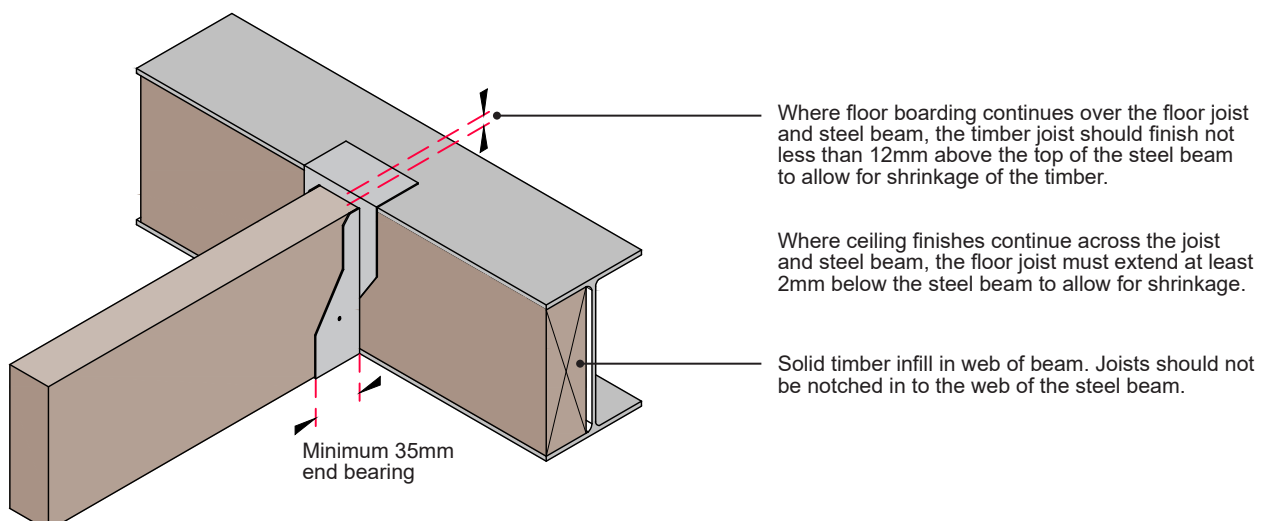
**10.1.6 Steel beams supporting timber joists**

The designer shall provide detailing where timber joists are to be supported off steel beams.

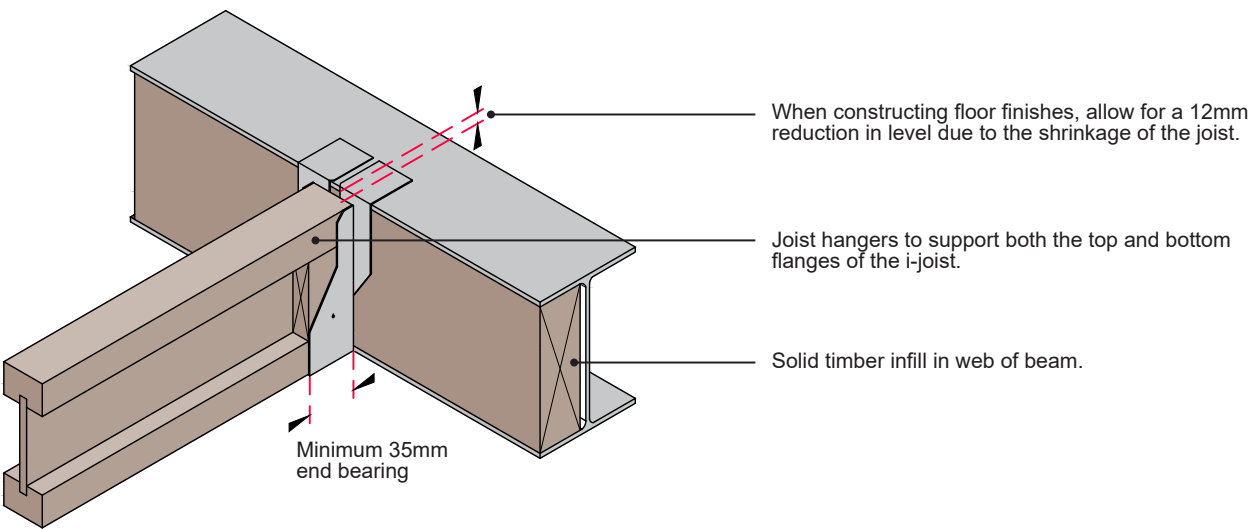
Steel beams should be designed by the Engineer and should have appropriate fire resistance to meet the requirements of the relevant Building Regulations.

Where steel beams and columns are used to support the upper floor construction on a project in a coastal location, and maybe exposed to an aggressive external environment (e.g. undercroft) please follow the requirements for additional corrosion protection in the 'Appendix B - Coastal Locations' and 'Appendix C - Materials, Products, and Building Systems' section.

To prevent the distortion of finishes, joists should be stopped from twisting over supports and provision provided to accommodate up to 12mm of drying shrinkage in floor joists supported by steel beams.

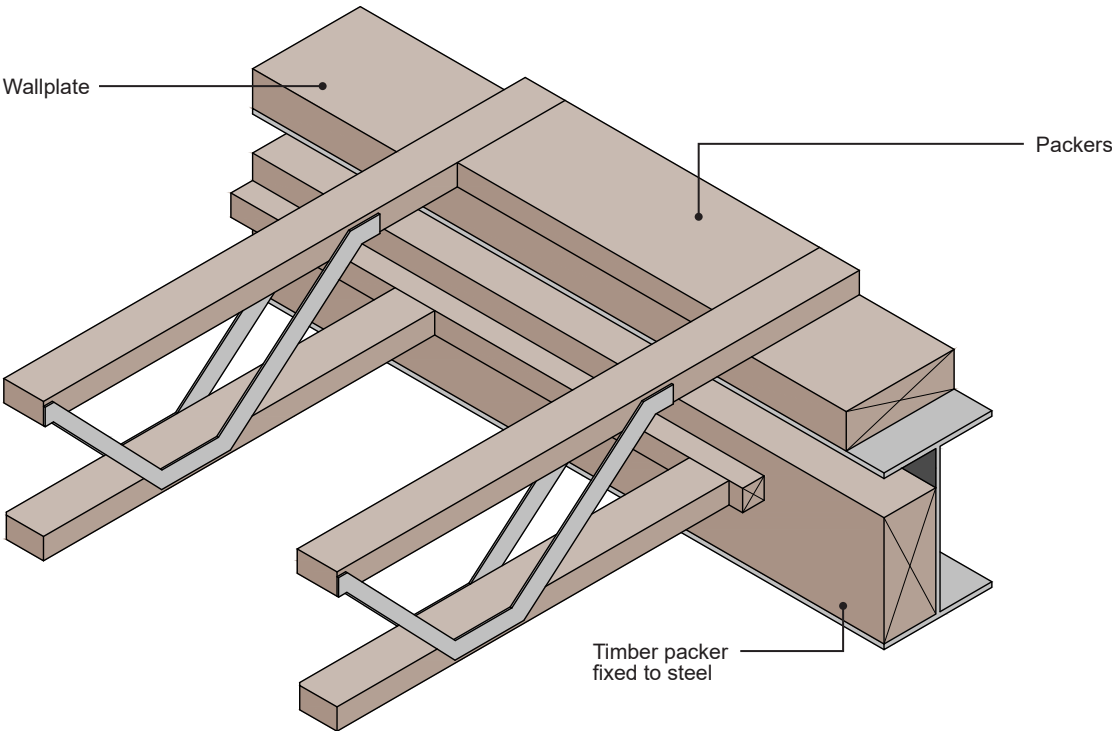
**Traditional solid timber joists**

I-joists



Metal web joists

Metal web joists may be top hung subject to the manufacturer's site specific design.



10.1.7 Strutting of timber joists

Strutting shall be provided in accordance with the design to distribute loads and ensure adequate rigidity of the floor structure.

Strutting for traditional solid timber joists and I-joists

Where traditional solid timber joists or I-Joists are specified, strutting should be provided in accordance with the following table. Where I-Joists are specified, strutting should also be in accordance with the manufacturer's recommendations.

| Joist span  | Rows of strutting                 |
|-------------|-----------------------------------|
| Up to 2.5m  | None                              |
| 2.5m - 4.5m | 1 at midspan                      |
| Over 4.5    | 2 at 1/3 points of the joist span |

**Traditional solid timber joists**

Where the span of a floor joist is more than 2.5m, strutting is necessary. This should be provided either by timber bridging or strutting in accordance BS 8103-3: 2009 or by a proprietary system.

Timber strutting can be in the form of solid bridging of at least 38mm basic thickness and with a depth equal to at least three-quarters of the depth of the joists; or it can consist of herringbone strutting with members of at least 38mm by 38mm basic size. Herringbone strutting should not be used where the distance between the joists is more than approximately three times the depth of the joists.

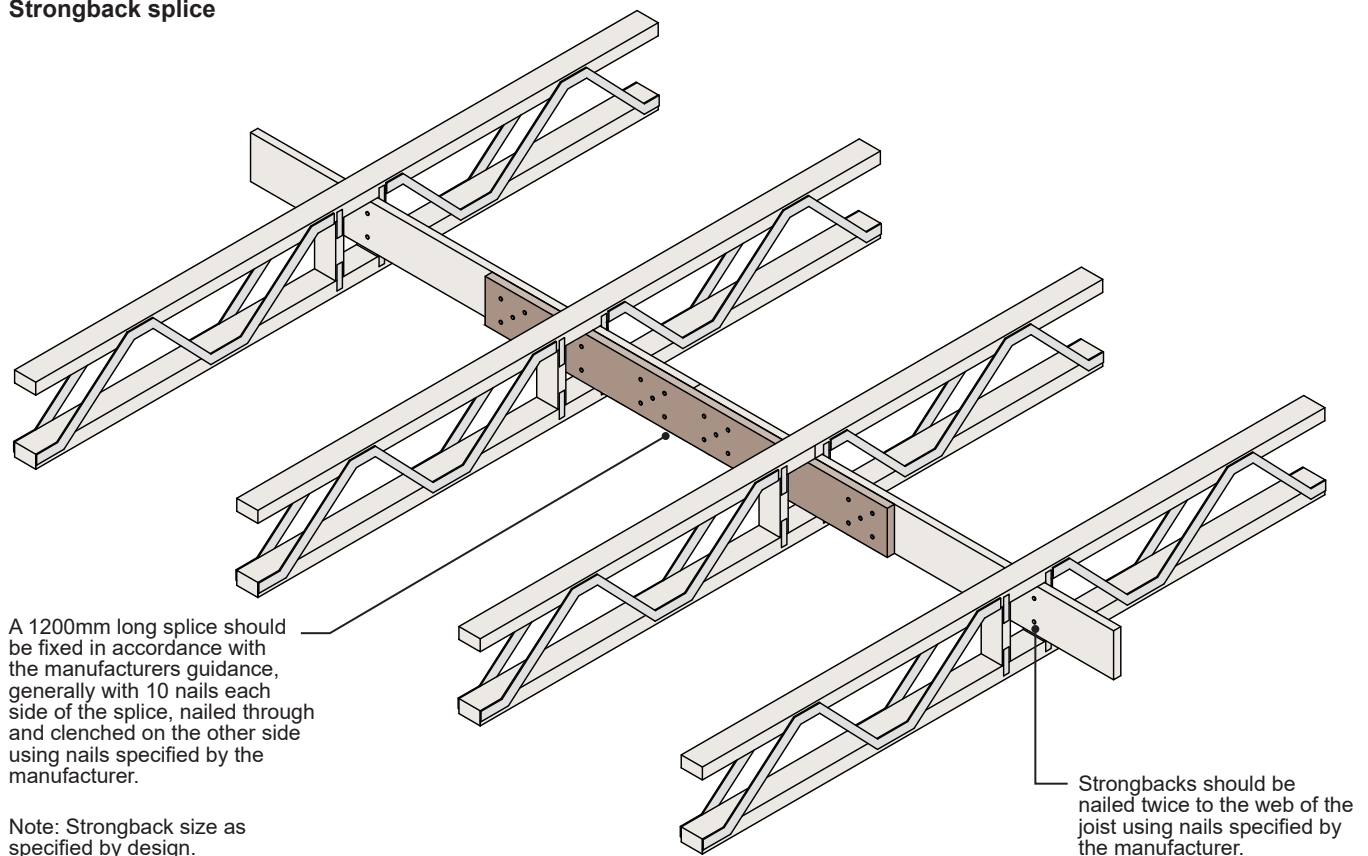
**Proprietary strutting devices for I-joists**

An alternative to solid strutting is Steel herringbone strutting systems, which are generally pressed lengths of galvanized mild steel, usually 1mm thickness and are produced in a variety of lengths to suit differing joist depths and spacings.

**Strutting for metal web joists**

Strutting to metal web joists should be provided in accordance with the manufacturer's guidance and the following table.

| Joist span | Rows of strutting                 |
|------------|-----------------------------------|
| 4m - 8m    | 1 (at centre of span)             |
| Over 8m    | 2 at 1/3 points of the joist span |

**Strongback splice**

Note: Strongback size as specified by design.

**10.1.8 Lateral restraint of walls**

Timber upper floors shall provide adequate lateral restraint in accordance with the design.

Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations. Restraint can be provided by:

- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Where restraint type joist hangers are specified, they should be detailed in the design, including confirmation that the joist hangers have the equivalent to restraint straps at 2m centres where required to provide restraint.

Please refer to the 'External Walls' section for further guidance.

## 10.1.9 Sound resistance

Internal separating floors shall, where necessary, meet the requirements for the resistance of sound in the relevant Building Regulations.

Internal separating floors shall, where necessary, meet the requirements of the relevant Building Regulations in relation to the resistance of sound and sound testing requirements.

## 10.1.10 Structural floor boarding

Structural floor boarding shall be:

- Suitable for the intended purpose.
- Of an adequate strength and suitably supported.
- Moisture resistant.
- Installed and fixed in accordance with the manufacturer's recommendations.

### General requirements

Where structural floor boards are specified, the following should be taken into account:

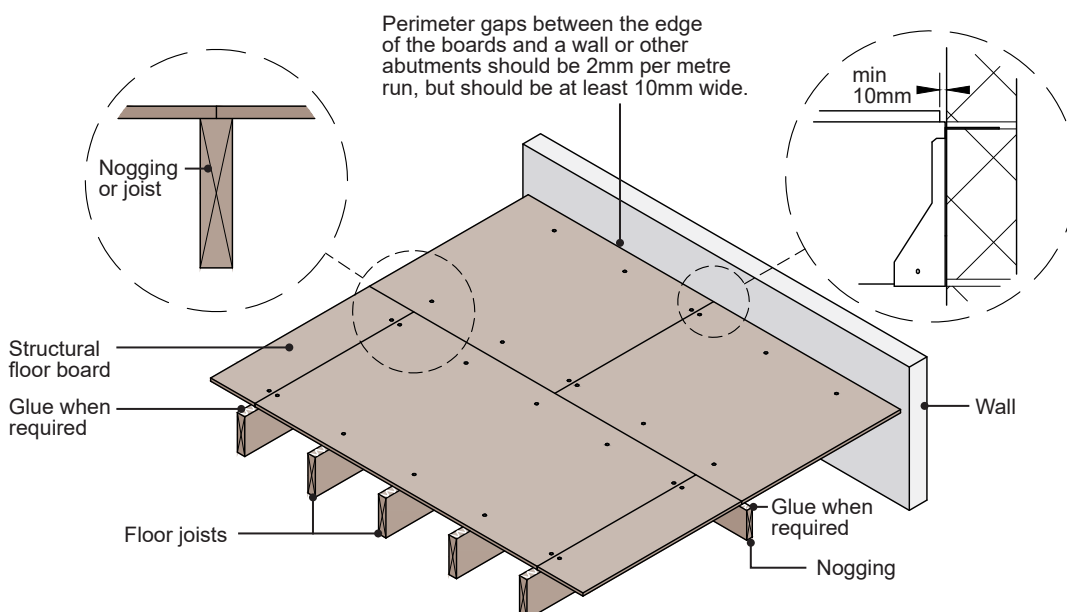
- They should be specified in accordance with the 'Minimum thickness for structural floor boards' table, guidance within this section and relevant British Standards.
- Fixings should be in accordance with the manufacturer's recommendations, where this is not provided, the guidance within this section or BS 8103-3 should be used.
- Where gluing is required, boards should be glued to the joists and between board joints, using a suitable polyvinyl acetate (PVAc) adhesive.
- Square edged boards should be supported on all edges by joists or noggings.
- Tongue and groove boards should be laid:
  - With long edges at right angles to joists.
  - So that short edges are supported on joists or noggings or they should be cut back to form a butt joint over a joist.
  - So that long edges at room perimeters are supported on a joist or noggings.
- Perimeter gaps between the edge of the boards and a wall or other abutments should be 2mm per metre run, but should be at least 10mm wide.

### Protection against weather

Structural floor boards that are built in as the work proceeds and left exposed to the elements will be subjected to various issues, especially during prolonged periods of precipitation. As such, we require these floor boards for timber joists (both engineered and traditional) to have a third party approval certificate from an independent approval body which is accepted by us which covers weather resistance for the period of time the boards are to be left exposed on site.

Any boards that are left exposed beyond the period stated in the third party product conformity certificate should be replaced.

### Typical floor board arrangement





### Minimum thickness for structural floor boards

Structural floor boards should be specified in accordance with the following table<sup>1</sup>.

| Structural floor board type | 400mm joist centres | 450mm joist centres | 600mm joist centres |
|-----------------------------|---------------------|---------------------|---------------------|
| Softwood floor boarding     | 16mm                | 16mm                | 19mm                |
| Particle board (chipboard)  | 18mm                | 18mm                | 22mm                |
| Oriented strand board (OSB) | 15mm                | 15mm                | 18mm/19mm           |
| Plywood boarding            | 15mm                | 15mm                | 18mm/19mm           |

<sup>1</sup> This table applies to normal domestic loads (imposed loads of 1.5 kN/m<sup>2</sup>)

### Softwood floor boarding

- Softwood floor boarding should be specified in accordance with BS EN 13353 and BS 1297.
- Maximum moisture content at the time of fixing should be between 15%-19% (this may be reduced when installing in heated spaces, see BS 8103-3 for further details).
- All boards must be double nailed or secret nailed to each joist using nails that are at least three times the board depth.

### Particle board (chipboard) and oriented strand board (OSB)

- Particle board should be type P5 to BS EN 312 or OSB boards should be type 3 or 4 to BS EN 300.
- Maximum moisture content at the time of fixing should be 12%.
- Flat headed annular-ringed shank nails or screws should be used.
- All fixings should be a minimum of 50 mm or 2 times the thickness of the board, whichever is greater.
- The diameter of the fixing should be a minimum of 0.16 times the thickness of the board.
- Fastenings should be spaced at centres not more than 150 mm along both continuously supported edges and 300 mm along the intermediate supports.
- Fastenings should be at least 8 mm from the edge of the board.
- Nail heads should be punched 2-3mm below the surface of the board and screws should pre-drilled and countersunk.
- Fixings in service class 2 fixings should be corrosion resistant.
- A 3 mm gap should be left between each square edge boards.

### Plywood boarding

- Plywood boarding should be specified in accordance with BS EN 636.
- Maximum moisture content at the time of fixing should be 12%.
- Plywood boarding should be laid so that the grain within the face is at right angles to the supporting elements.
- Fixings should be spaced at a maximum of 150mm around the outer perimeter of the boards, with fixings a maximum of 300mm apart at intermediate supports.
- An expansion gap of a minimum of 2mm should be allowed between each panel.

### Plywood boarding: Minimum fixing nails

|                     | Plain wire nails | Annular ring shank nails |
|---------------------|------------------|--------------------------|
| Minimum diameter    | 3.35mm           | 3mm                      |
| Minimum length      | 65mm             | 50mm                     |
| Minimum penetration | 40mm             | 32mm                     |

### 10.1.11 Plasterboard requirements

Plasterboards shall:

- Be adequately supported and fixed in accordance with the manufacturer's instructions.
- Provide an adequate surface to receive the intended finish required by the design.
- Supporting test evidence will be required where the plasterboard is intended to perform additional functions (e.g. fire or acoustic resistance).

### Support of plasterboard

Supports for plasterboard should be designed so that the following span limits are not exceeded:

| Board thickness | Timber support centres | Intermediate supports required | Perimeter supports required <sup>1</sup> |
|-----------------|------------------------|--------------------------------|------------------------------------------|
| 9.5mm           | 400mm                  | No                             | Yes                                      |
|                 | 450mm                  | Yes                            | Yes                                      |
| 12.5mm          | 400mm                  | No                             | Yes                                      |
|                 | 450mm                  | No                             | Yes                                      |
| 15mm            | 600mm                  | Yes                            | Yes                                      |
|                 | 600mm                  | No                             | Yes                                      |

<sup>1</sup> Fire resisting plasterboard should be fully supported at edges by noggins if the floor joist are not against the wall.

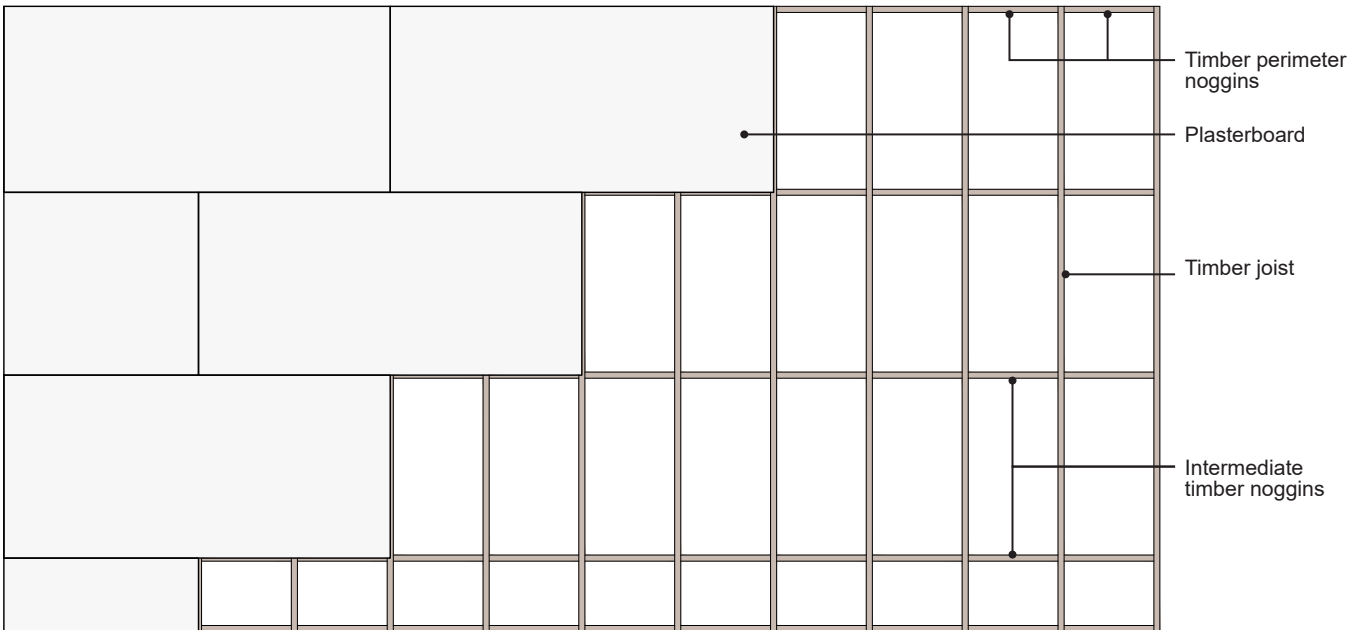
## Fixing of plasterboards

When fixing plaster boarding:

- Fix boards with decorative side out to receive joint treatment or a skim plaster finish.
- Lightly butt boards together and never force boards into position.
- Install fixings no closer than 13mm from cut edges and 10mm from bound edges.
- Position cut edges to internal angles whenever possible, removing paper burrs with fine sandpaper.
- Stagger horizontal and vertical board joints between layers by a minimum of 600mm.
- Locate boards to the centre line of framing where this supports board edges or ends.
- Fix to timber joists using dry-wall screws.

Gaps between boards should not exceed 3mm and consideration should be given to sealing all gaps to improve building air tightness.

### Ceiling plan - plasterboard fixed to timber joists



### 10.1.12 Plastering

Plastering shall provide an adequate surface to receive the intended finish as required by the design.

#### Plastered finishes

Workmanship of plastered finishes to ceilings should be applied to a certain standard to receive a suitable decorative finish. It should be durable enough to prevent surface cracking and, if applicable as part of the whole element, meet the required levels of fire and sound insulation in accordance with current Building Regulations.

#### Substrate and background

Plasterwork should be applied to suitable substrates. The substrate may also require additional sealing or bonding agents, in accordance with the requirements set out in BS 8481.

#### Plaster mixes

Plaster mix ratios should be in accordance with manufacturer's recommendations and be appropriate for the intended use.

#### Minimum plaster thicknesses

The thickness of plaster will vary depending on the evenness of the substrate. The finished element must meet the tolerances identified in this Technical Manual, and be of a suitable quality so that a decorative finish can be applied. Minimum thickness should be in accordance with the table below.

| Element                | Minimum number of coats | Typical thickness                           |
|------------------------|-------------------------|---------------------------------------------|
| Ceiling – plasterboard | 1                       | Skim to provide suitable and durable finish |



## Introduction

This section provides guidance on meeting the performance requirements for the following types of concrete upper floors:

- Beam and block
- Concrete plank

Throughout this section, both beam and block, and concrete plank floors will collectively be referred to as concrete upper floors.

### 10.2.1 Compliance

The design, specification and installation of concrete upper floors shall satisfy the performance requirements of this section.

### 10.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Manufacturer's floor layout drawings and calculations.
2. Plan details showing dimensions, levels and locations of incoming service penetrations.
3. Details indicating the locations of all load and non-load bearing walls.
4. The manufacturer's third party product conformity certificate for the proposed insulation to be used within the floor.
5. Details of underfloor heating systems where being used.
6. A third party product conformity certificate for non-standard beam & block flooring.
7. Details of proposed floor screeds including thickness and mix.
8. Details of substrates to which the screeds will be laid upon.
9. Details of proposed curing times and environmental constraints.
10. Details of services within the floor, including underfloor-heating.
11. Details of suspended ceilings and manufacturer's fixing instructions.
12. The following should be provided for the proposed plasterboard to be used:
  - a. Details of proposed plasterboards to be used; type of board, thickness, number of boards to create the layer.
  - b. Details of mechanical fixings of plasterboards.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 10.2.3 Structural design

Concrete upper floors shall be durable and safely support and transmit intended loads to the supporting structure without undue movement.

Concrete upper floors are proprietary products, which the design and construction are specific to the manufacturer of the product. Projects incorporating precast beams or planks must be provided with full manufacturers design, structural calculations and specifications including fixings specific for the project in accordance with BS EN 1992-1-1.

Concrete upper floors should have loads calculated in accordance with BS EN 1991-1-1.

## Deflection

For concrete upper floors, designers and Engineers must observe our tolerance requirements for levelness and deflection limits of floors. Please refer to the 'Tolerances' section for further guidance.

There may be an instance where a joist might be designed to meet permissible deflections within a relevant British Standard; however, our tolerance requirements will take precedence.

### 10.2.4 Storage and protection against damage

Concrete upper floors shall be carefully stored and handled on-site, preventing damage occurring before, during and after incorporation into the structure.

## 10.2.5 Installation and workmanship

Concrete upper floors shall:

- Be installed in a manner which does not effect their durability or performance.
- Be in accordance with the manufacturer's recommendations and the site specific specification.
- Have all workmanship satisfy the 'Tolerances' section.

Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

### General

- The installation of concrete upper floors must follow the manufacturer's guidance and specification for the project.
- Concrete upper floors should be fully supported by load-bearing walls.
- The bearing surface of walls, beams and other supports to receive precast units are to be smooth and level.
- Infill blocks and slabs should fully bear onto supporting beams and walls.
- Holes for service pipes are properly filled by laying non-timber formwork between PC joists and filling with good quality concrete (ST2 mix) prior to screeding.
- Beams and planks should bear onto masonry with a minimum 90mm bearing, and steelwork with a minimum 75mm bearing.
- Similar beams/planks of the same size may have differing strength properties because of their varying reinforcement size, so it is important to check unit reference numbers and their layout.

### Beam and block

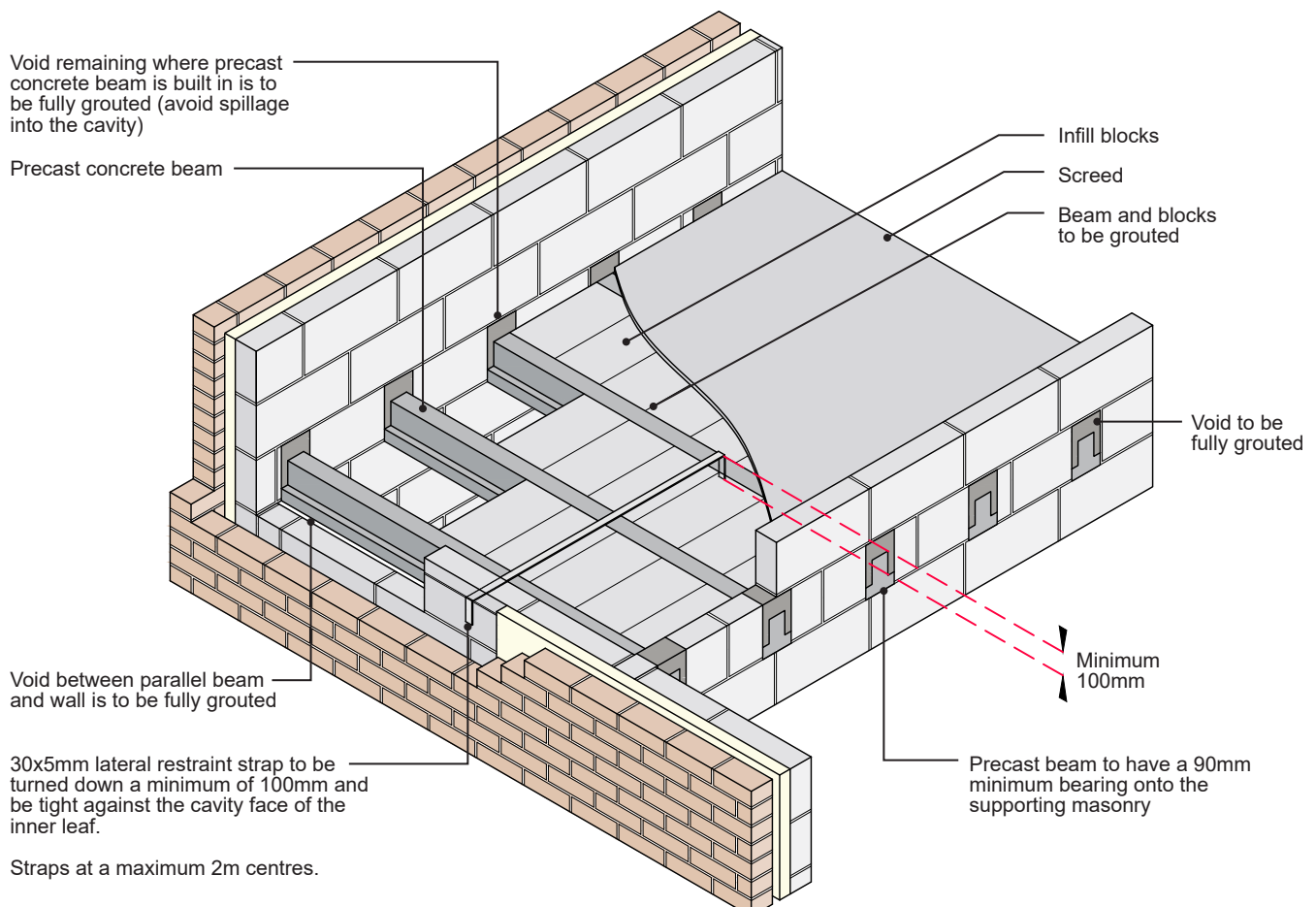
Precast beams or beam and block floor constructions must be laid reasonably level and onto suitable solid and level bearings.

It is essential sometimes to provide two or more beams adjacent to each other where spans are excessive or in heavily loaded areas. Suitable infill bricks or blocks are to be properly bedded on mortar and provided between pre cast (PC) beams where bearing onto supporting walls.

Beams and blocks are to be grouted together with a 1:6 cement to sand mix in accordance with the manufacturer's instructions.

Load-bearing walls are to continue through the beam and block floor.

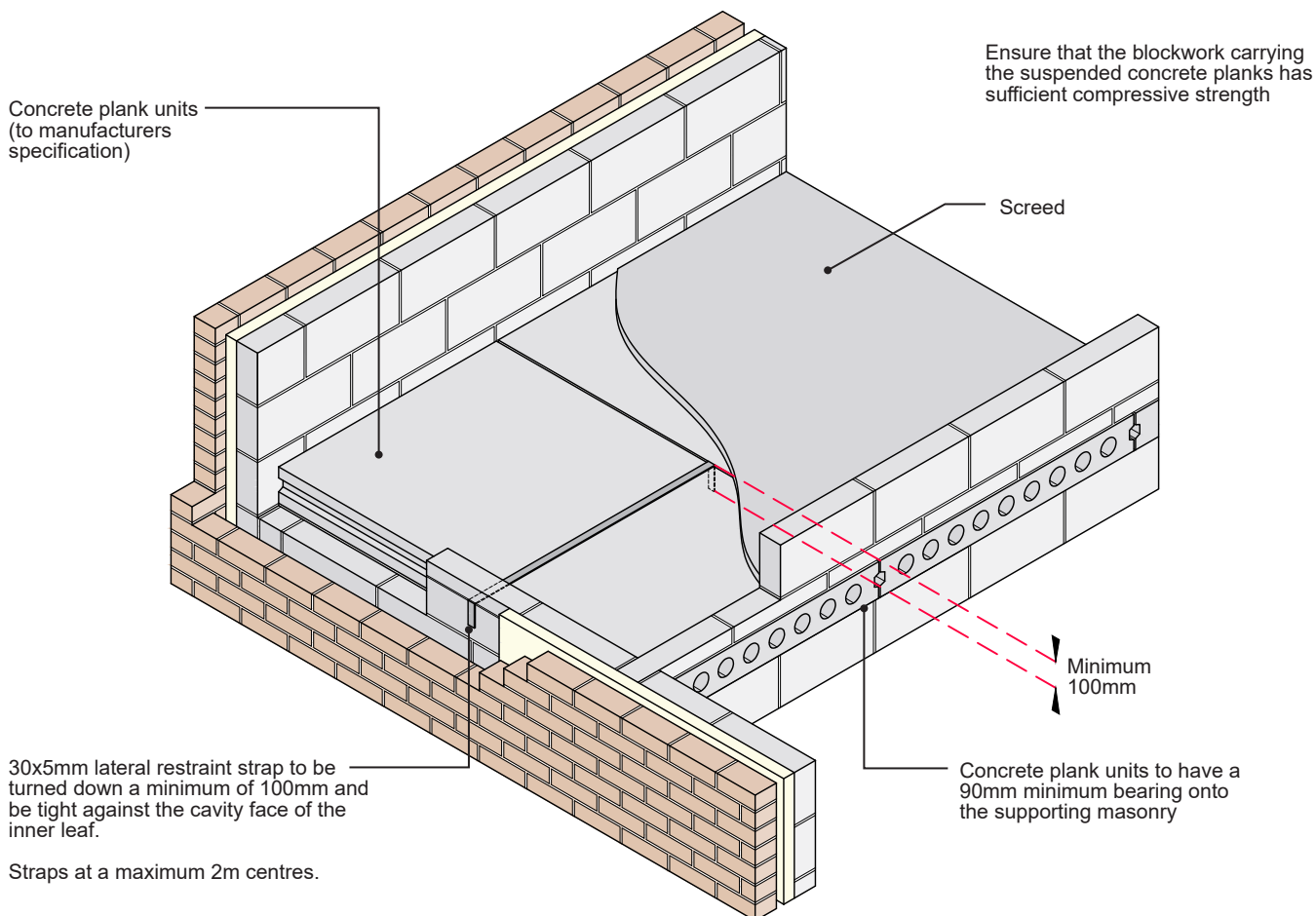
Ensure that the blockwork carrying the beam and block flooring has sufficient compressive strength.



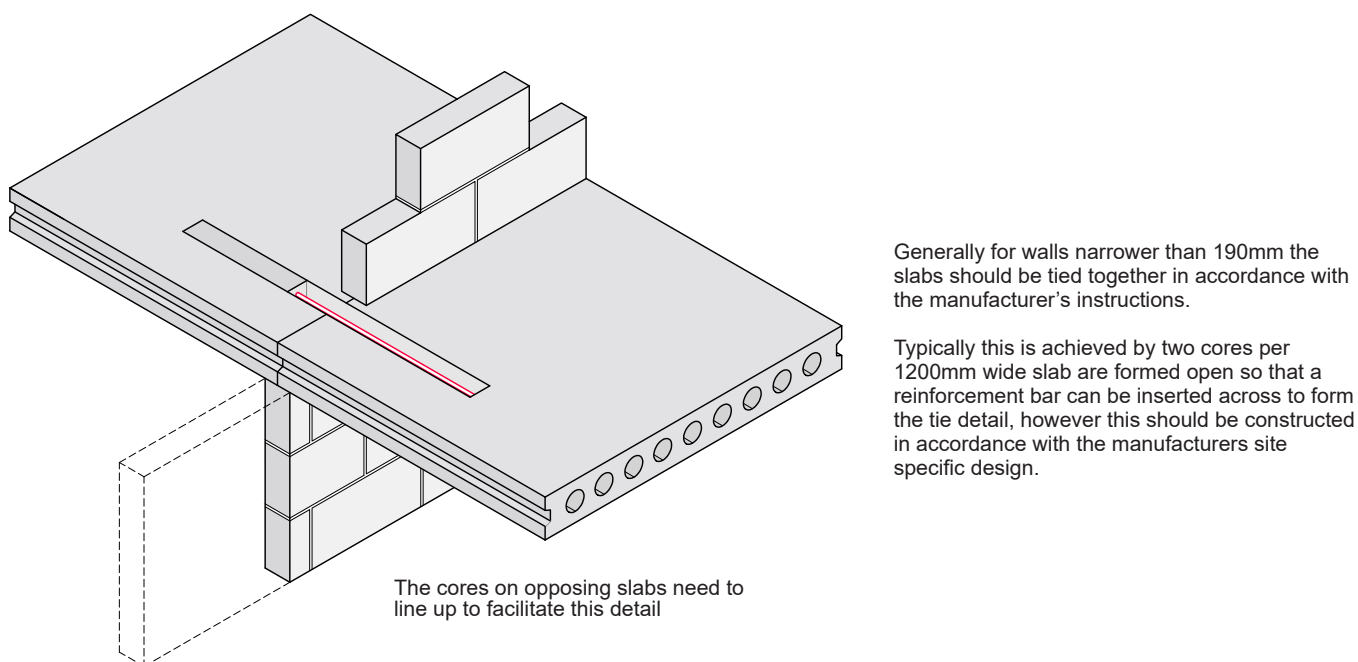
### Concrete plank

Suspended concrete planks should be grouted in accordance with the manufacturer's instructions ensuring the correct strength and aggregate size is used.

### General detailing



### Narrow wall bearing

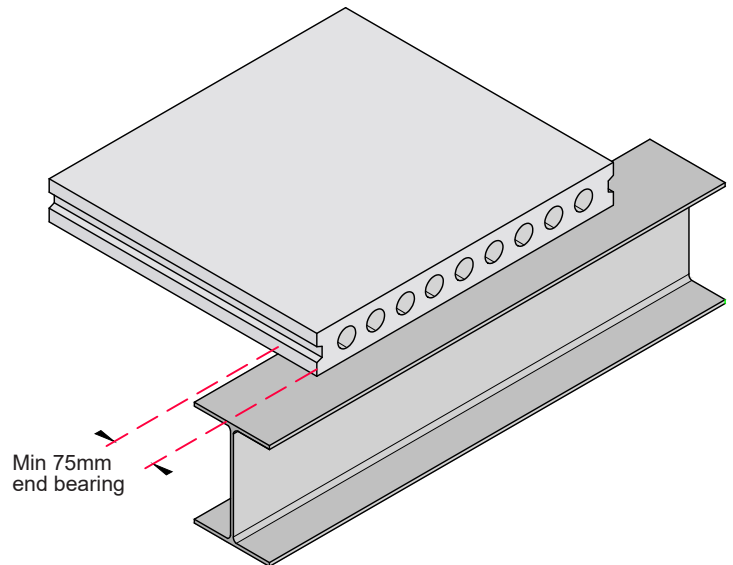


## Bearing on top of steelwork

A minimum of 75mm bearing should be provided on steel beams. Planks may require mechanical restraint to the steel beam in accordance with the manufactures specification.

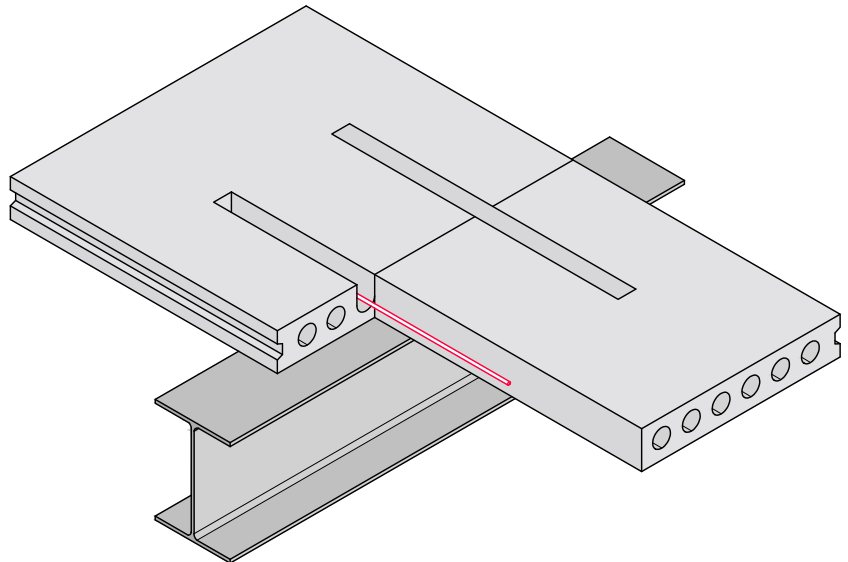
Steel beams should be designed by the Engineer and should have appropriate fire resistance to meet the requirements of the relevant Building Regulations.

Where steel beams and columns are used to support the upper floor construction on a project in a coastal location, and maybe exposed to an aggressive external environment (e.g. undercroft), please follow the requirements for additional corrosion protection in 'Appendix B - Coastal Locations' and 'Appendix C - Materials, Products, and Building Systems'.



## Continuity over steelwork

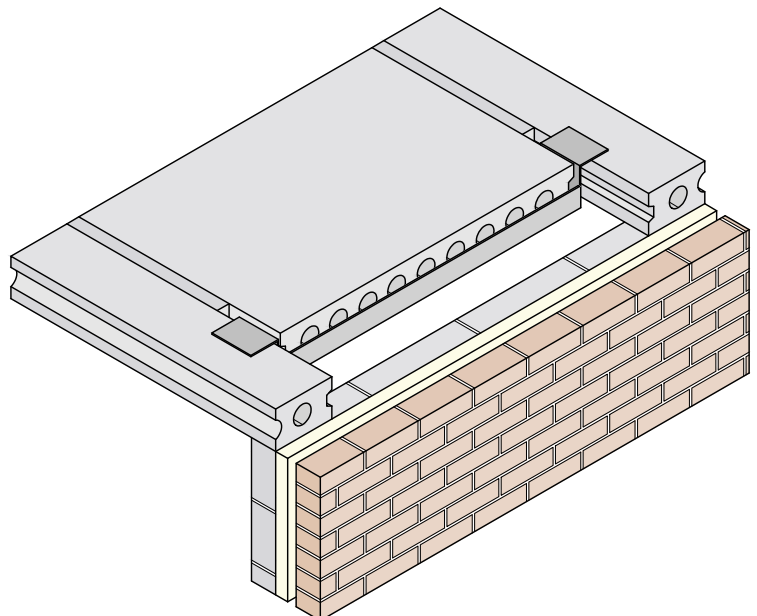
When continuing over steel work the slabs may also require tying together in accordance with the manufacturers recommendations.



## Holes and notches

Openings to accommodate service voids and column notches should be preformed. Large openings may require steel trimming supports. Holes of less than 100mm can be formed on site in accordance with the manufactures design.

All holes/openings should be in accordance with the manufacturers design.



### 10.2.6 Lateral restraint of walls

Concrete upper floors shall provide adequate lateral restraint in accordance with the design.

Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

Restraint can be provided by:

- Lateral restraint straps.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

### 10.2.7 Sound resistance

Internal separating floors shall, where necessary, meet the requirements for the resistance of sound in the relevant Building Regulations.

Internal separating floors shall, where necessary, meet the requirements of the relevant Building Regulations in relation to the resistance of sound and sound testing requirements.

### 10.2.8 Background surface for screeds

Background surfaces shall be suitably prepared to receive a screed.

Background surfaces where screeds are being supported should meet the following requirements:

#### Bond

Background surfaces for bonded screeds should provide an adequate mechanical key. If necessary, cement grouting or a bonding agent should be specified to provide adequate adhesion. Where bonded screeds are used, mechanical means of preparing the concrete should be used to create an adequate bond between the substrate and the screed.

#### Adequate support

Substrate structures must be adequately constructed to provide adequate support to the screed (note: Timber floor constructions are not suitable to support screeded finishes).

Substrates must be level with no pockets or high spots to ensure the thickness of the screed remains even.

Where screeds are laid over insulation; the insulation must be tightly butted together and level.

#### Additional steps where constructing screeds over concrete substrates

Where a concrete slab is insulated from below and a finishing screed is required to the top surface:

- The concrete substrate slab must be of the correct thickness and not less than 100mm thick.
- Concrete substrate must be adequately dried out and not wet.
- Surfaces of hardened in situ concrete bases for bonded screeds should be roughened (scrabbled) and cleaned to remove laitance and to expose cleanly, but not loosen, the coarse aggregate particles.
- Brushing to remove laitance from a fresh concrete base is inadequate preparation before laying a bonded screed and is not recommended.
- Remove all loose debris, dirt and dust by appropriate means, preferably with vacuum equipment.
- Carry out the preparation of the surface with as little delay as is practicable before the screed is laid so as to reduce the risk of contamination.
- The surface of the prepared slab must be reasonably level to avoid deviations in thickness's of the screed.

### 10.2.9 Screed specification

Non-structural floor screeds shall be of an adequate specification for the intended use and location. The screed shall also provide a suitable background for the desired floor finish.

Traditional floor screeds consist of sand and cement. If the ratios and properties of these screeds are not correctly controlled; cracking, peeling or collapse of the screed will occur (due to being too strong/weak).

Proprietary screeds typically are pre-blended to achieve greater consistency and strength and more suitable over larger areas. Where the floor area exceeds 50m<sup>2</sup> only a proprietary screed installed by the screed manufacturers trained installers will be accepted.

Screeds should be fit for purpose, have a suitable finish and be of an appropriate thickness and provide a reasonably level surface.

#### Screed mix

Cement and sand screeds should have a mix ratio of between 1:3 and 1:4½.

Proprietary additives should have been assessed and have a third party product conformity certificate.

The minimum thicknesses of screeds are as follows:

| Surface                                                                         | Minimum thickness at any point |
|---------------------------------------------------------------------------------|--------------------------------|
| Laid monolithically with base                                                   | 12mm                           |
| Laid and bonded to a set and hardened base                                      | 20mm                           |
| Laid on a separating membrane (e.g. 1000g polyethylene)                         | 50mm                           |
| Laid on resilient slabs or quilts (screed reinforced with galvanised wire mesh) | 65mm                           |

Where service pipes are bedded in the screed, the screed should be deep enough to provide at least 25mm of screed cover over service pipes, insulation and reinforcing.

#### Maximum areas of screed

Screeds should be laid room by room. Unreinforced screeds should have a maximum area of 40m<sup>2</sup>. Expansion joints should be provided and consistent with joints in the floor slab below.

#### Finishing of screeds

Screed should provide an even surface as appropriate, as defined in the 'Tolerances' section. Concrete floor slabs may be suitably finished to serve directly as a wearing surface without the need for an additional topping, in accordance with the recommendations of BS 8204. If required, surface sealers or hardeners should only be used in accordance with the manufacturer's instructions.

#### Anhydrite (liquid) screeds

If an anhydrite screed is used, it must be sealed before the application of any cement based floor finish adhesive is proposed. Anhydrite screeds can be difficult to identify once laid, if the screed type cannot be identified the screed should be fully sealed as a precaution to prevent the possibility of the floor finish adhesive de-bonding from the screed.

The floor screed should be fully dry before the sealant is applied. The screed drying time will depend on the thickness and type of screed.

A decoupling membrane is also recommended as this can reduce the stress on the fixed floor finish layer.

#### Dry times and curing

##### Drying times

- With cementitious levelling screeds, one day should be allowed for each millimetre of thickness for the first 50 mm, followed by an increasing time for each millimetre above this thickness (BS 8204).
- Polymer modified screeds: strictly follow the manufacturer's specifications and recommendations.
- The developer should keep an accurate record of the screed drying times elapsed before any fixed floor finish is constructed on top is laid and the Warranty surveyor may ask for this information.

Note: The moisture contents of levelling screeds onto which particular floorings are to be laid and methods for measuring moisture content are given in BS 5325, BS 8201, BS 8203 and BS 8425.

#### Curing

Movement joints will be required in the screed in accordance with the design. The following should also be taken into account:

- Movement joints will be required across door thresholds.
- Movement joints are required if bay sizes exceed 40m<sup>2</sup> with a maximum of 8m on any one side.
- Movement joints are also required where joints exist or a change of span occurs e.g. beam and block floors.

## Installation

Where screeds are being installed they should be correctly mixed, not be walked on during the drying period and shouldn't be constructed during cold periods (below 5°C).

### 10.2.10 Insulation

Insulation materials shall minimise thermal transmission through the floor and be suitable for their intended purpose and location.

Insulation below screeds should have enough compressive strength to support the screed. DPMs should be installed in the correct positions, as indicated by the insulation manufacturer's instructions. Sound insulation should be installed in accordance with the manufacturer's instructions.

### 10.2.11 Building services

Where building services pass through the screed, there shall be consideration for compatibility between the floor screed and the services.

Pipes should be protected against chemical attack (with the use of sleeves for example).

### 10.2.12 Screeds and underfloor heating systems

Where underfloor heating systems are specified under a screed there should be suitable movement joint and perimeter expansion joint provision.

## General requirements

Where underfloor heating systems are bedded into the screed:

- There should be a minimum 25mm cover over the highest point of the pipe or insulation.
- There should be consideration for thermal movement of water pipes.

## Provision and construction of movement joints

Movement joints should be provided in the floor screed / fixed floor finish where floor heating is provided in the following places:

- Between independently controlled heating zones.
- Between heated and unheated areas of screed.
- Additional joints should be considered in areas of high thermal gain e.g. large conservatories or glass atria.
- Across door thresholds.
- If bay sizes exceed 40m<sup>2</sup> with a maximum of 8m on any one side.

Bay joints should be formed using rigid joint formers where possible, which can be placed during the preparation phase and will remain in place during operation. The joint former should be 5mm lower than the finished screed depth to allow a smooth transition in height between bays:

- All joints in the screed should extend through to any subsequent bonded floor covering.
- Joint positions should be specified prior to the installation of the screed and full consultation between all parties including the main contractor, underfloor heating installer, finished flooring installer and the screed installer should take place to determine appropriate locations.
- Movement joints should be carried through the subfloor to the floor finish and all applied layers terminated either side of the joint.
- The joint should be filled with a suitable flexible filler and a proprietary cover strip applied to cover the joint. Grout must not be used.
- Movement joints should not be bridged by any resilient, textile or other adhered floor finish.
- Movement joint covers may be flush, surface mounted or bedded in mortar and metal, metal with a rubber insert or PVC.

## Provision of edge strip perimeter expansion joint

When incorporating under floor heating (UFH):

- Screeds should be isolated at all edges, abutments and columns to allow for movement due to thermal loadings.
- The floor screed and finished floor manufacturers guidance to be followed particularly when incorporating under-floor heating to determine the minimum thickness of edge strip required to allow for expansion. Typically, between 6-15mm may be required.
- The joint can be concealed by the skirting.
- These joints must be left empty, or else filled with a compressible material.
- Movement joints must not be filled with grout.



## Screed drying time

- The drying time allowed must be calculated for the proposed depth of screed, taking account of the environmental conditions present e.g. temperature and humidity. Where polymer modified type screeds are being used the manufacturer's requirements must be strictly followed for the actual depth of screed. Surface finishes placed on a screed too early will fail.
- Drying times for polymer modified screeds could potentially be different to cementitious screeds.
- All subcontractors involved with the screed and floor finishes (including installation of underfloor heating systems) must follow the installation requirements and not deviate or change materials.
- The screed should not be walked on until fully cured.

## UFH testing and commissioning

- Ensure there are no joints in the heating system loops.
- UFH systems should be commissioned before floor finishes are applied. This will add to the total time before any floor finish can be applied. If floor finishes are installed prior to the UFH being turned on and commissioned, any residual moisture in the floor is driven to the surface of the screed and can potentially cause delamination of the floor finish.
- Pressure testing of the system does not constitute commissioning of the system. The heat source has to be in place and operating in order to deliver the correct temperatures.
- The UFH system must be commissioned in accordance with the manufacturer's recommendations by their approved installers. A commissioning certificate will be required.

## Moisture testing of the screed where floor finishes are proposed

- Moisture testing should be carried out after the commissioning of the UFH system but before any floor finishes are laid.
- Where UFH is not installed, moisture testing of the screed should still be carried out before floor finishes are installed.
- Moisture testing is carried out using a suitable approved method such as a flooring hygrometer or carbide bomb test. Due to the potential inaccuracies of using hygrometers at high humidity levels, a direct measurement should be used such as Carbide Bomb or oven dried sample.
- The base is deemed to be sufficiently dry when the relative humidity, as measured by a surface mounted flooring hygrometer/probe is 75% RH or less. For the use of a flooring hygrometer, reference should be made to dampness testing in BS 5325, BS 8203, BS 8425 and BS 8201.
- If underfloor heating is present in the base, the heating must be switched off 96 hours prior to any hygrometer test being carried out.
- The hygrometer must be allowed to remain in position until full equilibrium has been established. This is generally considered to be 72 hours but could be longer over thick sections and considerably longer on power floated concrete.

## Screed preparation for finishes

- The top surface of screeds may require to be scored, sanded or keyed in preparation to accept the primer and floor finish.
- Sanding, keying etc. of the screed surface allows the penetration of primers. It also provides a "key" for the adhesive to grip onto.
- The surface must then be cleared of dirt and debris prior to primers being applied.
- Any primers and adhesives must not be applied until the screed has fully hardened and dried out. Drying times vary depending on the type of screed.
- Surfaces to receive fixed floor finishes should be rigid, dimensionally stable, flat with no dips and rises, sound, clean and free from laitance, paints, salts, grease, dust and any contamination which may prevent adhesion.

## Adhering to the manufacturer's process during the installation of the flooring finish

All the relevant manufacturers recommendations should be followed which will identify timelines to adhere i.e:

- Removing the laitance by sanding to provide a key for the primer and/or adhesive.
- Commissioning the underfloor heating before installing the fixed floor finish.
- Allowing the UFH system to cool down for at least 48 hours before installing the fixed floor finish.
- Moisture testing to confirm the dryness of the screed before installing the fixed floor finish.
- Ensuring the time from screed completion to installing the fixed floor finish commencement is calculated and adhered to.
- Ensure the fixing of the finished floor finish has stabilized before walking on. Some finishes require typically 12 -24 hours dependent on environmental conditions.
- Ensure the UFH system is not turned on for at least 48 hours after any adhered floor finish is completed.
- If an anhydrite screed is used, it must be sealed before the application of a cement based floor finish adhesive if proposed in conjunction with a finished floor surface covering.

## Exceeding the maximum 27°C floor temperature

The underfloor heating system must be correctly commissioned to ensure temperature fluctuations are avoided and potential damage to the floor finishes.

BS 8203 Code of Practice for the Installation of Resilient Floor Coverings states: When used with many flooring materials underfloor heating can cause problems if the temperature at the interface between the subfloor and flooring exceeds 27°C, or is subject to rapid fluctuations in temperature.

Where a resilient floor covering is proposed, the temperature should never exceed the agreed maximum of 27°C at the underside of the floor covering (the adhesive line).

### Notes:

- UFH designers may refer to this as the 'interface' temperature.
- BS EN 1264 - 2 refers to a max 29°C however for Warranty purposes a maximum 27°C is to be followed.



### End user information

End users must be aware of how to use an UFH system, as these need to be operated differently than other heating systems both for in use and to avoid damage to screeds and finishes.

#### 10.2.13 Plasterboard requirements

Plasterboards shall:

- Be adequately supported and fixed in accordance with the manufacturer's instructions.
- Provide an adequate surface to receive the intended finish required by the design.
- Supporting test evidence will be required where the plasterboard is intended to perform additional functions (e.g. fire or acoustic resistance).

### Support of plasterboard

Supports for plasterboard should be designed so that the following span limits are not exceeded:

| Board thickness | Support centres | Intermediate supports required | Perimeter supports required |
|-----------------|-----------------|--------------------------------|-----------------------------|
| 9.5mm           | 400mm           | No                             | Yes                         |
|                 | 450mm           | Yes                            | Yes                         |
| 12.5mm          | 400mm           | No                             | Yes                         |
|                 | 450mm           | No                             | Yes                         |
|                 | 600mm           | Yes                            | Yes                         |
| 15mm            | 600mm           | No                             | No                          |

### Fixing of plasterboards

When fixing plaster boarding:

- Fix boards with decorative side out to receive joint treatment or a skim plaster finish.
- Lightly butt boards together and never force boards into position.
- Install fixings no closer than 13mm from cut edges and 10mm from bound edges.
- Position cut edges to internal angles whenever possible, removing paper burrs with fine sandpaper.
- Stagger horizontal and vertical board joints between layers by a minimum of 600mm.
- Locate boards to the centre line of framing where this supports board edges or ends.

Gaps between boards should not exceed 3mm and consideration should be given to sealing all gaps to improve building air tightness.

#### 10.2.14 Plastering

Plastering shall provide an adequate surface to receive the intended finish as required by the design.

### Plastered finishes

Workmanship of plastered finishes to ceilings should be applied to a certain standard to receive a suitable decorative finish. It should be durable enough to prevent surface cracking and, if applicable as part of the whole element, meet the required levels of fire and sound insulation in accordance with current Building Regulations.

### Substrate and background

Plasterwork should be applied to suitable substrates. The substrate may also require additional sealing or bonding agents, in accordance with the requirements set out in BS 8481.

### Plaster mixes

Plaster mix ratios should be in accordance with manufacturer's recommendations and be appropriate for the intended use.

### Minimum plaster thicknesses

The thickness of plaster will vary depending on the evenness of the substrate. The finished element must meet the tolerances identified in this Technical Manual, and be of a suitable quality so that a decorative finish can be applied. Minimum thickness should be in accordance with the following table.

| Element                | Minimum number of coats | Typical thickness                           |
|------------------------|-------------------------|---------------------------------------------|
| Ceiling – plasterboard | 1                       | Skim to provide suitable and durable finish |

### 10.2.15 Suspended ceilings

Suspended ceilings shall be specified and installed to be suitable for the site specific conditions. The following shall be taken into account:

- Fixing requirements.
- High humidity and external environments.
- Fire resistance.

#### Fixing requirements

Fixings should be appropriate for the site conditions and the loads to be supported. They must also be installed in accordance with the manufacturer's specifications. Fixings to the floor construction should be at the correct designated centres using the correct wires/brackets that are compatible with the suspended ceiling (and the intended environmental conditions - see below). Pull tests should be carried out on ceilings with an area exceeding 100m<sup>2</sup> and a factor of safety of 2 is applicable.

Ceiling grid layouts and fixing schedule and method of fixing to soffit, should be provided.

Confirmation that the weight of the ceiling construction and any additional fire/sound insulation loads has been taken account of in the supporting structure design calculations.

Where there is any doubt regarding the adequacy or installation or variation from the initial design a manufacturer's inspection and certification will be required.

#### High humidity or external environment

Where the ceiling is above a high humidity area or is an external suspended ceiling; a third party product conformity certificate should be provided to demonstrate the product is suitable for the specified environment.

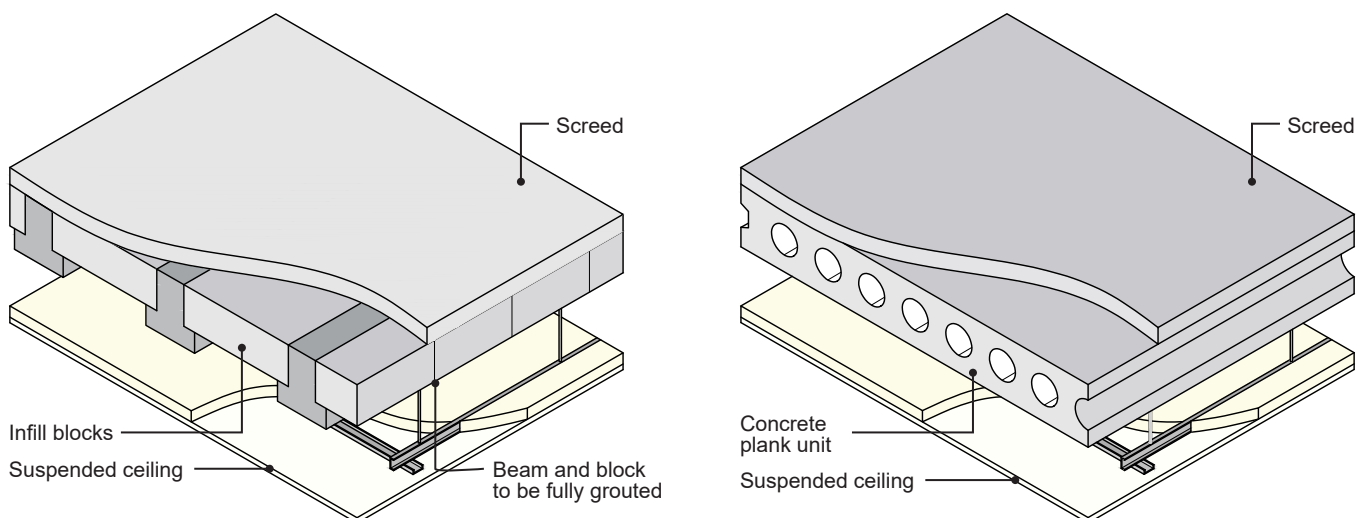
#### Fire resistance

Where suspended ceilings are designed to give a minimum period of fire resistance, fire test certification will be required to confirm the periods of fire resistance given. This should also take into account any recessed light fittings which may bypass the fire resistant layer. Consideration should also be given to the quality of workmanship in these installations, and a manufacturer approved installer be used.

The additional weight of materials used to achieve fire resistant specifications or where sound insulation requirements occur must also be taken account of in the structural design of the supporting structure and the fixings of the ceiling construction.

#### Typical detail for suspended ceilings

Suspended ceilings should be designed and constructed in accordance with BS EN 13964.



## Introduction

This section provides guidance on meeting the performance requirements for fire resistance, cavity barrier and fire stopping requirements for all upper floors where there is a Warranty requirement.

### 10.3.1 Compliance

The fire resistance of upper floors, the specification and installation of cavity barriers and fire stopping, shall satisfy the performance requirements of this section.

In all circumstances, the fire resistance of upper floors, the specification and installation of cavity barriers and fire stopping, should be in accordance with the relevant Building Regulations.

### 10.3.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Plans showing period of fire resistance for all upper floors.
2. Details of proposed cavity barriers including:
  - a. Specification of materials.
  - b. A third party product conformity certificate and/or test reports. This should include details of the period of fire resistance the cavity barrier achieves in relation to the site specific requirements and requirements of the relevant Building Regulations.
  - c. Plans and elevations showing positioning of cavity barriers.
3. Details of proposed fire stopping, including:
  - a. Specification of materials.
  - b. A third party product conformity certificate and/or test reports. This should include details of the period of fire resistance the cavity barrier achieves in relation to the site specific requirements and requirements of the relevant Building Regulations.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 10.3.3 Fire resistance

All floors and ceilings shall have adequate fire resistance as required by the relevant Building Regulations. Design details shall show the correct level of fire resistance for the building in accordance with the relevant Building Regulations. Fire resistance of floors and ceilings shall take into account:

- The floor construction.
- Penetrations in floors and ceilings.
- Provision of fire stopping.

Please note, any multiple occupancy building (which includes flats /apartment accommodation) shall have fire stopping completed by a third party approved Contractor, or have a suitable quality assurance process provided to evidence the installation of the fire stopping and cavity barriers. This is applicable to all floor levels of a building that has a floor 4.5m above the lowest external ground level.

## Floor construction

All floors and ceilings should have the fire resistance required by the relevant Building Regulations. To achieve the same fire resistance, I-joists and metal web joists may require a different specification for the ceiling than that for solid timber joists. Holes should not be made in the ceilings, e.g. for down lighters, unless it can be proven that the floor construction achieves the required fire resistance.

## Provision of fire stopping

Fire stopping should:

- Be provided where required by the Building Regulations.
- Be of a materials which is suitable for the intended purpose with a relevant third party product conformity certificate.
- Be installed in accordance with the manufacturer's recommendations.
- Have no holes or gaps for smoke to pass through once the fire stopping has been fitted.
- Take account of building movement. This should be considered at design stage. The fire stopping manufacturer should be contacted for further information.

## Penetrations in floors and ceilings

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### Penetrations by ducts and light fittings within floors and ceiling voids

Penetrations formed within any floors and ceilings should not comprise the fire resistance as required by the relevant Building Regulation.

For the purposes of Warranty, Supporting fire test evidence and/or extended field of application assessments should be provided upon request for the load bearing floor systems to BS EN 1365-2.

Where penetrations occur, the services and their associated components, and the fire protection measures employed to protect them must be part of the fire test certification issued for the specific floor construction.

Any materials which form a part of the test certification, should only be substituted where permitted within guidance provided in the test certification.

Proprietary sealants and/or products should be appropriately tested to the relevant material standards.

All materials and products should be fitted in accordance with the manufacturer's instructions.

### Openings for pipes in fire resisting floors

Pipes which pass internally through fire resisting floors must not compromise the required fire resistance of the element through which they pass. As a minimum, openings through floors should be as few as possible in number, as small as practicable in size and fire-stopped to the surrounding construction. For pipes passing through compartment floors, guidance supporting the Building Regulations in the relevant UK nation will need to be consulted for additional provisions.

Where intumescent paints are used to provide the required level of fire protection, certification confirming that the paint applied will achieve the correct level of fire protection is required.

### 10.3.4 Cavity barriers

Cavity barriers shall be durable and must not adversely affect the structure of the building or the performance weatherproof envelope.

Where required by statutory regulations, cavity barriers shall:

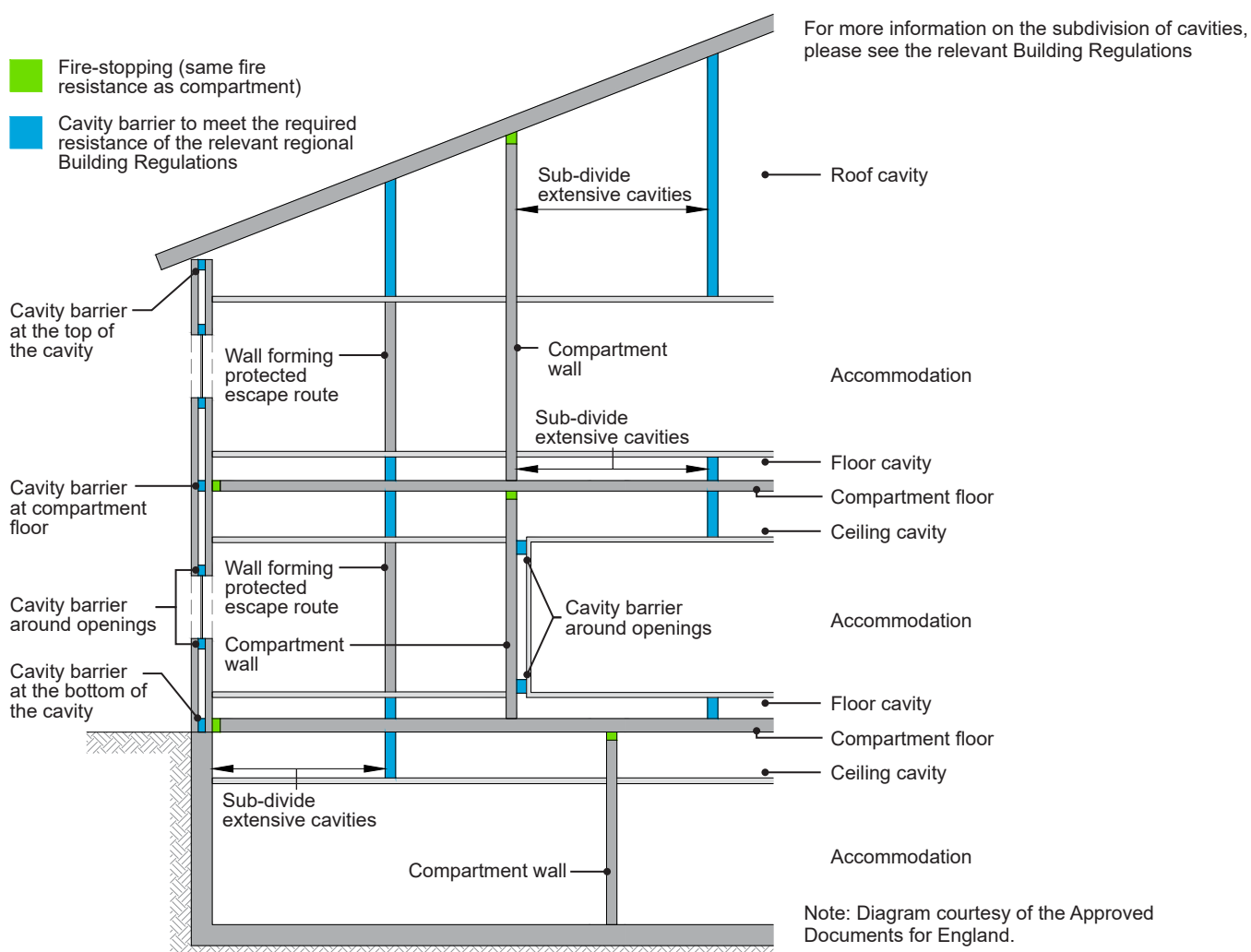
- Be of a suitable material.
- Specified and installed within the scope of the test certification and/or the third party product conformity certificate.
- Be installed in accordance with the manufacturer's recommendations.
- Be suitable for the location they are installed.

Any multiple occupancy building (which includes flats /apartment accommodation) shall have cavity barriers installed by a third party approved Contractor, or have a suitable quality assurance process provided to evidence the installation of the fire stopping and cavity barriers. This is applicable to all floor levels of a building that has a floor 4.5m above the lowest external ground level.

Where cavity barriers are required by statutory regulations, their specification, positioning and installation should satisfy the requirements of the Building Regulations.

### Provisions for cavity barriers and fire stopping

Drawings to show the position of cavity barriers should be provided, and the specification of cavity barriers included.



# 11.

## Roofs

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### Contents

|      |                                           |     |
|------|-------------------------------------------|-----|
| 11.1 | Pitched Roof Structures                   | 286 |
| 11.2 | Panelised Roof Cassettes                  | 307 |
| 11.3 | Pitched Roof Coverings (Tiles and Slates) | 309 |
| 11.4 | Flat Roofs                                | 325 |
| 11.5 | Green Roofs                               | 348 |
| 11.6 | Metal Deck Roofing                        | 354 |
| 11.7 | Blue Roofs                                | 365 |
| 11.8 | Podium Decks                              | 374 |

## Introduction

This section provides guidance on meeting the performance requirements for pitched roof structures. Types of pitched roof structures covered within this section include:

- Truss rafter roofs
- Traditional cut roofs

### 11.1.1 Compliance

The design, specification and erection of pitched roof structures shall meet the performance requirements of this section.

### 11.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Full details of:
  - a. The roof layout.
  - b. Any intersecting or supportive roof construction such as hips, valleys, purlins etc.
  - c. Details of girder trusses, multiple trusses and diminishing trusses, including how they are to be fixed together and supported on truss shoes.
2. A full set of Engineers drawings and calculations for the roof. This should also include fixing methodology and specification, full details of all associated bracing requirements, restraint and holding-down strapping and associated fixings.
3. Details of how gable and party wall spandrels interconnect with the surrounding roof and wall structure including details on:
  - a. The specification of all components for the spandrel panel including details on their durability.
  - b. Lateral and vertical restraint.
  - c. Fire resistance, cavity barriers and fire stopping.
  - d. The fixing specification of external cladding elements.
4. Details for any required trimming work around chimneys, formation of access hatches, details for the formation of supportive structure for equipment and access to equipment requiring periodic maintenance and inspection contained within the roof space, etc.
5. Waterproofing and flashing details around abutments, chimneys, service penetrations etc.
6. A third party product conformity certificate for the roof underlay.
7. Detailed sections and material specification for all components to be used in the construction of the pitched roof including but not limited to, vapour control layers, breather membranes, insulation etc.
8. Details of the ventilation strategy for the pitched roof in line with the guidance provided in this section and/or BS 5250.
9. Details of all fire stopping which should include specification and a detailed location layout drawing showing positioning of all fire stopping.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 11.1.3 Structural design and durability

Pitched roof structures shall be structural robust and safely transfer all loads to the supporting structure without causing any deflection or deformation to any part of the building.

Pitched roof structures should also be of an adequate durability.

Roof trusses shall be handled, transported and lifted in accordance with the manufacturer's recommendations to ensure their structural performance is not compromised. Please refer to 'Appendix C' for further information.

## Requirements for all pitched roofs

### Design

Pitched roof design must be in accordance with current relevant Building Regulations and:

- BS 8103-3, structure design of low rise buildings, code of practice for timber floors and roofs for dwellings.
- BS EN 1995-1, Eurocode 5 design of timber structures. General. Common rules for buildings.
- PD 6693-1.

For advice on 'sizing of certain timber members in floors and roofs for dwellings', the Designer should refer to the following sources:

- BS 8103-3, Structure design of low rise buildings, Code of Practice for timber floors and roofs for dwellings.
- BS EN 1995-1, Eurocode 5 design of timber structures. General. Common rules and rules for buildings.

The roof structure should be of such construction that it has adequate interconnection with the walls, allowing it to act as a horizontal diaphragm capable of transferring the wind forces to buttressing elements of the building.

## Loads

The roof of the building shall be constructed so that the combined dead, imposed, snow and wind loads are sustained and transmitted by it to the ground safely, and without causing such deflection or deformation of any part of the building.

Pitched roofs must have dead and imposed loads calculated in accordance with:

- BS EN 1991-1-1
- BS EN 1991-1-3
- BS EN 1991-1-4

Loads acting on rafters include dead loads (for example tiles/slates, battens, underlay and rafter self-weight), imposed loads (snow load and maintenance) and the wind load. Other dead loads that act on the ceiling ties (ceiling, insulation, water tanks and the tie self-weight) and imposed loads (loft access and weight of storage) will also have to be taken into account by the designer.

## Allowances for wind loading

The need for a roof to withstand wind pressure and suction will be met if the proposed roof is braced effectively and secured to the structure, with walls adequately restrained as outlined within this section.

## Timber specification and durability

BS EN 338 should be used by the designer to determine the suitable strength class for structural timber components.

All structural timber should be:

- Machine graded to BS EN 14081 or, visually graded to BS 4978 for softwoods or BS 5756 for hardwoods.
- Dry graded.
- Marked in accordance with BS EN 14081.

## Treatment of timber

Preservative treatment of roof timbers is normally unnecessary, except where specifically required under relevant standards and Codes of Practice, and in the following circumstances:

- Roof timbers should be preservative treated where the insulation and ceiling line follow the roof pitch.
- Trussed rafter construction which is cut back at eaves or where the rafter 'feet' is trimmed to sit into the external walls. Preservative treatment will be required to the cut ends.
- The Approved Document of Regulation 7 of the Building Regulations for England requires that in certain geographical areas, all softwood roof timbers should be treated against attack by the House Longhorn Beetle.

The treatment should be impregnated with a preservative suitable for use in 'Use Class 1' in pitched roofs and 'Use Class 2 flat roofs', in accordance with BS 8417, for a 60 year anticipated service life. Cut ends must be liberally brushed or dipped with an end-grain preservative.

It is strongly recommended that, where punched, metal fasteners are proposed to roof trusses. Only micro-emulsion or organic solvent preservatives should be used for timber treatment, to limit the possibility of corrosion of the fasteners and so as not to adversely affect glued joints.

Further information can be found in 'Appendix C- Materials, Products, and Building Systems'.

## Moisture content

The moisture content of structural timber should not exceed 20% at the time of stress grading and at the time of erection. All structural timber for use within the building fabric should be stress graded and marked 'KD' (Kiln Dry) or 'DRY'.

## Truss rafter roofs

The building designer is responsible for the 'framing' of any given roof as a whole. This means that they must take responsibility for the bracing together (framing) of the trussed rafter configuration, which then supports the roof covering and the tying together of the supporting walls.

Whilst it is the supplier of the rafters who generally has the knowledge and expertise required to achieve the best engineering solutions, the designer must be certain that the loading calculations and resultant configuration is fit for purpose.

## Spans

Maximum permissible spans for the most common building types and rafter configurations are given in BS EN 1995-1: Section 9.

For designs that fall outside BS EN 1995-1 conditions, the trussed rafter must demonstrate adequate jointing and structural integrity by calculation.

## Loadings

The design criteria set out is intended to be adequate for imposed roof loads of 1.00kN/m<sup>2</sup> for spans not exceeding 12m, and 1.50kN/m<sup>2</sup> for spans not exceeding 6m.

The following limits apply for imposed loads on the rafters uniformly distributed over the whole roof, measured on plan:

- Roofs pitched 10° to 30°: 0.75kN/m<sup>2</sup>, or
- Roofs pitched 31° to 75°: 0.75kN/m<sup>2</sup> - 0kN/m<sup>2</sup> (reduced linearly), or
- A concentrated load of 0.9kN, whichever produces the greater stress or deflection.



### Bracing

The need for diagonal rafter bracing equivalent to that recommended in BS EN 1995-1, or Annex H of BS 8103-3 for trussed rafter roofs, should be provided, especially for single-hipped and non-hipped roofs of more than 40° for detached houses.

### Modifications to trussed rafters

Trussed rafters should never be cut, altered or repaired for use without the full agreement of the Trussed Rafter Designer. Remedies for defects to erected trusses can be found in BS 5268: 3, but the Roof Designer's advice should be sought prior to repairs being carried out.

### Combined trussed rafter and traditionally framed roofs

Extra care is necessary where the two principal timber pitched roof types are used in conjunction. The trussed rafters should be specifically designed to accept any additional loadings imposed by an adjacent traditional roof. Similarly, account should be taken of any loadings imposed by trusses on traditional roofs where only nominal loadings have been allowed for. If in doubt, consult the roof designer.

### Traditional cut roofs

The building designer is responsible for the 'framing' of any given roof as a whole. This means that he or she must take responsibility for the bracing together (framing) of the roof configuration, which then supports the roof covering and the tying together of the supporting walls.

The designer must be certain that the loading calculations and resultant configuration is fit for purpose.

All cut roofs that are beyond the limitations of the 'Eurocode 5 Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings' published by TRADA should be designed by an Engineer and calculations and structural drawings should be submitted for assessment when requested.

The design of the cut roof should demonstrate:

- Finished sizes, species, stress grades or strength classes of timber members.
- The type, sizes and positions of all jointing devices with tolerances, or the number of effective teeth or nails required in each member at each joint.
- The positions and sizes of all bearings.
- Loadings and other conditions for which the cut roof is designed.
- The spacing of rafters, joists, binders and purlins.
- The positions, fixings and sizes of any lateral supports necessary to prevent buckling of compression members, such as rafters and struts. Details of the permanent bracing necessary to ensure the overall stability of the complete roof structure and supporting walls should be provided by the Building Designer.
- The method of support for water tanks and ancillary equipment, together with the capacity or magnitude of additional load assumed.
- The range of reactions to be accommodated at the support positions, including those required to resist wind uplift forces.
- The basis of the design.
- Details of any changes in spacing to accommodate chimneys or openings.
- Any special precautions for handling and erection, in addition to those covered by BS EN 1995-1.
- The span of the rafters, joists, binders, purlins etc.
- The pitch or pitches of the roof.
- The method of support and position of supports.
- The type or weights of roof tiles or covering, including sarking, insulation and ceiling materials.
- The size and approximate position of any water tanks or other equipment to be supported on the trussed rafters.
- The overhang of the rafters at eaves, and other eaves details.
- The positions and dimensions of hatches, chimneys and other openings.
- The size of any structural members and supporting calculations.
- Due to the site locality, any particular preservative treatment necessary for the timber, e.g. to protect against House Longhorn Beetle.

The need for diagonal rafter bracing equivalent to that recommended in BS EN 1995-1: 2004+A1, or Annex H of BS 8103-3 for trussed rafter roofs, should be considered, for all cut roofs especially for single-hipped and non-hipped roofs of more than 40° for detached houses.

For advice on 'sizing of certain timber members in floors and roofs for dwellings', the designer should refer to the following sources:

- Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings. Published by TRADA. Note: Reference should be made to the version of the TRADA document current at the time of construction of the roof.
- BS 8103-3, Structure design of low rise buildings, Code of Practice for timber floors and roofs for dwellings.
- BS EN 1995-1, Eurocode 5 design of timber structures. General. Common rules and rules for buildings.

The purlins/binders should be adequately supported to contribute fully to the roof structure. For example, they could be built into the inner leaf of a gable end wall and supported by struts onto the load-bearing structure at centres specified in the design.

Always ensure that the correct strength class of timber is both ordered and used. Structural timbers are allocated a strength class by BS 5268-2. The most common strength classes used are C16 and C24.

The timber supplier will require the following information before supplying timber:

- Type and strength class of timber required.
- Required sizes of timber.
- Any treatment required.

### The use of oak

Green oak, air dried (seasoned)/kin dried oak is not acceptable in the external wall construction, frame, window/door construction, internal wall or roof constructions, regardless of whether it forms part of the weather proof envelope or not. Projects incorporating such oak will not be acceptable for Warranty cover except where described in 'Appendix C - Materials, Products, and Building Systems' of this Manual.

## 11.1.4 Wall plate requirements

Timber wall plates shall be used to support all pitched roofs in order to distribute and transmit loads, and prevent wind uplift. Timber wall plates shall be adequately bedded and fixed to the supporting structure in accordance with the design.

Pitched roofs should be supported on timber wall plates. Rafters should only be supported at the junction between the ceiling tie and rafter unless specifically designed otherwise by an Engineer.

Wall plates should be:

- Minimum 38 x 100mm.
- Positioned level and on an inner leaf of cavity walls.
- All joints half lapped at joints including corners (butt joints are not acceptable in Scotland).

Rafters should be fixed back to the wall plate by a minimum of two 4.5mm x 100mm galvanized round wire nails, skew nailed, one on each side of the trussed rafter, or truss clips.

Holding down straps to resist wind uplift should:

- Be provided according to the geographical location.
- Be 30mm x 5mm x 1m long at a maximum of 2m centres.
- Be nailed to the wall plate and securely fixed to the inner surface of the wall with compatible fixings.
- Be galvanised mild steel.
- Be in accordance with BS EN 845-1 'Specification for ancillary components for masonry'.

## 11.1.5 Dormer construction

Dormers shall be durable and weatherproof and not effect the:

- The structural integrity of the roof or building, **or**
- The weatherproof envelope of the building.

### Site formed dormers

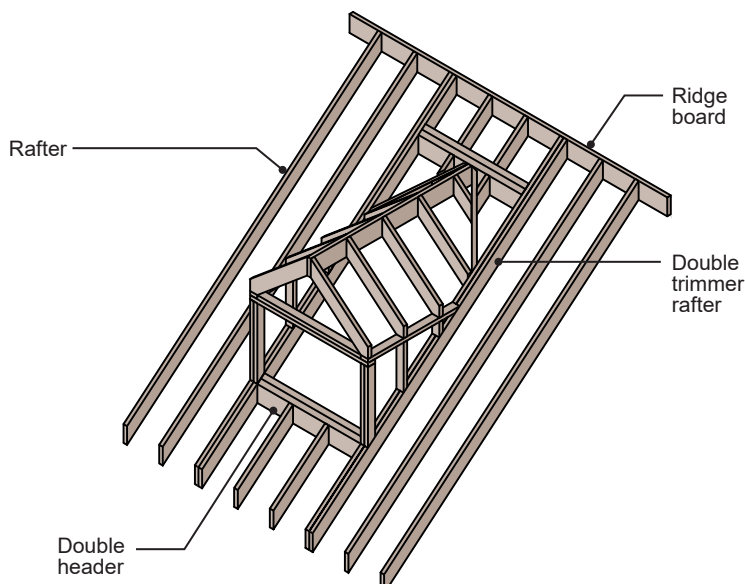
Where site formed dormers are specified, they should:

- Be constructed in accordance with the design.
- All timbers must be preservative treated or have natural durability in accordance with 'Appendix C' of our Technical Manual.
- Have the stud cheeks supported on double rafters or double ceiling joists.
- Have window openings that have lintels which are structurally independent from the window frame.
- Have trimming members which can take loads from main roof members, dormer framing and the cladding.

### Proprietary off site manufactured dormers

Where proprietary off site manufactured dormers are specified they must have appropriate UKAS accredited third party product conformity certificate. The dormer must be installed in accordance with the manufacturer's instructions and as per the certification instructions.

### Typical dormer construction



### Dormer cheeks

Dormer cheeks should have:

- A sheathing board and breather membrane that meets the requirements of our 'External Walls – Timber Frame' section of the Technical Manual.
- A drained and vented cavity which meets the requirements of our 'External Walls – Timber Frame' section of the Technical Manual.

Dormer cheeks must be clad with an appropriately durable material such as lead, timber cladding or vertical tiling/slating. For further guidance on timber cladding and vertical tiling/slating, refer to our 'External Walls – Claddings' section.

### Lead

Lead should conform to BS EN 12588 and should be specified, detailed and installed in accordance with guidance provided by the Lead Sheet Training Academy.

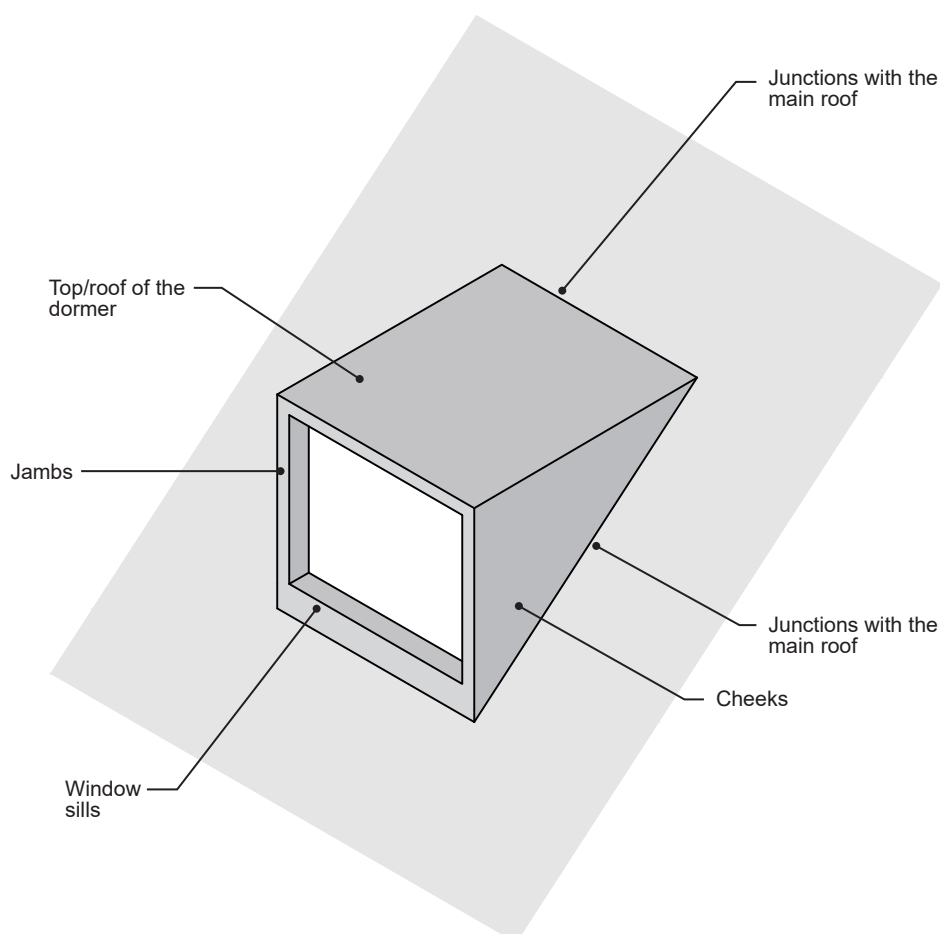
Where lead is used to clad dormer cheeks or roofs:

- A minimum code 4 or 5 lead should be used in moderate and sheltered exposure zones.
- A minimum code 5 or 6 lead should be used in severe exposure zones.

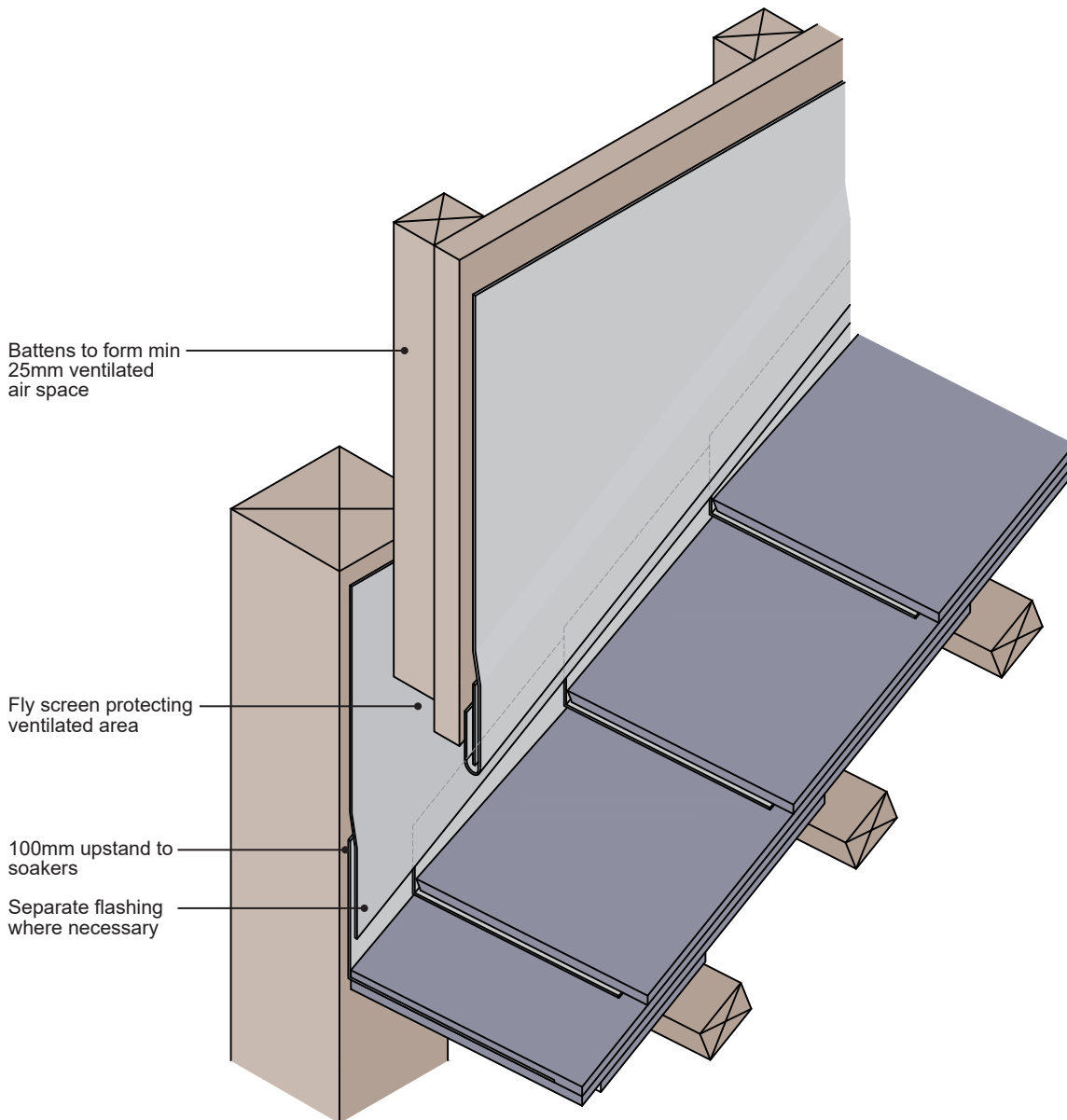
Lead should be appropriately secured to the structure, should allow sufficient ventilation where required, and should be dressed to resist water ingress in accordance with guidance provided by the Lead Sheet Training Academy in the following locations:

- Window sills.
- Junctions with the main roof.
- Jambs.
- Cheeks.
- Junctions with the top of the dormer and the main roof, dormer cheeks and soffits.
- Top/roof of the dormer.

For further information on the use of lead, please refer to our 'Roofs – Pitched Roof Coverings (Tiles and Slates)' section.



## Lead cheek ventilation



## Dormer flat roofs

Where dormer flat roofs are specified they should:

- Have falls towards the sides or front of the dormer.
- Be warm deck and specified and installed in accordance with the guidance provided in the 'Roofs – Flat Roofs' section. Where cold deck flat roofs are specified, they should be limited to 3m<sup>2</sup>.
- Cold deck flat roofs must be ventilated on two opposite sides.

## Pitched roof ventilation

Pitched roofs should be ventilated in accordance with the guidance provided within this section and from eaves to eaves or eaves to ridge.

## Insulation

Dormer roofs and walls must have thermal insulation that meets the requirements of the Building Regulations.

## Interstitial condensation and, air and vapour control layers

Air and vapour control layers should be specified and installed to dormer walls and roofs to limit interstitial condensation. For further guidance on air and vapour control layers, refer to the 'External Walls – Timber Frame' section and the 'Roofs' section of the Technical Manual.

### Junction detailing

Appropriate junction detailing (using lead flashing for example) should be provided where the dormer cheeks and roof meet the main roof construction to ensure the weatherproof integrity of the roof is maintained.

### Fire resistance

The material specification for dormers should satisfy the relevant regional Building Regulations with designers paying special attention to where the dormers are close to a boundary or party wall.

#### 11.1.6 General detailing for trussed rafter roofs

The erection of the trussed rafter roof should be in accordance with the truss designers design and specification.

### Bracing requirements

The correct bracing configuration locks all timber supporting roof elements into a single structural, load-bearing unit. Bracing should be designed in accordance with the guidance within this section or PD6693-1.

For projects with truss spans of over 12m, homes with complex roofs or roofs in severe and very severe exposures, the bracing should be designed by an Engineer.

Bracing should be installed:

- Prior to the roof covering being laid.
- In accordance with the design and not altered without prior approval from the designer.

There are three main types of wind bracing, which should be fixed:

- Diagonal rafter bracing.
- Longitudinal bracing.
- Chevron bracing (only necessary on duo-pitched roofs over 8m and mono-pitched roofs exceeding a 5m span).

Bracing and binders should be lap jointed and nailed to a minimum of two trusses where they are not continuous. The timber size for roof bracing should be 100mm x 25mm.

Diagonal and chevron bracing should pass across each rafter in the roof, however, small gaps, such as two trussed rafters between sets of bracing, or one trussed rafter adjacent to gable or separating walls, is permitted in the middle of an otherwise fully braced roof.

Longitudinal bracing should allow diagonal bracing to pass tightly abut against gable and party walls and extend the full length of the roof.

Diagonal and longitudinal bracing may be omitted where sarking boards (e.g. 9mm plywood/OSB or 12mm chipboard) are fixed to each rafter with 3mm x 50mm galvanised round wire nails at a 200mm spacing.

### Fixing

Bracing should be nailed twice to each rafter it crosses; fixings should be:

- 3.35mm x 65mm (10 gauge) galvanized round wire nails, **or**
- Minimum 3.1mm x 75mm mechanically driven gun nails.

PD 6693-1: 2019 should be referred to where this is not possible.

### Bracing for duo-pitched roofs

Diagonal bracing is required for all duo-pitched trussed rafter roofs and should be approximately 45° on plan to the rafters.

At least 4 diagonal bracing members should be fixed to the underside of the rafters and to the timber wall plate. In narrow fronted roofs, where the braces cross a suitable intersection detail should be specified by the designer.

Diagonal bracing should also be provided in-between hipped ends, where the length of roof between the hip ends exceeds 1.8m.

Longitudinal bracing should be provided at:

- Ridge node points.
- Rafter node points (except where spacing between nodes is less than 4.2m).
- Ceiling node points (except where spacing between nodes is less than 3.7m).

Chevron bracing should be nailed to at least three trusses and be:

- At approximately 45°.
- Provided where the span exceeds 8m.

Where the span exceeds 11m, chevron bracing should be designed by an Engineer.

## Bracing for mono-pitched roofs

At least two diagonal brace members (lap jointed as required) should be fixed to the underside of the rafter members at 45° to the rafters but not less than 35° or greater than 55°. Diagonal bracing should also be fixed to timber wall plates. Where the braces cross a suitable intersection detail should be specified by the Designer.

Diagonal bracing for mono-pitched roofs should also be specified to end vertical member of mono-pitch trusses where the truss is not restrained by a masonry wall or cladding (e.g. plywood).

Longitudinal bracings should be located at the apex and either:

- All other node points (excluding support points), **or**
- Where intermediate longitudinal bracing members are omitted, the resultant spacing between longitudinal braced node points does not exceed 4.2m measured along each rafter and 3.7 m measured along each ceiling tie.

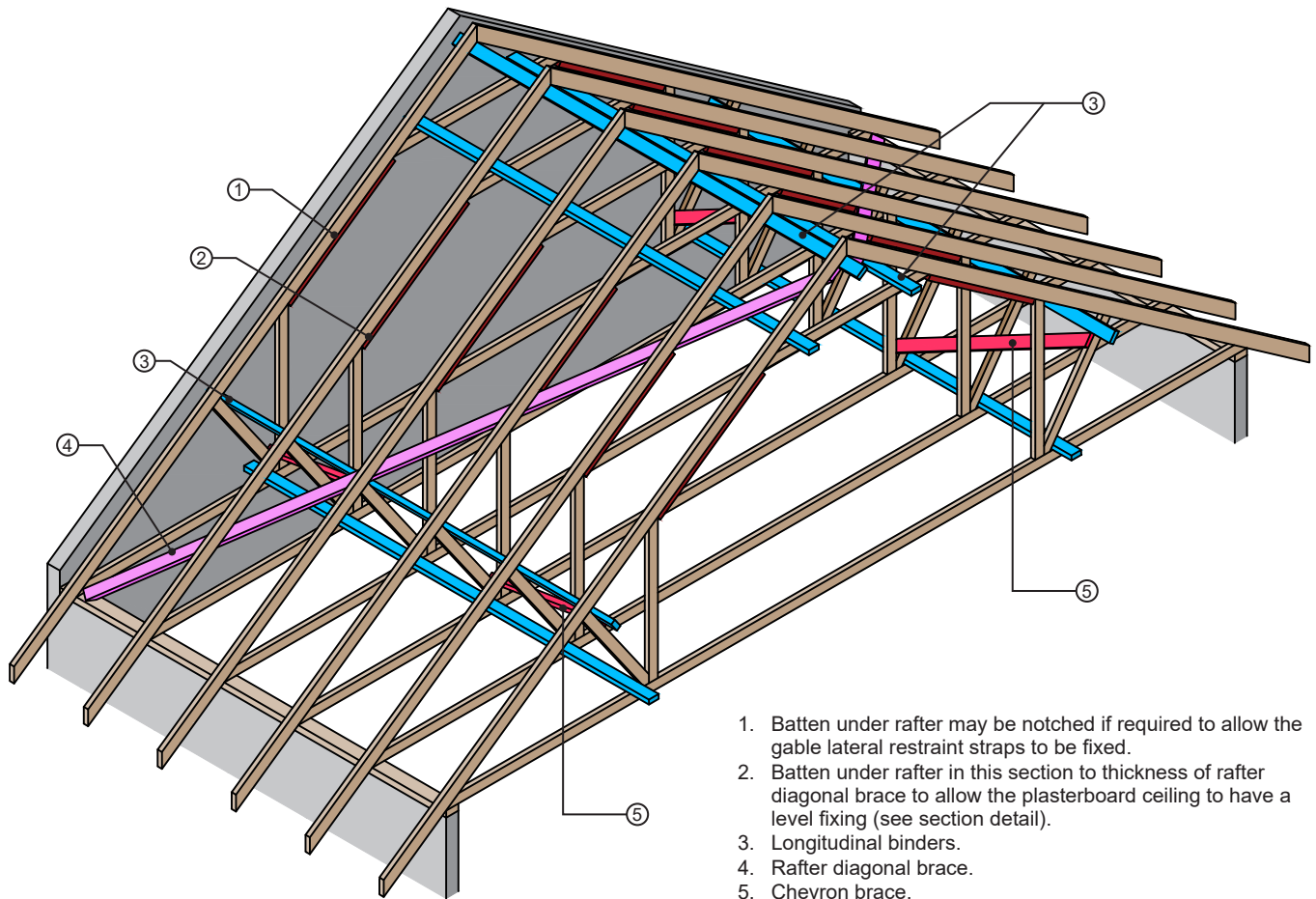
Chevron bracing should be at approximately 45° and be:

- Provided where the span exceeds 5m.
- Nailed to at least three trusses.

For mono-pitch roofs over 8m span, chevron bracing should be designed by an Engineer.

## Attic truss bracing

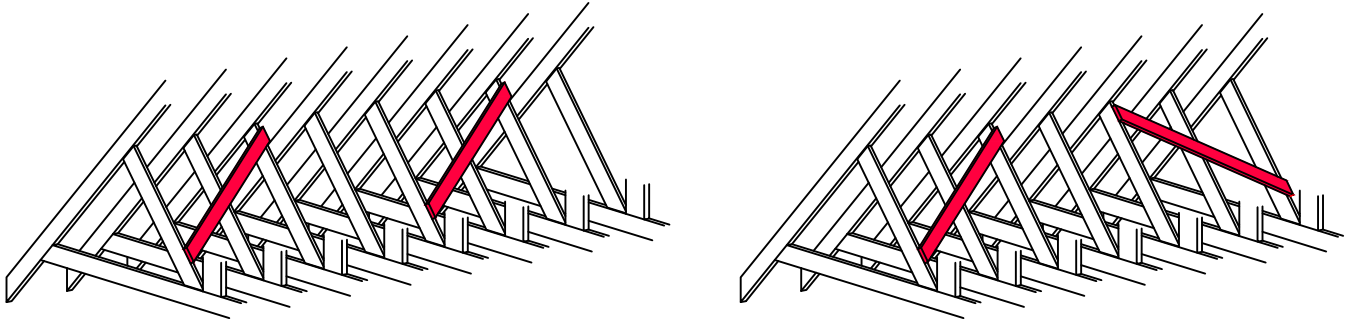
Where attic trusses are used, bracing should also be provided in accordance with the design, the diagonal bracing for attic trusses can be placed internally and the inside of the rafters battened out to take the plasterboard. Alternatively, plywood diaphragms can be placed between the rafters within the sloping ceiling area.



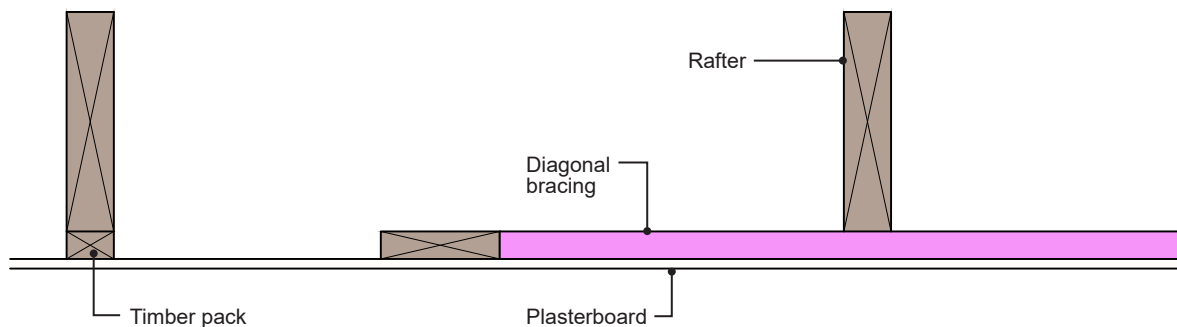
Trussed rafters, including attic trusses, should never be cut, altered, notched, or repaired for use without the full agreement of the trussed rafter Designer.

Drawings and guidance provided in conjunction with the Truss Rafter Association.

### Chevron bracing



### Section detail of internal diagonal bracing battened out for plasterboard



### Diminishing trusses

The Truss Roof Designer should provide details of fixings for the diminishing truss to the main roof truss:

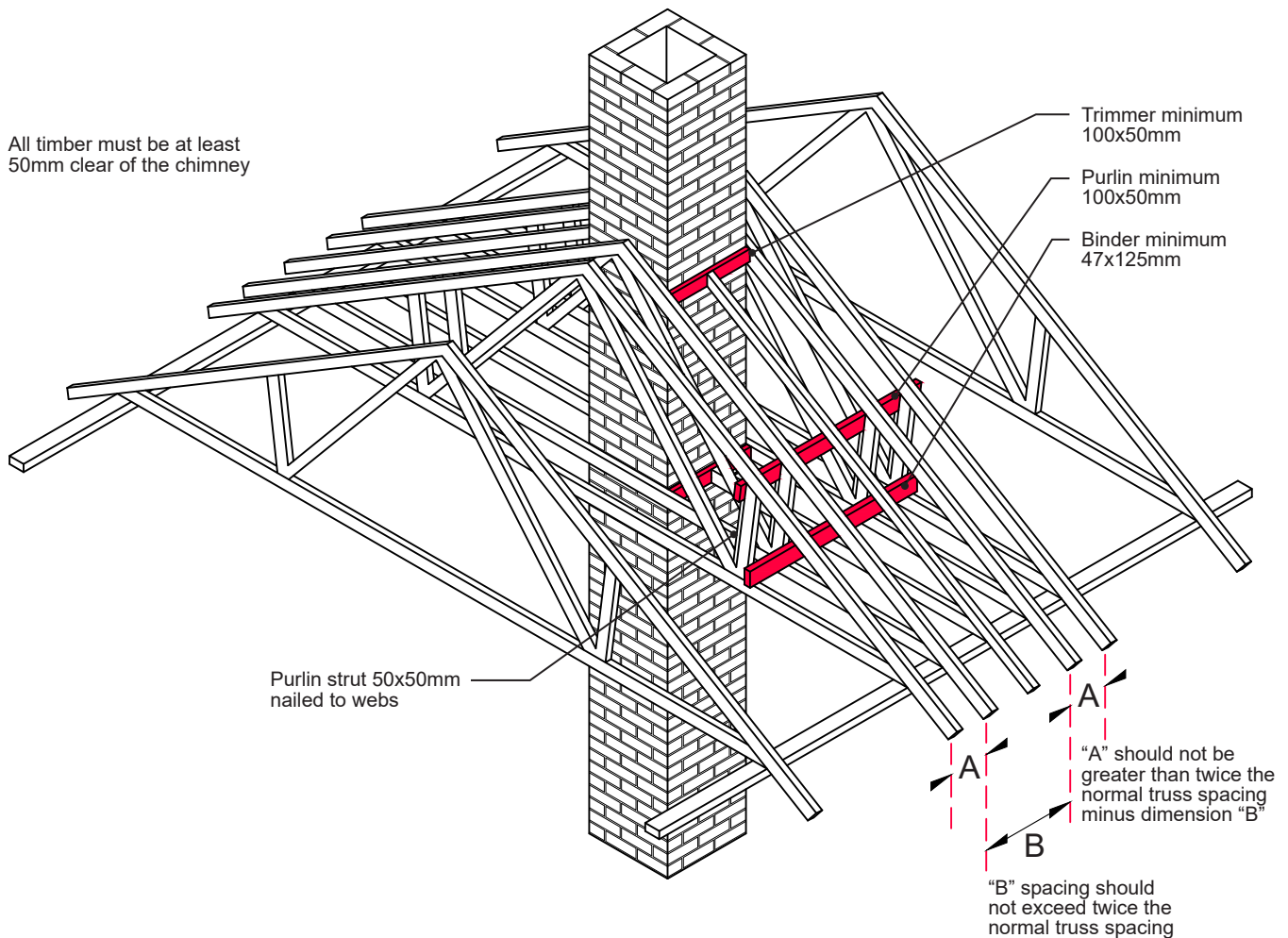
- Where the diminishing truss has a splayed bottom chord that matches the pitch of the main truss (usually where the roof pitch is less than 30°), the truss can be skew-nailed to the main truss with two no 3.35mm diameter x 75mm galvanised wire nails.
- Where the diminishing truss has a square bottom chord, the truss can be skew-nailed to the main truss and supported on a continuous binder also fixed to the main truss. The top of the binder should be splayed to suit the bottom chord and; 2 no. 3.35mm diameter x 75mm galvanised wire nails should be used for the fixing.
- Where proprietary metal fixings (such as truss clips) are used, they should be installed in accordance with the manufacturer's recommendations and appropriately specified by the designer. Proprietary metal fixings should be tested and be suitable for the intended purpose.

### Mono-pitch and girder trusses on trussed rafter hipped-end roofs

Mono-pitch trussed rafters can be used in conjunction with girder trusses on trussed rafter hipped roofs. Mono-pitched trusses are fixed to girder trusses using metal shoes. The bearing of mono-pitched trusses onto the mild steel proprietary girder shoe should be confirmed with the Roof Designer before site installation is attempted. Girder trusses are strengthened trusses designed to support loads in another plane (such as mono-pitched trusses).



## Roof trusses trimming around a chimney



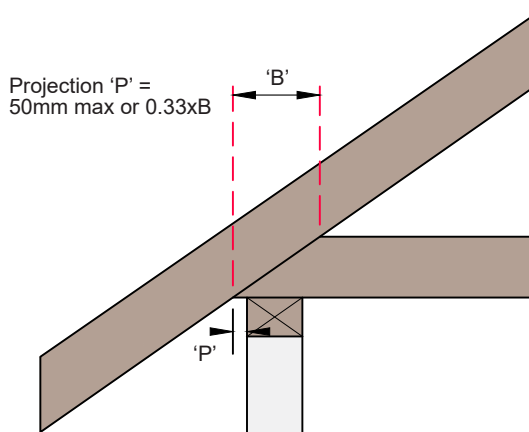
## Provision for openings, i.e. loft hatches, chimneys, etc.

Wherever possible, a trussed rafter roof should be designed to accommodate necessary openings within the trussed rafter spacing, e.g. a loft hatch. Trusses must never be cut or trimmed except according to details supplied by the truss manufacturer. The roof designer should provide all necessary details. This is applicable particularly for where roof lights and dormers are formed. Detailed specifications of the trimming joists at the side, head and base of the opening must be provided to ensure the roof is safely supported.

## Multiple-trussed rafters

Multiple-trussed rafters may be specified for a particular purpose, and may be delivered to site already fastened together. Alternatively, fixing together on-site of multiple trusses may be necessary, in which case it will be necessary to get full details of the fixing specification from the roof designer.

## Correct positioning of roof trusses

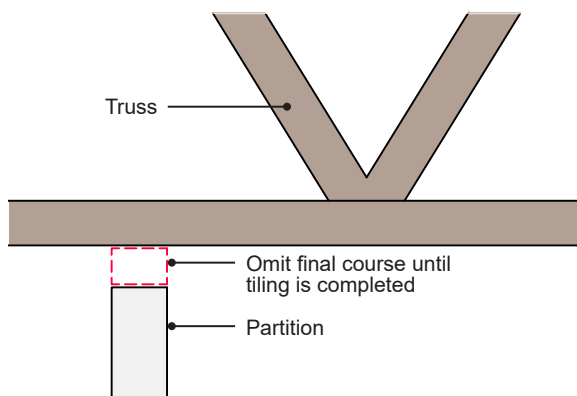


Trussed roofs should be supported on timber wall plates. Wall plates should be bedded to line and level, joined using a half lapped joints at all joints including corners.

The truss roof structure and the wall plate should be bedded and fixed to transmit and distribute loads and prevent uplift.



### Internal non-load-bearing walls



It is advisable to erect non-load bearing walls after the tiling has been completed thus allowing deflection to take place under dead load, thereby reducing the risk of cracking appearing in the ceiling finishes. If partitions are of brick or block, then alternatively the final course can be omitted until tiling has been completed.

### Items of plant, equipment or water storage tanks

Where items of plant, equipment or water storage tanks are proposed in a cold pitch roof void the following should be considered:

- The structural engineer should confirm the loadings from the equipment have been considered for the structural calculations.
- The equipment manufacturer needs to provide written confirmation the equipment can be installed in the roof void.
- The equipment manufacturer should confirm the roof void has sufficient ventilation for the equipment to function adequately.
- The building designer should provide a site specific ventilation strategy for the pitched roof space with takes account of the presence of the equipment in the roof space.
- The designer should ensure there is access for maintenance.
- The designer should provide relevant detailing for the passage of services to and from the equipment in the roof space. Where services pass through internally, they shall not damage or impede the structure, or diminish any performance required by it e.g. fire protection, acoustics, etc. Where services pass through the weatherproof envelope, appropriate weatherproof detailing shall be provided.
- Where equipment, and access to its location is provided in a loft space, the impact on thermal performance shall be considered. The mounting and positioning of equipment and the provision of access platforms, decks or walkways inside a pitched roof space shall not diminish thermal performance due to removal, reduction or compression of any insulating material.

Advisory note: Where there are significant sources of ignition within a roof void, such as gas boilers or electrical equipment for photovoltaic systems, the designer must consider the possible requirement for fire detection.

### Steps and staggers

Where the pitched roof construction incorporates steps and staggers the following should be considered by the designer:

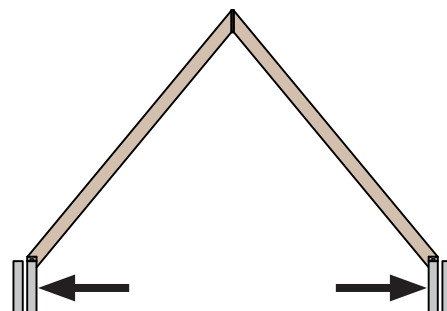
- All applied loads from the wall makeup above the pitched roof should safely transfer to supporting structure in accordance with the Engineers design.
- Abutments should have appropriate weathering details to prevent moisture ingress to the inside of the property in accordance with the guidance provided in 'Roofs - Pitched Roof Coverings (Tiles and Slates)'.
- Where the wall makeup above includes a timber frame panel to the inner leaf, the panel should meet the requirements the 'External Walls - Timber Frame' section with particular attention on:
  - A drained and vented cavity being Incorporated.
  - A sheathing board and breather membrane being provided.
  - The panel being clad with a suitable material and construction method in accordance with the 'External Walls - Cladding' section.

#### 11.1.7 General detailing for traditional cut roofs

General detailing for a traditional cut roof should be in accordance with the designers specification.

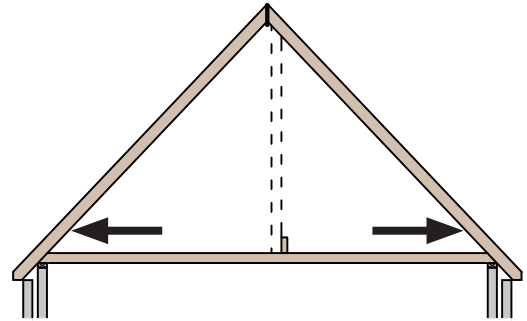
### Couple roof

This is the simplest method of producing a pitched roof, consisting of pairs, or couples, of rafters pitched against each other at their heads, with feet bearing on opposite walls. It is economical, but structurally limited, as heavy supporting walls are required to resist outward spread. When a steep pitch is combined with low eaves, the resulting clear roof space can be used to advantage. Where such roofs are designed, full structural calculations prepared by an Engineer should be provided to demonstrate how eaves spread will be prevented.



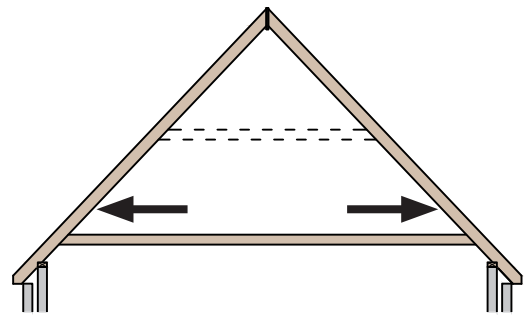
## Close couple

Pairs of rafter feet are joined together with ties, often doubling up as ceiling joists, to form triangulation. The tie resists the outward thrust, and load is transferred vertically to supporting walls. The connection of ceiling joists or ties with a binder, supported from the ridge by hangers, allows a smaller timber section to be used. Rafter and ceiling joist dimensions for typical spans are given in the TRADA document, Span Tables for Solid Timber Members in Floors, Ceilings and Roofs for Dwellings.

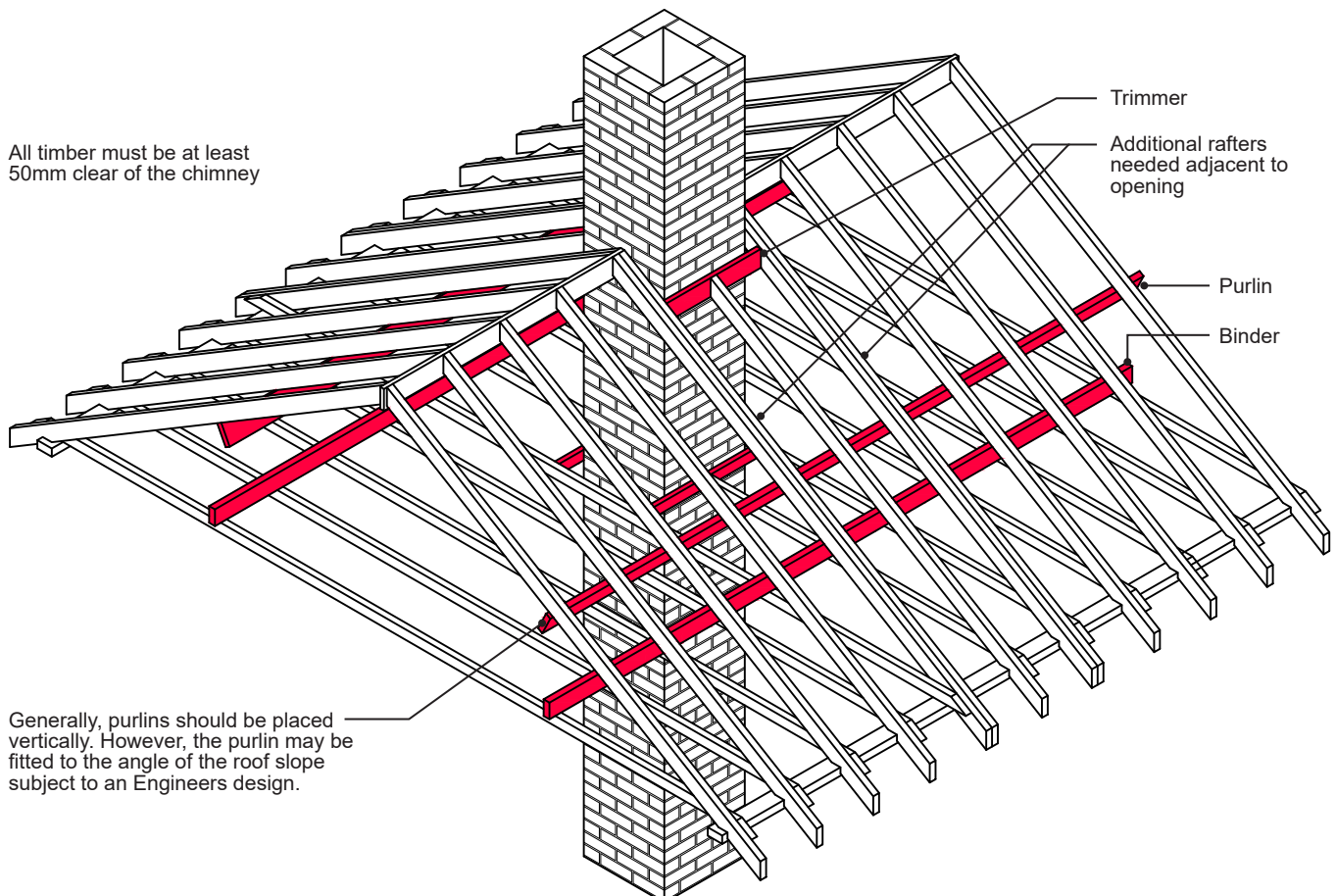


## Raised collar roof

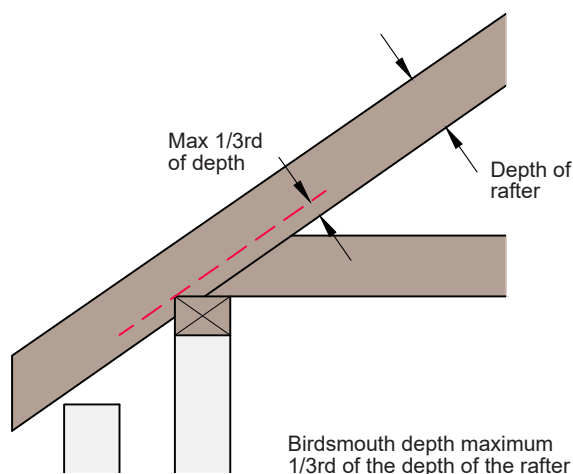
When ties are introduced at a higher level than the rafter feet, they are termed 'collars'. The higher the collar, the less influence on rafter spread and the larger the rafter section required to resist the bending moment. The height of supporting walls may be reduced, as the roof is effectively lowered so that the rafters and collars support the ceiling. To resist eaves spread, the height of the collar should be no higher than a third of the vertical height between the wall plate and ridge. Rafters supporting collar ties should be designed by an Engineer, taking into account the additional point load imposed by the collar. The collar should be fixed to the rafters using 10mm bolts and incorporating large washers to prevent the bolt from being pulled through the timber.



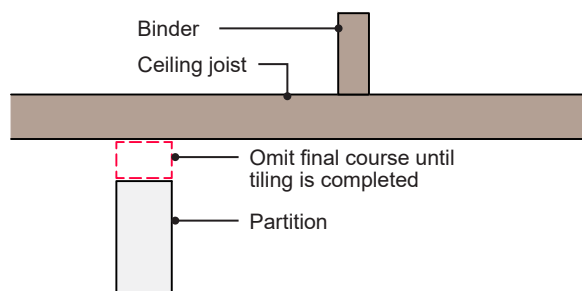
## Roof trimming around a chimney



### Maximum depth of birds mouth



### Internal non-load-bearing walls



It is advisable to erect non-load bearing walls after the tiling has been completed thus allowing deflection to take place under dead load, thereby reducing the risk of cracking appearing in the ceiling finishes. If partitions are of brick or block, then alternatively the final course can be omitted until tiling has been completed.

### Items of plant, equipment or water storage tanks

Where items of plant, equipment or water storage tanks are proposed in a cold pitch roof void the following should be considered:

- The structural engineer should confirm the loadings from the equipment have been considered for the structural calculations.
- The equipment manufacturer needs to provide written confirmation the equipment can be installed in the roof void.
- The equipment manufacturer should confirm the roof void has sufficient ventilation for the equipment to function adequately.
- The building designer should provide a site specific ventilation for the pitched roof space with takes account of the presence of the equipment in the roof space.
- The designer should ensure there is access for maintenance.
- The designer should provide relevant detailing for the passage of services to and from the equipment in the roof space. Where services pass through internally, they shall not damage or impede the structure, or diminish any performance required by it e.g. fire protection, acoustics, etc. Where services pass through the weatherproof envelope, appropriate weatherproof detailing shall be provided.
- Where equipment, and access to its location is provided in a loft space, the impact on thermal performance shall be considered. The mounting and positioning of equipment and the provision of access platforms, decks or walkways inside a pitched roof space shall not diminish thermal performance due to removal, reduction or compression of any insulating material.

Advisory note: Where there are significant sources of ignition within a roof void, such as gas boilers or electrical equipment for photovoltaic systems, the designer must consider the possible requirement for fire detection.

### Steps and staggers

Where the pitched roof construction incorporates steps and staggers the following should be considered by the designer:

- All applied loads from the wall makeup above the pitched roof should safely transfer to supporting structure in accordance with the Engineers design.
- Abutments should have appropriate weathering details to prevent moisture ingress to the inside of the property in accordance with the guidance provided in 'Roofs - Pitched Roof Coverings (Tiles and Slates)'.
- Where the wall makeup above includes a timber frame panel to the inner leaf, the panel should meet the requirements the 'External Walls - Timber Frame' section with particular attention on:
  - A drained and vented cavity being Incorporated.
  - A sheathing board and breather membrane being provided.
  - The panel being clad with a suitable material and construction method in accordance with the 'External Walls - Cladding' section.

## 11.1.8 Gable and party wall spandrel panels

Where gable and party wall spandrel panels are specified, they shall be designed by an Engineer to safely transmit loads to the roof structure and down through the supporting walls.

Gable and party spandrel panel should be suitably designed to transmit loads to the roof structure and down through the supporting walls.

It is important that gable and party wall spandrel panels should be designed to transmit these loads to the roof structure via lateral restraints and vertically down to the supporting walls. Full design with structural calculations should be provided.

The designer should provide details of the lateral resistant to the gable and/or party wall spandrel panel, including details of the restraint used and the fixings to be provided.

For further information on gable spandrel panels, please refer to the 'External Walls' section.

For further information on party spandrel panels, please refer to the 'Internal Walls' section.

## 11.1.9 Restraint of walls

Walls shall be adequately restrained at floors, ceilings and verges.

Restraint can be provided by:

- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Lateral restraint straps and restraint type joist hangers should be specified in accordance with BS EN 845-1 'Specification for ancillary components for masonry'.

Please refer to the 'External Walls' section for further guidance.

## 11.1.10 Additional requirements in a coastal location

Where developments are situated within a coastal location, key risks to construction in coastal locations in 'Appendix B' shall also be satisfied.

Further information on Warranty requirements within a coastal location can be found in 'Appendix B - Coastal Locations'.

## 11.1.11 Thermal insulation

Thermal insulation shall be specified and installed in accordance with the Building Regulations and be installed to prevent thermal bridging.

Thermal insulation products shall be suitable for their intended purpose.

## 11.1.12 General ventilation provisions

All pitched roofs shall have adequate provision for ventilation to prevent interstitial and surface condensation. The ventilation strategy shall take account of:

- The type of roof (warm, cold or hybrid).
- Providing a well-sealed ceiling.
- Vapour control layer.
- Underlay type.
- Roof covering type.
- The effect of items of plant, equipment or water storage tanks.

The guidance within this section has been derived from BS 5250: 2021 'Management of moisture in Buildings – Code of practice'. For the purposes of Warranty, all of the following guidance, relates to situations where ventilation is provided to pitched roof construction.

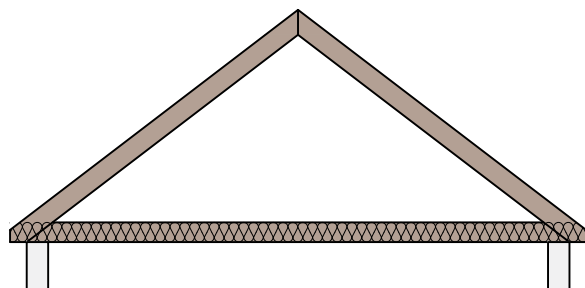
The guidance provided is based on a ventilation first approach. Any proposals to not provide ventilation to the roof construction should be supported by:

- A site specific ventilation strategy.
- A third party product conformity certificate for the underlay which confirms no ventilation is required.
- A well sealed ceiling being provided with a documented quality assurance procedure to the satisfaction of the Warranty surveyor.

Various construction processes can add additional moisture loads to the building envelope and therefore roof-space condensation may occur during the first year of occupancy. The designer should consider additional precautions than those stipulated in this section to help mitigate against this risk.

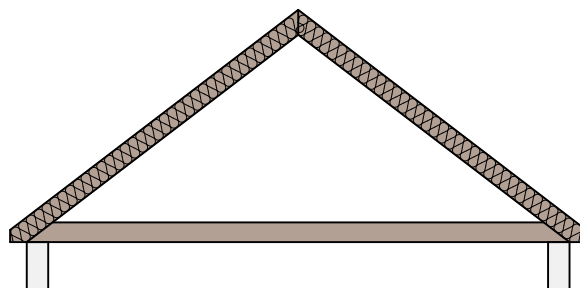
### Types of pitched roof

Pitch roof can be categorised as either cold, warm or hybrid with the determining factor being where the insulation is placed.



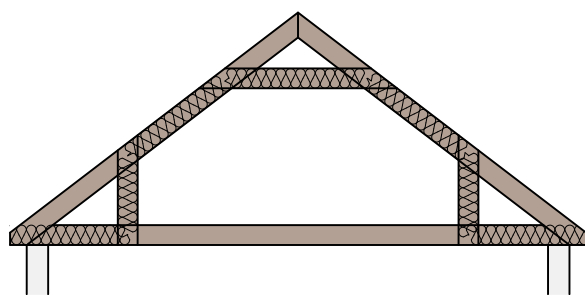
**Cold pitched roof**

Note: Insulation follows the line of the horizontal ceiling.



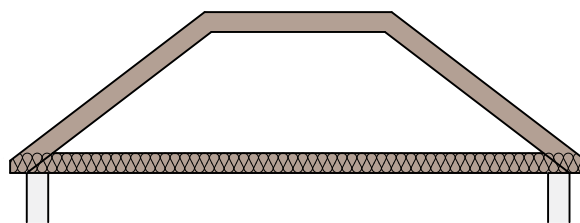
**Warm pitched roof**

Note: Insulation follows the slope of the roof.



**Hybrid pitched roof**

Note: Insulation follows horizontal, vertical, and the slope of the roof.



**Cold pitched roof with flat roof apex**

Note: Insulation follows the line of the horizontal ceiling.

### Providing a well-sealed ceiling

Where possible, a well-sealed ceiling should be provided as this can restrict the amount of warm moist air which is transferred into the roof structure/void. A well-sealed ceiling provides a ceiling or lining which is continuous, air tight and sealed to all adjacent surfaces.

Where a well-sealed ceiling is specified, it should satisfy the requirements of BS 9250 and the following should be considered:

- The tops of all cavities in walls and partitions which bypass the ceiling (including those behind plasterboard on dabs or battens) should be sealed to prevent transfer of warm moist air into the roof.
- Gaps and holes in the ceiling should be avoided.
- Recessed light fittings should either confirm to BS EN 60529 and be rated IP60 to IP65 or incorporate an appropriate sealed hood or box which may be tested using the method specified in BS EN 13131-1:2019. The total leakage through all recessed light should not exceed  $0.06 \text{ m}^3/\text{h} \cdot \text{m}^2$  of ceiling at 2 Pa.

### Loft hatches

Where loft hatches are provided, they should satisfy the below:

- The air leakage rate through an access hatch, including its frame, when tested in accordance with BS EN 13141-1:2019, should be less than  $1 \text{ m}^3/\text{h}$  at a pressure difference of 2 Pa. A third party product conformity certificate should be provided to demonstrate this can be achieved.
- Hatch covers should either be heavy enough to compress a seal or be clamped with a closed cell compressible seal, or O-ring between it and the frame.
- Loft access doors and hatches should not be located in rooms with high rates of moisture generation such as kitchens and bathrooms.

### Vapour control

All pitched roofs should incorporate an Air and Vapour Control Layer (AVCL) and it should be chosen in accordance with the design and ease of installation.

An AVCL is a moisture vapour-resistant material located on, or near, the warm side of the thermal insulation. Its purpose is to restrict the passage of moisture vapour through the structure and mitigate the risk of interstitial condensation.

The AVCL may take the form of:

- A vapour control plasterboard comprising a metallised polyester film bonded to the back face of the plasterboard.
- A minimum 125 micron thick (500 gauge) polythene sheet.
- A third party approved proprietary vapour control membrane product.

An AVCL should be provided in accordance with the design and should not be installed until framing timbers are below 20% moisture content and the building is weather tight.

A sheet membrane (polythene or proprietary) AVCL should be:

- Securely fixed to and cover all areas and lapped/sealed fully into openings such as roof lights and dormers.
- Fixed at 250mm centres onto framing members.
- Lapped and sealed by at least 100mm at joints. Joints should occur over rafters.
- Sealed around service penetrations.
- Made good where damage has occurred to the AVCL.

Vapour control plasterboard should be:

- Fixed in accordance with the plasterboard manufacturer's installation guidance.
- Tightly cut and fitted around service penetrations.
- Discarded if the vapour control backing is damaged.
- Junctions, joints and penetrations (switches and sockets for example) should be appropriately detailed to ensure the vapour resistivity is not adversely comprised.

## Criteria for a condensation risk analysis

Where a condensation risk analysis is required, the following boundary conditions should be used:

- 60% relative humidity.
- Internal temperature 21°C.
- External temperature -2°C.

Where external temperatures are considered to fall below -2°C due to exposure or geographical locations, lower temperatures should be used based upon climatic data within relevant standards.

## Underlay type

Roof underlays should be selected with consideration for the roof type, permeability of the roof covering, design of the property and the overall ventilation strategy of the property. All roof underlays are categorised as either high resistance (HR) or low resistance (LR):

- HR underlays have a water vapour resistance greater than 0.25 MN.s/g.
- LR underlays have a water vapour resistance less than 0.25 MN.s/g.

Where a LR underlay is used over a fully supported material (plywood, OSB or chipboard for example) which provides a high resistance to the passage of air and water vapour, the LR underlay should be treated, for design purposes, as a HR underlay.

Where open jointed square edged sarking boards are used, typically 150mm wide with a minimum of 2mm gaps between each board, they can for design purposes be treated as unsupported LR underlays.

The type of roof underlay should be selected as a part of the design and in accordance with the guidance provided within this section and BS 5250: 2021.

LR underlays should have an appropriate third party product conformity certificate.

'HR underlays should meet the requirements of either BS 8747 (Annex C BS 5534) or BS EN 13859-1'.

## Roof covering

The ventilation strategy of the roof should consider the air permeability of the roof covering.

Roof coverings can be categorised as either air permeable or air impermeable:

- Clay/concrete tiles and natural slates can generally be considered as air permeable.
- Roof integrated photovoltaic (PV) solar panel system, man-made slate, metal sheeting can generally be considered air impermeable.

Manufacturer's information should be checked to confirm the air permeability of the roof covering. Annex L of BS5534 provides information on testing the air permeability of tiles and slates.

In all circumstances, where an LR underlay is provided and the roof covering is categorised as air impermeable, there is risk of interstitial condensation forming between the external roof covering and underlay.

To mitigate against this risk, the batten space should be ventilation with the use of 25mm counter battens. 25,000mm<sup>2</sup>/m of Low level ventilation should be provided above the underlay and 5,000mm<sup>2</sup>/m at ridge level.

## Roof integrated photovoltaic (PV) solar panel system

Where a roof integrated PV solar panel system is installed as a part of the roof covering, even where the surrounding roof covering is classed as air permeable, the entire roof should be considered as impermeable.

Where the manufacturer can demonstrate their roof integrated PV panel system is sufficiently air permeable using the methods outlined in BS5250, an alternative ventilation strategy may be presented to the Warranty provider for consideration.

Roof integrated PV solar panel system manufacturers may require a larger ventilated air space to their underside to increase ventilation and cooling of the panel.

Where a LR underlay is specified, the manufacturer of the roof integrated PV panel system must confirm the underside of their system has a sufficient coating or protection to prevent corrosion.

For further guidance on roof integrated photovoltaic (PV) solar panel systems, refer to the 'Electrical Services - Photovoltaic (PV) Solar Panels' section.

### Hipped roofs

Where the length of the ridge is less than the eaves, the guidance provided in BS 5250 should be followed.

### Items of plant, equipment or water storage tanks

Where items of plant, equipment or water storage tanks are proposed to be stored in a cold roof void, their presence should not impede on the ventilation of the pitched roof. The ventilation strategy should take their presence into account.

#### 11.1.13 Additional ventilation requirements for cold roofs

Cold pitched roofs should be adequately ventilated to prevent surface and interstitial condensation forming.

The following guidance should be read in conjunction with the general ventilation provisions guidance for pitched roofs within this section.

The following table should be used to determine the amount of ventilation required for a cold roof.

| Table 1 - Minimum free area of openings at eaves and ridges for cold roofs |          |                                                         |                                                                    |                                                                         |
|----------------------------------------------------------------------------|----------|---------------------------------------------------------|--------------------------------------------------------------------|-------------------------------------------------------------------------|
| Pitch                                                                      | Underlay | Ceiling                                                 | Free area of opening at eaves (mm <sup>2</sup> /m) <sup>1, 2</sup> | Free area of opening at high level (mm <sup>2</sup> /m) <sup>1, 2</sup> |
| between 10° and 15°                                                        | HR       | Any                                                     | 25,000                                                             | 5000                                                                    |
| over 15° but less than 75°                                                 | HR       | Any                                                     | 10,000                                                             | 5000                                                                    |
| between 10° and 75°                                                        | LR       | Normal <sup>3</sup><br>Well sealed ceiling <sup>3</sup> | 7,000<br>3,000                                                     | 5000                                                                    |

Notes:  
<sup>1</sup> Based on longest horizontal dimension of roof.  
<sup>2</sup> Seek manufacturer's guidance.  
<sup>3</sup> A normal ceiling typically has an air permeability of 300mm<sup>2</sup>/m<sup>2</sup>. A well-sealed ceiling typically has an air permeability of not more than 30mm<sup>2</sup>/m<sup>2</sup>.

### Cold roofs and air impermeable external roof covering

#### Air impermeable roof covering and HR underlay

Where an air impermeable roof covering is chosen in conjunction with an HR underlay, table 1 should be used to determine the minimum free area of openings at eaves. No additional ventilation would be required to the batten space.

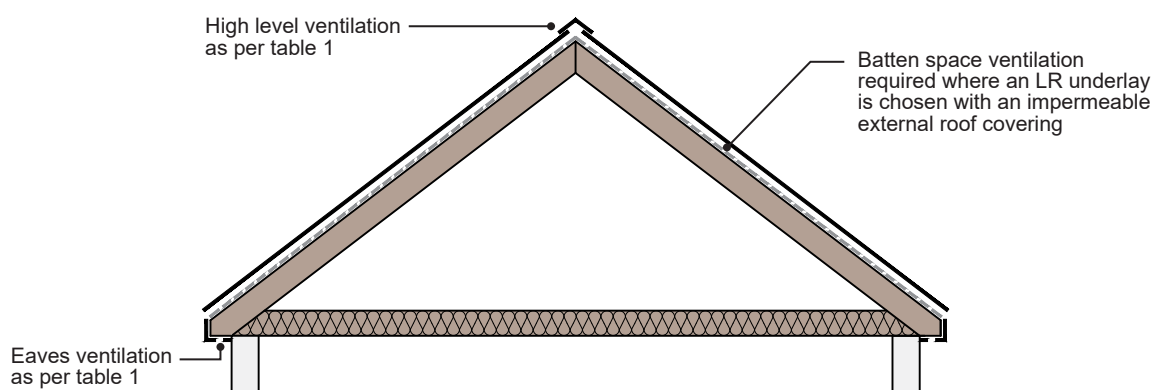
#### Air impermeable roof covering and LR underlay

Where an air impermeable roof covering is chosen with an LR underlay, table one should be used to ventilate the roof void. In addition, the batten space should be ventilated with minimum 25mm deep counter battens, having a minimum free area of not less than:

- 25,000mm<sup>2</sup>/m at eaves or low level, and
- 5000 mm<sup>2</sup>/m at ridge of high level.

Where batten space ventilation is not provided above the LR underlay, the situation should be treated as a HR underlay and therefore requires ventilation to the levels described in table 1.

#### Typical detail showing ventilation provision for a cold pitched roof





## Cold roof with a flat roof apex

Where a cold pitched roof meets a cold flat roof, there is a risk of condensation occurring on the underside of the flat roof deck. Ventilation beneath the underlay should therefore be provided in the following locations:

Where a HR underlay is used along the pitched roof sections:

- At eaves, 10,000mm<sup>2</sup>/m of free area of opening should be provided.
- At high level (where the pitched roof meets the cold roof), 5000mm<sup>2</sup>/m of continuous opening should be provided. This must be on both sides of the flat roof.

Where a LR underlay is used along the pitched roof sections:

- Eaves ventilation is required in accordance with table 1.
- At high level (where the pitched roof meets the cold roof), 5000mm<sup>2</sup>/m of continuous opening should be provided. This must be on both sides of the flat roof.

Where the flat roof span exceeds 5m additional 5,000mm<sup>2</sup>/m ventilation should be provided at the mid-point of the flat roof.

### 11.1.14 Additional ventilation requirements for warm roofs

Warm pitched roofs should be adequately ventilated to prevent surface and interstitial condensation forming.

The following guidance should be read in conjunction with the general ventilation provisions guidance for pitched roofs within this section.

| Table 2 - Minimum free area of openings for warm roofs                                                                                                                                                                                                                                                                                      |          |                                                         |                                                                           |                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Pitch                                                                                                                                                                                                                                                                                                                                       | Underlay | Ceiling                                                 | Free area of opening at low level (mm <sup>2</sup> /m)<br><sup>1, 2</sup> | Free area of opening at high level (mm <sup>2</sup> /m) <sup>1, 2</sup> |
| between 10° and 75°                                                                                                                                                                                                                                                                                                                         | HR       | Any                                                     | 25,000                                                                    | 5000                                                                    |
|                                                                                                                                                                                                                                                                                                                                             | LR       | Normal <sup>3</sup><br>Well sealed ceiling <sup>3</sup> | 7,000<br>3,000                                                            | 5000                                                                    |
| Notes:<br><sup>1</sup> Based on longest horizontal dimension of roof.<br><sup>2</sup> Seek manufacturer's guidance.<br><sup>3</sup> A normal ceiling typically has an air permeability of 300mm <sup>2</sup> /m <sup>2</sup> . A well-sealed ceiling typically has an air permeability of not more than 30mm <sup>2</sup> /m <sup>2</sup> . |          |                                                         |                                                                           |                                                                         |

## Warm roof and HR underlay

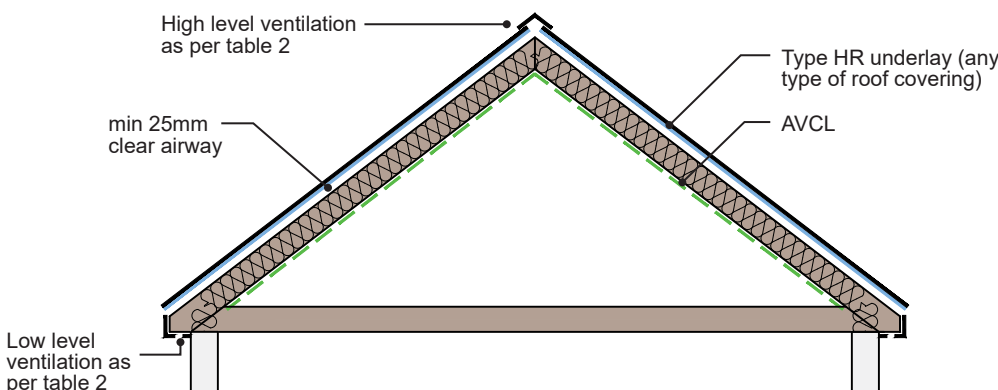
Where a HR underlay is provided with any type of external roof covering or ceiling, there is a risk of interstitial condensation forming on the underside of the underlay.

To avoid this risk the following needs to be satisfied:

- An AVCL should be provided on the warm side of the insulation.
- Ventilated voids should be formed between the underside of the underlay and the insulation.
- Each void should be at least 25 mm deep and be vented at both high and low level.
- The minimum free area should be in accordance with table 2.

Please note, the ventilated void should take into account the underlay drape, which can reduce the effective ventilation air-path. The depth of the ventilated void should be 25 mm plus the maximum allowable drape of the underlay, which is 15 mm.

Vents should be provided on both sides of any obstruction (such as horizontal ridge, fire break wall, roof windows or dormers etc).





### LR underlay with an air permeable external roof covering

#### Ventilation provision under the underlay

Where an LR underlay is provided, the following needs to be satisfied:

- An AVCL should be provided on the warm side of the insulation.
- Ventilated voids should be formed between the underside of the underlay and the insulation.
- Each void should be at least 25mm deep and be vented at both high and low level.
- The minimum free area should be in accordance with table 2.

#### Batten space ventilation

Where the external covering is sufficiently air permeable, it allows vapour to be released to atmosphere and there is no requirement to ventilate the batten space. In this scenario, the underlay drape should be maintained.

### LR underlay with an air impermeable external roof covering

#### Ventilation provision under underlay

Where an LR underlay is provided, the following needs to be satisfied:

- An AVCL should be provided on the warm side of the insulation.
- Ventilated voids should be formed between the underside of the underlay and the insulation.
- Each void should be at least 25 mm deep and be vented at both high and low level.
- The minimum free area should be in accordance with table 2.

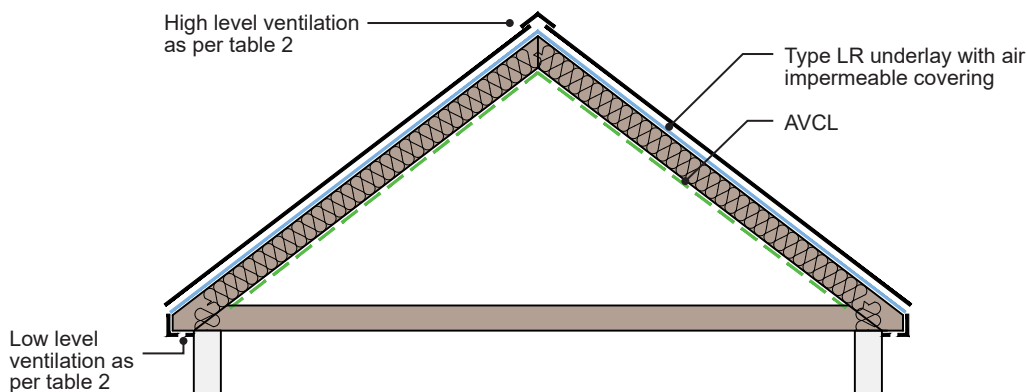
#### Batten space ventilation

Where an LR underlay is provided with a vapour impermeable roof covering there is risk of interstitial condensation forming in the batten space between the external roof covering and underlay.

To mitigate against this risk, the batten space should also be ventilated with the use of 25mm counter battens and the following levels of ventilation should be provided above the underlay:

- 25,000mm<sup>2</sup>/m at Low level, **and**
- 5,000mm<sup>2</sup>/m at ridge level.

In this scenario the underlay drape should be maintained.



### Warm pitched roof with a cold flat roof apex

Where a warm pitched roof has a cold flat roof apex, the flat roof should be a maximum of 3m<sup>2</sup> and be cross ventilated on two opposites sides.

## 11.1.15 Additional ventilation requirements for hybrid roofs

Hybrid roofs should be adequately ventilated to prevent surface and interstitial condensation forming.

The following guidance should be read in conjunction with the general ventilation provisions guidance for pitched roofs within this section.

To avoid the risk of interstitial condensation in a hybrid roof, ventilation should be provided to each cold void of the roof in accordance with the following guidance.

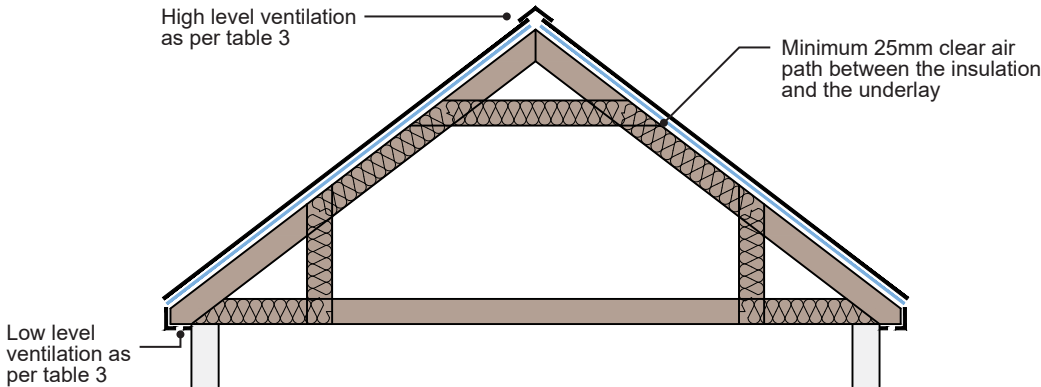
Due to the complexities with this type of roof configuration, there should be greater attention to detail with regards to achieving continuity of the insulation and AVCL.

**Table 3 - Minimum free area of openings for hybrid roofs**

| Pitch               | Underlay | Free area of opening at low level (mm <sup>2</sup> /m) | Free area of opening at high level (mm <sup>2</sup> /m) |
|---------------------|----------|--------------------------------------------------------|---------------------------------------------------------|
| between 10° and 75° | HR       | 25,000                                                 | 5000                                                    |
|                     | LR       | 7,000                                                  | 5000                                                    |

Notes:

1. Ventilated voids should be formed between the underside of the underlay and the insulation.
2. Each void should be at least 25 mm deep and be vented at both high and low level.
3. The ventilated void should take into account the underlay drape, which can reduce the effective ventilation air path. The depth of the ventilated void should be 25 mm plus the maximum allowable drape of the underlay, which is 15 mm.



### HR underlay and any type of external roof covering

Where a HR underlay is provided with any type of external roof covering or ceiling, there is a risk of interstitial condensation forming on the underside of the underlay.

To avoid this risk the following needs to be satisfied:

- An AVCL should be provided on the warm side of the insulation.
- Ventilated voids should be formed between the underside of the underlay and the insulation.
- Each void should be at least 25 mm deep and be vented at both high and low level.
- The minimum free area should be in accordance with table 3.

Please note, the ventilated void should take into account the underlay drape, which can reduce the effective ventilation air-path. The depth of the ventilated void should be 25 mm plus the maximum allowable drape of the underlay, which is 15 mm.

Vents should be provided on both sides of any obstruction (such as horizontal ridge, fire break wall, roof windows or dormers etc).

### LR underlay with air permeable roof covering

#### Ventilation provision under the underlay

Where an LR underlay is provided, the following needs to be satisfied:

- An AVCL should be provided on the warm side of the insulation.
- Ventilated voids should be formed between the underside of the underlay and the insulation.
- Each void should be at least 25 mm deep and be vented at both high and low level.
- The minimum free area should be in accordance with table 3.

#### Batten space ventilation

Where the external covering is sufficiently air permeable, it allows vapour to be released to atmosphere and there is no requirement to ventilate the batten space. In this scenario, the underlay drape should be maintained.

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**LR underlay with air impermeable roof coverings**

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**Ventilation provision under underlay**

Where an LR underlay is provided, the following needs to be satisfied:

- An AVCL should be provided on the warm side of the insulation.
- Ventilated voids should be formed between the underside of the underlay and the insulation.
- Each void should be at least 25 mm deep and be vented at both high and low level.
- The minimum free area should be in accordance with table 3.

**Batten space ventilation**

Where an LR underlay is provided with an air impermeable roof covering there is risk of interstitial condensation forming in the batten space between the external roof covering and underlay.

To mitigate against this risk, the batten space should also be ventilated with the use of 25mm counter battens and the following levels of ventilation should be provided above the underlay:

- 25,000mm<sup>2</sup>/m at low level, **and**
- 5,000mm<sup>2</sup>/m at ridge level.

In this scenario the underlay drape should be maintained.

## Introduction

This section provides guidance on meeting the performance requirements for panelised roof cassettes.

For the purposes of our Warranty, panelised roof cassettes are prefabricated pitched roof panels (open or closed) which may also be supplied with wall and floor panels, beams and other supporting elements of structure. The systems may be constructed from timber, metal or structural insulated panels (SIP) or a combination of these. They can provide a completely clear roof space free from struts ties or bracing.

For Warranty purposes, cross laminated timber is not an acceptable material for panelised roof cassettes.

### 11.2.1 Compliance

The design, specification and erection of panelised roof cassettes shall meet the performance requirements of this section.

### 11.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A complete site specific design package satisfying all of the guidance within this section.
2. Evidence the installers have been trained and approved by the manufacturer to install the specified panelised roof cassette system.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 11.2.3 Third party product conformity certificate

Panelised roof cassettes shall hold an appropriate third party product conformity certificate which is acceptable to us.

The roof cassette system must hold a full third party product conformity certificate from an independent approval body which is accepted by us. This could either be a UKAS, European equivalent product conformity accredited organisation or other body accepted by us, which looks at the system as a whole and reports on its suitability and scope of accepted use.

For systems which have not yet completed the process of obtaining the full third party product conformity certificate, a transitional arrangement deadline is set for the 1st of July 2026. This transitional deadline date, is only applicable to manufacturers that already have a contract engagement in place with a UKAS or European 'Product conformity' Technical approval body which are eligible to this transition arrangement.

Please refer to 'Appendix C – Suitability of Products and Systems' for further guidance on third party product conformity certificates.

### 11.2.4 Site specific design package

All panelised roof cassettes shall be supported with a site specific design package (per plot). An Engineer shall take overall design responsibility of the roof cassette systems and take account of interactions between the roof cassettes and the main house structure.

The site specific design package should include:

1. A full description and specification of the system and how this system complies with all current regulations and design codes, along with copies of calculations, drawings, reports, testing, etc.
2. Structural calculations and drawings should be carried out in accordance with the current European/British Standards and refer to the worst case scenario where the system could be used.
3. The Engineer must take account in the design of all structural components of the building, and elements that interact with the roof cassette to ensure they are all compatible. The calculation package must fully reflect the construction type and build-ups of the final structure of the house and roof including roof covering and any additional attachments (such as PV panels).
4. Principle connection details (drawing and calculations) must be provided for the floor and roof panel at the external wall, ridge connections, ceiling strut connections, and floor and roof connections. The calculations must cover all connection details and details of the roof load transfer.
5. There must also be a house type specific fixing schedule document available to allow the Warranty surveyor to check that the fixing specification has been followed on site. A generic fixing specification is not acceptable. It should also not be left to a third party to provide a fixing specification, this should be part of the holistic structural package from the Engineer.

6. The structural calculation package will need to include wind uplift calculations to ensure that the roof will be connected by restraint straps to the wall plates and gable/hipped ends accordingly. A gable restraint system will need to part of the design calculation package to consider the continuous or raised gable wall plate depending on the gable panel (i.e. masonry or timber frame or panels).
7. The whole design package must consider how all other elements will interact with the roofing cassette, such as insertion of false prefabricated chimneys, roof light penetrations or dormers, roof covering, Solar photovoltaic installations and ventilation systems.
8. The design package will also need to consider the prevention of fire spread, thermal insulation requirements, durability, weatherproofing, vapour permeability and sound insulation requirements (where applicable). The designer must consider critical elements especially at party walls and gable ends for fire resistance where Building Regulations may have different requirements than a traditional roof due to the differing loadbearing elements.
9. As part of the design there must be details on how the roofing cassettes will be finished at eaves and verge. Due to the varying nature of the roofing cassettes this could be done in different ways. Such as site attached constructed gable ladder or pre-installed gable ladder to roofing cassettes. Some have extended rafters to be cut on site and some have additional add on sections to extend the eaves. This must be in the design and not left as an ad-hoc solution to be constructed on site.
10. Roof cassette manufacturers must have a system operating procedure manual covering repairability and installation and sign off processes. All installers of the roof cassette system should receive suitable training from the manufacturer evidence of which must be provided to the Warranty surveyor upon request.

### 11.2.5 Site storage and temporary protection

Where delays are anticipated, there should be a site storage plan in line with the manufacturer's recommendations to ensure roof cassettes are not damaged and the moisture content does not impede on the performance or durability of the panels.

As panels are closed, storage on site with no protection is not acceptable.

Due to the closed panel nature of the roofing cassettes, storage on site shall be minimised and delivery of roof cassettes and lifting equipment/ installation shall be co-ordinated to prevent prolonged storage periods on site.

Where a breather membrane is proposed as a temporary weather protection details of maximum exposure of the membrane should be provided.

### 11.2.6 Installation

All installers of the roof cassette system shall receive suitable training from the manufacturer, evidence of which should be provided to the Warranty surveyor upon request.

#### Fillet pieces

Where additional fillet pieces are required at junctions (at wall plate and ridge level for example), they should be design and specified by the manufacturer prior to the roof cassettes being installed. Ad-hoc on site installations not designed or specified by the manufacturer will not be acceptable for Warranty purposes.

#### Service penetrations

Service penetrations through the roof cassette should not be through structural members. Where large service penetrations are required, they must be accommodated for in the design.

## Introduction

This section provides guidance on meeting the performance requirements for pitched roof coverings. Types of pitched roof coverings covered within this section include:

- Concrete interlocking tiles
- Plain concrete tiles
- Natural slates
- Fibre cement slates

### 11.3.1 Compliance

The specification and installation of pitched roof coverings and their ancillary components shall meet the performance requirements of this section.

### 11.3.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Evidence that all roof tiles and/or slates satisfy the relevant British Standards as outlined within this section. Evidence of CE/UKCA marking should be provided upon request.
2. A site specific fixing specification for the roof tiles and/or slates.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 11.3.3 Specification and installation of underlays

Pitched roof underlays shall be suitable for the intended purpose and:

- Be of a suitable material specification.
- Be suitable for the geographical location and wind zone.
- Be fixed in accordance with the underlay manufacturer's recommendation's.
- Be designed, specified and installed to prevent water ingress.

Underlays for use beneath tiles and slates are either fully supported over boarding, sheathing or sarking, or unsupported and draped over rafters/counter battens. Underlays may be of the following specification:

- BS 8747 Class 1F reinforced bitumen or Class 5U polyester reinforced bitumen.
- 2HR<sup>1</sup> underlay to BS EN 13859-1 Class W1 water penetration classification with a third party product conformity certificate for the use intended.
- 3LR<sup>2</sup> underlay to BS EN 13859-1 Class W1 water penetration classification with a third party product conformity certificate for the use intended.

<sup>1</sup> HR (high water vapour resistance) underlay - >0.25MNs/g.

<sup>2</sup> LR (low water vapour resistance) underlay - <0.25MNs/g.

(LR underlays are sometimes referred to as 'vapour permeable' or 'vapour open').

There are two categories of underlay: HR, non-vapour permeable and LR, vapour permeable. These types of underlay should comply with BS EN 13859-1 and have a third party product conformity certificate. They should also have sufficient tensile and nail-tear strength, and low extensibility, to produce the required resistance to wind uplift.

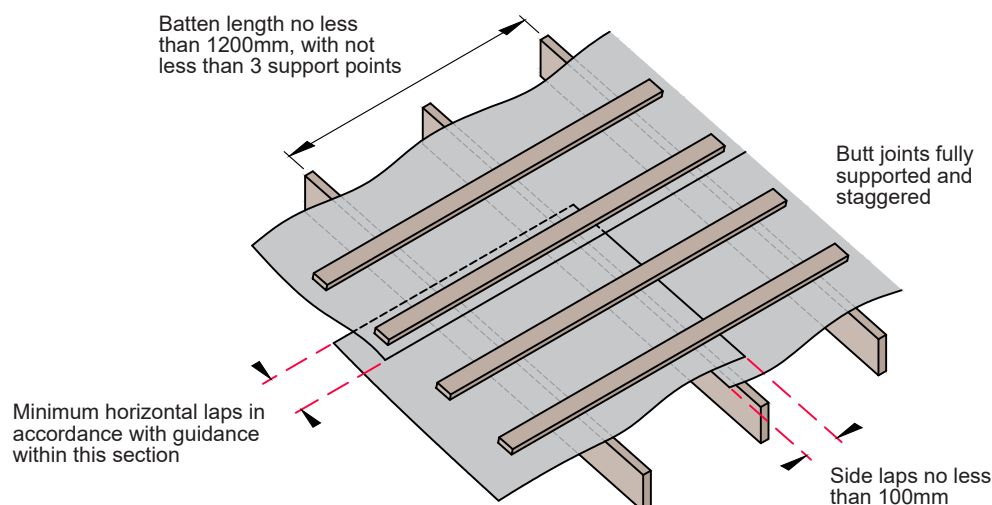
## Classification of underlays

Underlays should be classified in accordance with their geographic location and wind zone. Underlays should only be used in those wind zones for which the design wind pressure is not greater than the declared wind uplift resistance. Refer to BS 5534 A8. Figure A.4 for design wind pressures for geographical wind zones location map. It is important to ensure the underlay is suitable for the geographical wind zone and that laps in the underlay are secured in accordance with the manufacturer's third party product conformity certificate for the geographical wind zone and batten spacing. This lap can be secured either with a batten or a suitable product with third party product conformity certificate in accordance with the manufacturer's recommendations.

### Underlay nails

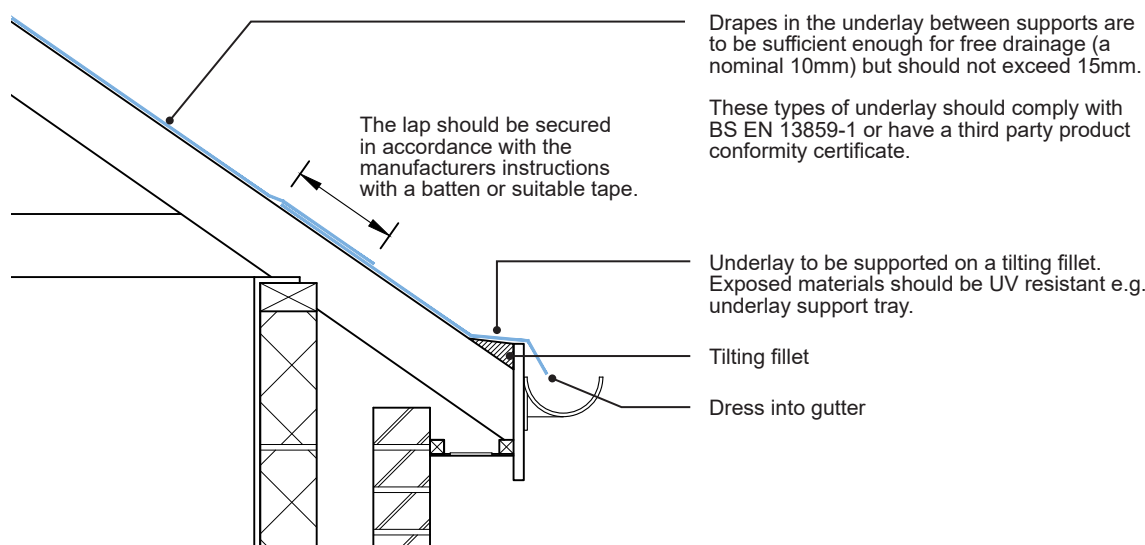
Nails for use with roofing underlays should be clout head nails of no less than 3mm shank diameter and 20mm length made of copper, aluminium alloy or steel coated by any of the zinc or zinc alloy coating methods specified in BS EN 10230-1.

### Roof underlay laps



The lap of the underlay should be secured in accordance with the manufacturers third party product conformity certificate.

### Roof underlay detailing at eaves level



### Installation of underlays

Lay the specified roofing underlay parallel to eaves or ridge with horizontal overlaps, as specified in the table below. Vertical side laps should be a minimum of 100mm. Minimise the gap at laps resulting from different tautness between underlay courses. Drape in underlay between supports is to be sufficient for free drainage (a nominal 10mm) but should not exceed 15mm in accordance with BS 5534. Fix underlay with the fixings specified, keeping the number of perforations to a minimum. Handle and fix underlay with care to ensure there are no tears or punctures, and repair any tears or punctures prior to tiling. Ensure that the underlay does not obstruct the flow of air through ventilators located at eaves, ridge or in the main roof, and appropriately weather all holes formed in underlays for soil vent pipes, etc. Avoid contact between the underlay and the underside of tiles. To prevent wind uplift, fix additional battens or timber strips where laps occur between tiling battens (refer to BS 5534 6.2 Underlays).

#### Minimum horizontal laps for underlays

| Rafter pitch  | Not fully supported | Fully supported |
|---------------|---------------------|-----------------|
| 12.5° to 15°  | 225mm               | 150mm           |
| 15° to 35°    | 150mm               | 100mm           |
| 35° and above | 100mm               | 75mm            |

## 11.3.4 Timber tiling battens

Timber tiling battens shall be of an adequate durability and be securely fixed in accordance with the design.

### Timber species

Tiling battens and counter battens should be selected from the timber species set out in BS 5534, and their characteristics and defects should not exceed the permissible limits given in Annex D to G of BS 5534.

### Grading

Battens should be suitably graded to meet the requirements in BS 5534. Only battens that have been graded and bear the BS 5534 marking will be acceptable for use.

### Sizing

Timber batten sizes should be not less than the minimum values recommended in BS 5534 and as per the 'Recommended batten sizes for pitched roofs and vertical work' table.

Battens for large spans or special loading conditions should be designed by structural calculation for strength and stiffness, in accordance with Annex F of BS 5534.

### Batten marking

Each batten should be permanently marked with the following information:

- Supplier.
- Origin (imported or British grown and/or species code).
- Graded BS5534.
- Size.

### Preservatives

BS 8417 provides recommendations for preservatives for timber. Indicative preservative treatment schedules are given in Annex E of BS 5534. Battens treated with preservatives can contain toxic substances that could introduce an environmental hazard, and should be disposed of safely.

### Fixing timber battens

Battens should be at least 1200mm in length and supported at each end and intermediately by at least three rafters or walls. Stagger butt joints over intermediate supports, splay nail each batten end and nail battens to each rafter.

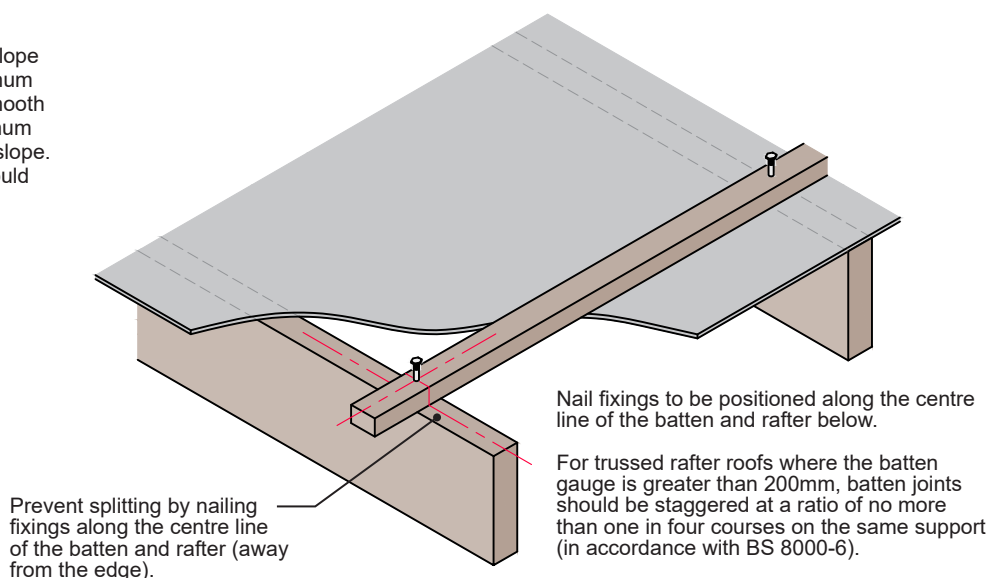
For trussed rafter roofs where the batten gauge is greater than 200mm, do not have more than one joint in any four consecutive battens on the same support.

For trussed rafter roofs where the batten gauge is less than 200mm do not have more than three joints together in any 12 consecutive battens on the same support.

The batten sizes given in the table should be taken as minimum dimensional requirements. Take care that nails used to secure tiles do not penetrate the underside of battens or the underlay.

### Fixing battens to rafters

Fix the specified battens up the roof slope on top of the rafters, ensuring a minimum 40mm nail penetration into rafters (smooth shank). Nail counter battens at maximum 300mm centres vertically up the roof slope. Where boarding is used the fixing should coincide with the line of rafters.





**Recommended batten sizes for pitched roofs and vertical work  
(BS 5534 in accordance with clause 4.11.4.1 Table 3)**

| Tile type                           | Basic minimum sizes <sup>1</sup> |       |            |       |
|-------------------------------------|----------------------------------|-------|------------|-------|
|                                     | 450mm span                       |       | 600mm span |       |
|                                     | width                            | depth | width      | depth |
| Plain pitched/vertical              | 38mm                             | 25mm  | 38mm       | 25mm  |
| Single lap interlocking tiles/slate | 38mm                             | 25mm  | 50mm       | 25mm  |
| Fibre cement slates                 | 38mm                             | 25mm  | 50mm       | 25mm  |
| Natural slates                      | 50mm                             | 25mm  | 50mm       | 25mm  |

<sup>1</sup> All dimensions subject to re-sawing allowance: width +3mm, depth 0 or +3mm based on measurement reference moisture content of 20%

### 11.3.5 Specification of tiles and slates

Tiles and slates shall be of an adequate durability, material specification and be suitable for the site specific weather exposure.

Roof coverings shall satisfy the Building Regulations in relation fire spread.

Tiled and pitched roof coverings should be in accordance with the relevant Building Regulations.

The principal British Standards relevant to the specification of tiles and slates are:

- BS 5534 Code of Practice for slating and tiling (including shingles). This gives recommendations for the design, materials, application, installation and performance of slates and tiles (BS 5534 should be read in conjunction with BS 8000-6).
- BS 8000-6 Workmanship on building sites. Code of Practice for slating and tiling of roofs and claddings. This applies to the laying and fixing of clay and concrete tiles, natural and fibre cement slates and their associated fixings and accessories.
- BS 5250 Management of moisture in Buildings: Code of Practice. This describes the causes and effects of surface and interstitial condensation in buildings, and gives recommendations for control of condensation in roofs.

### Material specification

Tiles and slates should meet the requirements of the following standards:

- BS EN 1304 – Clay roofing tiles and fittings
- BS EN 490 and BS EN 491 – Concrete tiles and fittings
- BS EN 12326 – Natural slates
- BS EN 492 - Fibre cement slates and fittings

Where roof integrated photovoltaic (PV) solar panels are specified, they must satisfy the requirements set out in our 'Electrical Services – Photovoltaic Solar Panels' section.

### Natural slates

Natural slates must meet the following level of performance and durability as detailed in BS EN 12326:

- Achieve a A1 code rating for water absorption less than 0.6%
- Achieve a T1 code rating for 'Thermal cycle' test.
- Achieve a S1 code rating for 'Sulphur dioxide exposure' test.
- A copy of the consignment documentation or "accompanying commercial document" (ACD) from the supplier/producer should be provided to confirm these test performances.

It is important that slates are graded on site to ensure an even finish.

### Weather exposure

Rain penetration of the roof covering is dependent on a combination of the rainfall rate, wind speed and the ability of the roof tile to resist the ingress of snow and rain water. The Designer should therefore be aware of the various means by which rain and snow can, under certain conditions, penetrate the roof covering.

These include:

- Capillary action and rain water creep.
- Raindrop bounce and negative pressure rain suction.
- Driving rain, deluge rain and flooding.
- Surcharging of rain water over laps on long-rafter roofs.
- Wind-driven snow.

### Rain and snow

The roof of the building shall adequately protect the building and people who use the building from harmful effects caused by precipitation and wind-driven spray. Roofs are required to resist the penetration of precipitation (rainfall) to the inside of the building, thereby preventing damage to any part of the building where it might be carried.

Most pitched roofs keep the rain and snow out of the building and give a satisfactory performance. However, it is acknowledged that similar roofs built to the same design and using identical roof materials, but in different locations, may not necessarily provide the same level of assurance since they will be subject to different weather conditions and exposure.

## Exposure to driving rain

The UK has a high risk of severe driving rain, and even in some sheltered locations may be subject to high levels of deluge rainfall. BS 5534 defines four categories of exposure, based on the driving rain data given in BS 8104 and BR 262, and should be used for buildings up to 12m in height. For buildings over 12m in height, the influence of increased wind speeds should be taken into account using BS EN 1991-1-4.

## Design for wind loading

When considering the wind loading on the roof covering, designers should consult BS 5534. This provides calculation methods to assess the wind load on each tile as a uniformly distributed load, and also takes into account the porosity of the tiles and the effectiveness of the substrate (boarding or sarking), and/or underlay shielding, when calculating wind uplift loads. The standard method in BS EN 1991-1-4 Eurocode 1. Actions on structures. General actions. Wind actions should be used to determine the basic wind speed of the site, which is then used to calculate the effective wind speed and dynamic wind pressure on the roof by applying a series of factors to account for terrain, topography, building height and length etc.

## Control of internal pressure

The total wind force on a roof is dependent on the pressure differential between the inner and outer faces of the roof covering. Such pressures are significantly reduced by the use of underlay or boarding beneath tiling or slating. Its contribution towards shielding the underside of the tiles or slates from the full transmission of internal pressures means the underlay is required to have an adequate tensile strength for the specific application. The tensile strength of the underlay, its air permeability factor and the withdrawal resistance of batten nail fixings are therefore important when determining the overall resistance to wind uplift of the roof system.

## Aircraft vortices

Roofs near airports can experience high local wind load forces due to air vortices created by certain aircraft when taking off and landing, which may be greater than the wind loads calculated to BS 5534. Designers should seek advice from the Airport Authority Planning Department when designing roof fixings in these locations, and refer to the guidance contained in BRE Digest 467 Slate and tile roofs: avoiding damage from aircraft wake vortices.

## 11.3.6 Fixing requirements for tiles and slates

Tiles and slates shall be fixed in accordance with a site specific fixing specification and site exposure conditions.

The procedures for calculating the wind loads and determining the fixing specification for tiles and slates in accordance with BS EN 1991-1-4 and BS 5534 are complex to undertake. Designers are advised to obtain a full roofing fixing specification from the slate or tile manufacturer.

Alternative proprietary mortar mixes may be accepted if they are shown to have similar durability and workability.

Tile fixing should be in accordance with BS 8000-6 and the manufacturer's recommendations.

## Nailing tiles and slates to battens

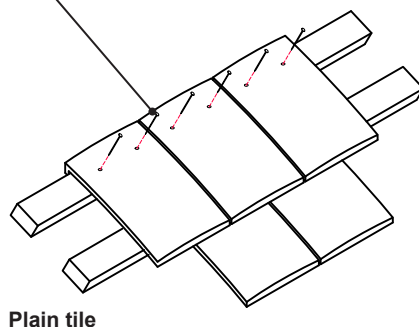
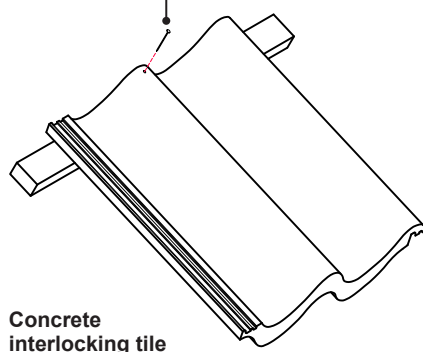
### Concrete interlocking, plain tiles and natural slate

Nails for use with tiles should be of copper, aluminium, stainless steel, phosphor or silicon bronze. Aluminium nails intended for use with tiles should conform to BS 1202-3 and should be clout head nails of 3.35mm or 2.65mm diameter. The length of nail will be determined by the required wind uplift and the design of the tile. Stainless steel nails for use with tiles should conform to BS EN 10088-3 and BS 5534 grade 304, 316, 321 or 347, and should be specified for coastal areas, areas of high exposure or where there is a risk from chemical reaction.

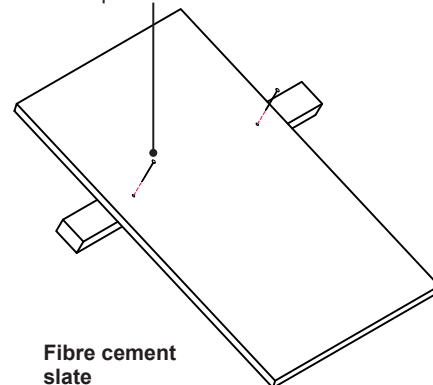
### Fibre cement slates

Nails intended for use with fibre cement slates should be of copper, conforming to the requirements for clout nails specified in BS 1202-2. The shank diameter and length should be determined by the exposure of the site and the nail's withdrawal resistance. Normally, 30mm x 2.65mm copper nails are adequate for most applications. For exposed sites, or where aggressive environments are encountered, contact the slate manufacturer. Copper disc 'tail' rivets are used to further secure the tail of fibre cement slates against wind chatter.

Nails for use with tiles should be of copper, aluminium, stainless steel, phosphor, or silicon bronze.

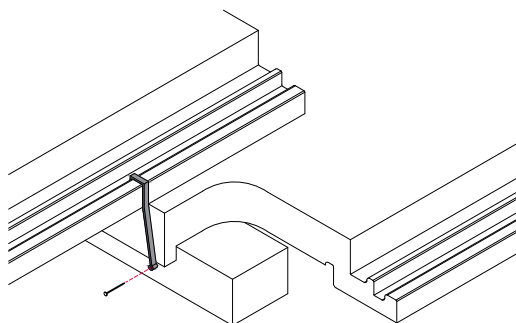


Nails for use with fibre cement slates should be of copper, conforming to the requirements for clout nails specified in BS 1202-2



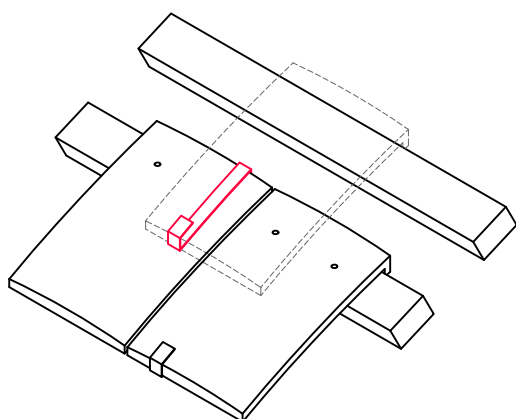
## Tile clips

### Interlocking tiles



Tile clips should be located over the side interlock of the tile immediately behind the overlapped tile, and nailed to the tiling batten. Tile clips provide resistance to the applied overturning moment more successfully than a nail fixing. The latter is closer to the pivot line, where the nib touches the batten and cannot resist the uplift force at the tail. The phenomenon is also related to roof pitch and the step height of the roof covering, and BS 5534 acknowledges that, at roof pitches of 45°-55°, all tiles should be at least nailed to battens to prevent displacement. At pitches exceeding 55° all tiles must be both head nailed and tile clipped to reduce 'chatter' in high winds.

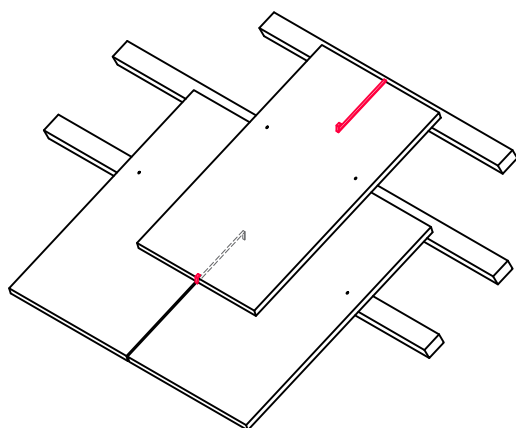
### Plain tiles



Tile clips may need to be utilized to achieve a suitable number of fixings to comply with BS 5534 especially on hips or valleys. Tile clips provide resistance to the applied overturning moment more successfully than a nail fixing. The latter is closer to the pivot line, where the nib touches the batten and cannot resist the uplift force at the tail.

BS 5534 acknowledges that for nibbed tiles, where the rafter pitch is below 60°, two nails should be used in each tile in at least every fifth course. For rafter pitches of 60° and above, including vertical, two nails should be used in every tile.

## Slate hooks



Hooks are formed from stainless steel wire conforming to BS 1554 grade 316 S11 or 316 S19. For further advice on the use of slate hooks, refer to BS 5534 section 4.12.3 and 5.3.6.4 Hooks and rivets for slates. Slates should not be nailed to accommodate hooks.

Hooks with crimped shanks reduce the capillary rise of water at the perpendicular joints between slates and are suitable for all roof pitches between 25° and 90°. Straight shank hooks should not be used at roof pitches below 30°. Hooks should not be used at roof pitches below 25°.

## 11.3.7 Installation and detailing for tiles and slates

Tiles and slates shall be specified and installed to prevent water ingress and be suitable for the site exposure conditions.

### Roof pitch and lap requirements

When determining the pitch, head-lap and/or side-lap of a tile, the roof pitch is taken to be equal to the rafter pitch. Hence, all references to pitch refer to the rafter pitch, with the laid angle of the roof tile or slate always being less than roof pitch.

The actual pitch of a tile should be determined in accordance with the following guidelines:

- Tile to rafter pitch angles.
- Interlocking single-lap tiles: 5° less than rafter pitch.
- Plain tiles: 7° less than rafter pitch.
- Double-lap fibre cement slates: 1.25° less than rafter pitch.

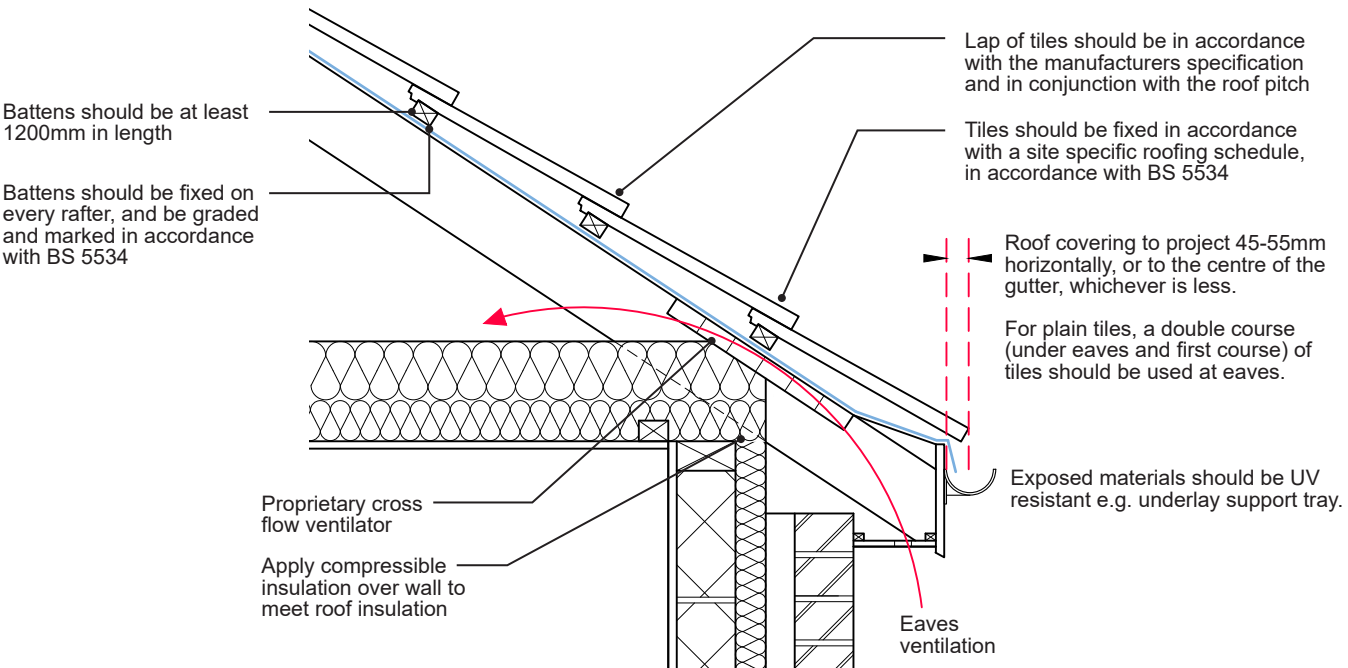
If the design rafter pitch is less than the minimum recommended rafter pitch for the particular tile, then they can be considered as having an aesthetic function only. In such cases, the true weatherproofing of the roof system must rely on a fully supported waterproof membrane with an uninterrupted drainage path between counter battens to the eaves gutter.

| Type of tile or slate              | Gauge                                | Minimum headlap                                                                      | Minimum permissible pitch |
|------------------------------------|--------------------------------------|--------------------------------------------------------------------------------------|---------------------------|
| Concrete interlocking (single lap) | As per manufacturers recommendations | 75mm or to the manufacturer's recommendations                                        | 30° <sup>2</sup>          |
| Plain (double lap)                 | Maximum 1/3 length lap               | 65mm generally for clay tiles<br>75mm in severe exposure conditions                  | 35°                       |
| Slates (double lap)                | Maximum 1/3 length lap               | 54mm <sup>1</sup> minimum, increased with lower pitch and severe exposure conditions | 20° subject to headlap    |

Notes:  
<sup>1</sup> For pitches greater than 45° in sheltered and moderate exposure zones only.  
<sup>2</sup> For pitches below 30°, evidence shall be provided as to suitable performance.

The roof pitch should not be less than 20°.

### General eaves detailing

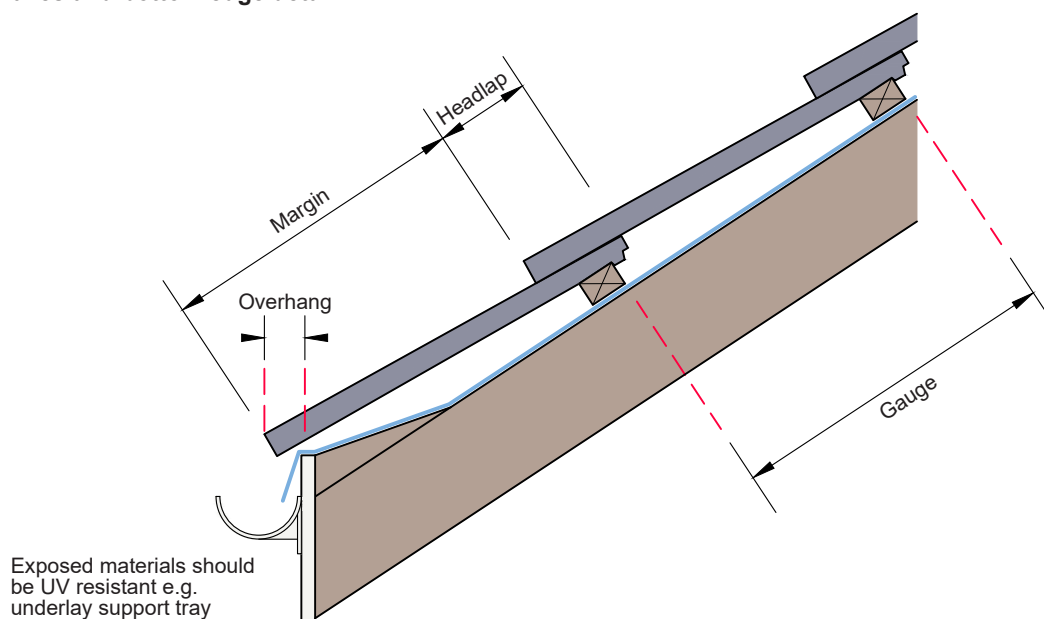


BS 5534 recommends the use of aluminium or stainless steel nails under normal conditions of exposure. Plain or galvanised nails may be used for fixing battens to rafters, but care must be exercised when there is high humidity as certain timber preservative treatments may corrode steel, zinc or aluminium. For all roof areas and rafter pitches, every tile should be mechanically fixed.

**Key check points at the eaves**

At the eaves (bottom edge), the batten should be set to provide the required overhang of the tiles into the gutters. The recommended overhang is 45mm-55mm horizontally or to the centre of the gutter, whichever is less.

- Ensure fascia board is to correct height so as to prevent tiles kicking up or drooping.
- Fit duct trays to retain insulation.
- Fix underlay protector trays, fascia vents and comb fillers (profiled tiles).
- Clip eaves course where required.
- Ensure vent path to roof space is achieved.
- Ensure exposed materials are UV resistant.

**Eaves and bottom edge detail****Relevant British Standards**

- BS EN 490
- BS 5250
- BS EN 1990
- BS 5534
- BS EN 1991-1-4
- BS 8000-6
- EN 13859-1
- BS 6399

**Ridges, hips, verges and valleys**

The use of mortar for the bedding of ridge tiles, hip tiles, or lay tiles does not provide sufficient tensile bond strength to resist wind uplift, as it can be affected by a number of factors, such as wind loadings, mix of mortar, design and movement of the roof structure. The tensile strength of mortar should not be taken into account as the mechanical fixings should provide the resistance. Tiles only bedded on mortar are not acceptable.

Note: Dry fix ridge and hip systems are available to provide full mechanical fixing of all ridge and hip tiles to meet BS 5534 recommendations.

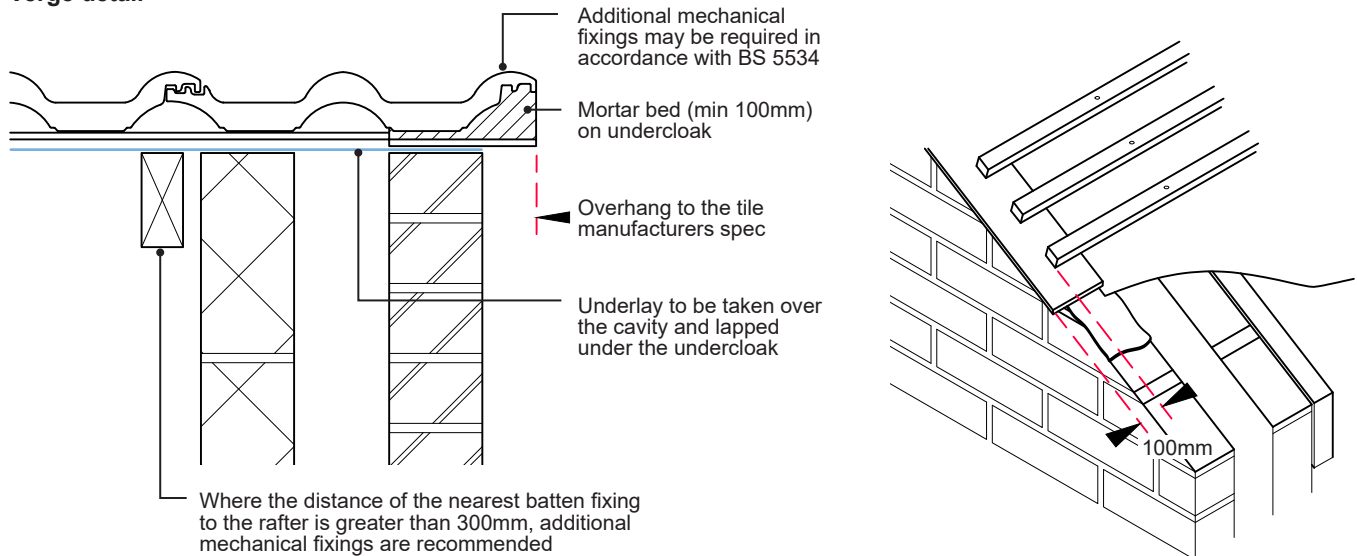
**Verge (in accordance with BS 5534, BS 8612 and BS 8000-6)**

Battens should overlap onto the outer skin of the brickwork or the undercloak material; the projection for plain tiles and slates should be 38-50mm beyond the gable wall. For concrete interlocking tiles, the projection should be 30-60mm beyond the gable wall. Where the distance of the nearest batten fixing to the rafter is greater than 300mm, an additional mechanical fixing is recommended.

Note: Where proprietary verge tiles or systems are specified, the detailing should be in accordance with manufacturers' recommendations that are relevant to UK conditions of use.

- Use recommended undercloak for mortar.
- Level off irregularities in brickwork.
- Carry underlay over gable wall or bargeboard, and fit undercloak.
- Use the correct mortar mix.
- Bed and point tiles in one operation.
- Keep mortar clear from the ends of tiling battens.
- Fix all perimeter tiles (clip and/or nail).
- Cut plain tiles are not acceptable, and purpose-made plain tile-and-a-half tiles should be used.
- Natural slate verges should be formed with full slates and either slate-and-a-half or half slates that are a minimum of 150mm wide.

## Verge detail



Where proprietary verge tiles or systems are specified the detailing should be in accordance with the manufacturer's recommendations that are relevant to UK conditions of use.

Mortar must not be the sole means of fixing and should only be used for decorative purposes. Suitable mechanical fixings are required. Mortar should be to the recommendations in BS 5534 and typically consist of a cement and sand mix based on sharp sand, with soft sand added to achieve workability. The proportion of sharp sand should not be less than a third of the total sand content to ensure the durability of the feature. The mortar should be 1:3 cement: sand with plasticiser.

## Undercloak

Where an undercloak is used it should comprise plain tiles, slates or fibre cement sheet strip. It is usually fixed at verges beneath the battens and on top of the underlay to support the mortar onto which the verge tiles are bedded. If batten ends are cut, treat with a suitable preservative. A 100mm wide bed of mortar should be neatly laid on the undercloak, this should be bedded solidly and finished neatly.

## Ridge (in accordance with BS 5534, BS 8612: Dry-fixed ridge, hip and verge systems for slating and tiling and BS 8000-6)

### Dry fix systems

Proprietary dry roofing products and systems should be used as an alternative to just mortar bedding at verges, ridges, hips and valleys to provide weathering and mechanical resistance properties. Dry roofing products as fitted should not adversely affect the performance of the roof as laid.

Dry ridge systems should be manufactured and tested to meet BS 8612. The dry ridge system should be specified in accordance with BS8612 and be suitable for the location and the wind loading (see 'Note 1' below).

Specifiers should seek evidence that this will not be the case, and should use dry roofing products only if such evidence is available.

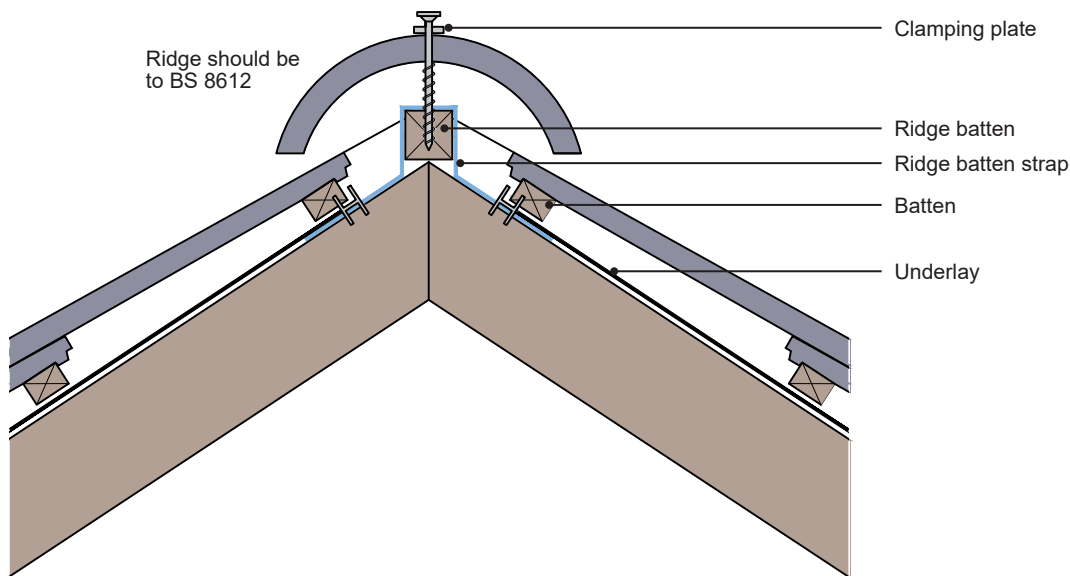
**Note 1:** Users should pay particular attention to the resistance to wind load and durability performance of dry roofing products.

The ridge or top course batten should be set to allow the ridge tiles, ridge units or metal ridge to overlap the top course of tiles by the overlap necessary for the main tiles. For interlocking tiles, this should be not less than 75mm. For double-lap products, the top batten should be set to allow the ridge to overlap the penultimate course by the required head-lap.

For ridge tiles:

- Check ridge tile is suitable for pitch of roof.
- Edge bed components onto tiles.
- Ensure top course tiles or slates are mechanically fixed.
- Mitre tiles neatly at hip ridge junctions, and use a lead saddle underneath for protection.
- Use the correct mortar mix.
- Use dentil slips in deep profiled tiles in all joints more than 25mm thick to reduce mortar and risk of shrinkage.
- **All** mortar bedded ridge tiles must also be mechanically fixed by proprietary fixings in accordance with the roof covering manufacturer's recommendations.

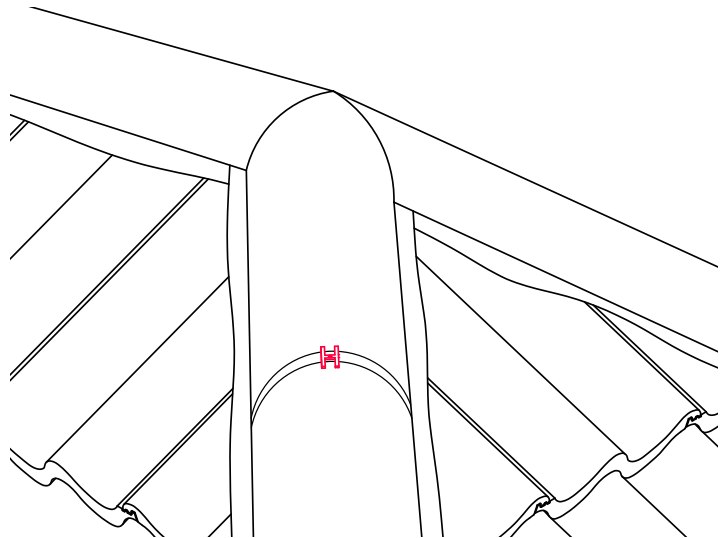
Note: Dry fix ridge systems are available to provide full mechanical fixing of all ridge and hip tiles to meet BS 5534 recommendations.

**Typical dry ridge detail****Hip (in accordance with BS 5534, BS 8512 and BS 8000-6)**

For hip roof construction:

- Check hip tile is suitable for pitch of roof.
- Mitre tiles neatly at hip ridge junctions and use a lead saddle underneath for protection.
- Use the correct hip iron at base of hip.
- Use the correct mortar mix.
- For concrete interlocking tiles, use dentil slips in deep profiled tiles in all joints more than 25mm thick to reduce mortar and risk of shrinkage.
- All mortar bedded hip tiles must also be mechanically fixed (screws, nails, clips, etc.).

Note: Dry fix ridge systems are available to provide full mechanical fixing of all ridge and hip tiles to meet BS 5534 and BS 8512 recommendations.

**Valley (in accordance with BS 5534 and BS 8000-6)**

The design of pitched valley gutters is just one roof detail where the latest guidance is much improved over previous Codes of Practice. The valley is the most vulnerable area of a pitched roof in respect to potential water ingress, as it drains all of the water from adjacent roof slopes.

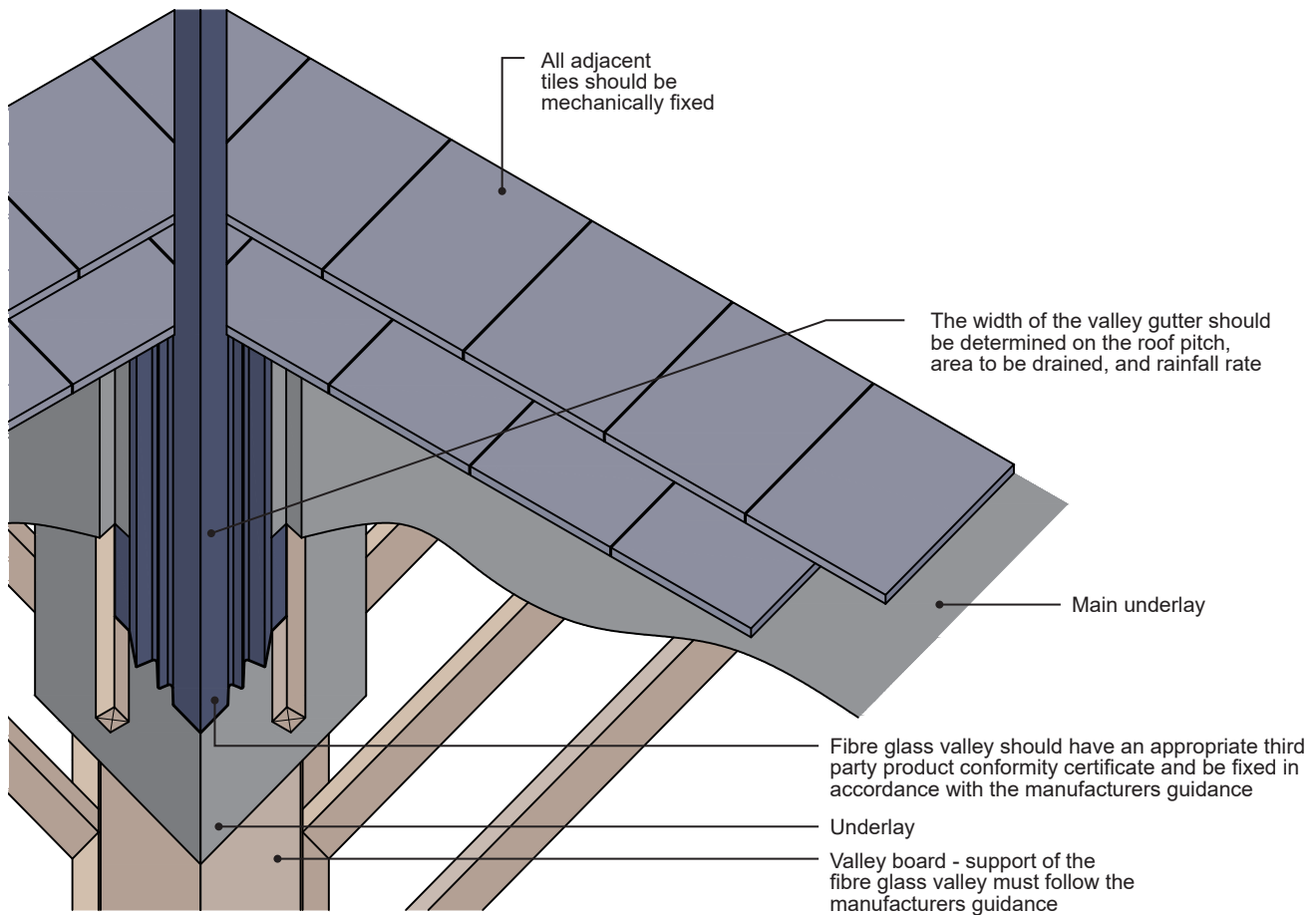
Consequently, the design data is related to the pitch of the roof, the rainfall rate, the length of the valley and the catchment area or area of the roof to be drained. Designers are able to determine the width of the valley trough so that it is appropriate for discharging the rain water from the adjacent roof covering to the eaves gutter.

For valley gutters:

- Check roof pitch, area to be drained and rainfall rate to determine width of valley gutter.
- Consider length of valley when choosing proprietary valley troughs (over 8m).
- Ensure roof structure provides adequate support for valley lining; make flush with top of rafter.
- Do not place bitumen underlay beneath a lead sheet valley.
- Keep open gutter width 100mm-250mm (correct width to be determined by reference to Table 11 and 12 in BS 5534).
- Keep roof design as simple as possible.
- Avoid discharge of valleys onto roofing wherever possible, but where inevitable use a lead saddle.
- Avoid direct contact with lead when using mortar; provide a fibre cement undercloak or tile slips.
- Do not block tile laps with mortar to avoid water damming.
- Where fibre glass valleys are used only products supported by a third party product conformity certificate will be acceptable and the installation and support of the fibre glass valley unit must follow the manufacturer's guidance.
- Mechanically fix all tiles adjacent to valleys.



## GRP dry valley detail



### 11.3.8 Weathering details

Durable weathering details shall be provided at all abutments, intersections and junctions to prevent moisture ingress to the inside of the home.

#### Materials for flashings and weatherings

Lead is generally ideal for roofing purposes; it is easily dressed over complicated shapes using simple hand tools, and can be joined by soldering or lead burning. For most roofing purposes, Codes 3, 4 and 5 will be adequate, but for extreme conditions of exposure, thicker codes may be necessary.

Lead sheet used for roofs, flashings and weatherings should, in terms of suitability to meet the Warranty requirements, be in accordance with BS EN 12588 or hold a valid UKAS (or European equivalent) third party product conformity certificate (e.g. British Board of Agrément, BRE, etc.) that demonstrates adequacy and durability for use.

Lead should be specified, detailed and installed in accordance with guidance provided by the Lead Sheet Training Academy.

#### Lead flashing, patination and compatibility with other metals

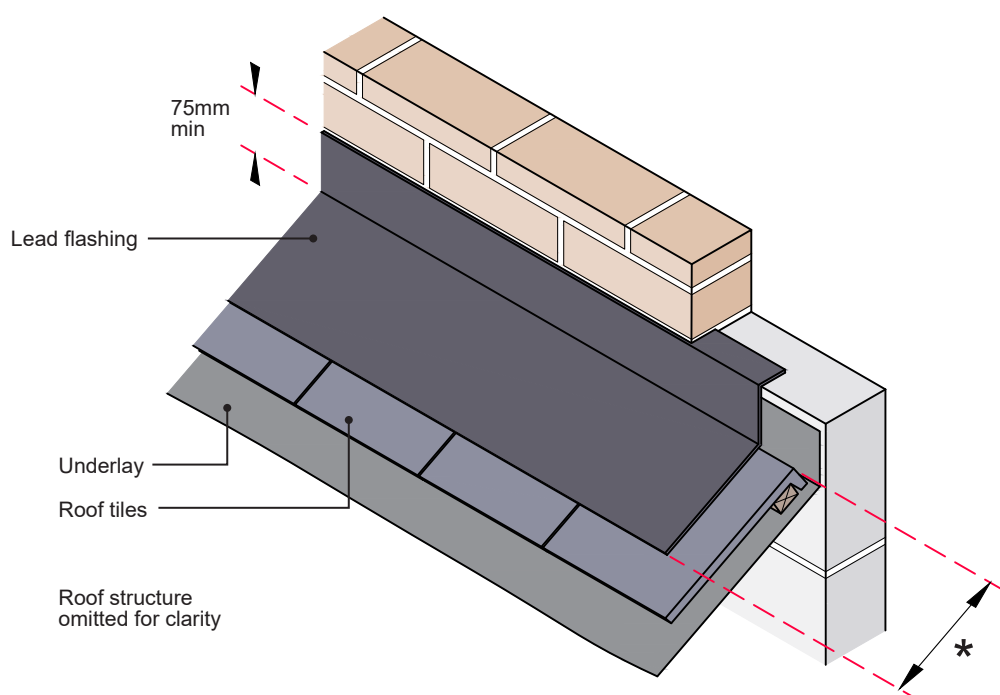
A coat of patination oil should be applied to lead flashings after fixing. Lead can be used in contact with other metals, such as copper and stainless steel, without risk of bimetallic corrosion, but should not be used with aluminium in a marine or coastal environment.



**Top edge abutment**

- Turn roofing underlay a minimum of 50mm up at the abutment.
- Fix the top tiling batten as close as possible to the abutment.
- Complete tiling in the usual way.
- Chase abutment and insert lengths of code 4 lead, no more than 1.5m long; wedge in with small pieces of lead or stainless steel lead flashing clips, no less than 450mm apart.
- Lead should be wide enough to give at least 150mm cover to top course of tiles, below 30°. Increase cover to 290mm at 15° rafter pitch.
- Vertical upstand should be 75mm-100mm.
- Lap each length of lead by no less than 100mm.
- Dress lead to the profile of the tiles.
- Secure lead flashings with copper or stainless steel clips, with frequency dependent on exposure.

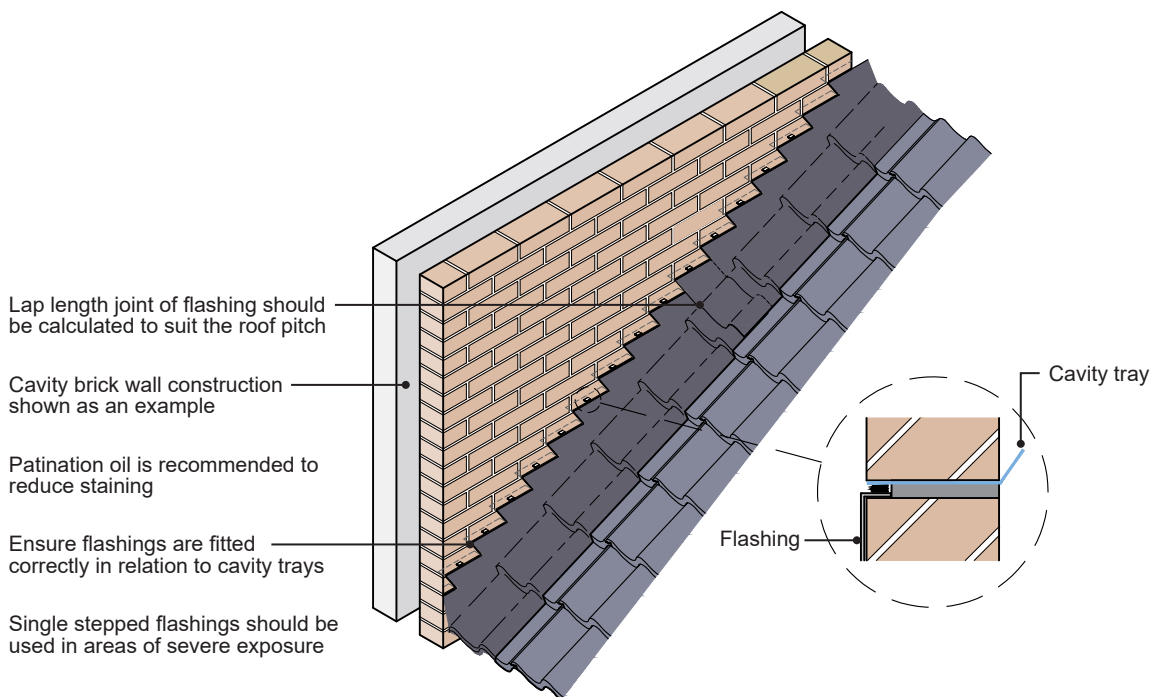
\*The lap should be measured from the lowest fixing of underlying material and be no less than 150mm or the 'Minimum lap of the flashing with the roof covering' table, whichever is the greater.

**Minimum lap of the flashing with the roof covering**

| Pitch of roof                                                                                                                                                           | Cover of lead flashing on roof (mm) |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| 30°                                                                                                                                                                     | 150mm                               |
| 20°                                                                                                                                                                     | 220mm                               |
| 15°                                                                                                                                                                     | 290mm                               |
| Note:<br>1. For pitches over 30°, a minimum lap of 150mm should be provided<br>2. In areas of severe/very severe exposure the vertical upstand should increase to 100mm |                                     |

**Side abutment (stepped cover flashing) with concrete interlocking tiles**

- Turn roofing underlay a minimum of 50mm up at the abutment.
- Finish the tiling battens as close to the abutment as possible.
- Lay the tiles to butt as close as possible to the wall.
- Cut a piece of Code 4 lead to form a combined step and cover flashing.
- Flashing should not exceed 1.5m in length, and should be 150mm-200mm in width or wide enough to cover the first roll, whichever gives the greater cover.
- Chase out brickwork mortar joints and push folds of flashing into chases; wedge in with small pieces of lead.
- Dress cover flashing as tightly as possible to tile profile.
- Re-point brickwork.
- In areas of high exposure, or when dressing lead over flat tiles, use clips to hold cover flashing in place.
- When using this type of flashing with flat tiles below 25°, increase cover of flashing over tile to 200mm.
- All free edges of flashings should be clipped to suit the exposure. Lead clips are only for use in very sheltered locations whereas all other clips should be of copper or stainless steel.



## Side abutment (soakers and step flashings) with plain tiles

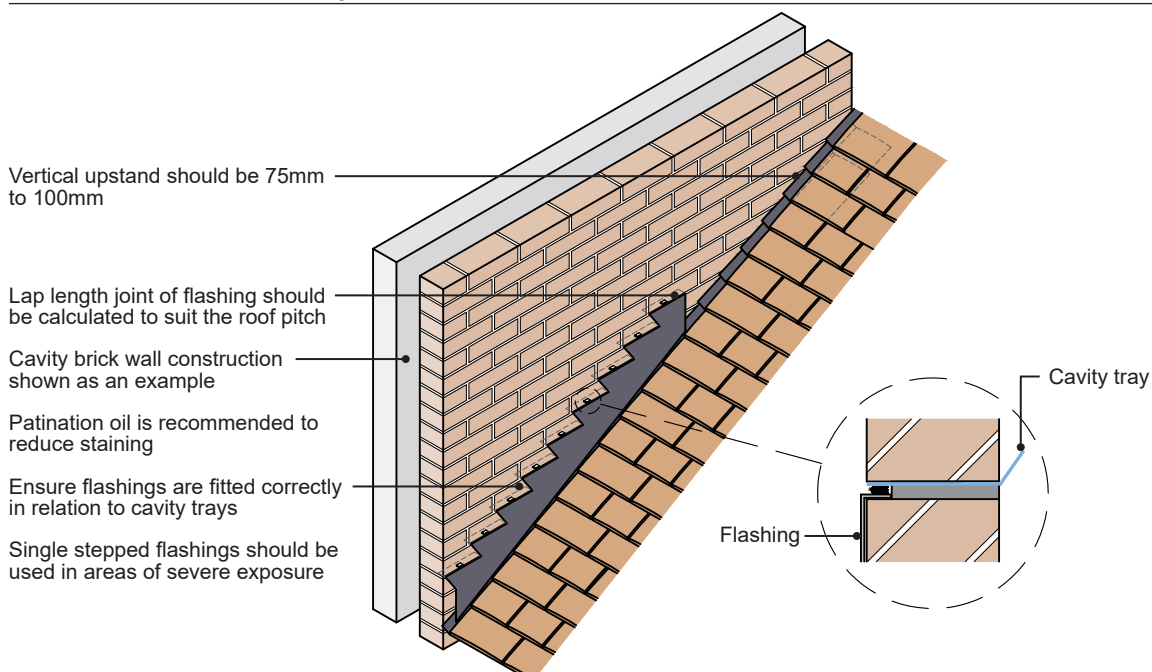
Soakers are used where double-lap plain tiles abut a wall.

- Turn underlay 50mm up the abutment and cut tiling battens 10mm-25mm short of the wall and fix securely.
- Lay tiles close to the abutment with a soaker fitted between each tile.
- Form Code 3 lead soakers with an upstand of 75mm to place against the abutment. They should be 175mm wide and 190mm long, allowing a 25mm downturn over the back of the tile. After all tiles and soakers have been fixed, insert a stepped flashing into the abutment wall and dress down over the upturned edges of the soakers.

## Side abutment (step and cover flashing with soakers) with fibre cement/natural slates

- Continue the underlay across the roof and turn up the wall by a minimum of 50mm. Cut the battens 10mm-25mm short of the wall, and fix securely.
- Finish the slating with alternate courses of slates and slate-and-a-half slates, cut as necessary to maintain the bond.
- Code 3 lead soakers, with a minimum width of 175mm and length equal to gauge + lap + 20mm, are to be interleaved with the slates and turned 75mm up the wall.
- The Code 4 stepped lead flashing should be secured in the brickwork bed joints with lead wedges and dressed neatly over the soakers.

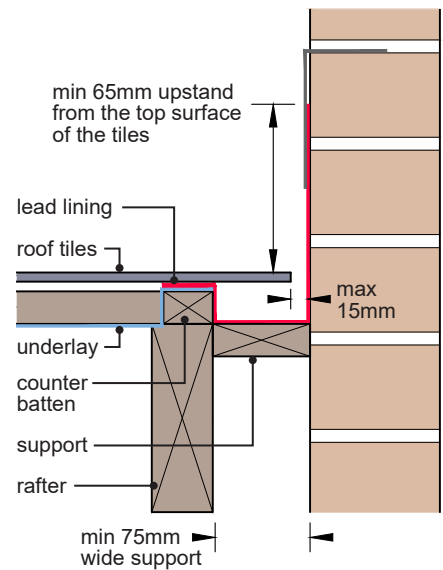
## Side abutment detail with plain tiles or fibre cement/natural slates



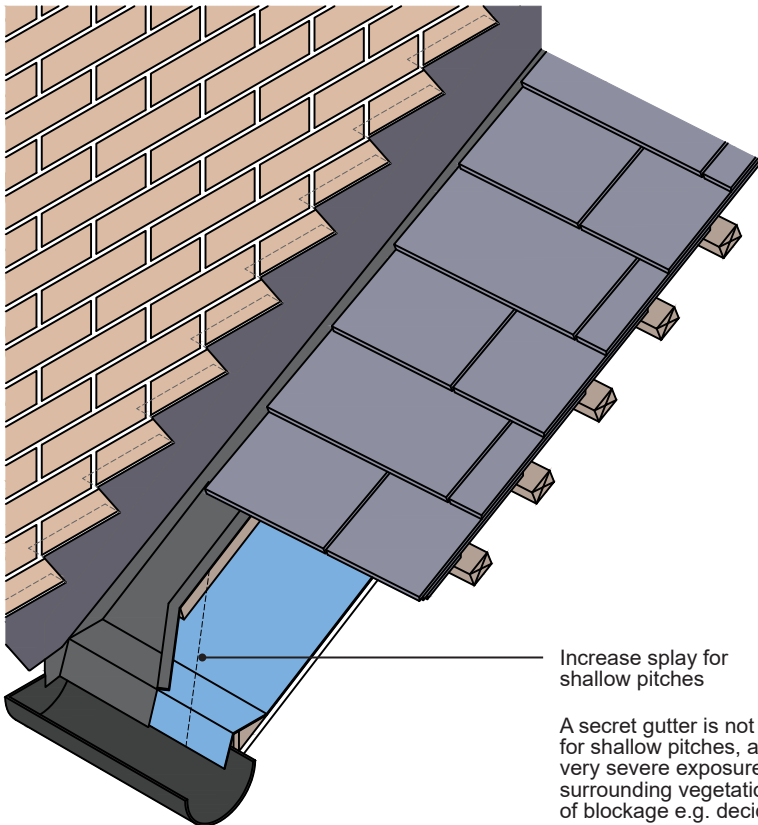
### Side abutment secret gutter arrangement

A secret gutter may be formed as an alternative to a step and cover flashing when using single-lap flat interlocking tiles. Profiled tiles are not suitable for use in conjunction with a secret gutter.

- Form secret gutters before starting tiling.
- Fix a support between the last rafter and the abutment; this should be a minimum of 75mm wide and run the full length of the abutment.
- Fix a splayed timber fillet at the discharge point to raise lead lining to the right height; avoid backward falls.
- Fix a counter batten along the outer edge of rafter.
- Line gutter with Code 4 or 5 lead, in lengths of no more than 1.5m.
- Lap each strip offered over the lower one by a minimum of 150mm, and fix with copper nails at head.
- Turn up lead welts to provide a weather check and exclude birds and vermin from entering tile batten space.
- Gutter should be a minimum of 25mm deep and have a vertical upstand of no less than 65mm above the top surface of the tiles.
- Fit a stepped flashing, chased into brickwork and dressed over vertical upstand.
- Turn the roofing underlay up the side of the counter battens and butt the tiling battens up to the counter batten.
- Lay tiles to leave a gap of 15mm by the side of the abutment.
- All free edges of flashings should be clipped to suit the exposure. Lead clips are only for use in very sheltered locations whereas all other clips should be of copper or stainless steel.



### Secret gutter construction for concrete interlocking tiles and slates



### Box/back gutters

Back gutters may be lead welded off-site and positioned when tiling is undertaken. A gutter should be formed where the bottom edge of tiling meets an abutment. Form the gutter before tiling, but after felting and battening is complete.

- Fix a lay board to support lead lining, with a tilting fillet, close to the abutment to flatten the pitch of the lead.
- Dress a sheet of Code 5 lead (width of abutment plus 450mm) into position with a vertical upstand of at least 100mm up the abutment.
- Dress the extra width of lead around the corner of the abutment after any side abutment weathering has been fitted.
- Dress the upper edge of lead over the tilting fillet and turn it back to form a welt.
- Chase abutment, insert a cover flashing of Code 4 lead and dress it over the vertical upstand of the gutter.

## Roof protrusions

The flashings against chimney stacks, skylights and other similar projections through the roof surface should be similar to that described for abutments where appropriate.

- Make perforations for pipes, chimney stays, supports for ladders etc. weather tight by dressing over and under tiling with a lead or copper slate to which a sleeve is burned or soldered.
- Boss sleeve around pipe or stay, and seal at top with a collar.

## Saddles

The following details can apply to any type of valley or hip /ridge intersection:

- Use Code 4 lead no less than 450mm square and large enough to give a lap of at least 150mm over the gutter lining on each side.
- Saddles should be capable of being readily dressed down when in position.

## Clips

Clips for flashings are important in all roofing applications and where used should be fixed at 300mm-500mm centres, depending on the exposure of the building.

Clips may be formed from the following materials:

- Lead: Only suitable for sheltered locations with a thickness the same as that of the flashing it is fixing.
- Copper: Should be a minimum of 0.6mm thick, and may be thicker for very exposed locations.
- Stainless steel: Should be 22swg or 28swg thick, and is used for very exposed locations or where the fixing point is more than 75mm from the free edge of the flashing.
- Nails and screws: Copper wire nails (with jagged shanks) should be a minimum 25mm long x 10 gauge. Stainless steel annular ring shank wire nails should be a minimum 25mm long x 12 gauge. Screws should be brass or stainless steel, minimum 25mm long x 10 gauge.

### 11.3.9 Roof lights

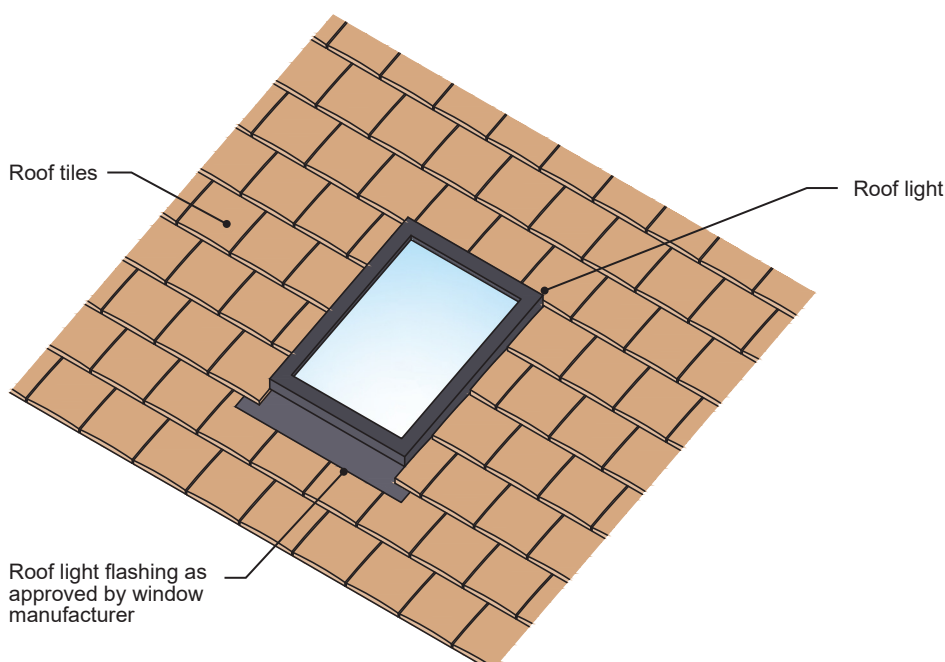
Roof lights shall:

- Be suitable for the intended purpose.
- Have an accompanying flashing kit.
- Be installed in accordance with the manufacturer's recommendations.

Most roof lights are of the 'factory manufactured' variety which should be proven to be suitable for the intended purpose. Most of these come with 'flashing kits' which should be installed in accordance with the manufacturer's instructions. If a flashing kit is not provided, the flashing should be installed following the Lead Sheet Association good practice guide.

Rainwater outlets should not be cited directly above rooflights to avoid a concentration of water discharge directly above the roof light.

### Lead flashing to roof lights



### 11.3.10 Fire stopping and maintaining compartmentation

Where fire stopping is provided to maintain compartmentation, it shall:

- Be specified and installed to satisfy the Building Regulations.
- Be of a material which is suitable for the intended purpose with a relevant third party product conformity certificate and testing.
- Be installed in accordance with the manufacturer's recommendations.
- Have no holes or gaps for smoke to pass through once the fire stopping has been fitted.
- Be specified to take account of any movement in the building.

#### Compartmentation

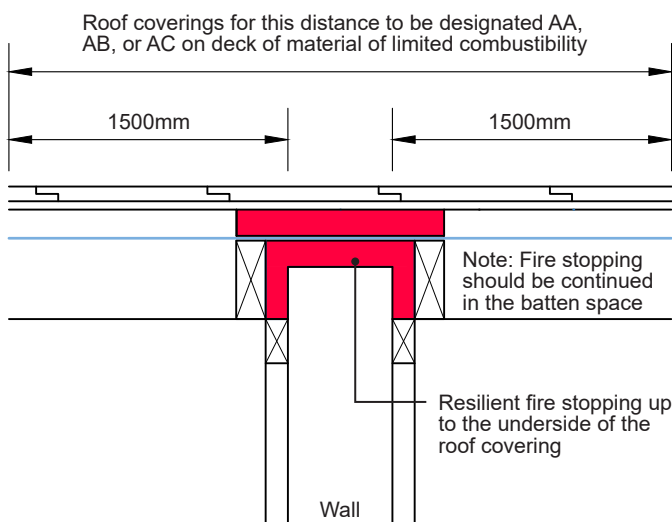
The spread of fire within a building can be restricted by sub-dividing it into compartments separated from one another by walls and/or floors of fire-resisting construction. The roof void, like most spaces within a building, can provide a route for the spread of fire and smoke. As an often-concealed space, it is particularly vital that fire-resistant cavity barriers are provided at the following points:

- At junctions of separating wall and external cavity wall.
- At junctions of compartment wall and compartment floor (not illustrated).
- At junctions of separating wall with roof, under roof tiles.
- Within boxed eaves at separating wall position.

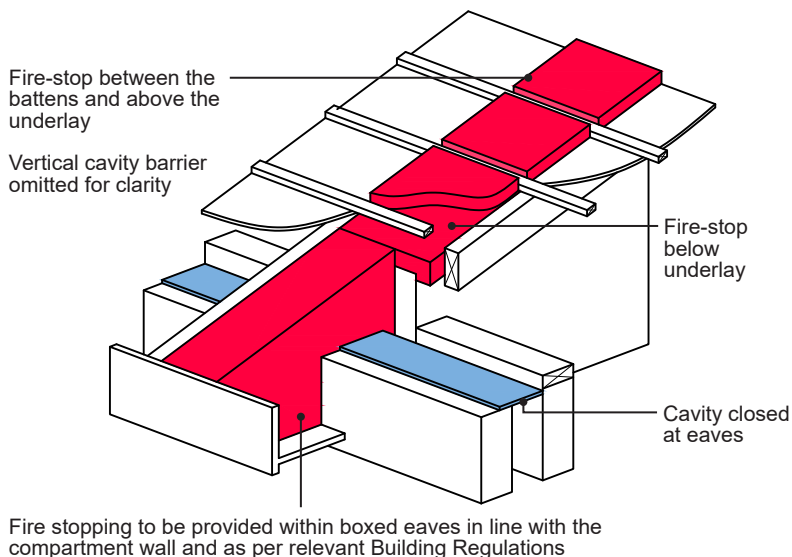
Drawings showing the lines of compartmentation and the lines of fire-resisting construction should be provided to the Surveyor and the Builder. The drawings should also give the required level of fire resistance for each element.

#### Junctions of compartment walls with roof

A compartment wall should be taken up to meet the underside of the roof covering or deck, with fire stopping, where necessary, at the wall/roof junction to maintain the continuity of fire resistance. The compartment wall should also be continued across any eaves cavity. If a fire penetrates a roof near a compartment wall, there is a risk that it will spread over the roof to the adjoining compartment. To reduce this risk, a roof zone 1500mm wide on either side of the wall should have a covering of designation BROOF (t4) to BS EN 13501-5 classification.



#### Fire stopping at roof level between party walls



#### Fire stopping should be provided in accordance with the relevant Building Regulations

- Party/separating walls 25mm below the top of the rafter line and a soft fire-resistant packing, such as mineral wool, should be used to allow for movement in roof timbers and prevent distortion of the roof tiles.
- The fire stopping should be continuous to eaves level and provided within the boxed eaves in line with the compartment wall and as per relevant Building Regulations.

## Introduction

This section provides guidance on meeting the performance requirements for flat roof constructions with a weathered surface at no more than 10° to the horizontal.

Types of flat roof systems covered by this section are:

- Warm roof systems
- Cold roof systems
- Inverted roof systems
- Hybrid roof systems

### 11.4.1 Compliance

Flat roofs shall comply with the performance requirements of this section. Cold deck roofs shall be no larger than 3m<sup>2</sup>.

### 11.4.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications should be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full set of detailed drawings including:
  - a. Roof plan showing direction of falls and position of outlets and overflows.
  - b. Sections showing roof build up and how falls are to be created. Sectional details should show all components to be used in flat roof build up (insulation type and thickness, vapour control layer, waterproofing membrane/layers etc.).
  - c. Site specific detailing for all junctions, outlets and penetrations.
2. Details of all components to be used in the construction of the flat roof should be provided.
3. Engineers drawings and calculations for the roof structure.
4. A third party product conformity certificate for the waterproofing membrane/layer.
5. Details of all fixings, their frequency and fixing method, including those for insulation and surfacing. Fixing methodology should be supported by appropriate wind uplift calculations.
6. Details of all fire stopping which should include specification and a detailed location layout drawing showing positioning of all fire stopping.
7. Outline of method and plan for testing the integrity of the waterproofing layer.
8. A flat roof membrane manufacturer's approved installer must be used for all flat roof coverings. Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty surveyor.
9. A roof deflection analysis should be provided for medium to large roofs, those with complex roof layouts and for any roof areas that carry items of plant or are subject to access provisions beyond periodic maintenance of the roof area.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

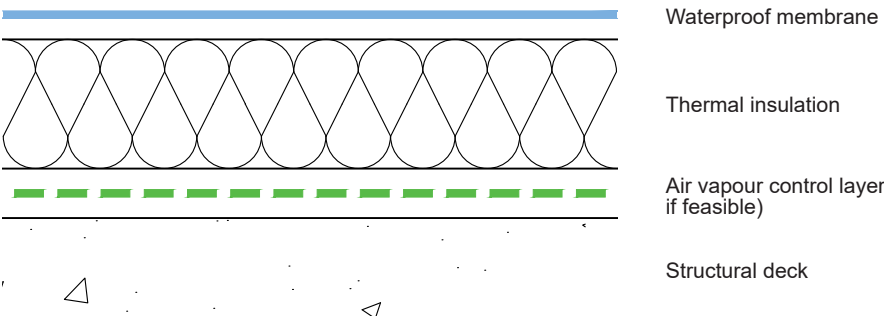
### 11.4.3 General design

Flat roof design and construction shall be appropriate for the intended use.

The design of a flat roof should be one of the following forms of construction.

#### Warm deck roof

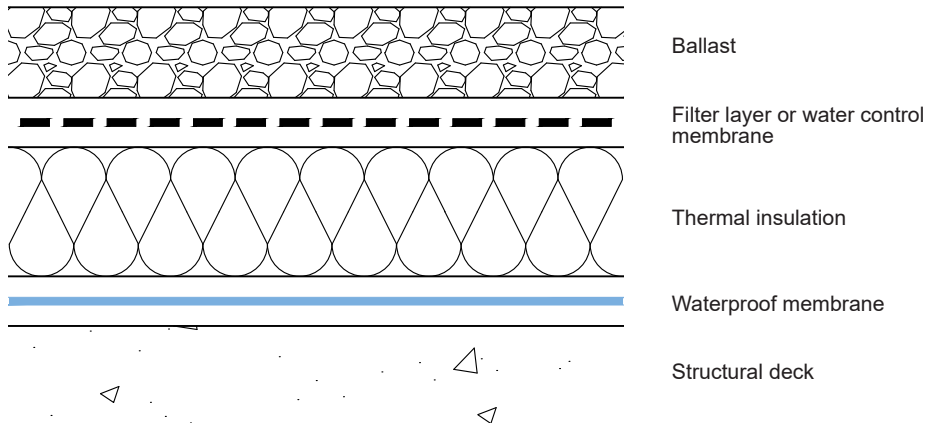
The principal thermal insulation is placed immediately below the roof covering, resulting in the structural deck and support being at a temperature close to that of the interior of the building.





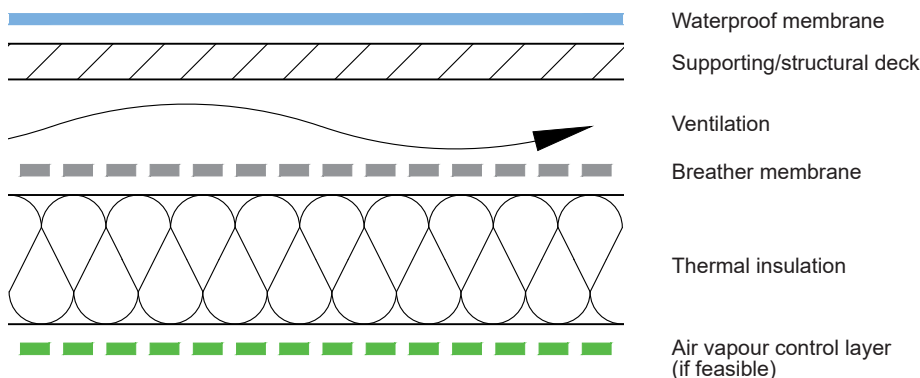
### Inverted warm deck roof

The principal thermal insulation is placed above the waterproof membrane, resulting in the waterproof membrane, structural deck and structural support being at a temperature close to that of the interior of the building. Generally, the principal insulation is secured by separate ballast (paving, gravel, or blue/green roof - minimum 80 kg/m<sup>2</sup>).



### Cold deck roof - only acceptable for roof areas less than 3m<sup>2</sup>

The principal thermal insulation is placed at or immediately above the ceiling i.e. below the structural deck, resulting in the waterproof membrane and structural deck being substantially colder in winter than the interior of the building.



#### 11.4.4 Structural design requirements for all flat roofs

Flat roof structures shall be designed and constructed so that all loads are sustained and transmitted to supporting structure(s) without causing instability, deflection or deformation. Factors to be considered are:

- Wind loading.
- Dead and imposed loading.
- Structural movement.
- Openings and penetrations.
- Fixing/attachment of ancillary structures and plant or equipment.

#### General

Flat roof structures should be designed and constructed so that combined dead, imposed and wind loads are sustained and transmitted to supporting and/or adjoining structure(s) without causing instability, deflection or deformation of any part of the building.

The roof structure should have adequate interconnection at all jointing within its structure and at all junctions with interfacing structure. It should be provided with appropriate bearing and support where it bears onto any supporting walls or intermediate beams. Bearing dimensions and connections should be carried out in accordance with the designing Engineers specification.

The designing Engineer should design in accordance with the principles of relevant standards and their relevant national annexes, such as:

- BS EN 1990 Eurocode – Basis of structural and geotechnical design.
- BS EN 1991-1-1 Eurocode 1: Actions on structures - General actions - Densities, self-weight, imposed loads for buildings.
- BS EN 1991-1-2 Eurocode 1: Actions on structures - General actions - Actions on structures exposed to fire.
- BS EN 1991-1-3 Eurocode 1: Actions on structures - General actions – Snow loads.
- BS EN 1991-1-4 Eurocode 1: Actions on structures - General actions – Wind actions.

## Wind loading

Flat roof structures should withstand wind pressure and suction, and have adequate interconnection with supporting structure to allow it to act as a horizontal diaphragm capable of transferring the wind forces to buttressing elements of the building.

The roof structure should be:

- Supported by adequately restrained load bearing structure e.g. walls, beams.
- Secured to the supporting structure e.g. via a wall plate, hangers, metal straps.
- Effectively strapped, braced and strutted to withstand the effects of wind loading e.g. uplift force, lateral force, suction force.

In all situations, a calculation of wind load at each zone of the roof to BS EN 1991-1-4 should be undertaken by a suitably competent person. Engineers should design structural connections and fixing methodology to resist the site specific wind loads.

## Dead and imposed loading

Flat roof structures should be designed to withstand all dead loads and imposed loads. It should remain structurally stable and remain within designed and acceptable deflection limits. Loading should not impede the service life of the roof structure, its structural performance and/or the functionality of any waterproofing, and associated drainage capabilities.

Designing Engineers should take account of any potential use and functionality of the roof with regards to imposed loading created by access related to use of a space, and/or placement of plant and equipment, servicing, and withstand the effect accordingly through appropriate structural design and material selection.

## Structural movement

Where movement joints are required, they should be designed by an Engineer. The rate of expected movement, type of movement joint(s), the materials used and their locations should be communicated to the waterproofing system designer for inclusion into the design process of any roof drainage strategy falls and detailing, and the waterproofing system.

## Openings and penetrations

Structural openings (e.g. rooflights or vents, staircase openings, lift overrun shafts) and penetrations created by services through any part of the roof structure should be designed by an Engineer.

## Fixing/attachment of ancillary structures and plant or equipment

Any item (e.g. balustrades, safety systems to facilitate access, items of plant or equipment) fixing into and/or through a flat roof structure should not impede the roofs overall structural performance. Any loads should be accounted for in the design and should not damage or reduce durability or stability of any element of the roof.

The structural fixings for any element located on or around the roof structure which imposes a load or structural stress (e.g. rotation) should be designed by an Engineer to ensure fixings are robust and are suitable for the performance required.

Fixings should only be located into an element of structure capable of providing the required support and restraint to any imposed and/or operational loading and/or structural stress created by the element being fixed.

Structural fixing(s) for such elements should not impede the roofs overall structural performance, and should not damage or reduce durability of any element of the roof, and must be fully protected by the final waterproof roof covering on completion. Penetrations created by these elements should be detailed and sealed in accordance with the waterproof covering manufacturer's recommendations.

## Roof structure and deck survey

Prior to the waterproofing, the deck erector should carry out a deck survey to ensure a minimum 1:80 as built fall is maintained. Any foreseeable and likely deflection of the deck should be confirmed and any back falls should be addressed prior to laying any waterproofing layers.

If the deck is intended to receive mechanical fasteners for the attachment of roof system components such as insulation, or equipment such as fall-arrest line posts, its resistance to pull-out should also be confirmed to enable design for resistance to wind load.

A formal handover procedure should be undertaken between the deck erector and the waterproofing contractor.

### 11.4.5 Timber flat roofs - material specifications and performance

All materials used to construct a timber flat roof structure shall be appropriately specified and approved for their intended purpose.

## Timber – structural members

Timber structural roofing members should be durable and fit for purpose. Any timber used must be:

- Strength graded and suitable for its position/function within the roof structure.
- Dimensionally stable and appropriately sized.
- Suitably protected from foreseeable risks where required e.g. insect attack.



All structural timber members used should carry demarcation of the strength grading information in line with BS EN 14081-1 'Timber structures - Strength graded structural timber with rectangular cross section – General Requirements'. All such timber must also be stamped as either 'DRY' or 'KD' (Kiln Dry).

The use of ungraded or 'green' timber is not acceptable.

### Structural connections

Joist hangers, horizontal and holding down tension straps, and brackets for the interconnection of a flat roof structure to walls, beams, and/or columns should be in accordance with BS EN 845-1 'Specification for ancillary components for masonry'.

### Timber treatments

Preservative treatments of roof timbers or any treatments applied to resist insect attack should be carried out where specifically required under relevant standards and Codes of Practice. Further information can be found in 'Appendix C - Materials, Products, and Building Systems'.

### Structural timber decks

Structural timber decks must be as one of following materials as listed below:

- Plywood board to BS EN 636, Use Class 3.
- Oriented strand board, to BS EN 300 type OSB3.
- Pre-treated tongue and grooved softwood boarding. Moisture content between 16-20% at time of fixing.

Notes:

- The thickness of the board may need to be increased to resist pull out forces on fixings.
- The timber deck must be protected against wetting until the final roof covering has been laid.
- Any damaged or saturated timber decks must be replaced.
- Cut edges should be treated to prevent moisture ingress.

#### 11.4.6 Timber flat roofs - strength and durability

Timber flat roof structures shall be constructed to be durable, robust and capable of receiving the specified waterproofing system.

The guidance on timber structures is limited to buildings of not more than three storeys above ground.

### Sizing of structural members

Structural timber members should be appropriately sized for their function and span. For guidance on sizing of certain timber members in roofs, the designing Engineer should refer to the following sources:

- Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings.
- BS 8103-3, Structure design of low rise buildings, Code of Practice for timber floors and roofs for dwellings.
- BS EN 1995-1: Eurocode 5 design of timber structures. General. Common rules and rules for buildings.

### Strutting

All timber joists should be appropriately struttled in accordance with the Engineers design or where engineered joists are specified, in accordance with the manufacturer's site specific specification.

#### Traditional solid timber joists and I-Joists

Where the span of a flat roof joist is more than 2.5m, strutting should be included at mid-span. Where the span of the flat roof joist is more than 4.5m, two rows of strutting at  $\frac{1}{3}$  the span position will be necessary.

Timber strutting can be in the form of solid bridging of at least 38mm basic thickness and with a depth equal to at least three-quarters of the depth of the joists, or it can consist of herringbone strutting with members of at least 38mm by 38mm basic size. Herringbone strutting should not be used where the distance between the joists is more than approximately three times the depth of the joists.

Timber strutting shall be in accordance with the guidance of BS 8103-3, or by a suitable alternative proprietary system. Its inclusion where required should not prevent cross ventilation in cold deck roofs.

#### Metal web joists

Where the span of a flat roof joist is between 4-8m, 1 row of strutting should be provided at mid span. Where the span of the flat roof is over 8m, 2 rows of strutting at  $\frac{1}{3}$  the span position will be necessary. This should be provided by timber strong backs in accordance with the manufacturers design.

For further information on strutting of timber joists, please refer to the 'Upper Floors' section.

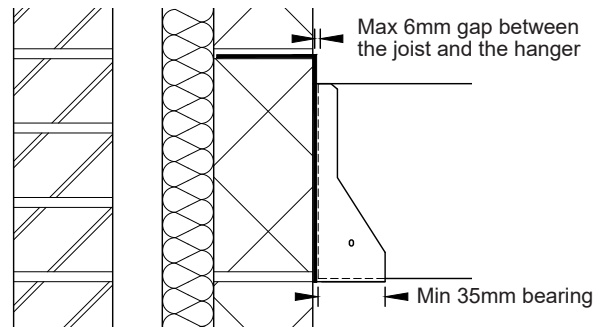
## Structural support connections

Structural support connections and all fixings, such as the use of joist hangers, horizontal and holding down tension straps, and brackets for the interconnection of a flat roof structure to walls, beams, and/or columns should be:

- Specified and installed in accordance with the Engineers design.
- In accordance with BS EN 845-1 'Specification for ancillary components for masonry'.

Where the securing of roof structure involves a timber wall plate or similar, it should fully supported and capable of directing loads perpendicularly down the supporting wall. The wall plate should be suitably fixed and incorporate galvanised mild steel holding down straps (30mm x 5mm x 1000mm long at maximum 2m centres) nailed to the wall plate and securely fixed to the inner surface of the wall with compatible fixings.

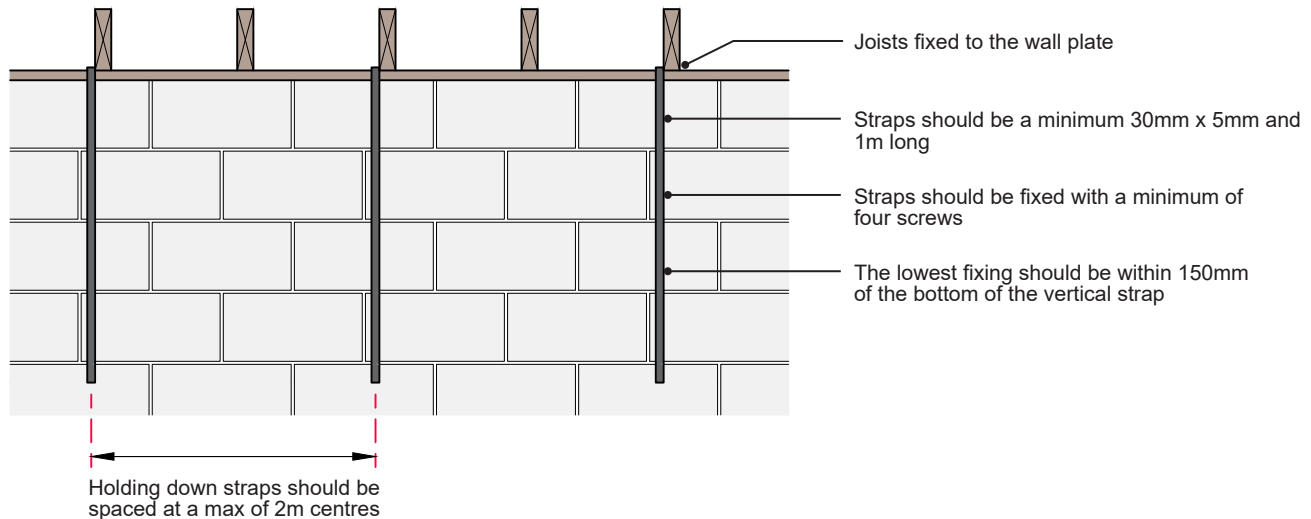
Restraint straps should be employed at 2m centres (maximum) where joists are parallel to walls.



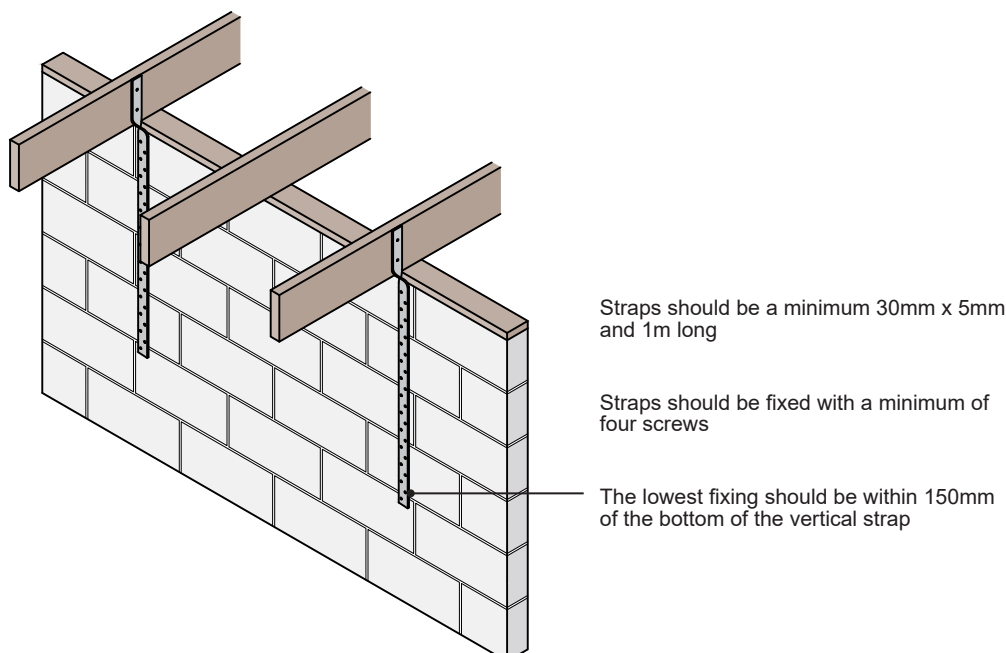
Joist hangers should be:

- In accordance with BS EN 845.
- The correct size for the timber joist or trimmer.
- Fixed in accordance with the design.

## Holding down straps



## Alternative strap detail



### Firring sections

Where timber firring sections are required to create falls, and they are installed perpendicular to the flat roof joists (at 90° to roof joists), they should:

- Be sized to span between flat roof joists without deflection – sectional depth should not be less than 50mm at any point along their length where supports are 600mm centres. For 450mm centres, firring sections may be reduced to 38mm at any point along their length.
- Have an adequate bearing at points of support.
- Be fixed at every intersection with the flat roof joist using appropriately sized screws or fully nailed proprietary bracket fixings. Where screws are used, they should achieve an adequate penetration depth into the supporting flat roof joist - as determined by the wind uplift calculations.

Where firring sections sit directly on top of the joists, they should:

- Be secured at 300mm centres, by 3.1mm x 90mm ring shank nails, with a minimum purchase of 40mm.
- Where firring sections become too deep to achieve the minimum purchase, utilise skew nailing using two 3.1mm x 90mm ring shank nails at 300mm centres.

### All timber decks

#### General requirements

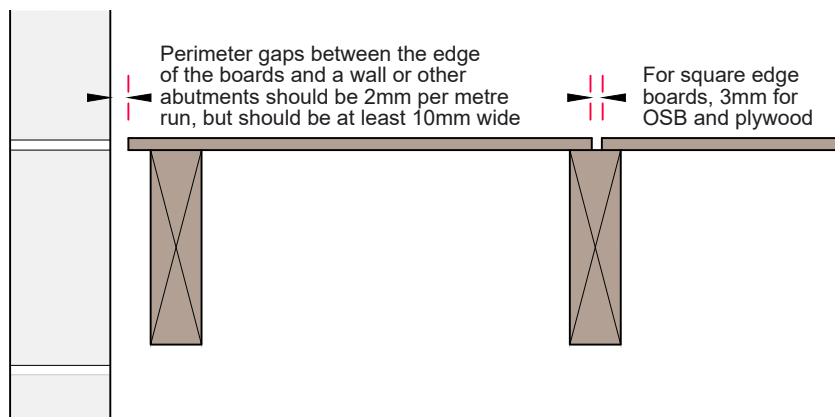
Structural decks must have a minimum recommended thickness of 18mm and boards should be laid in a staggered pattern. All square edged boards must be continuously supported on all edges. The minimum bearing onto a supporting timber is 18mm at board joints, with a full bearing for the width of the supporting timber achieved at perimeter or abutment detailing. Boards should be supported by noggins at the perimeter where they run at right angles to roof joists.

Fixings should be at centres not exceeding 150 mm along any end or edge, and not exceeding 300 mm along any intermediate support, and should be at least 8 mm from the edge of the board. Where nails are used, their heads should be punched 2 mm to 3 mm below the surface of the board. Where screws are used, they should be pre-drilled and countersunk.

All fixings should be of 'In service class 2' fixings, and should be corrosion resistant. Corrosion resistant materials include galvanized or sherardized steel, austenitic stainless steel, phosphor bronze and silicon bronze.

All structural decks should allow for the effects of expansion and include appropriate expansion gaps at all perimeter edge abutments and joints. The dimension applied to expansion gaps should be:

- Deck perimeter gaps between the edge of the boards and a wall or other abutment should be 2mm per metre run, but should be at least 10mm wide.
- Deck joints formed by square edge boards should be 3mm.
- Deck joints formed in boards with tongue and grooved edges should be aligned with manufacturers guidance.



#### Additional requirements for plywood decks

Plywood should be laid with the face grain perpendicular to the supports (at 90° to roof joists) and all end joints should occur over joists of at least 38 mm basic thickness or be supported by noggings. At the perimeter, boards should be supported by noggings where they run at right angles to roof joists.

All square edged boards must be continuously supported on all edges. Boards with tongue and grooved edges should be installed with the longest edge at right angles to the joists and short edges supported on a joist or noggings.

Fixing nails should be either:

- Plain wire nails at least 3.35 mm in diameter and at least 65 mm long, which penetrate at least 40 mm into the support, **or**
- Annular-ringed shank nails at least 3.35 mm in diameter and at least 50 mm long, which penetrate at least 32 mm into the support.

## Additional requirements for OSB decks

All boards should be fastened firmly to the supporting timber and their directional strength demarcation (printed on the boards surface) installed perpendicular to the joists and all end joints should occur over joists of at least 38 mm basic thickness or be supported by noggings. At the perimeter, boards should be supported by noggings where they run at right angles to roof joists.

All square edged boards must be continuously supported on all edges. Boards with tongue and grooved edges should be installed with the longest edge at right angles to the joists and short edges supported on a joist or nogging.

Flat headed annular-ringed shank nails and screws have superior holding power and should be used in preference to plain shank nails.

All fixings should be a minimum of 50 mm or 2 times the thickness of the board, whichever is greater; and the diameter of the fixing should be a minimum of 0.16 times the thickness of the board.

## Additional requirements for pre-treated T&G softwood boarding

Boards should be laid with the grain perpendicular to the supports (at 90° to roof joists), with all tongue and grooving engaged and all end joints should occur over joists of at least 38 mm basic thickness or be supported by noggings.

For boards of no more than 175 mm basic width, two nails should be used at each intersection with a supporting timber or nogging. For wider boards, a minimum of three nails should be used at each intersection.

### 11.4.7 Concrete flat roofs - material specification and performance

All materials used to construct a concrete flat roof structure shall be appropriately specified and approved for their intended purpose.

Concreting shall not take place during cold weather periods where working temperatures are below 2°C.

Material specification and execution of all work related to in-situ concrete and pre-cast concrete roof construction should be in strict accordance with the designing Engineers specification and design.

Concrete for flat roof construction should use ready mixed concrete sourced from a third party accredited supplier registered to either:

- 'The Quality Scheme for Ready Mixed Concrete' (QSRMC), or
- BSI Kitemark Certification.

Cementitious screeds should be in accordance with BS 8204 - Screeds, bases and in-situ floorings.

Further information relating to specification of concrete and execution of concreting works can be found in 'Appendix C - Materials, Products, and Building Systems'.

Where specified, the use of horizontal and holding down tension straps, and brackets for the interconnection of a flat roof structure to walls, beams, and/or columns should be in accordance with BS EN 845-1 'Specification for ancillary components for masonry'.

In situ concrete slabs and cementitious screeds contain large volumes of water which, if not allowed to dry out, can prevent adhesion of the waterproof layer. If bonding to the slab, it is advised that an adhesion test be carried out.

### 11.4.8 Concrete flat roofs - strength and durability

Concrete flat roof structures shall be constructed to be durable, robust and capable of receiving the specified waterproofing system.

In-situ and pre-cast concrete flat roof construction should be designed by an Engineer to comply with the current Building Regulations, and be in accordance with the principles of relevant standards and their national annex, such as:

- BS EN 1992-1-1 - Eurocode 2 — Design of concrete structures Part 1-1: General rules and rules for buildings, bridges and civil engineering structures.

Pre-cast concrete systems should:

- Have a minimum of 90mm bearing onto supporting structure, unless justified by the design.
- Have restraint straps at 2m centres (maximum) where concrete beams are parallel to walls.
- Be grouted in accordance with the design.
- Accommodate for foreseeable differential movement.

Where the Engineer references any manufacturers information on structural performance (e.g. span capability, connective detailing, installation requirements) or system specific bracketry for the interconnection of a flat roof structure to walls, beams, and/or columns this should be clearly referenced and supplementary information provided within any structural designs and calculations.

The concrete specification and any additional cementitious screeds should be capable of resisting the anticipated loadings. Where lightweight screeds are specified, they should be overlaid with a 1:6 (cement to sand) screed topping of a minimum 10mm thickness. Further information can be found in 'Appendix C - Materials, Products, and Building Systems'.

In pre-cast panel decks, the locations of any anticipated differential movement (e.g. at perimeter or abutment interfaces or between adjacent panels that are subject to differential loading) must be identified in order that stress is not transferred to the waterproof membrane. Where unavoidable, any movement joint passing through or requiring incorporation into the waterproofing system should:

- Use materials that are durable and have a service life equivalent to the waterproofing system.
- Supported by a design and specification that is approved by the waterproofing system manufacturer.

### 11.4.9 Profiled metal deck structure - material specification and performance

All materials used to construct profiled metal deck structures shall be appropriately specified and approved for their intended purpose.

Material specification and execution of all work related to profiled metal deck roof construction should be in strict accordance with the designing Engineers specification and design.

Materials used should demonstrate conformity to manufacturing and the appropriate structural design characteristics detailed within:

- BS EN 1090-1 – 'Execution of steel structures and aluminium structures. Requirements for conformity assessment of structural components'.

Profiled metal sheets should:

- For galvanised steel, have a minimum recommended thickness of 0.7mm (typical gauge range is 0.7mm-1.2mm), and meet the requirements of BS EN 10346 'Continuously hot-dip coated steel flat products for cold forming — Technical delivery conditions', and used in accordance with BS EN 1993-1-3.
- For plain aluminium, have a minimum recommended thickness 0.9mm and meet the requirements of BS EN 485-2 'Aluminium and aluminium alloys. Sheet, strip and plate. Mechanical properties' and BS EN 1396 'Aluminium and aluminium alloys - Coil coated sheet and strip for general applications. Specifications', and used in accordance with BS EN 1999-1-4.
- Be of suitable quality and finish before the waterproofing layer and insulation system is installed.
- Be fixed using suitable fixings which avoid bimetallic corrosion in accordance with the manufacturer's recommendations.

### 11.4.10 Profiled metal deck structure - strength and durability

Profiled metal deck structures shall be constructed to be durable, robust and capable of receiving the specified waterproofing system.

#### General

Profiled metal deck flat roof construction should be designed by an Engineer to comply with the current Building Regulations, and be in accordance with the principles of relevant standards and their national annexes, such as:

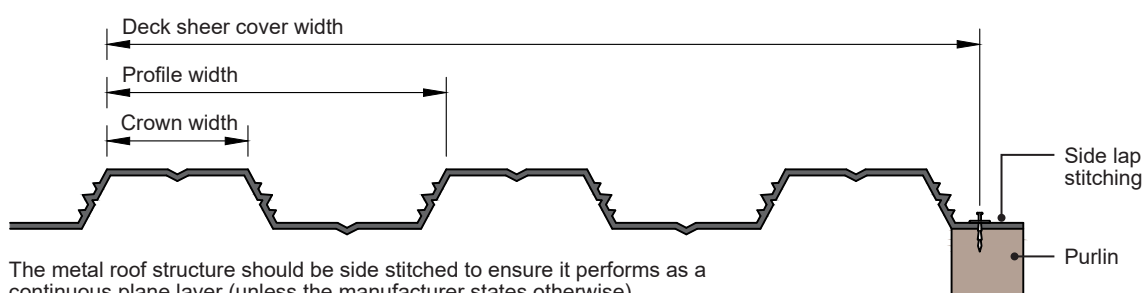
- BS EN 1993-1-3 - Eurocode 3 - Design of steel structures. Cold-formed members and sheeting.
- BS EN 1999-1-4 - Eurocode 9 - Design of aluminium structures. Cold-formed structural sheeting

Where the Engineer references any manufacturers information on structural performance (e.g. loading and span tables, and the application of appropriate factors of safety, installation requirements) or system specific bracketry for the interconnection of a flat roof structure to walls, beams, and/or columns this should be clearly referenced and supplementary information provided within any structural designs and calculations.

The installation of cold-formed structural members and sheeting made from steel or aluminium within flat roof structures should be in accordance with the principles of relevant standards, such as:

- BS EN 1090-4 - Technical requirements for cold-formed structural steel elements and cold-formed structures for roof, ceiling, floor and wall applications for steel.
- BS EN 1090-5 - Technical requirements for cold-formed structural aluminium elements and cold-formed structures for roof, ceiling, floor and wall applications.

Side lap stitching should be used to ensure the construction performs as a continuous plane layer - unless the manufacturer recommends otherwise. When considering the necessity for metal deck closures, reference should be made to the guidance of the manufacturer.



The metal roof structure should be side stitched to ensure it performs as a continuous plane layer (unless the manufacturer states otherwise).

Profiled metal decks should conform to the following standards:

- Galvanised steel: minimum recommended thickness 0.7mm to BS EN 10346 Fe E280G Z275. Typical gauge range 0.7mm-1.2mm.
- Plain aluminium: minimum recommended thickness 0.9mm to BS EN 485-2 AA3004 H34. Reference should also be made to BS EN 1396 as appropriate.

It is important that the deck has adequate provisions to resist wind uplift by being adequately anchored to the main structure.

Profiled metal decks should have a crown width at least 50% of the profile width to provide a sound base for the insulation and waterproofing system. The mid-span deflection of the metal deck should not exceed 1/200 of the span under uniformly distributed design loads to avoid reduced drainage performance.

Profiled metal decks should be adequately protected from the effects of temporary imposed loads e.g. avoidance of stacking and loading of construction materials.

## 11.4.11 Thermal performance and condensation control

Insulated flat roofs shall be designed and constructed to avoid the detrimental effects of interstitial and internal surface condensation. Factors to be included are:

- Air and vapour control layers.
- Thermal insulation requirements.
- Thermal bridging risks.
- Ventilation for cold roof systems.

For Warranty purposes, flat cold deck roofs over 3m<sup>2</sup> in area are not acceptable.

The risk of condensation due to the movement of water vapour into or through a roof construction should be suitably mitigated using appropriate methodology and materials, and be the subject of specialist design and specification.

Any provision required to control interstitial condensation within the roof should be determined to the calculation method defined by BS 5250, but with ambient conditions set in BS 6229. The calculated maximum accumulation of moisture within thermal insulation should not exceed 350g/m<sup>2</sup> and there should be no net accumulation in any annual cycle.

## Air and vapour control layers (AVCL's)

Air and vapour control layers should be appropriate to level of risk posed by the building use and foreseeable moisture vapour loads. They should be:

- Positioned on the warm side of the insulation.
- Suitable for their position within the type of construction chosen e.g. warm roof system, cold roof system.
- Suitably attached and fixed to resist the effects of wind uplift on the completed waterproofing system.
- Continuous and fully sealed at laps, perimeters and penetrations – termination detailing should be sealed and lapped to the waterproofing layer (where compatible or extend 50mm above the insulation and sealed to the associated structure e.g. wall, pipe, rooflight, outlet).
- Compatible with any building fabric to which they are in contact with and the chosen method of attachment e.g. structural decks, insulation, bonding adhesives.

AVCL specification and selection should be determined by site specific calculations and performance requirements e.g. Condensation Risk Analysis (CRA), wind uplift calculations, the waterproofing system manufacturers requirements.

Any fixings that penetrate the AVCL e.g. those securing insulation boards to the deck, should be carefully installed to avoid pathways for water vapour to pass through.

In an inverted warm roof, the waterproofing layer is beneath the insulation and therefore acts as the AVCL. To avoid the opportunity of water transfer to this layer and any associated risks with interstitial condensation forming:

- Insulation should be butted tight at joints without gaps, **and**
- Protected by the correct installation of a water flow reducing layer laid over the insulation.

## Criteria for a condensation risk analysis

Where a condensation risk analysis is required, the following boundary conditions should be used:

- 60% relative humidity.
- Internal temperature 21°C.
- External temperature -2°C.

Where external temperatures are considered to fall below -2°C due to exposure or geographical locations, lower temperatures should be used based upon climatic data within relevant standards.

### Thermal insulation requirements

Insulation materials should be approved for their intended purpose and be the subject of specialist design and specification.

Insulation materials should:

- Have a relevant third party product conformity certificate confirming suitability for use in proposed situation.
- Provide the required level of thermal performance and contribute to mitigation of condensation risks.
- Be suitable for the type of construction chosen e.g. warm roof system, inverted roof system - insulation in an inverted roof should have a high resistance to water absorption and the effects of freeze/thaw cycling.
- Be suitably attached and fixed to resist the effects of wind uplift on the completed system.
- Provide a suitable surface for the application of a waterproofing system.
- Be compatible with any building fabric to which they are in contact with and the chosen method of attachment e.g. structural decks, insulation, bonding adhesives.
- Be installed to be continuous and free from any damage or distortion that may impact on required performance.
- Support loads created by the waterproofing system, and any associated surface finishes. Where required loads created by ballast, systems facilitating access to foot traffic, and placement of plant or equipment may also need to be factored in.

The attachment of the thermal insulation should be designed to resist calculated wind load by a declared margin of safety. Typically, attachment is either:

- Bonded or mechanically fixed to resist wind uplift.
- Ballasted to resist wind uplift (ballasted warm roofs and inverted warm roofs).

Where mechanically fixed, the fixings should be in accordance with the fixing specification and associated wind uplift calculations. Fixings should be thermally broken and of sufficient length to ensure adequate penetration into the supporting structure to resist pull out.

When installing in a warm roof system, the insulation should:

- Be fully supported by the receiving deck – on substrates of profiled metal, the short dimension should be parallel to the deck crowns and supported across half the crown width.
- Be laid in a broken bond pattern (except in tapered insulation schemes).
- Where two or more layers are laid, the joints in each layer should be offset.
- Insulation should be tightly butted at joints – any infilling of joints or small gaps should be to manufacturer's specification.
- Be kept dry and have appropriate controls to avoid trapping moisture during installation.

When installing in an inverted roof system, the insulation should also:

- Be protected by a water flow reducing layer (WFRL).
- Be ballasted in accordance with the specification to avoid floatation and wind uplift.

### Thermal bridging risks

Design and specification of the roof system should take account of the effects of thermal bridging within the roof field areas, and at interfaces between the roof system and adjoining elements as parapet walls or abutments.

In particular, suitably designed safeguards against the effects of thermal bridging risks should be made for:

- Connections and junctions with adjoining or connected structure e.g. abutting walls, parapets, upstands.
- Fixings and fasteners used to secure insulation and/or waterproofing membranes.
- Threshold positions, formed gutters and sumps that result in a reduced thickness of insulation.
- The use of tapered insulation systems, and determination of the 'effective' performing minimum thickness.

When installing an inverted roof system, the effects of thermal bridging risks should also be considered for drainage of rainwater or snow-melt through insulation in inverted roofs – appropriate calculations to take account of the cooling effect of rainwater seeping through the insulation board joints should be carried out in accordance with BS 6229 and ETAG 031-1.

### Ventilation for cold roof systems

Cold roofs are only acceptable for roof areas less than 3m<sup>2</sup>.

Ventilation detailing should be the subject of an appropriate design in accordance with BS 6229 and BS 5250. Any proposals should include:

- An unobstructed minimum 50mm ventilation space above the insulation – measured from the upper surface of the insulation to the underside of the structural deck.
- Adequate cross ventilation served by openings at both ends of each joist void equivalent to a minimum 25mm gap.
- A maximum clear distance of 5m between ventilators on opposite sides of the roof.
- An effective AVCL at ceiling level.



## 11.4.12 Creation of falls

Flat roofs shall have a minimum finished fall of 1 in 80 to facilitate rainwater drainage.

The designer should ensure:

- Flat roofs should have a minimum finished fall of 1:80 (1.25%) on all main roof falls and intersecting falls (cross falls).
- Where two roof planes intersect at a cross fall, the line of the cross fall junction that is formed must effectively drain along its entire length. To achieve this, the adjoining roof planes should be designed to achieve a minimum installed finished fall of 1:60 or 1:40.
- Design falls should take account of any potential deflection and construction tolerances. In the absence of detailed calculations for deflection, design falls of twice the minimum finished falls (1:40 or 2.5%) should be used.

For Major Projects, the use of zero and absolute zero fall approaches may only be permitted where strictly agreed with the Major Projects Surveyor prior to commencement, and will be subject to a site specific appraisal.

Dependant upon construction type, roof falls may either be created by:

- The initial roof construction e.g. roof structure set to fall, firing sections (timber structure only).
- The addition of cementitious screed materials (concrete structure only).
- Tapered insulation systems.

Cementitious screeds should be in accordance with BS 8204 - Screeds, bases and in-situ floorings.

Lightweight screeds should be overlaid with a 1:6 (cement to sand) screed topping of a minimum 10mm thickness.

Tapered insulation systems are often produced to a 1:60 (1.7%) fall or 1:40 (2.5%) fall. However, where falls are created by tapered insulation, the design should ensure that the average U-value and maximum U-value required by the Building Regulations is achieved.

The use of these systems does not remove the need to check that deck deflection and tolerance is overcome and that a resulting fall in the waterproof membrane of a minimum of 1:80 is achieved. Allowance for deflection is particularly important in designing inverted roofs where calculation of dead loading should be based upon the ballast type and depth to be used.

## 11.4.13 Roof drainage

Flat roofs shall effectively drain rainwater from roof areas to a suitable drainage system.

All flat roofs should be designed to collect, direct and discharge rainwater to a suitable drainage system by a suitably experienced drainage designer prior to roofing work commencing.

### Information on roof plans

Flat roof designs should be supplemented by a schematic roof plan with all relevant points of the design clearly detailed. As a minimum, roof plans should include clear information on:

- Fall directions and gradients of all main roof falls.
- The position of any intersecting falls (cross falls) and the associated fall gradients.
- The position of all formed gutters, sumps, rainwater outlets (RWO's) and overflows.
- Any walkways or accessible areas.
- Any plant or equipment located on the roof.

### Rainwater calculations

All relevant aspects of the drainage design should be based upon rainwater calculations, completed in accordance with BS EN 12056-3. The calculation should clearly communicate the design head of water used (taken typically 30-35mm above the outlet level) to inform gutter and outlet capacity, and overflow positioning.

### Additional design considerations

The following should be factored into flat roof drainage designs:

- Roof areas with perimeter upstands or parapets that include formed gutters, should have at least two outlets serving each formed gutter. Alternatively, a combination of one outlet plus an emergency overflow may be used.
- Outlets should be positioned so that the direction of flow is not changed sharply (e.g. through 90° just before reaching it).
- The effects of additional surface finishes to facilitate access that may impede drainage. Where the roof includes paving on paving support systems, it should be designed and installed to ensure drainage is not detrimentally impeded.
- The effects of obstructions and/or plant/equipment (including cabling) located on the roof. Additional rainwater outlets and/or insulation crickets should be provided to avoid ponding behind wide obstructions to the drained slope such as plant plinths or roof lights.
- Where rainwater downpipes from other higher roof areas, balconies or terraces discharge via a lower roof, an open downpipe shoe is not permitted. The downpipe should be connected directly to the downpipe serving the lower roof.



The disposal of rainwater discharge from the roof drainage system should be into an appropriate drainage system. The Performance Requirements and guidance stated by the 'Drainage – Above Ground Drainage' section should be considered applicable.

### Siphonic drainage systems

The use of siphonic drainage systems will be considered on a case by case basis by the Warranty provider.

They should be the subject of a full design and calculations which should be submitted for Warranty approval before construction begins on site. The Warranty provider does not consider siphonic drainage appropriate for inverted roofs.

#### 11.4.14 Rainwater outlets

Rainwater outlets shall be appropriately sized and have the required capacity.

Rainwater outlets should:

- Be of the size and number required to deal with the expected rainfall intensity as determined by rainwater calculations completed in accordance with BS EN 12056-3.
- Be positioned to provide effective drainage to all areas of the roof - roof areas with perimeter upstands or parapets that include formed gutters, should have at least two outlets serving each formed gutter. Alternatively, a combination of one outlet plus an emergency overflow may be used.
- Interface with the waterproofing in a manner that facilitates the free flow of water, and does not check, slow or create an opportunity for ponding.
- Be accessible for maintenance.
- Be insulated to avoid surface condensation on the outlet and downpipe if passing through habitable areas.

Rainwater outlets should have their suitability assessed using information provided by the outlet manufacturer and supporting independent certification, and should include information on:

- Capacity in litres per second at a range of typical water heads.
- Compatibility with the waterproof membrane.
- The method of attachment.
- Where required, any integral insulation performance to avoid condensation where rainwater outlets constitute thermal bridges.

Rainwater outlets used in inverted roofs should be of the dual height type, designed to maximise removal of rainwater at WFRL level.

#### 11.4.15 Overflows

Where required, overflows shall be provided and be adequately sized to avoid the risk of flooding to any roof area.

Roofs which drain to a single internal outlet or combined outlets connected into a single downpipe, should be provided with an overflow to drain and warn of outlet/downpipe blockage and so avoid the risk of flooding or structural overloading.

The capacity of the overflow should be not less than that of the outlet or combined outlets, and its discharge should be visible but directed away from the building.

Overflows should be conspicuously positioned for inspection and as close to the outlets as practicable to avoid rainwater build up on roofs.

The overflow level should be set at the design water level for the rainwater outlets, which in most instances is typically 30-35 mm above the outlet. Where there is a sump included at the rainwater outlet position, the overflow should be set at the level of the lip into that sump.

The level of overflows should be 25 mm below the underside of the any sill positions e.g. thresholds.

#### 11.4.16 Formed gutters

Formed gutters shall be appropriately sized to meet the required rainwater capacity, and all gutter beds constructed with a fall 1:80. Water collected by any formed gutter shall discharge water to a suitable drainage system via an outlet (or outlets).

Formed gutters (often referred to as boxed gutters) should be robustly constructed and gutter beds should achieve a 1:80 fall.

All relevant aspects of formed gutter(s) design should be based upon rainwater calculations, completed in accordance with BS EN 12056-3. The calculation should inform the gutter design in relation to:

- Length and size of the roof area to be drained, and any limiting factors.
- Size e.g. width, depth and length of the gutter to the outlet.
- Capacity and gutter flow rate.
- The design head of water used and overflow positioning.
- The position, size and number of outlets.
- All gutters (inclusive of their outlets) should be accessible for period maintenance and inspection.

Gutter beds and sides should use material capable of providing continuous support to any waterproofing system without deflection. Where required, insulation should be incorporated to avoid the detrimental effects of condensation and thermal bridging of the surrounding building elements. Thermal performance should be to the level required by the Building Regulations and proven by appropriate site specific condensation risk analysis.

## 11.4.17 Waterproofing systems

Flat roof structures shall be waterproofed so that they resist the passage of moisture due to rain and snow to the inside of the building. All waterproofing systems shall be suitable for their intended purpose.

All flat roof waterproofing systems, and all associated detailing shall be installed by a competent installer approved by the manufacturer.

### General

Flat roofs should incorporate a waterproofing system and be designed and constructed to adequately resist the passage of water to the inside of the building and to materials that may be adversely affected by such moisture.

The selection of a waterproofing materials should be the subject of specialist design and specification, and be approved for their intended purpose. Selection should consider the following minimum criteria:

- Anticipated service life based on independent certification.
- Compatibility of components.
- Expected usage.
- Maintenance requirements.
- Ease of repair.

### Material characteristics and independent certification

Material performance characteristics should be declared and relevant for their intended use.

Where a product has a harmonised standard, evidence of attainment of UKCA/CE marking should be provided.

Where a product does not have a harmonised standard, CE marking is still required and should be based on a European Technical Assessment (ETA) document produced in accordance with the relevant European Assessment Document (EAD).

All waterproofing systems should be used within their scope and be suitable for the intended purpose. This should be demonstrated by providing a valid third party product conformity certificate from an independent approval body which is accepted by us. For further information, please refer to 'Appendix C'.

### Statutory requirements in relation to fire

All roof coverings and associated waterproofing should achieve compliance with current Building Regulations.

### Approved installers

All work execution should be strictly in accordance with the design and specification, and should be carried out by competent operatives with demonstrable experience in the area of flat roofing and the waterproofing system at hand.

This competence should be supplemented by evidence of the manufacturer's approval of the contractor to install their products and this should be provided to the Warranty surveyor prior to works commencing.

Typically, this 'Approved Installer' evidence is provided in the form of an identity card, which features:

- The installer's name.
- A passport-style photograph.
- A unique card number.
- An expiry date.
- The manufacturer's name and logo.
- A list of the products and/or systems for which the installer has been trained.

## Polymeric single ply membranes

### Materials

All polymeric single ply membranes should declare compliance with the harmonised European Product Specification BS EN 13956 'Flexible sheets for waterproofing — Plastic and rubber sheets for roof waterproofing — Definitions and characteristics', and provide declaration of characteristic values achieved by their product.

### Installation

The installation of a single ply membrane should be:

- The subject of a site specific design and specification document which clearly details all materials and an appropriate installation methodology.
- In accordance with the 'Single Ply Roofing Association's Design Guide to Single Ply Roofing', and the manufacturers installation requirements.

The site specific design and specification should include all relevant documentation e.g. a fixing schedule with supporting wind uplift calculations, Condensation Risk Analysis calculations, a roof plan, and all relevant waterproofing details.

The attachment of the single ply membrane should be designed to resist calculated wind load by a declared safety factor of two times (200%).

Where mechanical fixings are specified, the number and distribution of mechanical fasteners required to the membrane and/or preceding layers will be determined by calculation, and should relate to the geographical location of the building, topographical data and the height of the roof concerned.

Where roof systems are adhesively bonded, the adhesive should be approved by the insulation manufacturer and should be laid at the coverage rate and pattern designed to achieve a performance level to resist the effects of the calculated wind loads.

In all instances, specific restraint should be provided at the roof perimeter, at changes of slope and around details. Restraint methodology should be aligned with the manufacturers requirements and may include approaches such as:

- Individual fasteners, protected by a flashing.
- A linear bar, protected by a flashing.
- Clamping underneath a mechanically fastened, membrane-laminated trim, with the line of fixings waterproofed by a cover strip.
- Welding the field sheet to a membrane-coated metal trim secured to the deck (with thermal break fasteners where appropriate). This is not recommended for fully adhered membranes.

The upper termination of the single ply membrane at linear details such as plinths, parapets, abutments and door openings should be secured by one of the following mechanical means:

- Clamping beneath a metal rail, e.g. a parapet capping or roof light frame.
- Welding to a membrane-metal laminate trim (itself mechanically fixed).
- Mechanical fixing using individual fasteners or a mechanically fixed termination bar.

The welding of single ply membranes is a critical process. The following should be considered:

- Supply of certification for each installer indicating successful completion of the manufacturer's product specific training.
- Production and retention of test weld samples at the start of each day.
- Provision of consistent electrical power supply.
- Declared procedures for repair of weak welds or damage.

## Liquid applied membranes

### Materials

As there is no harmonised standard, all liquid applied membranes should have compliance declared using an ETA and EAD approach. Applicable EAD's are considered to be:

- 030350-00-0402 'Liquid Applied Roof Waterproofing Kits', or
- 030019-00-0402 Polysiloxane (where waterproofing on the basis of a silicone).

### Installation

The installation of a liquid-applied membrane should be:

- The subject of a site specific design and specification document which clearly details all materials, material coverage rates in kg/m<sup>2</sup> or l/m<sup>2</sup>, and an appropriate installation methodology.
- In accordance with the manufacturers installation requirements, and guidance documents published by the Liquid Roofing and Waterproofing Association.

The site specific design and specification should include all relevant documentation e.g. a fixing schedule for substrate/material receiving the liquid-applied system, any supporting wind uplift calculations, Condensation Risk Analysis calculations, a roof plan, and all relevant waterproofing details.

The type of insulation used for liquid applied membranes must be confirmed by the manufacturer of both the liquid applied membrane and insulation board manufacturer as being compatible.

The site installation of an OSB or plywood sheet over a proprietary rigid insulation board to facilitate application of a liquid-applied membrane should only be acceptable when supported by a site specific condensation risk analysis calculation.

Where an adhered carrier or preparation membrane is installed over an insulation board to facilitate the application of the liquid applied membrane, confirmation should be sought from the manufacturer of the insulation board regarding the compatibility of any roofing system primers or adhesives used for the attachment of the carrier material.

Where a liquid-applied membrane is required to bond onto lead pipe sleeves, flashings, steel balusters, anchoring system, etc., the preparation and any application of system specific primer should be in strict accordance with the specification and the manufacturers instructions.

The installation of a liquid-applied membrane should be the subject of a documented Quality Assurance procedure executed by the installing contractor to adequately demonstrate that a consistent material thickness and coverage rates have been achieved.

During installation, the Warranty provider may request assessment of wet film thickness by either gauge pin, 'Comb' type measurer or visual inspection.

## Mastic asphalt

### Materials

Within any documentation provided, mastic asphalt should demonstrate an appropriate specification for the intended purpose, and be in accordance with BS 6925 Specification for mastic asphalt for buildings and civil engineering (limestone aggregate).

Separating membranes should be laid directly under the mastic asphalt, and should be either:

- Sheathing felt, comprising a base of flax or jute, or other suitable fibres, impregnated with bitumen.
- Glass fibre tissue.

Bitumen-coated plain expanded metal lathing included within the system should be in accordance with BS EN 13658-2 'Metal lath and beads. Definitions, requirements and test methods.'

Stone chippings (bedded) for use as a protective topping should be washed, crushed rock, normally 10mm-14mm nominal size aggregate, bedded in a proprietary gritting solution over the mastic asphalt membrane.

## Installation

The installation of a mastic asphalt should be:

- The subject of a site specific design and specification document which clearly details all materials, the number of coats required, and an appropriate installation methodology.
- In accordance with the guidance of BS 8218 'Code of practice for Mastic asphalt roofing', and guidance documents published by The Mastic Asphalt Council.

The site specific design and specification should include all relevant documentation e.g. a fixing schedule for substrate/material receiving the liquid-applied system, any supporting wind uplift calculations, Condensation Risk Analysis calculations, a roof plan, and all relevant waterproofing details.

BS 8218 gives recommendations for the use of mastic asphalt in roofing for both flat and sloping roofs and covers a variety of applications. The number of coats should be appropriate to the waterproofing requirements and traffic conditions of the roof. Typically:

- When laid to falls of 1:80 or more, mastic asphalt roofing is laid in two coats to a thickness of 20mm, on a separating membrane of sheathing felt.
- On sloping and vertical surfaces over 10° pitch, the mastic asphalt should be laid in three coats to a thickness of 20mm without a separating membrane.
- On sloping and vertical surfaces of timber or lightweight concrete, the mastic asphalt should be laid in three coats to a thickness of 20mm on expanded metal lathing over a separating membrane of sheathing felt.

## Reinforced bitumen membranes

### Materials

All reinforced bitumen membranes should declare compliance with the harmonised European Product Specification for reinforced bitumen membranes, BS EN 13707, and provide declaration of characteristic values achieved by their product.

Specifications for systems of multi-layer reinforced bitumen membranes for flat roofing should comply with BS 8747 'Reinforced bitumen membranes (RBMs) for roofing. Guide to selection and specification'.

Minimum recommended specification for reinforced bitumen membranes are provided below:

| Roof system type   | Deck type      | Insulation type <sup>1</sup>              | Venting layer <sup>2</sup> | Underlayer <sup>3</sup> | Cap sheet <sup>4</sup> |
|--------------------|----------------|-------------------------------------------|----------------------------|-------------------------|------------------------|
| Warm deck          | Profiled metal | Thermoplastic foam                        | 3G                         | S2P3 <sup>5</sup>       | S4P4 <sup>5</sup>      |
|                    |                | Mineral fibre                             | -                          | S2P3                    | S4P5                   |
|                    | Concrete       | Thermoplastic foam                        | -                          | S2P3                    | S4P4                   |
|                    |                | Mineral fibre                             | -                          | S2P3                    | S4P4                   |
|                    | Timber panel   | Thermoplastic foam                        | 3G                         | S2P3                    | S4P5                   |
|                    |                | Mineral fibre                             | -                          | S2P3                    | S4P4                   |
| Inverted warm deck | Profiled metal | Extruded Polystyrene (XPS)                | 3G                         | S2P3                    | S4P5                   |
|                    | Concrete       |                                           | -                          | S2P3                    | S4P5                   |
|                    | Timber panel   | Deck type not suitable for inverted roofs |                            |                         |                        |

Notes:

<sup>1</sup> Insulation type: Thermoplastic foam: PIR, EPS, PF. Mineral fibre: MW.

<sup>2</sup> Venting layer: BS 8747 3G or proprietary equivalent with suitable certification.

<sup>3</sup> Under layer: as defined in BS 8747. SBS-modified products are recommended.

<sup>4</sup> Cap sheet: as defined in BS 8747. SBS-modified products are recommended.

<sup>5</sup> S and P are classifications 1-5 of Strength (tensile strength and elongation) and resistance to puncture (static and dynamic); the higher the rating, the higher the performance.

Bitumen membranes should be protected from solar radiation by integral protection provided in the product in the form of:

- Mineral granules.
- Metal foil.

The use of solar reflective paint is not permitted. The use of stone chippings is not recommended unless required to achieve enhanced external fire performance. If used, chippings should be washed, crushed rock, normally 10mm-14mm nominal size aggregate, bedded in a proprietary gritting solution.

**Installation**

The installation of reinforced bitumen membranes should be:

- The subject of a site specific design and specification document which clearly details all materials and an appropriate installation methodology.
- In accordance with the relevant guidance within BS 8217 and BS 8747, and the manufacturers installation requirements.
- In accordance with guidance documents published by the National Federation of Roofing Contractors.

The site specific design and specification should include all relevant documentation e.g. a fixing schedule with supporting wind uplift calculations, Condensation Risk Analysis calculations, a roof plan, and all relevant waterproofing details.

Where a reinforced bitumen membrane is installed over an insulation board, work should be executed strictly in accordance with the specification. This specification should include confirmation from the manufacturer of the insulation board regarding the methodology used for the attachment of the bitumen membrane e.g. torch-applied, adhesive bonding, and cover the compatibility of any roofing system primers or adhesives with the insulation boards receiving surface.

**Site-applied hot melt coverings****Materials**

As there is no harmonised standard, all site applied hot melt coverings should have compliance declared using an ETA and EAD approach. The applicable EAD is:

- 030065-00-0402 'Composite Roof Waterproofing Kits'.

**Installation**

The installation of hot melt coverings should be:

- The subject of a site specific design and specification document which clearly details all materials, and an appropriate installation methodology.

The site specific design and specification should include all relevant documentation e.g. a fixing schedule with supporting wind uplift calculations, Condensation Risk Analysis calculations, a roof plan, and all relevant waterproofing details.

The installation of hot melt coverings should be the subject of a documented quality assurance procedure executed by the installing contractor to adequately demonstrate that the required material thickness detailed within the specification has been achieved.

Bond tests between the covering and substrates should also be carried out prior to commencement of works to prove and demonstrate the required bond is achieved, and these should be documented within the Quality Assurance documentation on site. If bonding problems occur, advice must be sought from the manufacturer.

**EPDM roof coverings****Limitations**

EPDM products are only acceptable for Warranty purposes where the roof:

- Does not exceed a 100m<sup>2</sup> maximum roof area (Gross flat roof area of the project – not individual plots), **and**
- Is a simple open plan laid to fall roof is proposed (i.e. no parapets, changes of levels or plant installations).

EPDM membranes are not acceptable where any pedestrian access is proposed (other than occasional maintenance) and are not acceptable for use in the following constructions:

- Balcony / Terrace deck.
- Blue roof.
- Green roof.
- Podium deck.

**Materials**

Within any documentation provided, the manufacturer should declare compliance with the harmonised European Product Specification BS EN 13956 'Flexible sheets for waterproofing — Plastic and rubber sheets for roof waterproofing — Definitions and characteristics', and provide declaration of characteristic values achieved by their product.

**Installation**

The membrane should only be acceptable for Warranty where it is installed as a fully adhered bonded only membrane to the roof deck (not mechanically fixed with ballast covering), and should be:

- The subject of a site specific design and specification document which clearly details all materials and an appropriate installation methodology.
- In accordance with the manufacturers installation requirements.

The site specific design and specification should include all relevant documentation e.g. a fixing schedule with supporting wind uplift calculations, Condensation Risk Analysis calculations, a roof plan, and all relevant waterproofing details.

## 11.4.18 Detailing

Flat roof waterproofing systems shall be appropriately detailed to ensure satisfactory performance against the effects of weather. Factors to be included are:

- Rain and snow.
- Wind and exposure.
- Movement – structural and thermal.

The site specific design and specification should include a roof plan which includes the type and position of all detailing.

The following key principles should be followed in design of all details:

- Upstands to extend 150mm above the finished roof level.
- Down stands (of separate metal or other flashings) should lap the upstand by a minimum 75mm.
- Construction should achieve independence between different elements and trades.
- Thermal and fire performance should be maintained across the detail.
- A continuous barrier to air leakage should be maintained.
- Reliance on sealant as the sole means of protection should be avoided.

The total roof zone depth should be assessed at critical points, such as the top of drainage slopes, to ensure that there is enough free upstand available to create the minimum required 150mm of waterproofing protection above finished roof level.

It is important that this minimum 150mm upstand is maintained at all points around the waterproofed area, except at continuous water checks and verges.

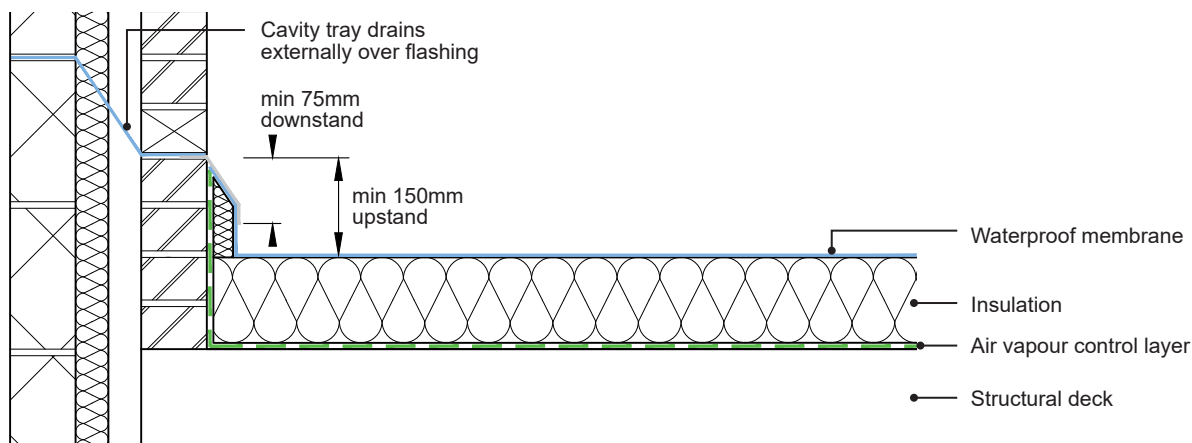
Designers should carefully consider the risks of any departure from this criterion. In the event of this being unavoidable, a written justification should be provided.

Special design features are essential, depending upon the type of waterproof membrane, including:

- Minimum clearances to enable the waterproof membrane to be installed.
- Termination of the waterproof membrane at interfaces to other elements.
- Penetrations.
- Supports.

The following illustrations are intended as a guide to demonstrate the general principles of common used flat roof detailing. Further information on specific waterproofing systems may be obtained from BS 6229 and BS 8217.

### Example of warm deck roof at an abutment

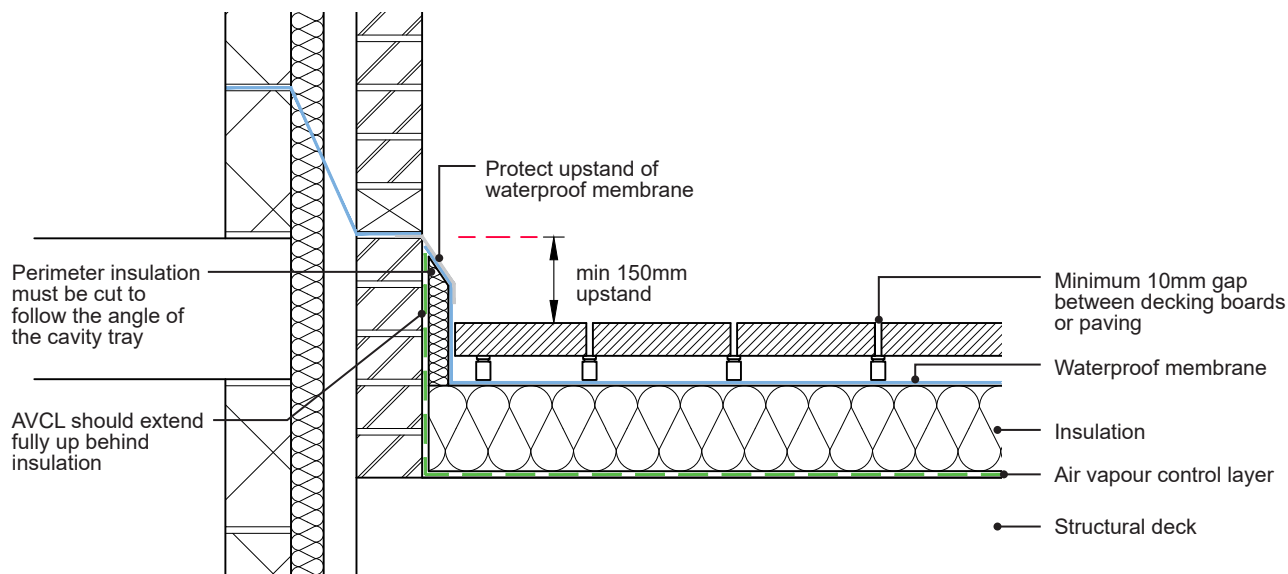


Insulation fully wrapped around by air vapour control layer and waterproof membrane.

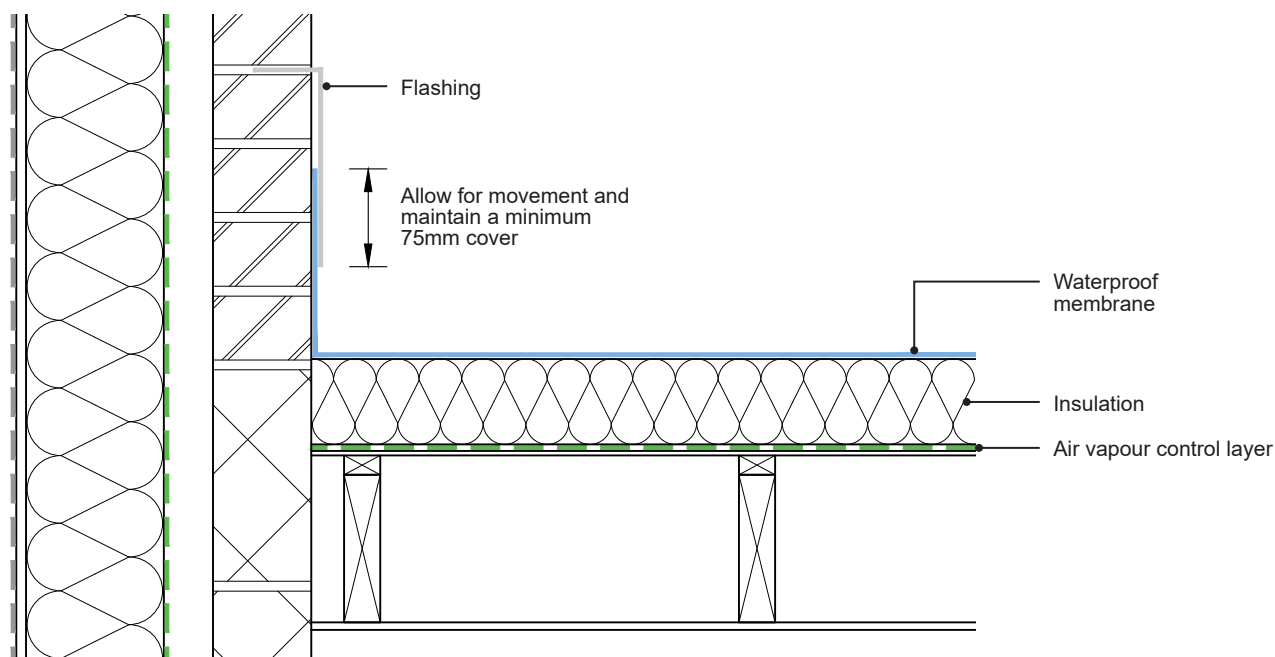
Notes:

- A fillet is required at the base of the upstand for certain types of waterproof membrane.
- Vertical insulation may not be required.
- AVCL, waterproof membrane, or both may form the air seal to the abutting wall.
- The principles for a parapet wall are similar but the cavity tray may be detailed differently.
- Discharging the cavity tray in the course above the corner flashing (a) avoids it being damaged during the roofing works and (b) allows for increase in insulation depth at refurbishment.

### Upstand to decking and paving finishes - e.g. where access is required



### Allowance for movement where a timber frame with masonry cladding abuts a flat roof

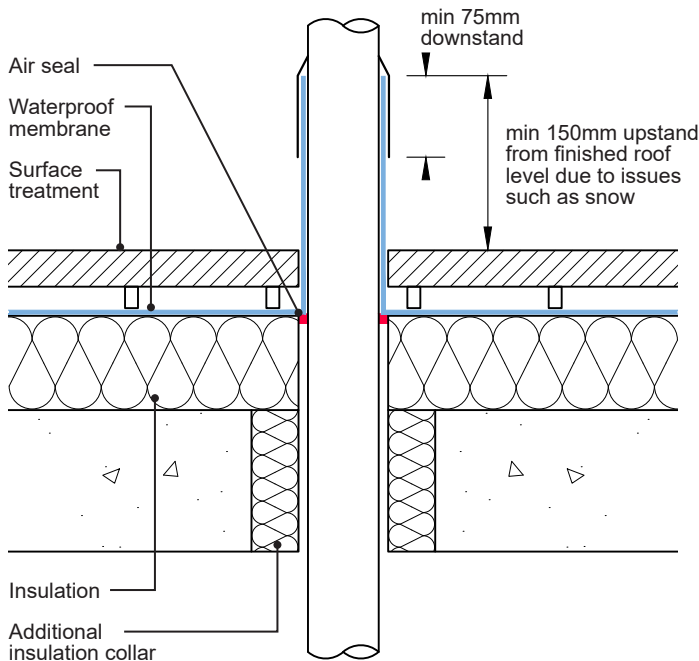


Where a timber frame structure abuts a masonry structure, allowance should be made to accommodate movement in the timber frame and ensure the appropriate cover is maintained.

For detailing with parapet wall construction, see the 'External Walls' section.



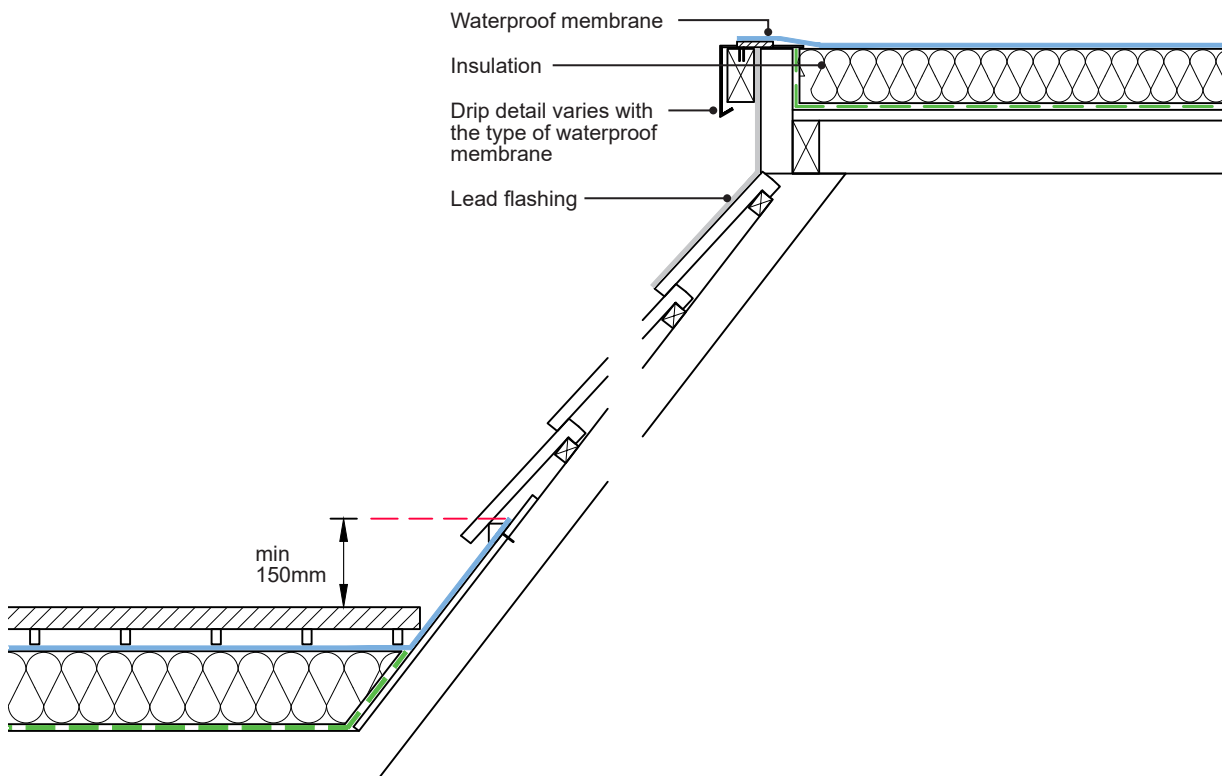
## Penetration through roof system



### Notes:

- Upstands to extend 150mm above the finished roof level.
- Down stands (of separate metal or other flashings) should lap the upstand by a minimum 75mm.
- A chamfered fillet is required at the base of the upstand for certain types of waterproof membrane. Roof membrane manufacturer specification should be followed.
- An effective seal is required between the air vapour control layer and pipe. It is difficult to dress a sheet material around a pipe. 'Star cut' approaches should be avoided where possible and proprietary "top hat" products are often most suitable. The method for doing so should be stated in the contract drawings and/or specification.

## Principles: Flat roof interface to pitched roof



## Special design features

Special design features are essential, depending upon the generic type of waterproof membrane, including:

- Minimum clearances to enable the waterproof membrane to be installed.
- Termination of the waterproof membrane at interfaces to other elements.
- Penetrations should be grouped wherever possible.
- Supports.



### 11.4.19 Completion testing

Waterproofing systems shall be tested where required by this section, when complete, to prove and demonstrate resistance to the passage of moisture.

#### Final inspection prior to test commencement

At practical completion of the flat roof, all areas should be clear of stored material, other site operations and all protection. A thorough, recorded, visual inspection of all areas, including details, should be carried out with representation from the General Contractor and Roofing Contractor in attendance.

#### Testing of flat roofs (all types of waterproofing systems)

Upon completion testing of the flat roof covering will be required to be carried out as per the following criteria.

##### Parameters for testing

Testing is required in the following situations:

- On low rise housing: Detached/semi-detached/terraced housing 3 stories or less in height (including the ground storey) when:
  - The roof areas exceed 50m<sup>2</sup>, **or**
  - Where the project consists of 10 or more properties: one test per ten houses (with a minimum of two tests per site) are required.
- On large developments: Apartments etc. over 3 stories in height (including the ground storey), where the total combined roof areas exceed 50m<sup>2</sup>. In this case, a minimum of 20% of the roof areas must be tested.
- On developments involving our Major Projects Team, all flat roofs will require low voltage testing.
- Where, after completion of the site risk assessment, the Warranty surveyor has identified areas of complexity in relation to the roof and its ancillary components that present a higher risk to Warranty (e.g. service penetrations, abutments with claddings, and penetrations from fixed items such as man safe systems).

These areas of complexity may be resultant of elements of:

Design, where:

- The roof includes features beyond a typical wall abutment e.g. (but not limited to); variations of upstand constructions/penetrations/fixings/ external permanent machinery/balustrading fittings etc.
- The waterproof membrane is to be covered over (by pedestrian finishes or solar panels). Note: Inverted roofs of straightforward design and with continuous hot-applied waterproof membrane could be exempted.

Construction, where:

- There are to be/have been, follow on trades on the roof after completion of the roof covering.
- Secondary items such as fall protection devices, PV supports, balustrades etc. are to be attached.

In all circumstances, testing should be carried out when the first flat roofs are completed to determine if there are any inherent issues with the design or workmanship. Where there is a failure the root cause should be determined and appropriate remedial actions should be taken. The Warranty surveyor may request an increase in the amount of testing required.

#### Testing of EPDM roof coverings

Where EPDM roof coverings are installed and require testing, they must be tested at completion to demonstrate waterproofing integrity. The testing provider will need to demonstrate their chosen technique is suitable for testing EPDM roof coverings as electronic leak detection techniques are not suitable.

#### Procurement of testing services

If testing to demonstrate waterproofing integrity is required, it should be undertaken by a suitably qualified and experienced third party who is independent of the roofing contractor.

The testing service provider should provide evidence of the following:

- Efficacy of the method proposed in the circumstances of the project.
- A detailed testing regime that includes integrity testing of detailing, specifically where the Warranty surveyor has raised these as elements of complexity within the site risk assessment.
- Experience and training of operator.
- Membership of an appropriate trade association that sets a Code of Conduct for the service.

#### Methods of test

##### Low voltage earth leakage

Low voltage earth leakage is a safe and effective method for the testing of waterproofing integrity in roofs where the waterproof membrane is an electrical insulator, and the deck provides an electrical earth. It is not suitable for testing flat roofs where the waterproof membrane has been overlaid with insulation and ballast (inverted roofs) or ballast only (ballasted warm roofs); therefore, testing should be carried out prior to completion of the roofing system.

## Voltage Field Mapping

Voltage field mapping uses a generator, trace wire and field electrodes on a roof with a thin layer of water spread across the selected test area. The trained operator uses electrodes and generated voltage flow to determine the presence and precise location of defects in the area being tested.

## High voltage electrical discharge

High voltage electrical discharge method is a versatile and effective method of testing. It can be used on steep slopes or inverted surfaces, provided the underlying structure will provide the necessary ground. Can be used for single ply (check with the relevant manufacturer before testing), reinforced bitumen membranes and liquid applied coatings.

## Vacuum

Vacuum testing of seams of membranes manufactured off-site is an effective means of quality assessment, but is not recommended as a method of demonstrating the integrity of flat roofs.

## Flood testing

Flood testing is not recommended as a method of demonstrating the integrity of flat roofs. It may be used to test balconies.

### 11.4.20 Operations and Maintenance Manual

The operations and maintenance manual shall be provided to the homeowner upon completion.

Periodic inspection and maintenance should be completed in line with the advice provided within the Operation and Maintenance Manual, by an appropriately skilled or trained party.

As a minimum it is advisable that a flat roof is inspected at least twice yearly. Typically, in the autumnal period of the year to ensure outlets are operational and the roof is free draining to deal with any subsequent inclement weather conditions in coming winter months. A further inspection is then carried out in spring to discover and rectify any damage due to weather. Extra inspections are advisable following any extreme weather events or where it is suspected that vandalism, and/or theft may have occurred on the roof.

As a minimum, it is advisable that any inspections should include the following elements:

- An examination of ceilings for signs of water damage.
- An examination of external walls, eaves and soffits for signs of movement.
- Signs of damage to the roof surface and subsequent layers of construction along with associated flashings.
- Mounted or ballasted roof top installations e.g. safety equipment, communications and renewable energy installations should be examined to ensure their attachment and associated work remains waterproof.
- Extensive build-up of leaves, moss, plants or debris should be recorded along with any influencing factors such as the effect of overhanging trees, mounted plant items, etc.

It is advisable that when additional construction work is planned on or near to the roof, an appropriate and specific inspection regime is established to cover the aspects of risk associated with the work at hand.

### 11.4.21 Protection of completed waterproofing

Where access provision is required, the waterproofing systems shall be appropriately protected to prevent damage.

## Protection of roof system

The anticipated use of the roof during service should be assessed and the associated risk of damage determined based upon factors such as:

- Type of load exerted e.g. foot traffic, equipment.
- Risk of damage posed by use.
- Frequency of access e.g. permanent foot traffic, periodic maintenance and servicing access.

The design should include protection to suit the anticipated conditions as appropriate:

- Polymeric single ply membranes: compatible sheets or tiles welded to the membrane.
- Load-spreading materials.
- All waterproof membrane types: paving on paving supports or protection layer.
- Polymeric single ply and reinforced bitumen membranes: galvanised steel sheet with additional covering with slip-resistant finish.

## Temporary protection (during construction)

Responsibility for temporary protection and a method statement for its use should be agreed prior to commencement of works. Suitable materials should be selected in consultation with membrane manufacturers as appropriate, for example:

- Linked recycled thermoplastic sheets.
- Rolled recycled thermoplastic or elastomeric sheets.

Consideration should be given to locations of concentrated access, such as step-out areas onto the roof or where wheeled equipment may be used.

**Permanent protection (during service)**

Permanent protection should be laid on routes where access is most likely, and should not be laid on routes where temporary ponding is likely e.g. near parapet walls in the absence of cross falls between rain water outlets.

It is recommended that concrete paving is laid on support pads, as this allows adjustment. The following should be considered:

- The height of support pads should not exceed the maximum recommended by the manufacturer.
- Paving should not be cut. If cutting (part-slabs) is unavoidable to match plan geometry then an alternative means of support may be required.
- Paving should be firmly butted up against support pad separating pegs.

Further guidance on the suitability of finishes for temporary access can be found in the 'Roof Terraces and Balconies' section.

**Ancillary components installed on top of a waterproof layer****Non-access areas: stone ballast**

Stone ballast for inverted warm deck roofs and ballasted warm deck roofs should be clean, rounded aggregate graded 20mm-40mm and as free from fines as practicable. Ballast should be applied over a protection layer on warm ballasted systems and over a filter layer or WFRL on inverted warm roofs.

**Access areas: concrete paving slabs**

Concrete paving slabs for use as walkways or as paving on terrace decks should conform to BS EN 1340 and be laid in accordance with the manufacturer's instructions.

**Access areas: flexible walkway tiles**

Evidence of the compatibility of the tile with the waterproof membrane is required.

**Pedestals**

Where pedestals are specified to support pedestrian surface finishes (such as paving slabs), they should be:

- Appropriate for the intended purpose.
- Appropriate for the site specified conditions.
- Compatible with the waterproofing system, thermal insulation and all other components within the roof terrace build-up.

Pedestals, and the loads they impose on the structure below should not exceed the expected designed loads. The compressive strength of the insulation, waterproof membrane and other materials within the flat roof build up should be considered by the designer when specifying pedestal systems.

Where dead and/or live loads are anticipated to be high, there should be consideration for the use of a cover board underneath the waterproof layer and/or a rail system.

In addition, the pedestal should not create a risk of damage to the waterproofing (e.g. sharp edges).

**11.4.22 Control of work post waterproofing completion**

Any additional works carried out by a third party, after the waterproofing system completion but prior to the building being signed off for Warranty shall:

- Be a part of the original design proposal.
- Appropriately managed.
- Controlled to avoid a loss of waterproofing integrity.

**General**

Where additional work is required to facilitate a follow-on service or function, as far as practicable, any waterproofing work should be executed by the approved installer of the waterproofing system. Where this cannot be accomplished, any work conducted by a third party should be inspected and signed off by the approved installer when complete. The Warranty surveyor at their discretion may request evidence of this for record purposes.

Relevant additional work is considered to include:

- Installation of lightning protection.
- Installation or placement of mechanical, electrical and communication services.
- Installation or placement of renewables e.g. PV panels.
- Installation of safety equipment for access.

The placement of services and or equipment is considered a foreseeable function that can be factored in at design stage, and as such the Warranty provider requires that all work is included into the site specific design and specification.

**Surface attachment**

Any form of attachment made to the surface of a waterproofing system (e.g. lightning protection pads or clips) must not compromise the integrity of the waterproofing system or diminish its longevity. The materials, inclusive of bonding adhesives, and methodology for attachment should be confirmed as compatible with the waterproofing system by the waterproofing manufacturer.

## Service penetrations

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If penetrations can be avoided and cabling and/or pipework suitably routed without penetrating the waterproofing system, then this is considered the preferred course of action. Where penetrations cannot be avoided, then they should be formed to avoid water ingress and formed using appropriate detailing and materials.

Where ductwork is located on a roof:

- A 50mm clearance should be provided to horizontal ductwork to ensure it does not rest upon the waterproof membrane or roof finish.
- Entry/exit points should be suitably weathered without loss of integrity of the waterproof membrane – this should include the formation of appropriate upstands in the waterproof membrane at risers and include separate down stand or weathering flashing to be formed in ductwork.

## Equipment and plant installations

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Loads from equipment, associated mounts or frames and any ballast should appropriately transfer loads to the structure without damage to the waterproofing system. The placement of equipment and/or plant, and any associated proprietary framework systems or mounts onto the waterproofing system should include all relevant protection measures to ensure that the risk of damage is avoided.

Where there is a requirement for structural fixings or mounts to penetrate through the waterproofing system and into the roof structure, installation requirements stipulated by the manufacturer of the associated equipment should be communicated to the waterproofing system manufacturer and installer to enable the design and execution of an appropriate waterproofing detail.

## Penetration from structural fixings or anchor points

Where there is a requirement for structural fixings or anchor points to penetrate through the waterproofing system and into the roof structure, installation requirements stipulated by the manufacturer of the associated equipment should be communicated to the waterproofing system manufacturer and installer to enable the design and execution of an appropriate waterproofing detail.

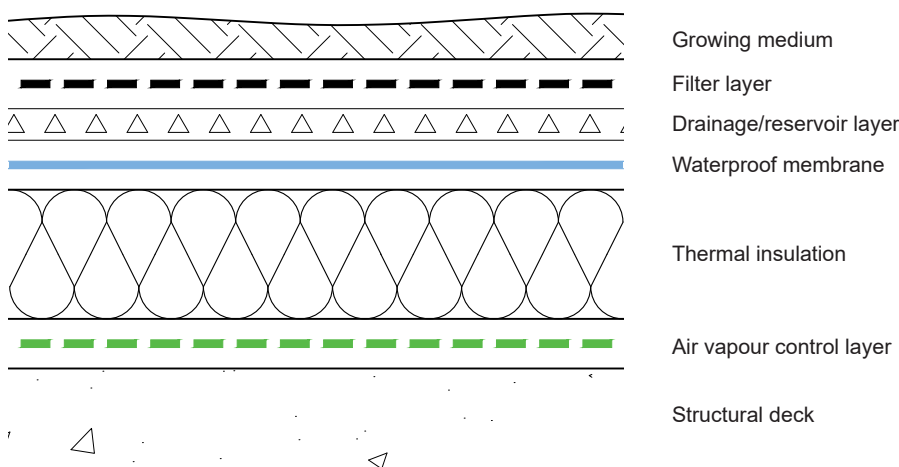
## Introduction

This section provides guidance on meeting the performance requirements for green roofs.

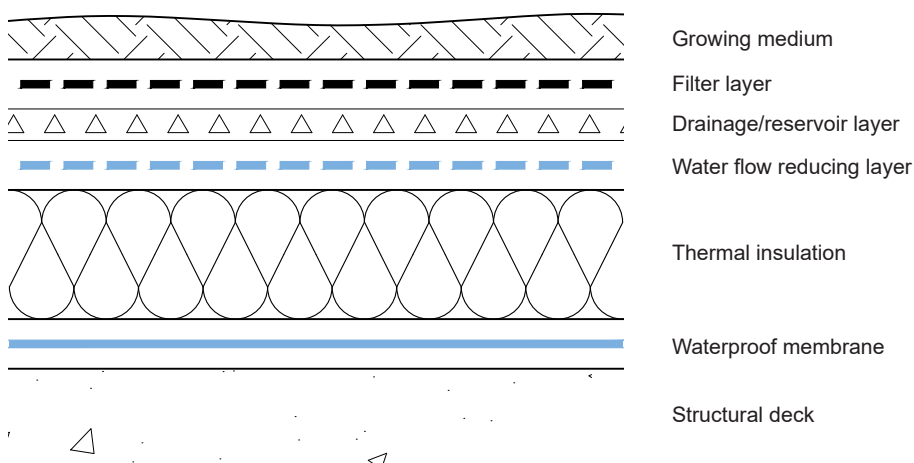
For the purposes of Warranty, a green roof comprises an organic vegetation layer and those components necessary to support its growth, which is placed over a membrane roof system. The following types of green roofs are covered within this section:

- Extensive green roof - a lightweight, low maintenance roof system, typically with succulents or other hardy plant species (often sedum) planted into a shallow substrate (typically less than 100 mm) that is low in nutrients. Irrigation is not normally required. A variant using Wildflower species will require a deeper substrate (typically 100mm to 150mm depending on species mix). Permanent irrigation is not required but it is advisable to include an option to irrigate in times of drought.
- Semi-intensive green roof - intermediate green roof type with characteristics of both extensive and intensive green roofs. Typically with a 100mm-200mm substrate depth, sometimes irrigated, occasionally managed and usually planted with a range of species.
- Intensive green roof - a version of a green roof often referred to as a roof garden that provides benefits akin to a small urban park or domestic garden. Designed primarily for recreational use, intensive roofs are typically configured with 200mm+ of substrate, and often require regular maintenance and irrigation.

### Extensive green roof - warm roof system (section)



### Intensive green roof - inverted warm roof system (section)



## 11.5.1 Compliance

Design, specification and installation of green roofs shall satisfy the performance requirements of this section.

The performance requirements of the 'Roofs - Flat Roofs' section shall also be satisfied.

## 11.5.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full set of detailed drawings including:
  - a. Roof plan showing direction of falls and position of outlets and overflows.
  - b. Sections showing roof build up and how falls are to be created. Section details should show all components to be used in the green roof build up (insulation type and thickness, vapour control layer, waterproofing membrane/layers etc.).
  - c. Site specific detailing for all junctions, outlets and penetrations.
2. Details of all components to be used in the construction of the green roof.
3. Engineers drawings and calculations for the roof structure.
4. A third party product conformity certificate for the waterproofing membrane/layer. This must confirm the membrane can be used in a green roof build up.
5. Details of all fixings, their frequency and fixing method, including those for insulation and surfacing. Fixing methodology should be supported by appropriate wind uplift calculations.
6. Details of all fire stopping within structure and fire mitigation measures made within the green roof elements e.g. vegetation free zones. This should include specification and a detailed location layout drawings showing positioning.
7. Outline of method and plan for testing the integrity of the waterproofing layer.
8. A flat roof membrane manufacturer's approved installer must be used for all flat roof coverings. Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty surveyor.
9. A roof deflection analysis should be provided for medium to large roofs, those with complex roof layouts and for any roof areas that carry items of plant or are subject to access provisions beyond periodic maintenance of the roof area.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

## 11.5.3 Structural design

Flat roof structures incorporating a green roof shall be designed and constructed so that all loads are sustained and transmitted to supporting structure(s) without causing instability, deflection or deformation. Factors to be considered are:

- Wind loading.
- Dead and imposed loading.
- Structural movement.
- Openings and penetrations.
- Fixing/attachment of ancillary structures and plant or equipment.

### Statutory requirement

Design for loading should comply with current relevant Building Regulations. Further information can be found in the 'Roofs - Flat Roof' section of this Technical Manual.

### Resistance to wind load

In all situations, including ballasted and inverted roofs, a calculation of wind load to BS EN 1991-1-4 should be undertaken by a suitably competent person. Wind load acting on a green roof will be affected significantly by the design of the perimeter and by the geometry and finishes on the elevations of the building. Any changes to these elements will necessitate a review of the calculation output.

In biodiverse, brown and extensive green roof systems, the dead load contribution from the growing medium should be calculated on an assumption of dry substrate conditions. Such loadings may be insufficient to restrain the green roof and certain types of waterproof membrane and insulation, necessitating the provision of supplementary ballast or netting restraint. Information on loading is available from horticultural suppliers.

### Resistance to imposed loads

At the earliest possible stage, the employer should define the range of potential imposed loads for which the green roof is to be designed, such as seats, stand-alone planters, storage and public access. In the absence of such a performance requirement, the loading limits of the roof should be defined.

### 11.5.4 General design principles

The design, specification and installation of green roofs shall be suitable for the intended purpose.

Where green roofs are proposed, the design of the flat roof shall satisfy the performance requirements in the 'Roofs - Flat Roofs' section.

#### General

The guidance within this section should be read in conjunction with the 'Roofs - Flat Roofs'. The general build up and specification of materials for the green roof should satisfy the requirements within our 'Roofs - Flat roofs' section.

Green roofs must be designed in accordance with the GRO Code of Practice and CIRIA C753 SuDS Manual 2015.

#### Structural deck positioning within the flat roof build up

The roof system may be of warm deck or inverted warm deck configuration. The approach taken will be dependent on a number of variables which should be considered by the designer. The chosen approach should be discussed with the Risk Management Surveyor as early as possible to ensure all Warranty risks are mitigated.

For Warranty purposes, cold deck roofs are not suitable for green roof applications.

#### Weatherproofing

At an early stage in the design process, an audit of roof geometry should be carried out to establish what types of details will be required and whether they are to be weatherproof (incorporating an upstand/cover flashing arrangement) or waterproof (providing continuous waterproofing across the detail).

The following key principles should be followed in design of all details:

- Upstands to extend 150mm above the finished roof level i.e. top of growing medium.
- Downstands (of separate metal or other flashings) should lap the upstand by a minimum of 75mm.
- Reliance on sealant as the sole means of protection should be avoided.
- Consideration of the effect of vegetation growth on the integrity of the weatherproofing.

The total roof zone depth should be measured from the surface of the growing medium and assessed at critical points, such as the top of drainage slopes, to ensure that there is enough free upstand available to create the minimum required 150mm of waterproofing protection above finished roof level. It is important that this minimum 150mm upstand is maintained at all points around the area of the green roof, except at continuous water checks and at verges.

#### Protection layer

Protection layers should be provided to protect the waterproof membrane in accordance with the design.

#### Floatation

There should be measures in place to mitigate against the risk of floatation.

#### Permanent pedestrian access finishes

Pedestrian finishes should be designed to suit the purpose and frequency of access in the context of the intended planned maintenance regime. For example, paving on paving supports may be desirable to allow drainage and to level up the finish, but may be unsuitable if plants could spread beneath the paving. Generally, for amenity access, a finish of porous or hard concrete paving laid directly on a suitable protection fleece may be most suitable.

For service and maintenance access only, a flexible walkway tile may be sufficient (depending on the waterproof membrane and roof system type).

For further information regarding permanent protection during service, see the 'Roofs - Flat Roofs' section of this Technical Manual.

#### Temporary provision during construction

At the earliest possible stage, the anticipated loading of the roof system (prior to application of the green roof components) should be assessed in terms of:

- Load e.g. foot traffic, equipment.
- Risk of impact.
- Frequency.



If such usage is intense or long-lasting during the construction phase, consideration should be given to temporary works only, with completion occurring after all non-roofing usage has ceased as follows:

- Warm deck roof system: following the installation of vapour control layer, temporary protection is required to be overlaid until the remainder of the system is installed.
- Inverted warm deck roof system: overlay completed waterproof membrane with a geotextile and continuous temporary decking, such as plywood, Oriented Strand Board or compatible recycled thermoplastic board.

## 11.5.5 Rainwater drainage

Green roofs shall effectively drain rainwater from roof areas to a suitable drainage system. Green roofs shall have a minimum finished fall of 1 in 80 to facilitate rainwater drainage.

All flat roofs should be designed to collect, direct and discharge rainwater to a suitable drainage system by a suitably experienced drainage designer prior to roofing work commencing.

The following guidance should be read in conjunction with the guidance provided in the 'Roofs – Flat Roofs' section on:

- Roof drainage
- Rainwater outlets
- Formed gutters
- Creation of falls
- Overflows

The following should also be read in conjunction with the 'Drainage' section.

### Drainage design

Green roofs are likely to reduce the volume and rate of transfer of rain water-to-rain water goods. This effect is clearly dependent upon many factors, including depth and type of growing medium, type of drainage/reservoir layer, weather conditions prevailing prior to the rainfall event and fall in the waterproof membrane. Due to these variables, it is recommended that the design for rain water drainage in accordance with BS EN 12056 is as follows:

- Brown, biodiverse and extensive green roof systems: no allowance for rain water attenuation.
- Intensive green roof systems: attenuation as advised by the horticultural supplier. If no data is supplied, no allowance should be made.

The UK's National Annex to BS EN 12056 does permit the use of a coefficient to factor down the drainage infrastructure to account for factors such as the additional retention performance of green roofs. However the coefficient that is used to reflect this reduction should be based on average annual retention and not on responses to dynamic storm events.

Any drainage infrastructure designed to accommodate this reduced flow rate may not accurately account for seasonal differences or individual storm events. Any reductions in drainage capacity should be countered by alternative measures, e.g. appropriate detailing to ensure that any attenuation of water at the roof level will not be detrimental to the building structure or fabric.

Rain water goods from higher roof areas or adjacent roof areas should not be designed to discharge onto the green roof.

### Falls

Falls are required for green roofs because:

- Standing water will inevitably result from design without falls, due to tolerances and deflection. Standing water, which may become stagnant, is not conducive to plant growth and should not be confused with the temporary retention of water in drainage/reservoir layers.
- Absence of falls will result in ponding, a potential slip hazard and the retention of mineral fines in vegetation-free zones, which in turn may encourage the growth of weeds.

### Rainwater outlets

Rainwater outlets must be accessible and have a visible inspection hatch.

Rain water outlets should be readily accessible without disruption to the green roof or pedestrian finish. On finishes raised above the waterproof membrane (warm deck roofs) or Water Control Membrane (inverted roofs), this may be achieved by a suitably marked paving slab or demountable section of decking. Within the area of the green roof, a system approved vegetation-free inspection chamber and cover must be provided in order to avoid plant growth obstructing the outlet.

### Design for irrigation

Rainfall is the typical source of water. However, complementary irrigation options may be required for semi-intensive and intensive systems or those where, for example, the appearance of a grass finish may be important.

Provision may include hoses, sprinklers, overhead irrigation and automated systems that pump from some reservoir storage. The establishment of a need for an irrigation system, and the design of an irrigation scheme, should be in accordance with the principles of BS 7562-3. Where irrigation is required, a frost-protected water supply, rain water or grey water storage facility should be provided at roof level.



### 11.5.6 Material specification

Materials and components for the green roof system shall be suitable for the intended purpose.

The waterproofing system shall have a third party product conformity certificate which confirms it can be used in a green roof build-up.

The material specification of the flat roof components under the waterproofing system should satisfy the performance requirements of the 'Roofs - Flat Roofs' section.

### Insulation

Insulation material should have adequate compressive strength to withstand likely applied loads and the designer should taken account of differing loads applied across the surface between the green, margin and paved areas.

### Roof barrier

A root resistant element is required above the waterproofing layer. Alternatively, an approved root resistant waterproofing layer can be used. If the waterproof membrane is also intended to provide root resistance, suitable certification of testing in accordance with BS EN 13948 should be available.

Consideration should be given to the potential for large roots to enter and disrupt inverted warm roof insulation, the system provider should be consulted for advice.

### 11.5.7 External fire performance

Where green roofs are proposed, they shall satisfy the relevant Building Regulations in relation to external fire performance.

### Design for resistance to external fire

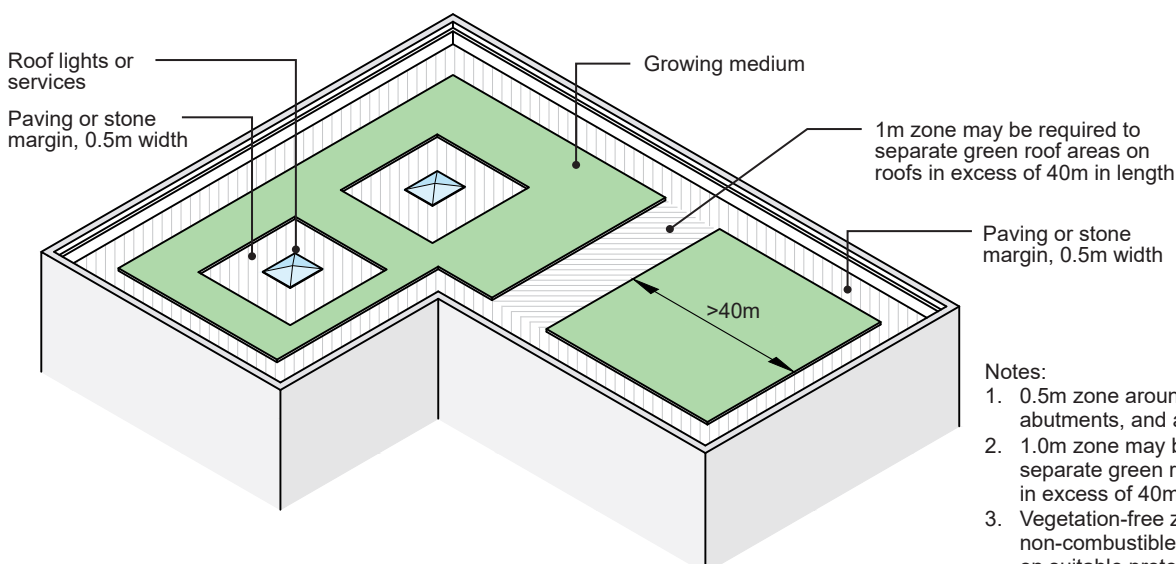
The design of green roof systems can influence the fire performance of the overall roof system. The rate of growth and moisture content of natural vegetation is unpredictable and determined by irregular weather conditions. The substitution of planted species with others is also unpredictable. Design to minimise fire risk cannot be based on an assumption of regular maintenance or of irrigation during drought. The latter is not relevant with sedum species, which die back, but is important for intensive roof gardens or extensive systems planted with wildflowers and grasses.

The design should not allow the vegetation to grow or propagate towards adjoining elements, such as abutments, eaves or pitched roofs. It should also be kept away from openings, such as roof lights and smoke vents.

This is achieved may be achieved by:

- A vegetation-free zone of minimum 0.5m width consisting of either 20 – 50mm rounded gravel at 75mm depth or 40mm thick paving slabs at all vertical perimeters, vertical abutments and vertical openings. This zone should be extended to 1m to separate large roof zones in excess of 40m in length.
- Design of flexible walkways, hard paving and ballasted areas so as to minimise root and plant spread.

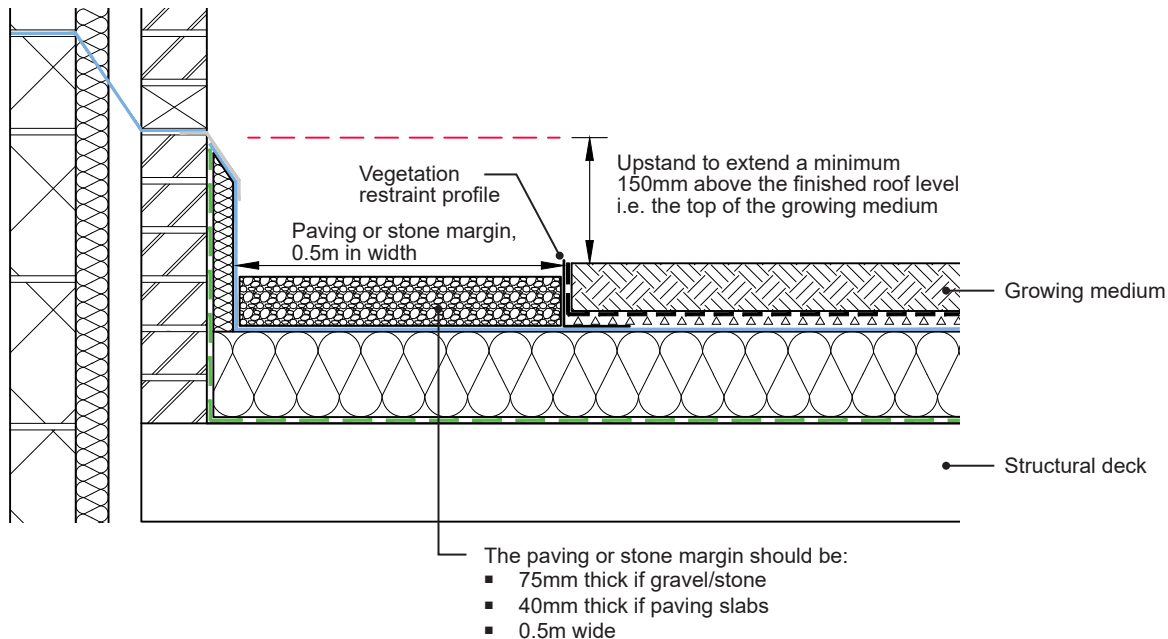
### Green roofs: Vegetation-free zones (Plan, zone width: not to scale of building)



#### Notes:

1. 0.5m zone around openings, along abutments, and at perimeters.
2. 1.0m zone may be required to separate green roof areas on roof in excess of 40m length.
3. Vegetation-free zone to comprise non-combustible stone or paving on suitable protection.

## Green roofs: Vegetation-free zones: Warm roof (section)



### Notes:

1. Vegetation restraint profile should be secured with ballast as necessary. Additional restraint will be required on sloping roofs to stop creep of the vegetation zone.
2. Protection of waterproof membrane should be extended under ballast zone.
3. Paving or stone should not simply be added to the growing medium at the perimeter as this:
  - a. May reduce the available height of upstands, **and**
  - b. Will not stop plants growing in the zone.

## 11.5.8 Testing of the waterproofing integrity

Waterproofing systems shall be tested prior to any green roof components being laid and at completion of the green roof to prove and demonstrate resistance to the passage of moisture.

Testing shall be completed in accordance with the 'Roofs - Flat Roofs' section and the following guidance.

No reliable method is available for testing the integrity of a green roof following application of the green roof components. Therefore the roof covering should be tested at completion to demonstrate waterproofing integrity before application of the green roof components. For guidance on testing of flat roof membranes, please refer to the 'Roofs - Flat Roofs' section.

Care should be taken to ensure that damage to the waterproof membrane does not occur during installation.

With extensive greening on certain warm roof systems, it may be feasible to use low voltage earth leakage, but any defects recorded will in any case involve removal of the green roof components. Therefore, it is strongly recommended to ensure the very highest possible standards of protection of the water proof membrane during the application of the green roof components.

This section provides guidance on meeting the performance requirements for fully supported single skin metal roof coverings and self supporting double skin metal roof coverings. Both systems may be defined as:

- Fully supported single skin metal roof coverings – This is where metal sheets (typical materials include zinc, copper, lead, or powder coated aluminium) are fully supported on either insulation or a deck. Throughout this section, these systems will be referred to as single skin metal roof coverings.
- Self supporting double skin metal roof covering – is either assembled on-site or off-site manufactured and consists of liner sheet, vapour control layer (VCL), spacer system, insulation, breather membrane and finished externally with top weathering sheet. They are often referred to as self-supporting double skin metal faced insulating panels or sandwich panels within the industry. Throughout this section, these systems will be referred to as double skin metal roof coverings.

### 11.6.1 Compliance

The specification and installation of metal deck roofing and their ancillary components shall meet the performance requirements of this section.

### 11.6.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

Where single skin metal roof coverings are proposed:

1. A detailed site specific design from either the manufacturer or the designer (see checklist within this section).
2. A third party product conformity certificate for the single skin metal roofing system where applicable.
3. Details of all materials to be used in the construction of a fully supported single skin metal roof including (but not limited to, the metal sheet, insulation, separation layers/membranes, vapour control layers, structural deck, ancillary components etc.).
4. In all circumstances, the fully supported single skin metal roof will need to be installed by an approved contractor who is recognized by the manufacturer as competent. Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty surveyor.

Where self supporting double skin metal roof coverings are proposed:

1. Details of all materials to be used in the construction of a double skin metal roof including (but not limited to, the metal sheet, insulation, separation layers/membranes, vapour control layers, support system, ancillary components etc.).

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 11.6.3 Material specification for single skin metal roof coverings

Single skin metal roof coverings and components used within the system shall be suitable for their intended purpose and the site specific conditions.

All metal sheet roof coverings should be of a suitable material specification and satisfy the following relevant standards:

- |                                                 |                                         |
|-------------------------------------------------|-----------------------------------------|
| ▪ Zinc and zinc alloys - BS EN 988 and CP 143-5 | ▪ Stainless steel - BS EN 508-3         |
| ▪ Copper - BS EN 1172 and CP 143-12             | ▪ Aluminium - BS EN 508-2 and CP 143-15 |

All products and components should be suitable for the intended purpose and have UKCA marking in accordance with UK Construction Product Regulations.

#### Zinc warm roof systems

Fully supported zinc warm roof systems, the product must have a third party product conformity certificate from a UKAS accredited body which covers the complete build-up and clearly details all of the components used.

The certificate should carefully be reviewed by all interested parties to ensure all of the conditions within the certificate are satisfied. Where materials or components have been substituted with alternatives not covered within the certificate, the build-up should not be accepted.

#### External environments

External metal sheets can degrade at a faster rate in coastal locations. In addition, certain chemically corrosive environments, such as sites in close proximity to manufacturing facilities such as chemical works, cement works, copper foundries or coal mines can also cause external metal sheets to degrade at a faster rate.

Where external metal sheets are used within a coastal location (as defined by 'Appendix B') or when they're used in chemically corrosive environments as specified above, a third party product conformity certificate from a UKAS accredited body must be available for the external metal sheet (for both warm and cold pitched roofs).

For the purpose of Warranty, the third party product conformity certificate must be made available to the Warranty surveyor prior to the selection of the system and explicitly state the product has been assessed for use in the environment it is intended to be used and it has at least a minimum life expectancy of 25 years.

In instances where the third party product conformity certificate does not explicitly state the metal sheets are suitable for use in the above environments, the product should not be specified within 5km of the coast or in chemically corrosive environments as it has not been assessed for use in that location.

Where external metal sheets are specified in the above environments, periodic cleaning may be necessary; and a man safe system should be included as part of the design to aid in the periodic cleaning. Advice should be sought from the external metal sheet manufacturer.

## 11.6.4 General design principles for single skin metal roof coverings

Single skin metal roof coverings shall be specified and installed to prevent interstitial condensation, underside corrosion and moisture ingress into the building.

### Avoidance of underside corrosion

All metal roofs are prone to underside corrosion (to varying degrees) by various means:

- Moisture becomes trapped between the metal and the supporting material.
- The use of incompatible materials.
- An inability for the product to develop a protective layer to the underside (Patina).

The following guidance covers how to mitigate the risk of underside corrosion occurring.

### Determination of internal humidity classes

For the purpose of Warranty, 'Humidity Class 3' should be adopted as the internal humidity class for a residential property. In all other instances, the guidance of the Humidity Class table should be used to determine an appropriate humidity classification.

| Humidity class | Building type                                                                                                |
|----------------|--------------------------------------------------------------------------------------------------------------|
| 1              | Storage areas.                                                                                               |
| 2              | Offices, shops, dwellings with low occupancy.                                                                |
| 3              | Dwellings with high or unknown occupancy.                                                                    |
| 4              | Sports halls, kitchens, canteens, school classrooms, hospitals, buildings heated with flue less gas heaters. |
| 5              | Special buildings (laundry, brewery, swimming pools).                                                        |

### Deck selection

Deck selection should be based on the humidity class of the building and should be the subject of a condensation risk analysis. For Warranty purposes, the boundary conditions for a condensation risk analysis should be as follows:

- 60% relative humidity.
- Internal temperature 21°C.
- External temperature -2°C.

Where external temperatures are considered to fall below -2°C due to exposure or geographical locations, lower temperatures should be used based upon climatic data within relevant standards.

Where the roof construction is effected by high vapour loads generated by bathrooms, kitchens etc, a condensation risk analysis should be based on these worst case scenarios, which may see an increase to relative humidity levels and internal temperatures.

### Separation layers and low resistance membranes

For the purpose of Warranty, separation layers and Type LR membranes specified in the site specific design must:

- Be as per the system manufacturer's recommendations.
- Where applicable, align with products that are set out within the third party product conformity approval certificate.
- Not be substituted and they should be subject to strict on-site quality assurance measures, which should include but not limited to, verification of product specification.

Separation layers are employed to avoid the metal sheet roof covering from sitting directly on the supporting material. Underside corrosion can manifest itself where either incorrect membranes have been specified, or the correct membranes have been specified but they've been substituted for an inferior product post design approval.

Low resistance (Type LR) membranes, also referred to as 'breather membranes' will be employed in between insulation layers and any ventilated void serving the underside of the material supporting the metal roof covering. Due to the opportunity for increased temperatures created within ventilated voids inherent of the metal roof covering, any breather membrane specified must be tested for use within metal roof covering build-ups.

### Air and Vapour Control Layer

As moisture can accelerate the onset of corrosion to unprotected metal sheets, this creates an increasing importance on the arrangement of vapour control layers within the built element in controlling this risk. Many fully supported metal roofing systems use a product specific air and vapour control layer (AVCL) to reduce this risk so particular attention should be paid to the correct and system specific requirements in this area.

AVCL's should always be on the warm side of the insulation. For continuity of detailing, typically the use of self-adhesive aluminium foil backed modified bitumen membranes is predominant within manufacturer's guidance literature with specific termination detailing for penetrations, etc.

For the purpose of Warranty, the Air and Vapour Control Layer (AVCL) should be strictly in accordance with the third party product conformity certificate and have a minimum vapour resistance between 5000-7000 MN.s.g. All detailing should be strictly in accordance with the manufacturer's guidance literature.

### Compatibility of materials

Underside corrosion can also be caused by incompatible materials being specified together. The table below shows which metals **should not** be used together.

|                        | Al | Pb | Cu             | Zn | S.S | G.S              |
|------------------------|----|----|----------------|----|-----|------------------|
| Aluminium (Al)         | ✓  | ✓  | X              | ✓  | ✓   | ✓                |
| Lead (Pb)              | ✓  | ✓  | ✓              | ✓  | ✓   | ✓                |
| Copper (Cu)            | X  | ✓  | ✓              | X  | ✓   | X <sup>1,2</sup> |
| Titanium Zinc (Zn)     | ✓  | ✓  | X              | ✓  | ✓   | ✓                |
| Stainless Steel (S.S)  | ✓  | ✓  | ✓              | ✓  | ✓   | ✓                |
| Galvanised Steel (G.S) | ✓  | ✓  | X <sup>2</sup> | ✓  | ✓   | ✓                |

<sup>1</sup> Steel hollow rivets are not compatible when used externally.  
<sup>2</sup> Galvanic copper plating of galvanised components can increase corrosion development; they do not provide corrosion protection.

It's important to consider both direct contact and surface run off from incompatible materials; for example with the use of rain water goods. If the use of incompatible materials cannot be avoided, they should be separated from each other by either non-conducting, non-metallic isolators (e.g. seals and grommets in fixing systems) or coated with compatible or inert materials.

Timber treated with certain types of preservative, particularly of copper-chrome-arsenic formulation, can cause corrosion of zinc, carbon steel and aluminium in contact with the timber. As such, external metal sheets supported on any timber deck such as plywood must have a factory applied coating specified and be separated from the timber deck by a compatible separation membrane as specified by the system manufacturer.

In addition to the incompatibility issues highlighted above, external metal sheets can also be susceptible to incompatibility issues with other common materials. Zinc for example may be incompatible with materials such as, bituminous membranes, mortar and building paper.

In all situations, the metal sheet manufacturer should be consulted with regards to incompatible issues and this should be highlighted in the site specific design.

### Permitted build-ups

For the purpose of Warranty, the use of fully supported single skin metal roof covering are not permitted in a cold flat roof build up.

In all other instances, a site specific design should be provided as early as possible so it can be reviewed by the Warranty surveyor before any works to the roof covering is started. A checklist is present within this section highlighting the areas the site specific design must cover as a minimum for our Warranty purposes.

All designs should follow best practice as per the guidance available within the UK Guide to Good Practice in Fully Supported Metal Roofing and Cladding, published by the Federation of Traditional Metal Roofing Contractors (FTMRC).

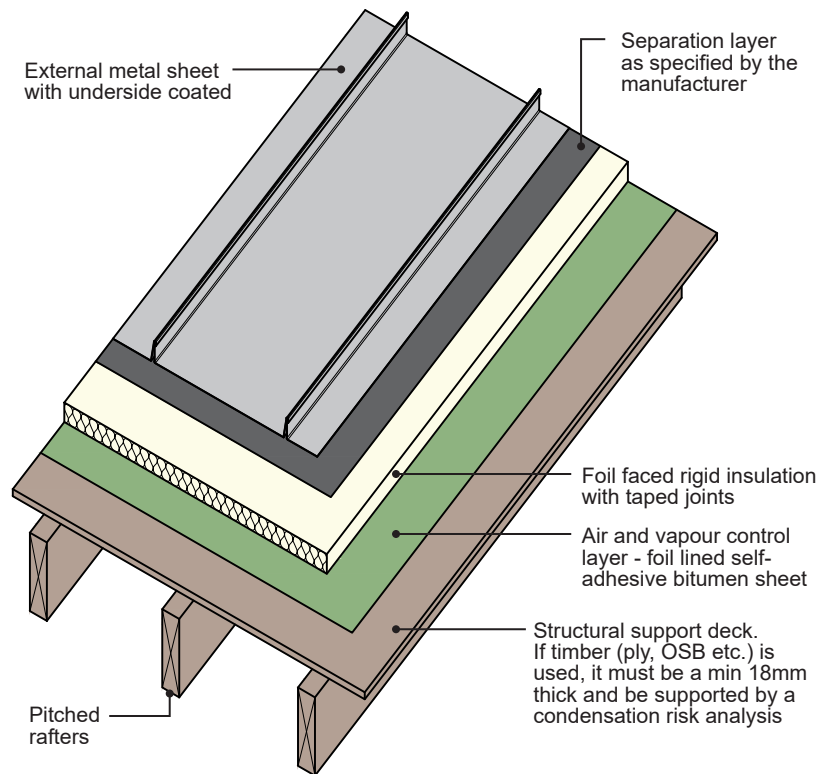
The following illustrations and associated narratives are given only as guidance to typically employed build-ups.

## Warm non-ventilated roof – pitched or flat

Constructed without ventilation provision, the warm deck roof relies on the moisture resistant properties of the fully sealed AVCL that sits beneath the insulation. It is critical that this layer is as specified in the system manufacturers' guidance, with its integrity remaining undamaged during construction.

Any fixings from layers above must be fully considered in design with provisions for sealing penetrations, as untreated, they may give risk to moisture transfer and increase the risk associated with interstitial condensation and a premature failure of both the external metal sheet and supporting material.

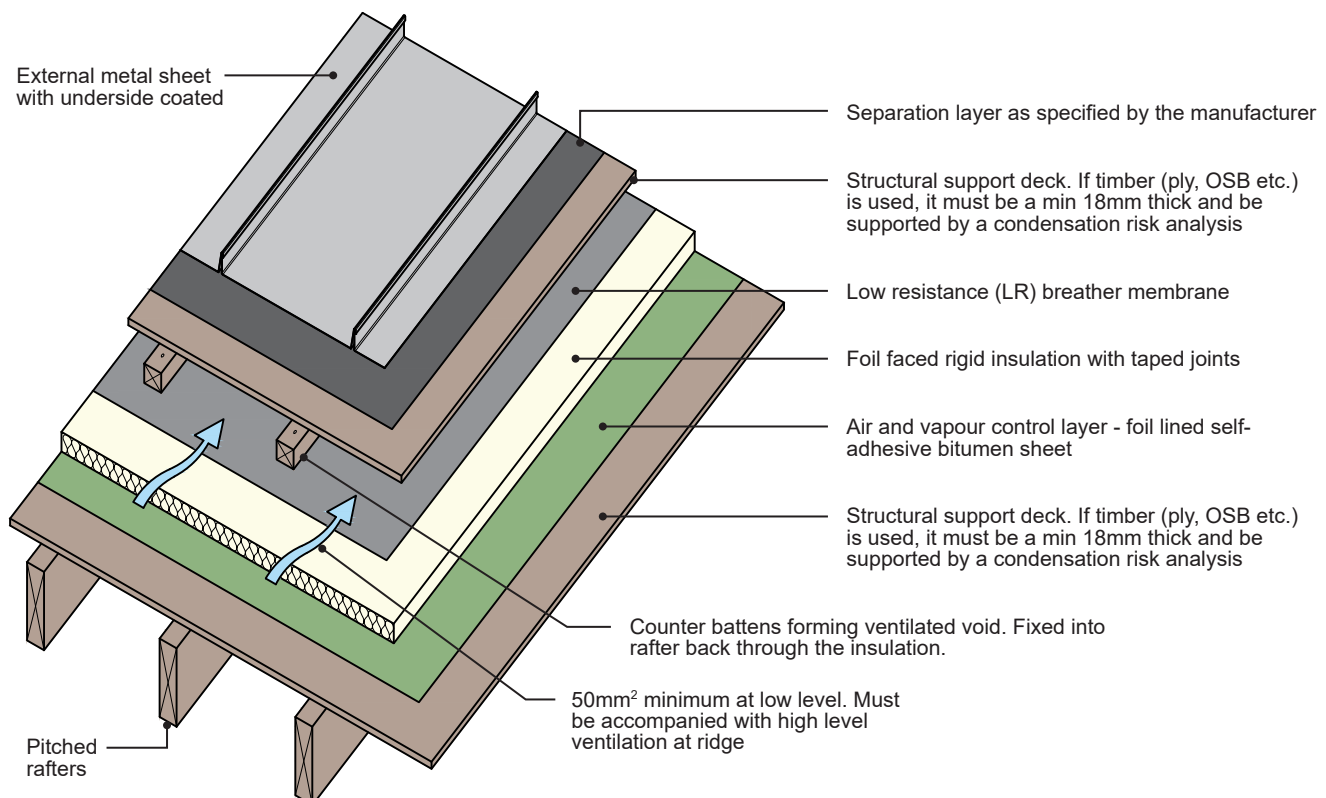
Mechanical fasteners should be avoided above conditioned spaces with high humidity e.g. swimming pools, gymnasiums. This approach, subject to an appropriate supporting site specific design, may be employed on both flat and pitched roofs.



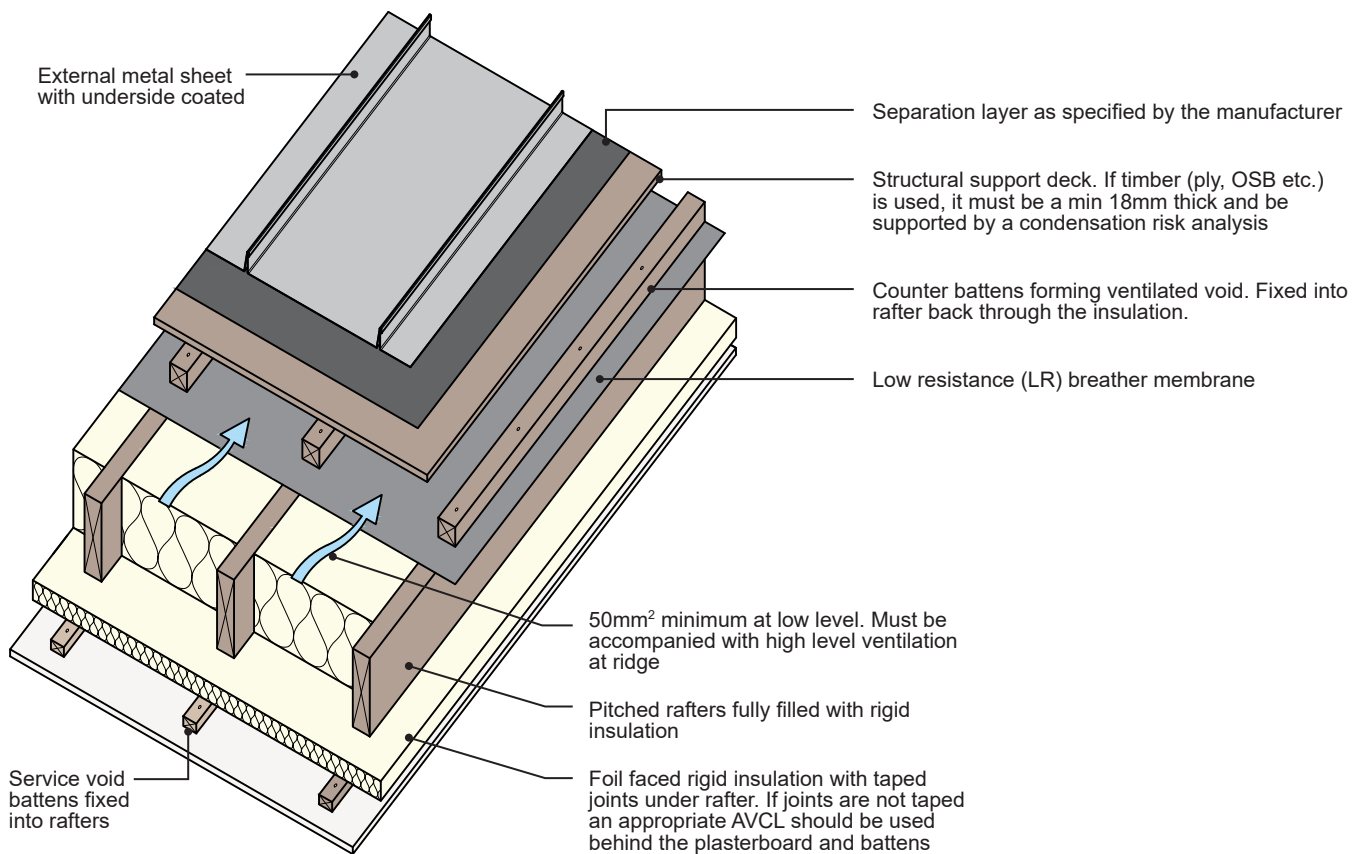
## Ventilated warm roof

The ventilated warm roof arrangement incorporates a well-sealed AVCL directly on top of the structural deck and a well ventilated void between the supporting board to the underside of the external metal sheet and the overlying low resistance breather membrane layer.

This ventilated roof void allows for any moisture escaping through the fabric to be expelled by a cross flow of air. The span of the roof should be considered when using this approach as larger spans will require an increase to the void depth and eaves ventilation provisions.

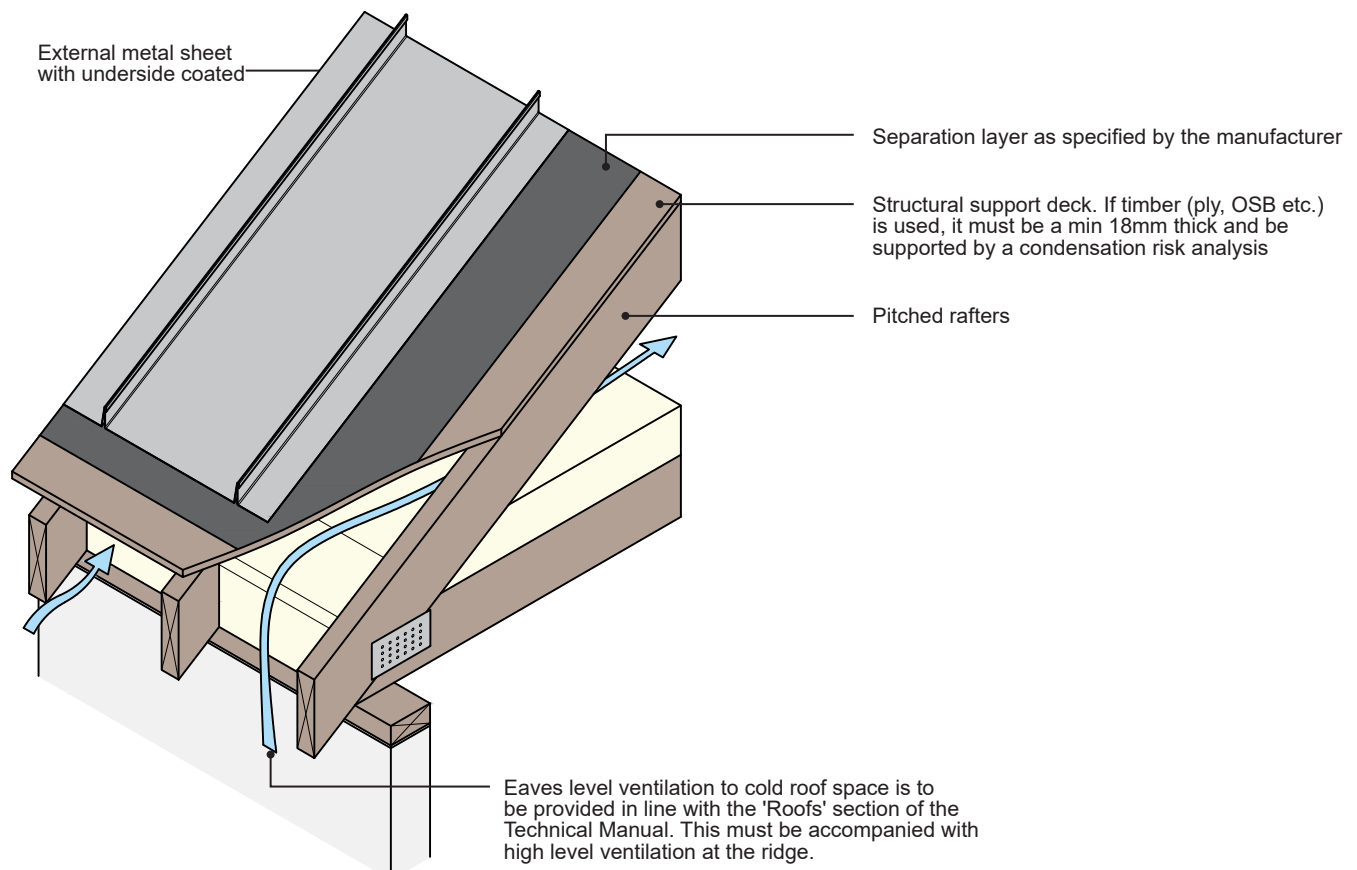






### Cold ventilated pitched roof

The cold pitched roof arrangement requires ventilation at low level and at high level as per guidance in the 'Roofs' section, as the timber deck prevents any warm air escaping.



## Other considerations

### Fire classification

The entire system (not just the external metal sheet) should be assessed to meet the requirements of the Building Regulations, Approved Document B in England and Wales. In particular, the entire system must meet B4 of Approved Document B.

### Deck exposure during construction

Any membrane applied during construction that is left open should be capable of resisting moisture penetration. In the event that a LR membrane is used, the deck should be assessed in relation to its moisture content before any further layers of building fabric are applied. Moisture content of timber boarding should not exceed 20% at point of roof covering being applied.

### Ply bonded on insulation

Ply or timber topped insulation should not be a site formed configuration. Ply or timber topped insulation boards must be produced in a controlled factory environment which holds all the necessary accreditation for production and has a demonstrable quality control procedures to ensure they are fit for purpose. Such documentation may be requested by the Warranty surveyor to prove and demonstrate the above is achieved.

The overall performance of such insulation boards, inclusive of structural capabilities, compatibility and durability should be subject to assessment utilising suitable third party product conformity certificate as a minimum.

### Expansion

If timber such as plywood is used for the structural support deck, movement gaps should be considered for square edged boards at rigid upstands and between boards. A minimum gap of 3mm needs to be maintained between boards and 10mm with rigid abutments.

## Checklist for manufacturer's site specific design for single skin metal roof coverings

As a minimum, the site specific design should include all of the following points:

- The site specific design must reference a third party product conformity certificate for the complete system, not only individual components to confirm this has been reviewed in line with our Warranty requirements. Please note, this is not applicable where we do not require a third party product conformity certificate.
- The location of the development must be reviewed - if the location is a chemically corrosive environment (as described within this section), reference should be made to the third party product conformity certificate confirming it is suitable for use with a minimum life expectancy of 25 years.
- The manufacturer should be consulted with regards to the site specific fixing specification for the external metal sheets.
- Roof build up needs to be detailed to be aligned with the third party product conformity certificate (where applicable) for the complete system, not only individual components.
- A list of components to be used needs to be provided and any incompatible components should be clearly highlighted. Details for methods of separation between incompatible materials (location, type and method of fixing) must be specified.
- Details of protective coating applied to the underside of the external metal sheeting needs to be highlighted (type and thickness of coating). Protective coatings must be factory applied.
- Air and Vapour control layers (AVCL's) should have a minimum vapour resistance of 5000-7000 MN.s.g. This must be detailed in the site specific design.
- A condensation risk analysis must be provided with reference to the humidity class used.

### 11.6.5 Specification for double skin metal roofing

Double skin metal roof coverings shall be of a suitable material specification and be suitable for their intended purpose and the site specific conditions.

Double skin metal roof coverings should be specified and installed in accordance with:

- BS 5427 Code of practice for the use of profiled sheet for roof and wall cladding on buildings
- BS EN 14782 Self-supporting metal sheet for roofing, external cladding and internal lining. Product specification and requirements
- BS EN 14509 Self-supporting double skin metal faced insulating panels — Factory made products — Specification
- BS EN 508 — Parts 1, 2 and 3 Roof and cladding products from metal sheet. Specification for self-supporting products of steel, aluminium or stainless steel
- BS EN 506, for self-supporting copper and zinc
- BS EN 1991-1-1, 3 and 4 for structural loads and be fixed in accordance with the manufacturer's instructions

Components for a double skin metal roof covering system should be in accordance with the system manufacturer's specification. Components should not be changed on-site or by the designer without prior agreement from the system manufacturer.

Top weathering sheets are generally secret fixed onto clips or standing seam sheets onto halters, these being machine seamed once fixed. Pierce fixed sheets are still widely used, which are fixed directly to the spacer system with external visible fixings.

Liner sheets can be solid or perforated to give an acoustic, sound-deadening roof. They are fixed directly to purlins, and can act as a VCL if a separate vapour barrier is not specified. If the liner is not used as a VCL, a reinforced vapour control sheet should be incorporated within the roof.

Insulation must be installed between the VCL and the top weathering sheet; some systems may require ventilation above the insulation and others may not; it varies from manufacturer to manufacturer. Where there is no requirement to ventilate, the insulation should be compressed slightly to ensure that there are no air voids where condensation may occur.



### 11.6.6 Workmanship and installation requirements for double skin metal roof coverings

Double skin metal roof coverings shall be installed in accordance with the manufacturer's recommendations.

#### Top weathering sheets

Ensure that the top weathering sheets are installed in accordance with the manufacturer's instructions.

These must be long enough to discharge into the gutter correctly and allow for an eaves angle if required by the system.

Check that end and side lap tape sizes conform to the manufacturer's requirements.

For pierce fixed trapezoidal sheets, check for tell tales to end laps and side laps for the correct number of rows of tape.

#### Liner sheets

Where the liner sheet is solid and used as a vapour check, note the following:

- Frequency of main fixings to purlins and frequency of side lap stitchers.
- End laps to be sealed with mastic tape; check the size and that this is continuous. Side laps have a wider 50mm Polyband tape placed from the inside so this is visible from above.
- Check for cuts or splits in this metal liner.
- Ensure that to eaves and ridge the correct filler blocks have been used, bedded in mastic; if necessary, a closure flashing must be used from the crown of the sheet to the wall junction to maintain a vapour check. Check the use of sealant tapes and fire-retardant foam.

#### Separate air and vapour control layer (AVCL)

This should be a reinforced sheet, and is used to ensure a more positive air seal around the perimeter of the building. The AVCL should be sealed in the field area with the correct tape, with the number of rows dependent on the application. Check the integrity of these tapes and that they are continuous and correctly joined. Where the vapour check abuts the walls to the verge or eaves, it must be properly sealed in accordance with the Architect's detail. Around penetrations, the vapour check must be cut and sealed to any pipes or upstands.

The spacer system is fixed through the vapour check and liner into the purlins. The spacer system will have a soft sealing pad to ensure the vapour check is maintained around the fixing. Check for punctures of the vapour check by foot traffic or damage, and patch as required.

#### Insulation

Check the packaging to ensure that the correct thickness is being used if one layer is used, or a combination of thicknesses to give the correct specified thickness. For two thicknesses or more, check that all joints are staggered and check the Lambda value against the specification.

Ensure that no packaging or debris is left in the roof void prior to or during the installation of the insulation. The insulation should fill the void or be compressed into the void; there should be no slumping or gaps and it should be packed into voids at the junctions of the ridge and verge.

With standing seam roofs, a rigid mineral slab insulation should be placed at eaves, ridge and around all penetrations and walkways to support the vulnerable areas of the roof, which will give a solid support to the roof sheet pans. This is easy to see during construction and easily felt on completion. The supported pan of the sheet feels solid to walk on.

#### Support system

Check the frequency of brackets against the specification and the number of fixings per bracket, and that they are the correct type of fixing. With standing seam roofs, the halter may be fixed with a stainless steel fixing, check the type and frequency of fixing. Check the orientation of the halter in relation to the lay of the sheet, i.e. will they pick up the seam, as there is a right and wrong way round for halters.

Manufacturers provide halter templates to set out halters, and there must be one on-site to obtain the correct gauging of the halters.

#### Roof penetrations

These must be sealed to maintain the AVCL. Where the liner is used as a AVCL, the metal-to-metal junction must be sealed with fire-retardant foam. With a separate AVCL, this must be sealed to the upstand or pipes with the appropriate tape. Externally with aluminium roof sheets, the junctions with penetrations should be site welded or weathered using glass reinforced plastic (GRP) in-situ weathering.

#### Roof lights

Standing seam roof sheets are usually on separate insulated upstands. With pierce fixed trapezoidal roof sheets, roof lights are in line, either factory or site assembled. Ensure that the correct size of tape is used, check the number of rows of tape that are required and that side lap tapes are not twisted by fasteners.

#### General

Check surface finishes for abrasions, dents and cuts, and that the roof has not been used as a cutting surface for flashings or other metal. Hot swarf from angle grinders burns into the plastisol coating of steel sheets, marks aluminium and rapidly turns to rust. Flashings should have sufficient overlap or butt straps, 150mm wide, and be sealed and supported. Check the frequency of fixings and that they are of the correct type.

## Factory assembled units

---

Where factory assembled units are used, the following should be checked:

### Fixings

There may be a requirement for stainless steel fixings to be used. Check by inspecting boxes and use a magnet; drill points will be magnetic only. Check fixings are suitable for the purlin type - steel, light gauge cold rolled, heavy gauge or timber - as all fixings are different.

Check the bearing area of the purlin; if the building is not square, the sheets will run out and the end lap detail will not be supported. This can be overcome by using a galvanised support that is fixed to the purlin and which supports the end lap.

Check that the right number of fixings has been used for the panel and the frequency of side lap stitchers; ensure that they are side lap stitchers and not main fixings.

### Sealant tapes

Check the number of rows required by the manufacturer of the panel for end laps. Tell tales should be visible at side laps of each sheet. Tell tales are the ends of the mastic tape run that can be seen or must be felt for at the side of each sheet. The same applies to side laps; there should be a tell-tale at the end of the sheet. Use the end of a hacksaw blade to locate the rows of mastic tape.

On roof lights, mastic tape is visible; check its location, that its size complies with the manufacturer's requirements and that there are the correct number of rows. Tape should not be twisted by the fixings.

### Air tightness

There must be a supply of gun foam, fire rated, at roof level for filling in voids before flashings are fixed. If there is not one on site, air tightness and maintaining the insulation cannot be fully achieved.

The use of foam needs to be inspected during the course of construction, and internal tapes to eaves and ridge purlins need to be inspected for size and position. At the ridge, the gap between panels needs to be filled with foam to maintain the insulation and prevent condensation forming. There also needs to be a suitably sealed inner ridge.

Verge details are difficult and it may be necessary for an internal verge to be cut and sealed around purlins. Check sealant tapes and the use of gun foam to maintain insulation. The manufacturer's details may not be achievable, but an alternative must be devised to maintain air tightness. A degree of confidence in this requirement should be shown on-site as an indication of the importance of air tightness and how this can be achieved.

### Gutter junctions

If parapet or valley gutters are being used, check the air seal at the junction of the two. Gutter joints are not always level, and any gaps have to be filled. This will not only prevent wind-driven rain from entering the building, but will also maintain an air seal.

Check that roof sheets are oversailing into the gutter correctly.

### Roof penetrations

Penetrations such as flues, vents, upstand-type roof lights and sun tubes need to be sealed internally, the insulation being maintained with site-applied foam. Externally, upstands must be weathered correctly and, with steel composite sheets, this is best achieved using GRP in-situ weathering.

### General

Check surface finish for cuts and abrasions.

Check that the roof has not been used as a cutting surface for flashings or other metal. Hot swarf from angle grinders burns into the plastisol coating and rapidly turns to rust.

Flashings should have a sufficient overlap and be sealed and supported. Check the frequency of fixings and that they are of the right type. Check for closure from gutters and sheet oversails. There should be suitable shrouds to prevent birds or vermin from getting into the building, which can be often overlooked.

## Inspection checklist for double skin metal roof coverings

| Component/Inspection                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Rectification needed |    | Comments     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----|--------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Yes                  | No |              |
| <b>Check bearing width of purlin.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                      |    |              |
| <b>Check minimum overlap of linear decking sheets:</b> <ol style="list-style-type: none"> <li>1. Light gauge steel</li> <li>2. Hot rolled steel</li> <li>3. Timber - check for minimum penetration</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                      |    |              |
| <b>Check that side laps are stitched at the correct centres.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                      |    |              |
| <b>Vapour control checks using the liner:</b> <ol style="list-style-type: none"> <li>1. Check tape to side laps, minimum width 50mm air and moisture barrier tape</li> <li>2. Check tape to end laps</li> <li>3. Check inner fillers to ridge, eaves and verge</li> <li>4. Check for sealing around the perimeter with fire-resisting foam</li> </ol>                                                                                                                                                                                                                                                                                                                                                   |                      |    |              |
| <b>Vapour control checks using a separate VCL:</b> <ol style="list-style-type: none"> <li>1. Check the minimum overlap is correct</li> <li>2. Check for the correct sealant tape</li> <li>3. Check for the correct number of rows of sealant tape</li> <li>4. Check junctions between VCL and building elements, e.g. upstands, eaves, verge, etc.</li> <li>5. Check for puncture and repair where necessary</li> </ol>                                                                                                                                                                                                                                                                                 |                      |    |              |
| <b>Spacer systems:</b> <ol style="list-style-type: none"> <li>1. Check for correct height of bracket or halter</li> <li>2. Correct number of fixings per bracket or halter</li> <li>3. Check for stainless steel if specified</li> <li>4. Check for gauging of halters for standing seam and secret fix roof sheets</li> </ol>                                                                                                                                                                                                                                                                                                                                                                          |                      |    | Use a magnet |
| <b>Insulation:</b> <ol style="list-style-type: none"> <li>1. Check that the correct thickness is being used</li> <li>2. Check that insulation is the correct type and has the same properties as specified</li> <li>3. Check for compression</li> <li>4. Check that insulation joints are staggered</li> <li>5. Ensure that insulation designed to support load has been correctly installed to eaves, ridge, penetrations and walkways</li> <li>6. Ensure all packaging and debris is removed prior to fitting of the roof sheets</li> </ol>                                                                                                                                                           |                      |    |              |
| <b>Breather membranes:</b> <ol style="list-style-type: none"> <li>1. Ensure the membrane is laid in the correct direction and in accordance with the manufacturer's instructions</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                      |    |              |
| <b>Roof sheets - standing seam and secret fixed:</b> <ol style="list-style-type: none"> <li>1. Check that sheets are long enough so that water effectively drains into the gutter</li> <li>2. Check the direction of lay of sheets in relation to the direction of the prevailing wind</li> <li>3. Check eaves detail, including eaves drips and fixing, in accordance with the manufacturer's details</li> <li>4. Check ridge detail, including turn up fillers and ridge dams, in accordance with the manufacturers details</li> <li>5. Check verge detail and adequacy of support for cut sheets</li> <li>6. Check flashing supports, sheet/verge flashing seals and frequency of fixings</li> </ol> |                      |    |              |

| Component/Inspection                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Rectification needed |    | Comments            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----|---------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Yes                  | No |                     |
| <b>Roof sheets - pierced fixed:</b> <ol style="list-style-type: none"> <li>1. Check overlap dimension</li> <li>2. Check end lap tape and correct number of rows of tape</li> <li>3. Check for side lap tape</li> <li>4. Check quantity of fixings per sheet per purlin</li> <li>5. Check washer size of main fixings and side lap stitchers</li> <li>6. Check frequency of side lap stitchers</li> <li>7. Inspect for correct tightening of main fixings and side lap stitchers</li> </ol>                                                                                                                                                                                                                                                                                                   |                      |    |                     |
| <b>Penetrations for vents, sun pipes etc.</b> <p><b>A - Aluminium sheets:</b></p> <ol style="list-style-type: none"> <li>1. Check sheets are site welded and area post coated where colour sheets are used</li> <li>2. Check that the VCL and breather membrane are maintained around the welded area</li> <li>3. Check upstands are at least 150mm</li> </ol> <p><b>B - Steel sheets:</b></p> <p>Ideally use GRP in-situ weathering flashings; however, if folded flashings are used, check:</p> <ol style="list-style-type: none"> <li>1. Overlap</li> <li>2. Sealing and fixing of overlaps</li> <li>3. If a flat sheet back to the ridge is used, check for insulation under the sheet</li> <li>4. Check frequency of fixings</li> <li>5. Check sealing of overlapping sheets</li> </ol> |                      |    |                     |
| <b>Flashings:</b> <ol style="list-style-type: none"> <li>1. Check end overlap</li> <li>2. Check frequency of fixings</li> <li>3. Check correct type of fixing is used</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                      |    |                     |
| <b>General:</b> <ol style="list-style-type: none"> <li>1. Check roof surface for cuts and abrasions</li> <li>2. Check for hot swarf damage</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                      |    |                     |
| <b>Panel laps to be tight when viewed from inside the building.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                      |    |                     |
| <b>Constant straight line on side laps to be achieved.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                      |    |                     |
| <b>Fasteners correct for the purlin:</b> <ol style="list-style-type: none"> <li>1. Light gauge steel</li> <li>2. Heavy gauge steel</li> <li>3. Timber</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                      |    |                     |
| <b>Fastener material:</b> <ol style="list-style-type: none"> <li>1. Coated carbon steel</li> <li>2. Stainless steel</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                      |    | Check with a magnet |
| <b>Fastener frequency main roof:</b> <ol style="list-style-type: none"> <li>1. Main fixings</li> <li>2. Side lap stitchers</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                      |    |                     |
| <b>Fastener frequency roof lights:</b> <ol style="list-style-type: none"> <li>1. Main fixings</li> <li>2. Side lap stitchers</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                      |    |                     |

| Component/Inspection                                                                                                                                                                                                                                                                                                                                                                 | Rectification needed |    | Comments                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----|-------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                      | Yes                  | No |                         |
| Bearing area of purlin at end lap; is a supporting bearing plate required?                                                                                                                                                                                                                                                                                                           |                      |    | Is the building square? |
| <b>End laps:</b> <ol style="list-style-type: none"> <li>1. Correct number of rows of joining tape</li> <li>2. Correct size of end lap tape</li> <li>3. Correct position of end lap tape in relation to fixing</li> </ol>                                                                                                                                                             |                      |    |                         |
| <b>Roof light tape positions:</b> <ol style="list-style-type: none"> <li>1. Correct number of rows of joining tape</li> <li>2. Correct size of end lap tape</li> <li>3. Correct position of end lap tape in relation to fixing</li> </ol>                                                                                                                                            |                      |    |                         |
| Is the roof adequately air tight (visual inspection and air tightness test where necessary)?                                                                                                                                                                                                                                                                                         |                      |    |                         |
| <b>Provision of fire-retardant gun foam:</b> <ol style="list-style-type: none"> <li>1. Eaves level</li> <li>2. Verges</li> <li>3. Gutters</li> <li>4. Internal verge positions</li> <li>5. Foam insulation at ridge</li> </ol>                                                                                                                                                       |                      |    |                         |
| <b>Gutter junctions:</b> <ol style="list-style-type: none"> <li>1. Adequacy of seals at gutter junctions</li> <li>2. Correct provision of weir overflows to gutter runs</li> <li>3. Correct junction detail between gutters and verge flashings</li> <li>4. Gaps sealed to prevent vermin infestation</li> <li>5. Correct discharge of water from roof sheets into gutter</li> </ol> |                      |    |                         |
| <b>Roof penetrations:</b> <ol style="list-style-type: none"> <li>1. Check seals around cut foam insulation internally</li> <li>2. Check internal flashing closures</li> <li>3. Check weather penetrations externally</li> </ol>                                                                                                                                                      |                      |    |                         |
| <b>Flashings:</b> <ol style="list-style-type: none"> <li>1. Check end overlaps</li> <li>2. Check frequency of fixings</li> </ol>                                                                                                                                                                                                                                                     |                      |    |                         |
| <b>General:</b> <ol style="list-style-type: none"> <li>1. Check roof covering for cuts and abrasions</li> <li>2. Check for hot swarf damage</li> </ol>                                                                                                                                                                                                                               |                      |    |                         |

### 11.6.7 Approved installers

The installation of single skin and double skin metal roof coverings shall be completed by an installer who is approved by the manufacturer.

Due to the complex nature of external metal sheet roofing, we require the installer to be approved by the manufacturer.

Where the manufacturer doesn't retain a list of approved installers, evidence should be provided showing the installer is competent and trained with external metal sheet roofing.

## Introduction

This section provides guidance on meeting the performance requirements for the following applicable situations:

### Blue roofs

A roof design that is explicitly intended to store rainfall temporarily at a level not exceeding the designed hydraulic head, for a defined period of time above a thermally conditioned space.

### Blue podium decks

A deck design that is explicitly intended to store rainfall temporarily at a level not exceeding the designed hydraulic head, for a defined period of time above a thermally unconditioned space.

Throughout this section, we will refer to the term blue roofs which covers both of the above situations.

Blue roof systems manage rainfall by temporarily attenuating rainfall at a controlled predetermined rate and capacity before discharging into the rainwater sewers. Blue roofs may be classified as either 'Active' or 'Passive' depending on the types of control devices used to regulate drainage of water from the roof and overflows. For the purposes of Warranty, passive systems are the preferred approach. An active or smart approach may be reviewed on a case-by-case basis.

## Limitations of this guidance

- For Warranty purpose, where insulation is required, 'cold deck' applications are not an acceptable approach in any circumstance in the design of above ground attenuation surfaces such as blue roofs.
- Blue roofs used in conjunction with green roof finishes can be acceptable. In these situations only, the green roof build-up may be considered as part of the attenuation storage where the percolation rate is known. However, the attenuated water must not exceed the designed head of water.
- Loadings applied must be checked and approved by the Engineer for the design and deflected form of the roof or podium slab.
- When designing reinforced concrete roofs or decks, the total loading must be carefully checked and approved by the Engineer. The maximum head of water allowable for Warranty purposes is 100mm (1.0kN.m-2), equivalent to about 60mm of water or a minimum snow load of 0.6kN.m-2.
- Inverted Blue roofs where water storage is layered below the insulation and the waterproofing are not encouraged as they will have to withstand potential buoyancy up thrust. This may restrict the depth of insulation which can be used as, a ballast weight of 1.0 kN.m-2 is required for every 100mm thickness of insulation (in addition to the water loading).
- Inverted insulated roofs will require additional insulation to satisfy Building Regulation requirements through reduction of thermal performance of the insulation due to saturation and the cooling effect of water at the waterproofing layer.
- This guidance is not intended as a standalone design guide and does not include full details of what must be considered to comply with other associated design guides.
- All proposals for above ground attenuation surfaces are considered on a case by case basis due to the developing nature of guidance available.

### 11.7.1 Compliance

The design, specification and construction of blue roofs shall meet the performance requirements of this section.

### 11.7.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Written demonstration that all other retention and within-site attenuation and release strategies have been explored before a blue roof has been proposed.
2. A clear indication of the usage for the roof or deck surface along with its possible future use.
3. A full set of detail drawings, including:
  - a. A full set of section details detailing each proposed build up for the above ground attenuation layers and blue roof areas and junctions with adjoining structures.
  - b. GA plan details for each above ground attenuation surface areas, noting build up types if these vary.
  - c. Waterproof membrane threshold detailing linked back to damp proof course which is to be 150mm above the datum of the highest level of attenuated water proposed in all circumstances.
  - d. Detail for pipe penetrations through wall and floor and detail showing 150mm waterproofing upstand around penetrations which is to be 150mm above the datum of the highest level of attenuated water proposed in all circumstances.
  - e. Details of locations of any fixings into slab.
  - f. Details showing waterproofing upstand around penetrations which is to be 150mm above the datum of the highest level of attenuated water proposed in all circumstances.
  - g. Details of large obstructions such as planters, M&E equipment or similar and method to ensure water is diverted around these obstructions where applicable.
  - h. Details showing location of movement joints proposed.
4. Engineers design philosophy statement including but not limited to calculation of substrate deflection, design wind loads, supply of long-term deflection gradient drawings and required installation tolerances. The design team must also collaborate with the drainage consultant to demonstrate clearly that ponding or back falls will not occur.

- Full details of component products used, including details of a third party product conformity certificate for all components of the all elements of complete proposed waterproofing and drainage system.
- Drainage design drawings and peak flow calculations showing position of outlets and provision of overflows. Overflows should be clearly visible to warn of potential blockages in the drainage system.
- Details of access and repair plan from the building management to address how remedial works could be undertaken in the event of a defect.
- Details of proposed maintenance strategy, including an undertaking from the building management to ensure that frequent maintenance to the above ground attenuation surfaces are evidenced to be implemented.
- A condensation risk assessment through the roof, or otherwise demonstrate how the risk of condensation will be limited.
- All installers must have a demonstrable history of installing blue roof systems. Evidence of this must be provided to the Warranty surveyor.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

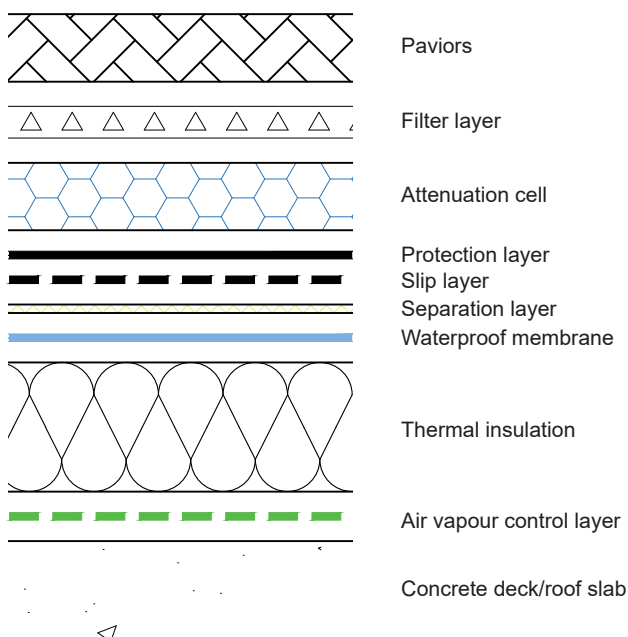
### 11.7.3 General design

The design and construction of blue roofs shall be appropriate for the intended use.

The design of a blue roof should be one of the following forms of construction.

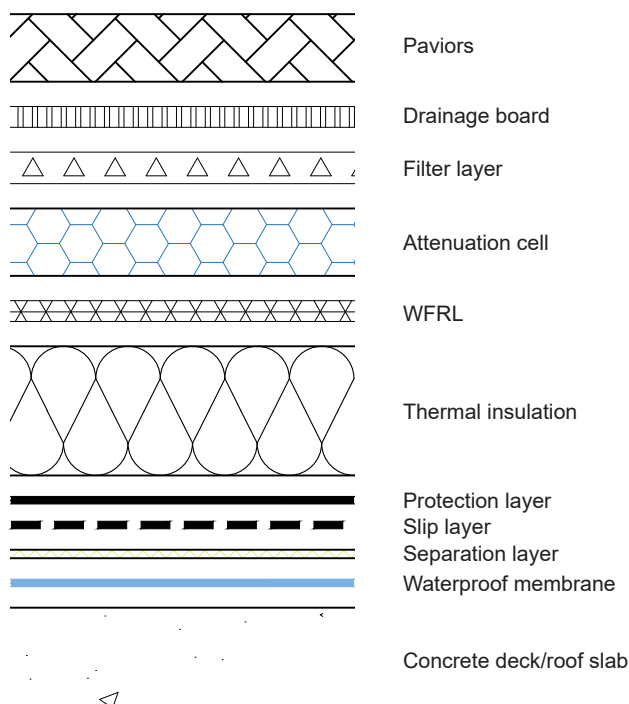
#### Blue roof (warm) – Layering

The principal thermal insulation is placed immediately below the roof covering, resulting in the structural deck and support being at a temperature close to that of the interior of the building. Follow on layers are subsequently placed on the waterproof membrane to form a blue roof system.



#### Blue roof (inverted) – Layering

The waterproofing membrane is laid directly onto the deck with follow on layers subsequently placed on the waterproof membrane to form a blue roof system. The principal thermal insulation sandwiched between the layers of the blue roof system and which is then secured by separate ballast.



### General design principles

A "Roof First, Attenuation Second" approach must be taken by the design team. In all instances, all aspects of the design are to satisfy the 'Roofs' section. In addition, the following will also apply:

- Blue roofs should half empty in no more than a 12-hour period from the end of the specified design storm, AND should manage water for no more than a 24-hour period from the end of a 1:100 year storm profile for the roof (+40% minimum factor for climate change).
- A warm roof to falls is encouraged to avoid the risks associated with flotation in an inverted warm blue roof.
- There must be a concealed void to contain the designed attenuation capacity of storm water.
- Rainfall at the exposed surface level must be managed to ensure that it does not accumulate or pond water on the final finishes.
- There must be a multidirectional flow path above the waterproofing membrane, for water to reach the drainage points.
- All component materials and products used for a Blue roof system must include a recognised third party product conformity certificate or other harmonised European Standard.
- Flotation risk for inverted roofs should be calculated and addressed by providing loading to the insulation such that it cannot become buoyant.
- Visible overflows must be provided in every instance.
- The design must ensure provisions for access for maintenance and repair to critical components of the blue roof system.



For the design of a blue roof, it is recognised that other associated technical standards are available and may be used by designers to establish general principles not covered within this section. Where those standards contradict the guidance within this section, the position of the Warranty provider will take precedence unless otherwise agreed.

The guidance within this section should be followed in conjunction with guidance on: continuous membrane roofing, green roofs, podium decks and drainage.

## Blue roofs and basements

If the space beneath the Blue Roof is situated below ground level, the design may require to be coordinated alongside a CSSW qualified structural waterproofing specialist. Please refer to the 'Waterproofing Below Ground Storeys and Structures' section for further guidance.

### Associated principles

- The principles of BS 6229 Flat roofs with continuously supported flexible waterproof coverings - Code of practice: are to be applied to waterproofing of roof and deck slabs to ensure water ingress does not occur.
- BS 8102 – Code of practice for protection of below ground structures against water ingress Code of Practice to be applied to ensure continuity of waterproofing at junctions with below ground construction.

### 11.7.4 Structural design requirements

Flat roof structures shall be designed and constructed so that all loads are sustained and transmitted to supporting structure(s) without causing instability, deflection or deformation. Factors to be considered are:

- |                                                                                                                                        |                                                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>▪ Wind loading.</li> <li>▪ Dead and imposed loading.</li> <li>▪ Structural movement.</li> </ul> | <ul style="list-style-type: none"> <li>▪ Openings and penetrations.</li> <li>▪ Fixing/attachment of ancillary structures and plant or equipment.</li> </ul> |
|----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|

For guidance on the structural design requirements of a flat roof structure, please refer to the 'Roofs – Flat Roofs' section, in addition, the following should be considered for blue roof systems:

### Substrate – the roof slab or podium deck

The introduction of a Blue Roof system may have loading implications for the structure of the building. It is vital to consult an Engineer at an early stage, especially when designing for a SuDS solution where water will be attenuated within the roof structure. For example: Designing for heads of water and drainage from the roof can result in an uneven distribution load across the substrate and can lead to large horizontal forces on parapet walls and building upstands.

Substrates constructed of reinforced concrete and correctly designed by a competent Engineer have proven to be the most reliable, designed in accordance with BS EN 1992-1-1 Design of Concrete Structures.

Other substrates will require specialist involvement to demonstrate that the substrate will be dimensionally stable and be suitable for a Blue roof proposal.

For Warranty purposes, roof or deck slabs constructed using pre-cast block and beam systems or pre-cast concrete planks are not acceptable for Blue Roof substrate applications.

Where there is any risk for potential excessive movement as a result of the substrate selection or any subsequent usage of the deck area, the designer must ensure through clear evaluation and demonstration that the system is able to cope with the worst case anticipated movement to avoid inducing tensile and shearing stresses in the water proof membrane.

### Deflection

The hydraulic design must take into account any deflections, and re-evaluate peak water depths and loadings in light of this deflection.

Where hydraulic loads are increased due to zero fall and absolute zero falls, then the opportunity for deflection will increase and this should be factored in the structural design and the ability of the roof to drain effectively. The designer is responsible for demonstrating the roof is structural capable and able to drain.

### Movement joints

The roof design should take account of possible differential movements within the slab/deck and at junctions with supporting structure, parapets, kerbs and upstands. Where there is a designated movement joint within the structure, a proprietary joint detail should be incorporated. Consult with the manufacturer of the waterproofing system to prevent differential movement exceeding the capabilities of the waterproofing system.

Structural movement joints are required in large areas of reinforced concrete roofs and decks. Detailing of all movement joints must be provided to demonstrate that ingress or accumulation of water adjacent at or local to the joint will be prevented to limit the risk of frost-thaw action.

Materials forming movement joint must be durable and be able to flex with the waterproofing membrane. Joints must be accessible for inspection and maintenance to allow for a repair in the event of a defect.



Where zero fall and absolute zero falls are proposed, there will be an increased performance requirement placed upon the materials functioning as movement joints due to hydraulic loads which may be stored on the roof for longer periods. The designer is responsible for demonstrating the design and specification of movement joints is capable of maintaining a watertight structure when subject to the conditions created by zero and absolute fall roofs (e.g. increased hydraulic loads).

### 11.7.5 Waterproofing systems

Blue roofs shall incorporate waterproofing which shall resist the passage of moisture due to rain and snow to the inside of the building. All waterproofing systems shall be appropriate for use in a blue roof system and be suitable for their intended purpose.

All waterproofing systems, and all associated detailing shall be installed by a competent installer approved by the manufacturer.

The following guidance should be read in conjunction with the guidance on waterproofing systems within the 'Roofs – Flat Roofs' section.

The selection of waterproofing materials should be subject of a specialist design and specification. All waterproofing systems should be appropriate for use in a blue roof situation and be suitable for their intended purpose.

Where zero fall and absolute zero falls are proposed, there will be an increased performance requirement placed upon the waterproofing due to hydraulic loads which may be stored on the roof for longer periods. Waterproof membrane manufacturer's should confirm their products are suitable for zero and absolute zero fall applications and that the product will achieve a service life of at least 25 years when exposed to this increased head of water.

All systems provided must have a third party product conformity certificate referencing the proposed use.

All aspects of the design of the waterproofing membrane to conform to BS 6229 Flat roofs with continuously supported flexible waterproof coverings – Code of Practice.

Fully bonded or monolithic systems are typically appropriate for 'above ground attenuation surfaces' such as those provided for Blue roof waterproofing membranes. Any certified system MUST NOT allow 'tracking' of water between the substrate and the waterproof membrane.

Curing agents may, on occasion, be applied to the top surface of the concrete substrate to:

- Enhance the concrete quality and durability.
- Reduce the curing period.

The curing agent essentially forms a membrane across the concrete surface of the laid concrete to increase the density of the cement paste and lower the porosity at the surface. This increases resistance to external influences, surface stresses and attack.

Applied curing compounds are not always compatible with a proposed hot-melt application. Adhesion may be reduced causing delamination from the substrate and potentially cause water to track under the waterproof layer following a membrane failure.

Compounds based on a Sodium Silicate base are generally acceptable for a direct applied hot-melt waterproofing application. Adhesion reduction is likely when the base component of the curing agent is:

- |                                  |             |
|----------------------------------|-------------|
| ▪ Acrylic and Chlorinated rubber | ▪ Wax       |
| ▪ Resin                          | ▪ Wax/Resin |

As soon as is practically possible, the waterproof membrane will require protection against damage from either follow on trades or the deck being used as material storage space.

Prior to applying surface finishes above the waterproof layer, the waterproof membrane must be integrity tested and verified by an independent third party. Additional testing may be required where by inspection there is potential that defects may have occurred as a result of damage from follow on trades or the deck being used as storage.

The waterproofing membrane must be linked to any cavity tray to avoid discontinuity resulting in moisture ingress.

### Slab penetrations and access provisions

Where possible it is best to avoid penetrations for service provisions and where required, the designer should look to group the services to minimise the necessary number of penetrations. Back falls are not acceptable at service penetrations.

Waterproofing must allow also for potential movement with the service penetration detailing, be fully bonded and compatible with the service pipe material. Waterproofing to extend 150mm above Blue Roof surface finished level.

## 11.7.6 Roof drainage

Blue roofs shall effectively drain rainwater from roof areas to a suitable drainage system.

It is important that the blue roof system is effectively designed to adequately deal with the predicted rainwater for the sites geographical location. Analysis calculations to determine the drainage load using a dynamic storage assessment method to find the critical duration can be determined by using data models:

- FEH13 (preferred)
- FSR rainfall data

Analysis is based on 1:100 year risk + 40% climate change allowance. This method examines a series of storm durations from 5 minutes to 48 hours. Each model calculates flow storage and outflow to determine the storm which creates the largest depth becomes the critical duration for blue roof system.

A drainage design must be provided for the blue roof element by a suitably qualified and experienced engineer using the methods set out above, with overflow provision being calculated in accordance with BS EN 12056-3.

The design is to specify the following:

- A retention of no more than 100mm water head (1.0kN.m-2) should be used. In all cases, the total loading must be checked and approved by the Engineer for the project.
- Drainage flow calculations accompanied with an explanatory statement including assumptions made.
- Multi directional drainage flow above waterproof membrane.

The specified hydraulic head must never be exceeded and therefore drainage outlets must be designed and positioned to remove excess water. Overflows must be conspicuously positioned.

Drainage from blue roofs should not discharge onto lower roof or decks.

Please note: the design of site drainage controls may be determined by flood risk strategies in planning consents with run-off rates typically in the range 5-10 l/s/hectare.

## 11.7.7 Creation of falls

Blue roofs shall have a minimum finished fall of 1 in 80 to facilitate rainwater drainage.

Where positive falls are proposed, the falls should not be less than 1:80. Where positive falls are not provided due to constraints they should show that water is able to drain from the roof using an alternative approach to produce an equivalent risk, these situations will only be accepted on a case by case basis with agreement from the Warranty surveyor.

It should be noted that the degree of fall on a roof is absolutely critical to the functionality of a blue roof and warm blue roofs tapered or laid to fall have several beneficial advantages such as the avoidance of flotation risk and the removal of standing water. However, the designer should note a positive fall will increase water depths on the roof, and lead to an uneven loading on the slab as water is stored in the tapering storage zone a fall creates which must be considered in the structural design approach for the slab.

Great care must be taken on long roofs with a slope to ensure that the fall is adequately designed into the storage, and that water depths at the downstream end are not excessive, either in terms of the vertical or horizontal loading.

Where a 'blue roof' system is proposed above an unheated space these would be considered a podium deck. The designer should ensure that the deck is able to be sufficiently drained to limit ponding and back falls.

## 11.7.8 Rainwater outlets

Rainwater outlets shall be appropriately sized and have the required capacity.

The choice of outlet is critical in a Blue Roof construction. Rainwater outlets must be designed so as to allow:

- No significant retention after 24 hours in the water reservoir.
- Retention of water reduced by a minimum 50% after 12 hours.
- Have an overflow facility with a capacity to discharge a peak rainfall discharge rate. (BS EN12056-3 Category 1).
- Certification of rainwater outlet to include water head test of the seal to the waterproof membrane.

Rainwater outlets are also to be:

- Positioned in the locations of maximum deflection.
- Countersunk into the deck surface level under the waterproof layer.
- Waterproofing membrane must be dressed into the outlets.
- Surface water from roof and deck finishes should not discharge directly onto the waterproof membrane.

Particular care and attention is required to demonstrate the fixing method between the outlet and flow rate restrictors are fitted to achieve a homogeneous seal between the waterproofing and the outlet.

### Outlets on warm roofs

Insulation should be isolated from the rainwater outlet:

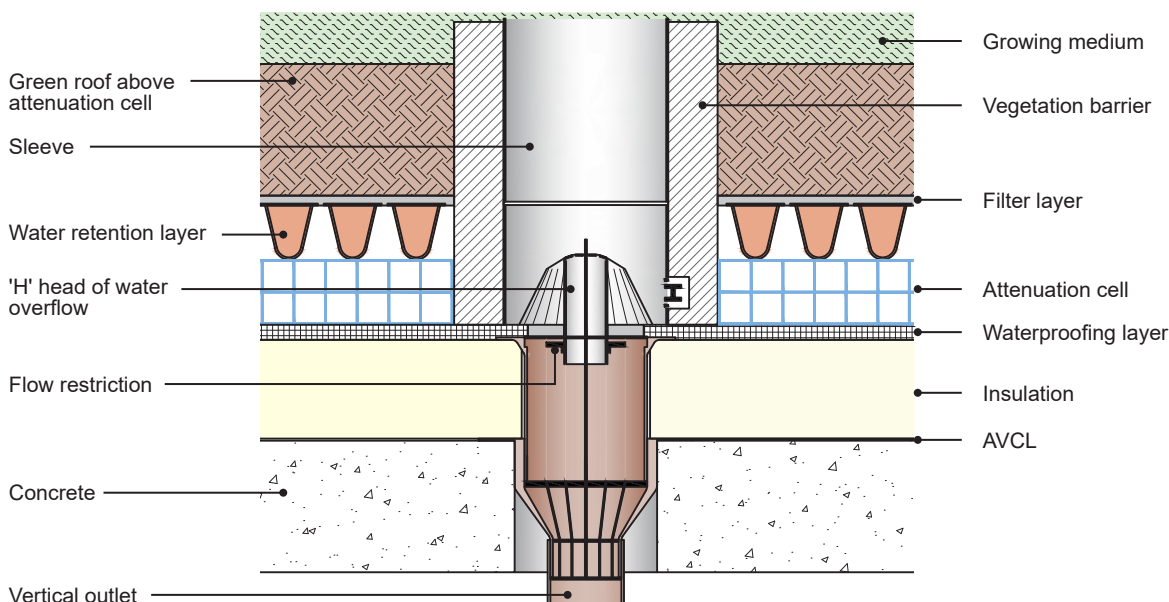
- Air and vapour control layer to be sealed to the waterproof membrane at a square (plan) exclusion zone to all rainwater outlets.
- The exclusion zone is to be not less than 250mm from the rainwater outlet.
- A condensation risk in these locations is to be reviewed and avoided.

### Outlets on inverted roofs

Drainage discharge provision should be made to ensure:

- The provision for drainage occurs at waterproof membrane level.
- The provision of clearly marked access to rainwater outlets, which are free of obstruction.
- Sufficient ballast to prevent flotation of insulation.

### Outlets for where blue roofs are used in conjunction with a green roof



Note: This section is only indicative of the construction - reference to supplier system installation and design must be referenced. Falls should be provided.

#### 11.7.9 Thermal performance, condensation control and floatation.

Blue roofs shall be designed and constructed to avoid the detrimental effects of:

- Interstitial condensation
- Internal surface condensation
- Floatation

Insulation specified must be proposed as part of a compatible system from a manufacturer.

The U-value achieved in an inverted roof, greatly depends upon the amount of water that passes through the joints of the insulation and sits on the waterproofing is available in test method Appendix C of ETAG 031-1.

Following BS 6229, it is deemed reasonable to apply an increase 10% correction factor to the thickness of the insulation on what might normally be applied to address the potential reduction in performance of the U-Value of the system.

Condensation risk assessments should be undertaken in the roof build up at an early stage to eliminate the potential risk Interstitial Condensation should calculations show it occur.

Thermal bridge loss factors (for drainage via the water flow reducing layer WRFL and insulation) need to be considered in the U-Value calculation and the designer should demonstrate that the necessary U-Value will be provided.

Measures to achieve this could include applying the following parameters:

- a. Insulation boards butted:  $0.04W \cdot \text{day} \cdot \text{m}^{-2} \cdot \text{K}^{-2} \cdot \text{mm}^{-1}$  ( $f=1$ ).
- b. Insulation boards twice-rebated:  $0.03 W \cdot \text{day} \cdot \text{m}^{-2} \cdot \text{K}^{-2} \cdot \text{mm}^{-1}$  ( $f=0.75$ )

The warm roof insulation compressive strength must be greater than the proposed loads including additional safety factors for a fully saturated blue roof and allow for the proposed pedestrian surface finish and traffic.

In a warm roof construction, abutting insulation can cause localised depressions in the waterproofing membrane which can promote ponding in these areas which may have a detrimental effect on the lifespan of the waterproofing membrane and so abutments should be checked prior to laying the membrane.

Inverted blue roofs with water storage above the insulation will have to withstand the buoyant up thrust of that insulation. The Water Flow Reducing Layer (WFRL), even where fully taped or glued, properly lapped and with no folds or creases has been shown by testing not to be able to fully resist standing water above it allowing significant rates of water to pass to the waterproofing layer under the insulation. This causes a tendency to produce a buoyant effect and providing uplift and therefore floatation on the system which is not acceptable.

It can take some time for this to occur over the lifespan on the building and so robust measures in inverted roofs are required to ensure the integrity of the WFRL are in place.

The water separation layer is not fully waterproof. Water penetration of that layer should be expected during the longer duration storms which can lead to uplift and so conservative assumptions should be taken on the efficacy of the ability of the WFRL to disperse water for the purposes of avoiding floatation.

Without controls, full floatation of the insulation should be expected, as water level in the insulation will be the same as that at the control. In all cases sufficient loading must be applied to any inverted blue roof, such that uplift of the system due to floatation cannot occur.

This floatation risk may require the designer to consider the depth of insulation that can be used, as every 100mm of insulation thickness will typically require a ballast weight of around  $1.0 \text{ kN} \cdot \text{m}^{-2}$ , which will be in addition to the water loading. Thus, an inverted roof with 200mm of insulation and 100mm water storage will have a total loading of nearly  $3.0 \text{ kN} \cdot \text{m}^{-2}$ . It should be noted that this will also act as the horizontal loading on all parapets and upstand walls, which must be checked to ensure they can resist the pressure of the water build up against them. Inverted blue roofs are therefore not the recommended approach.

## Criteria for a condensation risk analysis

Where a condensation risk analysis is required, the following boundary conditions should be used:

- 60% relative humidity.
- External temperature  $-2^{\circ}\text{C}$ .
- Internal temperature  $21^{\circ}\text{C}$ .

Where external temperatures are considered to fall below  $-2^{\circ}\text{C}$  due to exposure or geographical locations, lower temperatures should be used based upon climatic data within relevant standards.

### 11.7.10 Surface finishes

The blue roof shall have a suitable surface finish which:

- Is compatible with the blue roof system, **and**
- Does not impede on the performance of the blue roof system.

Blue Roofs should have a surface finish above the water attenuation layers, this surface finish can be constructed from any suitable permeable pedestrian surface. An impermeable surface can be used but adequate measures should be taken to ensure the water can filter into the Blue Roof attenuation void. The requirements of the Building Regulations should be considered with regard to Approved Document B (Fire Safety).

Where green roofs are used in conjunction with blue roofs, the green roof build up may be usable as part of the attenuation storage. The reservoir storage must be assumed to be full for blue roof design. Silting and biological growth in the reservoir is to be avoided. A root barrier is to be provided.

Excess water accumulation in a Green or Brown Roof system can have an adverse effect on the imposed dead load and planting. In extreme conditions it could change the whole green roof ecosystem, making the system ineffective. Separate maintenance requirements should be considered in a dual green/blue roof to ensure that both systems achieve the minimum required lifespan.

### 11.7.11 Blue roof to wall façade abutments

Abutment joints with isolated vertical construction adjacent to the roof or deck slab, shall prevent the ingress of water to the space below.

#### Abutments

Allowance in the waterproofing detailing for anticipated movement between the roof slab or deck and the vertical façade must be allowed for to prevent the waterproof layer shearing. Blue Roof to Wall façade abutments are potentially breached by water between the cavity tray and the waterproofing membrane. Continuity and allowance for movement is essential.

Additional waterproofing maybe required for any water passing the cavity tray to discharge to the Blue Roof waterproofing membrane. The detailing shall ensure that in the event of a defect in the cavity tray it will not result in moisture ingress into a conditioned space.

#### Level access thresholds

Level door access from the Blue Roof level to occupied spaces should provide:

- A drainage channel in front of the door cill.
- A 10mm gap between the drainage channel and the cill.
- The door cill should have a minimum 45mm overhang of the construction below.

#### Upstands

The designer should check that in all areas there is an upstand height able to provide a waterproofing upstand at least 150mm in height. At critical points, such as the top of drainage slopes may potentially compromise this upstand height.

### 11.7.12 Architectural features

All architectural features designed and installed as part of the blue roof system shall be appropriately detailed to be waterproof, weathertight and prevent water ingress.

At the pre-construction phase, an audit should be established of the surface treatments, architectural features, planters and landscaping that are placed on roof or deck slab. Such detailing will require the necessity for:

- Weatherproofing - incorporating an upstand and cover flashing arrangement for solid features placed on the Blue Roof slab.
- Waterproofing – provide continuous waterproofing under the architectural feature.
- Diversion – measures should be taken to divert water around large structures to ensure that it is directed to outlets provided.

Where structures are built off the Blue Roof slab a suitably designed monolithic upstand or kicker rising above the waterproofing membrane must be provided.

Attenuated water should fall away from any structures built off the roof slab or deck.

### 11.7.13 Installation and quality assurance

A quality assurance and record keeping system shall be provided at pre-construction to ensure that standards of workmanship can be demonstrated throughout installation.

1. Main contractor to provide report of testing for integrity of waterproof membrane, including credentials of test Engineer, method statement, full description of defects found and their location, evidence of repair and re-test.
2. Installer of blue roof system to provide signed certificate of satisfaction with roof finishes over blue roof if these are installed by others.
3. Installer of roof system to provide final inspection report of waterproof membrane manufacturer.
4. Inverted roofs only: Water Flow Reducing Layer (WFRL).
  - a. WFRL to be dressed up to finished roof level at all abutments and penetrations noting the requirement for upstands and thresholds to be 150mm above the greatest expected height of the water line datum. Checks to be undertaken to assess the integrity of the WFRL.
  - b. WFRL to be dressed down at all Rain Water Outlets.
5. The Engineer is to provide confirmation that the final construction satisfies the design deflection analysis prepared for drainage provisions.

An approved 'installation contractor' recognised by the material manufacturer with installers with a demonstrable history of installing blue roof systems are to be permitted to install the manufacturer's waterproof membrane. Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty surveyor at the earliest opportunity.

#### Final inspection

At practical completion of the waterproofing membrane to the Blue Roof. All areas should be cleared of stored material, site operations and all protection. A thorough, visual and photo graphic recorded inspection of all areas, including deck surface architectural and landscaped features, must be carried out with representation from the main and roofing contractors in attendance.

A deflection analysis will be required, 'before' and 'after' completion by the Engineer to confirm the minimum falls are achieved and that no back falls to the waterproofing surface occur.

#### 11.7.14 Testing

Waterproofing systems shall be tested where required by this section, when complete, to prove and demonstrate resistance to the passage of moisture.

Testing is required to demonstrate the integrity of the primary waterproof membrane. Where a system incorporate several waterproofing layers, both layers must be tested. Testing should be undertaken by a suitably qualified and experienced third party certified test agency independent of the roofing contractor.

Certification should be made available to the Warranty surveyor prior to handover.

The testing service provider should provide in their report:

- Date of test.
- Project name, address and reference number.
- Name, address and contact details of the test provider.
- Experience and training of tester.
- Membership of trade association which sets a code of conduct for the service.
- Description and efficacy of the waterproof installation.
- Details and large, clear photographs of defects identified (where applicable).
- Number of tests undertaken.
- Confirmation of result of testing.

#### 11.7.15 Operations and maintenance

The Developer shall have in place an operation and maintenance manual (O&M) detailing the access and inspections provisions required for the blue roof system.

The Developer should have in place an operation and maintenance manual (O&M) and should identify areas of risk including:

1. Failure of maintenance and cleansing of rainwater outlets.
2. Failure of filter membranes leading to obstruction of storage units.
3. Flotation of inverted roof insulation.
4. Blockage of small diameter control holes to drains.
5. Removal of controls, leading to unrestricted discharge (risk to wider community rather than the project building).

Access and inspections provisions should be incorporated into the design at surface level to allow for routine maintenance to outlets. Surface Finishes should be demountable to allow for routine maintenance whilst meeting the requirements to resist wind uplift.

## Introduction

This section provides guidance on meeting the performance requirements for podium decks with the following definitions being applicable:

### Podium deck

Podium decks are an open spaced amenity structural slab/deck and are defined for Warranty purposes as:

*An externally weathered elevated platform over an unconditioned (unheated or soundproofed) space.*

The requirement to waterproof is to:

- Protect the deck surface from water accumulation, **and**
- Prevent the ingress of water to the space below, **and**
- Prevent ingress of water to adjacent buildings.

Where a space below a proposed deck is conditioned (heat and sound), it would no longer be considered as a 'podium' and instead is classified as an insulated flat roof deck.

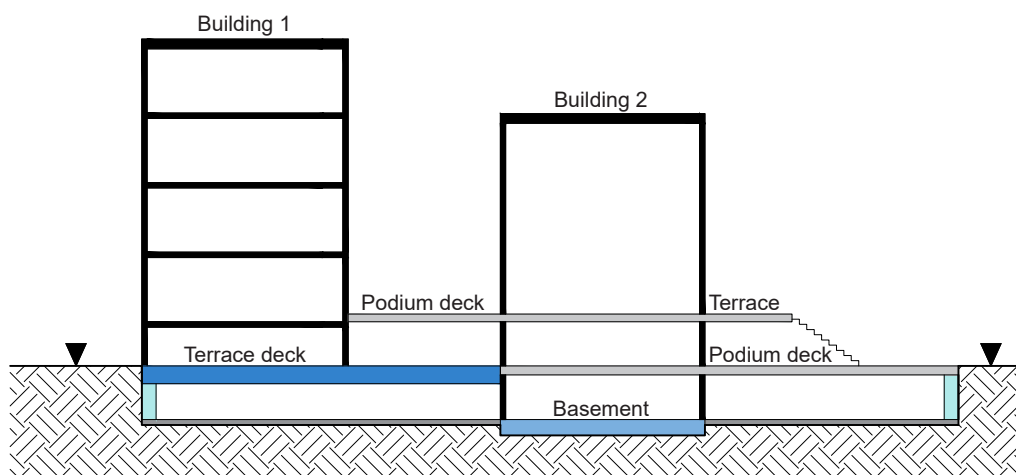
Please refer to BS 6229 'Flat roofs with continuously supported flexible waterproof coverings - Code of practice' and the 'Roofs' section of this Technical Manual.

### Transfer deck

A transfer deck is a uniquely loaded supporting podium deck. The designed vertical superstructure loads supported from the deck are transferred along a horizontal load path along designed beams integral with the slab to new supports.

The requirement to waterproof is to:

- Protect the deck surface from water accumulation, **and**
- Prevent the ingress of water to the space below, **and**
- Prevent water ingress into buildings supported on and adjacent to the deck.



### 11.8.1 Compliance

The design, specification and construction of podium decks shall meet the performance requirements of this section.

### 11.8.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full structural design for the podium deck.
2. Slab design and deflection analysis.
3. General arrangement plans for each podium deck area showing:
  - a. Deck features and landscaping.
  - b. Directions of falls for surface water management.
  - c. Drainage provisions and the position of accessible outlets to provide effective drainage with no back falls.
  - d. Deck finishes.
  - e. Below slab space.
  - f. Due to complexity and additional loadings, deflection and drainage analysis should also be provided.



4. General sections and section details that show thickness, specification and position of the components inclusive of all materials relating to the podium. This should also include:
  - a. Layering/build up types above the slab showing waterproofing, water flow control and finishes.
  - b. Variance of build-up types.
  - c. Movement joints.
  - d. Entrance thresholds.
  - e. Building abutments and upstands on and adjacent to podium deck.
  - f. Through slab services and pipe penetrations.
  - g. Planters and Green landscaping.
  - h. Slab fixings.
  - i. Other base details for architectural features placed on the slab.
5. Surface water drainage design philosophy and peak flow calculations for entire podium slab (including countersunk outlets).
6. Specification of component materials and products used, including a third party product conformity certificate.
7. Details of all fixings, their frequency and fixing method.
8. Methodology and evidence of pull testing for fixings and pull/peel testing for bonded materials.
9. A suite of site specific details for all junctions, outlets and penetrations.
10. Details of all fire stopping within structure and fire mitigation measures. This should include specification and a detailed location layout drawings showing positioning.
11. Outline of method and plan for testing the integrity of the waterproofing layer.
12. Maintenance plan to address how remedial works could be undertaken in the event of a defect.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

## 11.8.3 Structural design requirements

Podium decks shall be designed and constructed so that all loads are sustained and transmitted to supporting structure(s) without causing instability, deflection or deformation.

Concreting shall not take place during cold weather periods where the working temperatures are below 2°C.

At the earliest possible pre-construction stage, the client design should define the range of potential uses of the podium deck with reference to the worst case of dead loads (permanent finishes), live imposed (use types) and rolling (traffic) loads. Detailing should be undertaken to ensure that in the event of a defect, a repair can be feasibly undertaken and should be at the forefront of the design process.

Podium Decks constructed from reinforced concrete and correctly designed by an Engineer have proven to be the most reliable when designed in accordance with BS EN 1992-1-1 Eurocode 2:2004 Design of Concrete Structures (+A1:2014). In any event the substrate in all cases must be proven to be dimensionally stable.

For Warranty purposes, Podium Decks constructed of pre-cast block and beam systems or pre-cast concrete planks are not acceptable for any podium deck applications.

Other approaches such as pre-cast concrete hollow core planks with a structural screed and ribbed metal deck formwork require additional specialist involvement to demonstrate that the construction will meet the requirement to show that the substrate will be dimensionally stable.

When there is any risk for excessive movement as a result of the substrate selection or any potential future use of the deck area increasing slab movement, the designer must ensure through clear evaluation and demonstration that the system is able to cope with the worst case anticipated movement.

## 11.8.4 Movement joints

Where movement joints are required, they should be designed by an Engineer. The rate of expected movement, type of movement joint(s), the materials used and their locations should be communicated to the waterproofing system designer for inclusion into the design process of any drainage strategy falls and detailing, and the waterproofing system.

Structural movement joints are required in large area reinforced concrete podium decks. Detailing of all movement joints are required to demonstrate they will prevent water ingress or accumulation of water adjacent at or local to the joint to limit the risk of frost-thaw action.

Materials forming the movement joint must be durable and be able to flex with the waterproofing membrane. Joints must be accessible for inspection and maintenance to allow for repair in the event of a defect.



### 11.8.5 General design

The design, specification and construction of podium decks shall be suitable for the intended purpose.

The design of a Podium Deck, the client must provide a clear indication of the surface usage and its possible future use.

The design should demonstrate a satisfactory level of:

- Structural performance of the slab for surface treatment, finishes and drainage.
- Architectural and landscaping placed on the podium deck.
- Management of surface water around landscaped features to drainage points.
- Drainage from the podium deck.

#### Guidance limitations

This guidance is not intended as a standalone design guide and does not include full details of what must be considered to comply with other associated design guides.

#### Technical standards

In the design of a podium deck, reference to other associated technical standards may be appropriate. Examples include:

- Continuous Membrane Roofing (also see the 'Roofs – Flat Roofs' section).
- Landscaped areas requiring water irrigation will require additional control of surface water. Please refer to the 'Roofs – Green Roofs' section for further guidance.
- Drainage (also see the 'Drainage' section).
- Basements (also see the 'Waterproofing Below Ground Storeys and Structures' section).
- Surface water attenuation systems – Blue roofs on the Podium Deck will require additional structural analysis of the deck and drainage control. Please refer to the Warranty 'Roofs – Blue Roofs' section for further guidance.

#### Waterproofing design

If the space beneath the podium deck is below ground, the design of the waterproofing layer must be coordinated alongside a CSSW qualified structural waterproofing specialist.

#### Associated design principles

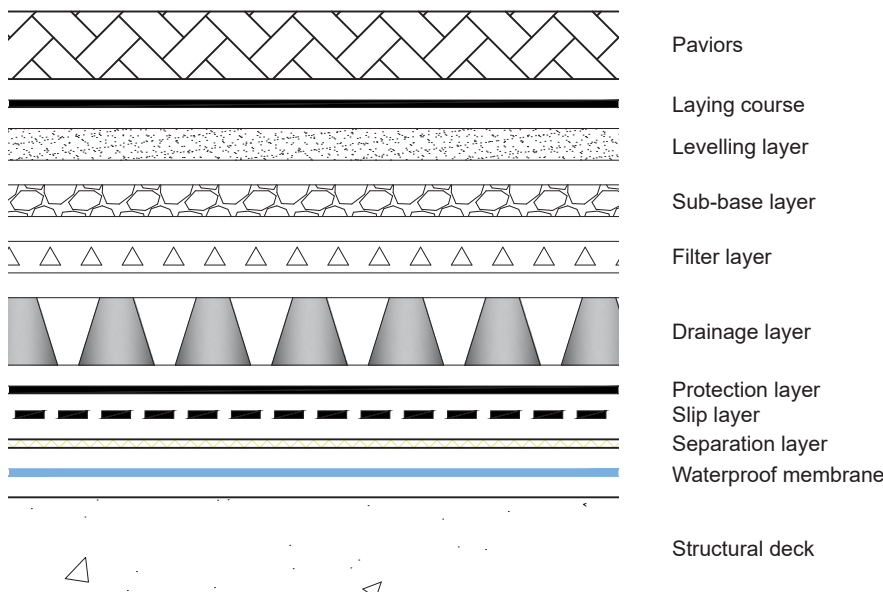
The principles of BS 6229 Flat roofs with continuously supported flexible waterproof coverings – Code of Practice, are to be applied to waterproofing of podium decks to ensure water ingress does not occur.

BS 8102 – Protection of below ground structures against water ingress – Code of practice are to be applied to ensure the continuity of waterproofing of junctions of basements to podium decks is managed to ensure that water ingress does not occur.

Further practical guidance on this and compliance with Warranty requirements for podium decks is included herein.

#### Typical podium deck layering

The compatibility and co-operation of each individual layer is critical to determining a reasonable life span for a flexibly paved surface. Each layer must have the ability to absorb and constrain potential dynamic and static loading.



Note: Manufacturers will provide systems which are a combination of elemental layers i.e. protection layer + slip layer + separation layer.

**Layering course:** Accommodates variation in thickness of paver units.

**Levelling layer:** To overcome any height differences combination of the laying and sub-base layer.

**Sub-base layer:** Absorbs and spreads static loads to prevent deformation of the paving.

**Filter layer:** Protects the drainage layer against clogging by fine particles from the sub-base or layering course. It also ensures effective horizontal drainage. If topsoil is used, special measures should be taken for fine soil particles clogging the filter layer.

**Drainage layer:** Relieves hydrostatic pressure. Discharges excess water under the sub-base layer, prevents ponding, and risk of frost heave affecting the surface.

**Protection layer:** The layer protects the waterproofing membrane from damage caused by the static and dynamic loads. Protection layers may also fulfil the function of the slip and separation layers.

**Slip layer:** Horizontal loads occur by temperature change and dynamic forces. Waterproofing materials cannot withstand these loads and therefore care should be given for its specification.

**Separation layer:** Incompatible materials need to be isolated.

## 11.8.6 Rainwater drainage

Podium decks shall effectively drain rainwater from podium areas to a suitable drainage system.

The waterproof layer of the podium deck shall achieve a minimum design fall of 1:80 – ‘as built’. A levels survey shall be undertaken to demonstrate this is achieved.

All podium decks should be designed to collect, direct and discharge rainwater to a suitable drainage system by a suitably experienced drainage designer prior to work commencing.

The following guidance should be read in conjunction with the guidance provided in the ‘Roofs – Flat Roofs’ section on:

- Roof drainage
- Rainwater outlets
- Overflows

### Drainage

A complete drainage design for the Podium Deck must be provided, by an Engineer and in accordance with BS EN 12056-3. Drainage calculations should be accompanied with a short explanatory statement including assumptions made.

It is important that the Podium Deck be designed to adequately deal with the predicted rainwater for its geographical location. Additional consideration should be made for drainage from upper areas such as façade run off or external balconies from the adjacent structure(s).

Surface water from upper podium levels or roofs must not discharge onto lower podium deck levels.

Podium deck surface finishes shall be positively drained to discharge surface water so that it does not accumulate and it does not compromise the use of the space at surface level.

Where a green/blue roof proposal forms part of a podium deck proposal, our Warranty guidance on Green and Blue roofs must be followed as such proposals may impact on the Podium deck performance (loadings and effective drainage).

### Deck falls

Drainage falls should be constructed in a manner that they fall away from any structures built off the podium. Water standing on the deck, can exert pressures laterally on the external walls of structures built over the deck, therefore, the waterproofing line from the podium deck surface must be continuous to DPC level.

Cementitious screeds provide a stable substrate to mitred falls and are recommended. Screeds to be in accordance with BS 8204. Surface water should always fall away from any above deck protrusions or abutments.

The finish surface is to have a minimum design fall 1:80 prior to applying the waterproofing layer. This will ensure that adequate flow of surface water is maintained to the drainage system and that no ponding occurs on the deck.

Consideration should be given to height differences between the top and bottom of the falls. Where there are large height differences in the screed forming the falls the height for dressing the waterproof membrane up an abutment wall may be reduced.

On large podium decks it may be necessary to increase the number of drainage outlets to avoid excessive fall heights in the screed.

The use of ‘zero falls’ approaches should only be permitted where strictly agreed with the Warranty provider prior to commencement, and will be subject to a site specific appraisal. In such instances, the design approaches of BS 6229 for ‘zero falls’ should be assumed to prevail.

### Rainwater outlets

Should be positioned in the locations of maximum deflection.

Outlets within the slab must be designed to be countersunk and discharge at deck level, not at surface finish level.

The waterproofing layer must be dressed into the outlets.

Inlet gullies which collect water from the deck and finishes level and then discharge directly onto the waterproof membrane should be avoided.

Where podium decks form part of an enclosed area, an overflow for each outlet required, should be provided to ensure that surface water does not accumulate in the event of a blockage. Surface water should be discharged through the external perimeter in a readily apparent location to allow for maintenance to be undertaken at the earliest opportunity.

### 11.8.7 Waterproofing systems

Podium decks shall be waterproofed so that they resist the passage of moisture due to rain and snow to the inside of the building. All waterproofing systems shall be suitable for their intended purpose.

Fully bonded or monolithic systems are typically appropriate for podium deck waterproofing. Any waterproofing system must not allow the 'tracking' of water under the waterproof membrane.

Curing agents may, on occasion, be applied to the top surface of the concrete substrate to:

- a. Enhance the concrete quality and durability.
- b. Reduce the curing period.

The curing agent essentially forms a membrane across the concrete surface of the laid concrete to increase the density of the cement paste and lower the porosity at the surface. This increases resistance to external influences, surface stresses and attack.

Applied curing compounds are not always compatible with a proposed hot-melt application. Adhesion may be reduced causing delamination from the substrate and potentially cause water to track under the waterproof layer following a membrane failure.

Compounds based on a sodium silicate based are generally acceptable for a direct applied hot-melt waterproofing application. Adhesion reduction is likely when the base component of the curing agent is:

- Acrylic and chlorinated rubber.
- Resin.
- Wax.
- Wax/resin.

In all cases a Hot-melt waterproofing membrane must be applied to a primed concrete surface with reference to BS EN 13670 Execution of Concrete Structures (E) - 8.5 Curing and protection states (10) (11).

All 'systems', specified products and materials require a third party product conformity certificate which references the areas the material can be used. In the selection of a system, it should be considered whether that system is reliant on insulation or a 'Water Flow Reducing Layer' (WFRL) to disperse water to the outlets.

For podium deck applications, loose laid or partially bonded waterproofing materials are not acceptable.

The use of a 'waterproof concrete' is not considered to be an acceptable approach for Podium Deck waterproofing.

As soon as is practically possible, the waterproof membrane will require protection against damage from either follow on trades or the deck being used as material storage space.

Prior to applying surface finishes above the waterproof layer, the waterproof membrane must be integrity tested and verified by an independent third party.

The waterproofing layer must be linked to any cavity tray to avoid discontinuity which could result in moisture ingress.

### 11.8.8 Detailing

Waterproofing systems shall be appropriately detailed to ensure satisfactory performance against the effects of weather.

### Abutment joints

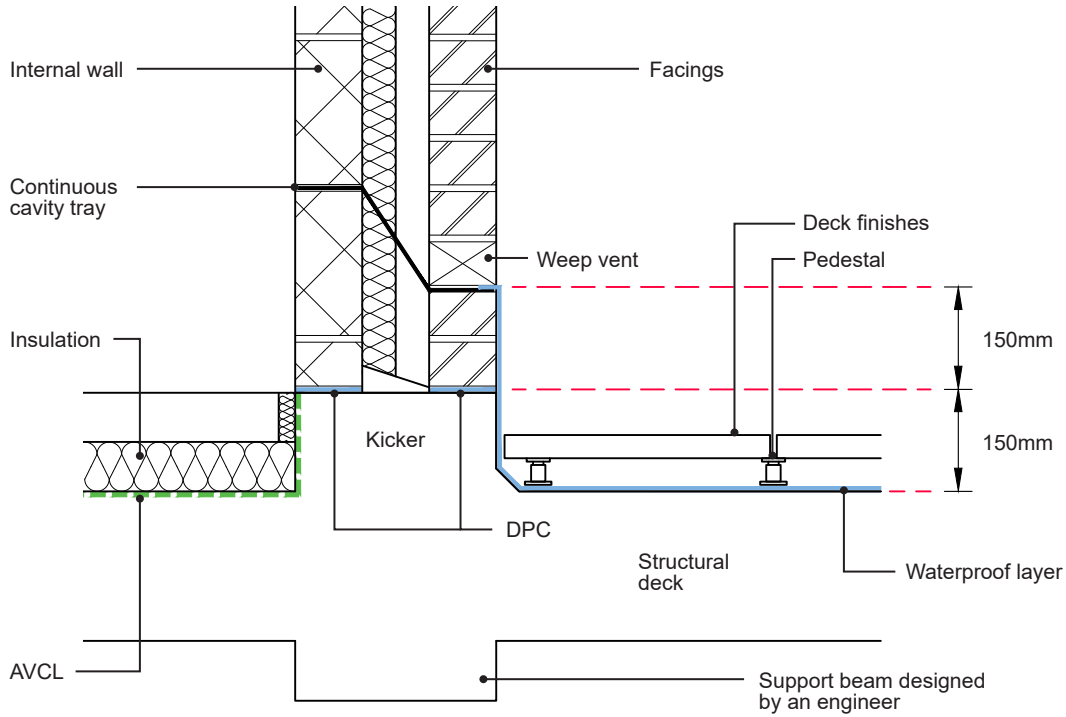
Abutment joints with isolated vertical construction adjacent to the podium deck should not permit the ingress of water to the space below.

Allowance should be made in the detailing for anticipated movement between the podium deck and the vertical façade, to prevent the waterproof layer from shearing.

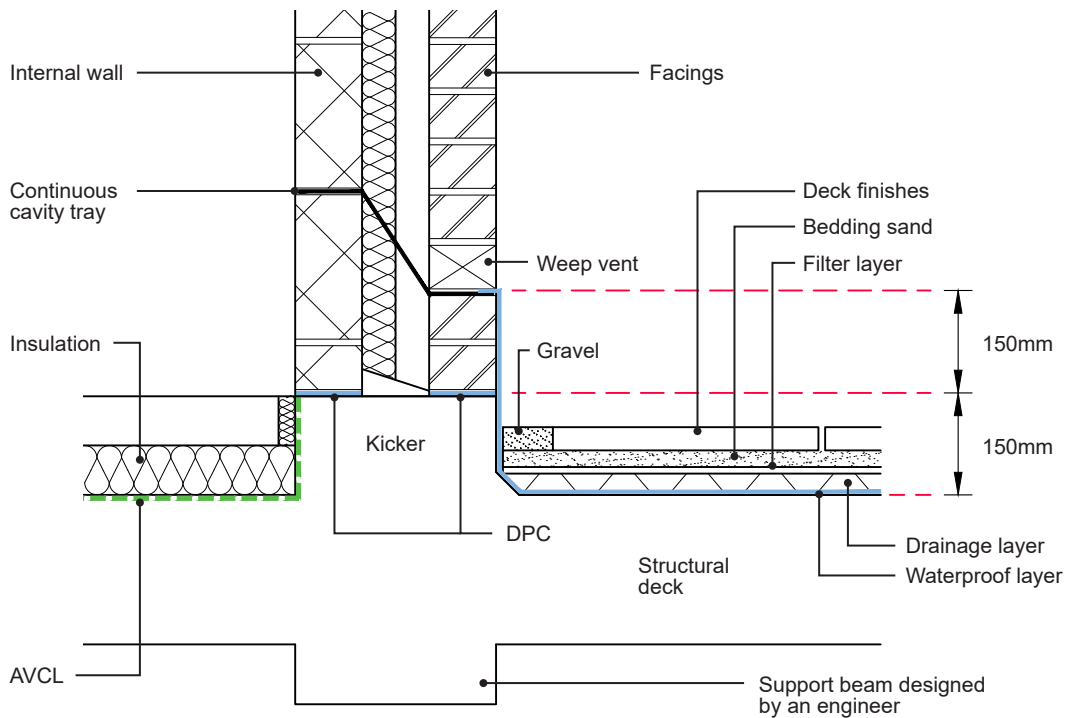
Where structures abut or are built off the podium deck, the waterproofing must be dressed up the vertical surface of the facade to a minimum of 150mm above the finished podium deck level.

Cavity trays above abutments (podium deck to wall junctions) are often breached at the podium deck level, allowing water to seep into the building. Continuity is therefore essential between these two elements and waterproofing detailing is required to ensure any water passing the cavity tray is discharged to the podium deck adequately. Waterproofing layers must be linked with the DPC which should be at least 150mm above the finished surface level. The masonry should be durable against saturation in accordance with BS EN 771-1.

## Wall waterproofing detail (slabs on pedestals)



## Wall waterproofing detail (bedded slabs)

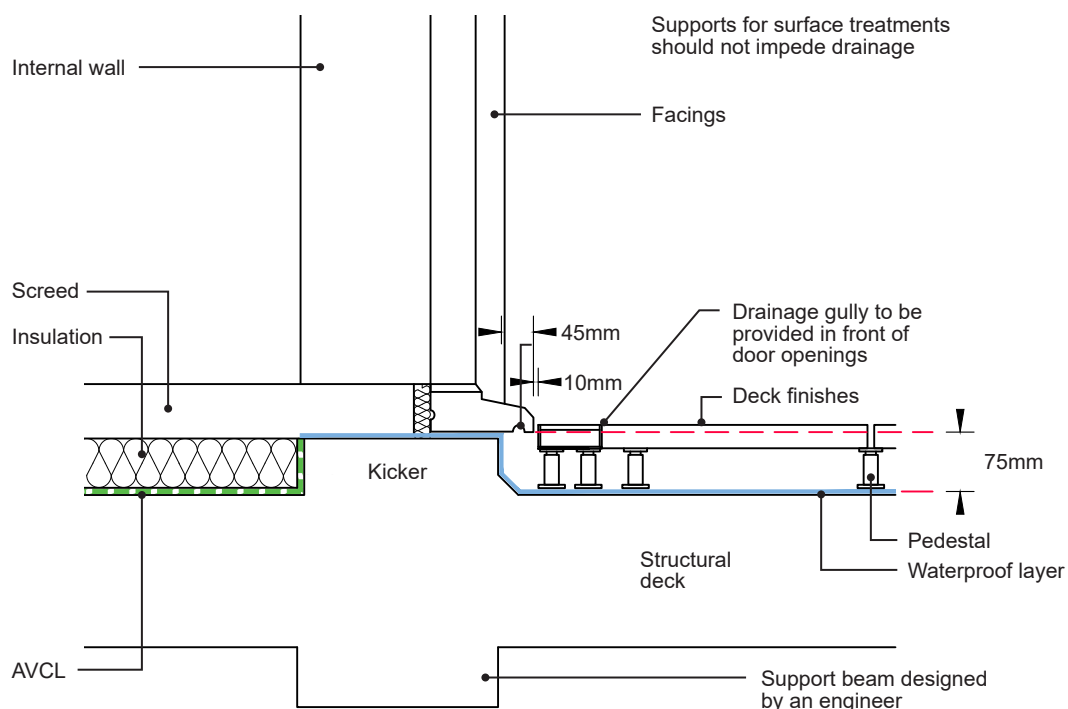


### Threshold abutments

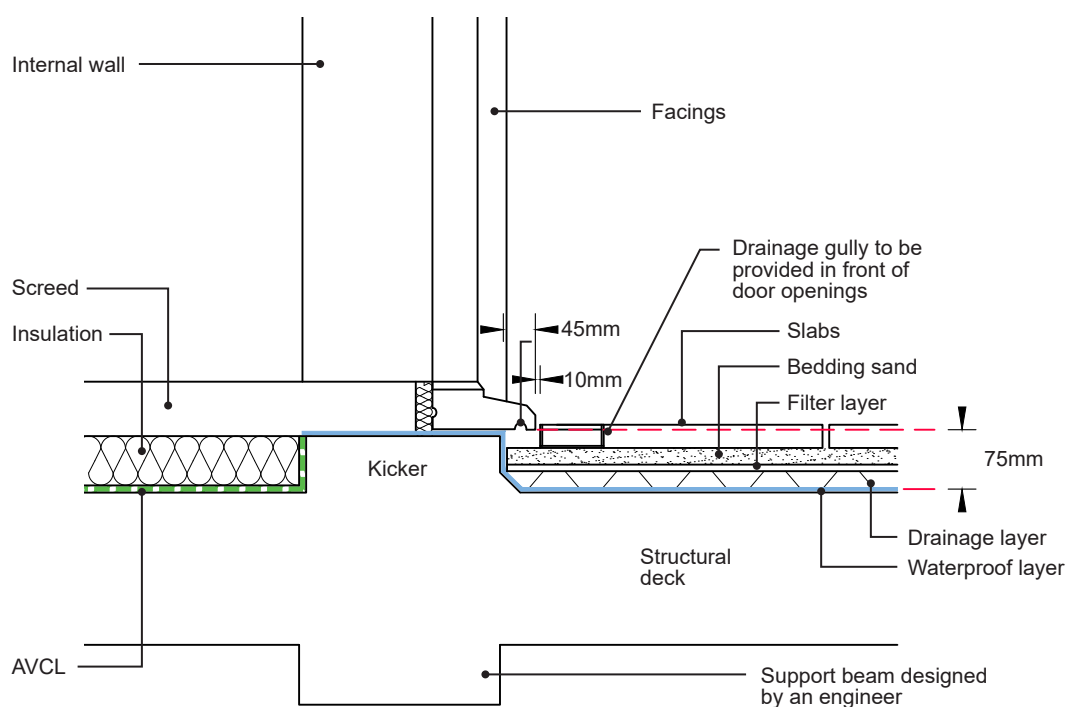
All level door accesses formed from the podium deck level to occupied spaces should provide:

- A 10mm gap between the drainage channel and the door cill.
- The door cill should have a minimum 45mm overhang of the construction below.
- In order to have a reduced upstand of 75mm max from the underside of the door cill to the top of the structural deck, there must be a fall on the structural deck away from the door opening.
- Waterproofing to be dressed and linked with DPC at reveals.
- Waterproofing may be continuous under door threshold as creep (gradual deformation under stress) is likely to be minimal.
- Where podiums are also being used as a blue roof function, threshold design must take account of level of retained water (H-Max).

### Threshold waterproofing detail (slabs on pedestals)



### Threshold waterproofing detail (bedded paviers)



## Slab penetrations

Where possible, it is best to avoid Podium Deck penetrations for service provisions. Where required, the designer should look to group the services to minimise the necessary number of penetrations.

Detailing of the penetration or group to prevent ingress or accumulation of water at the penetration requires consideration and should ensure:

- Back falls are not created at service penetrations.
- Waterproofing must allow for potential movement with the service penetration detailing.
- Waterproofing must be fully bonded and compatible with the service pipe material.
- The waterproofing must extend 150mm above Podium Deck surface finished level.

## Architectural features

At the pre-construction phase, an audit of the surface treatments, architectural features and planters that are placed on the podium should be established. Such detailing will require the need for:

- Weatherproofing - incorporating an upstand and cover flashing arrangement for solid features placed on the podium deck, **or**
- Waterproofing - providing continuous waterproofing under the architectural feature.
- Diversion – measures should be taken to divert water around large structures to ensure that it is able to reach the outlets provided.

Where structures are built off the podium deck, a suitably designed 150mm upstand above the waterproofing layer must be provided. Surface water should be designed to fall away from any structures built off the podium.

Planters should be built off a 150mm monolithic kicker with the podium deck slab.

## Pedestals

Where pedestals are specified to support pedestrian surface finishes (such as paving slabs), they should be:

- Appropriate for the intended purpose.
- Appropriate for the site specified conditions.
- Compatible with the waterproofing system and all other components within the podium deck build-up.

Pedestals, and the loads they impose on the structure below should not exceed the expected designed loads.

Where dead and/or live loads are anticipated to be high, there should be consideration for the use of a cover board underneath the waterproof layer and/or a rail system.

In addition, the pedestal should not create a risk of damage to the waterproofing (e.g. sharp edges).

### 11.8.9 Installation

An approved installation contractor recognised by the material manufacture as being competent to install the manufacturer's waterproof membrane shall be used.

All materials shall be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.

Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty surveyor upon request .

A quality assurance and record keeping system should be provided at pre-construction to ensure that standards of workmanship can be demonstrated.

An approved installation contractor recognised by the material manufacture as being competent to install the manufacturer's waterproof membrane should be used. Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty surveyor.

The waterproof layer of the podium deck shall achieve a minimum design fall of 1:80 – 'as built'. A levels survey should be undertaken to demonstrate this is achieved.

### 11.8.10 Testing

Waterproofing systems shall be tested where required by this section, when complete, to prove and demonstrate resistance to the passage of moisture.

Testing is required to demonstrate the integrity of the waterproof membrane.

It must be undertaken by a suitably qualified and experienced third party certified test agency who is independent of the roofing contractor using either:

- Low Voltage Earth Leakage, **or**
- High voltage electrical discharge.

Additional testing may be required where by inspection, there is potential that defects may have occurred as a result of damage from follow on trades, or the deck being used as storage.

Certification should be made available to the Warranty surveyor prior to handover. The testing service provider should provide in their report:

- |                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>▪ Date of test.</li> <li>▪ Project name, address and reference number.</li> <li>▪ Name, address and contact of certifier.</li> <li>▪ Description and efficacy of the waterproof installation.</li> <li>▪ Experience and training of tester.</li> <li>▪ Membership of an appropriate trade association, which sets a Code of Conduct for the service.</li> </ul> | <ul style="list-style-type: none"> <li>▪ Details and provision of large- clear photographs of defects identified (when applicable).</li> <li>▪ Number of tests undertaken.</li> <li>▪ Confirmation of result of testing.</li> </ul> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Final inspection

At practical completion of the waterproofing to the Podium Deck. All areas should be clear of stored material, site operations and all protection. A thorough, visual and recorded inspection, of all areas, including deck surface architectural and landscaped features, to be carried out with representation from the main and roofing contractors in attendance.

### 11.8.11 Protection of completed waterproofing

Where access provision is required, the waterproofing systems shall be appropriately protected to prevent damage.

For more guidance please refer to the 'Roofs – Flat Roofs' section.

### 11.8.12 Control of work post waterproofing completion

Any additional works carried out by a third party, after the waterproofing system completion but prior to the building being signed off for Warranty shall:

- |                                                                                                                                  |                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>▪ Be a part of the original design proposal.</li> <li>▪ Appropriately managed.</li> </ul> | <ul style="list-style-type: none"> <li>▪ Controlled to avoid a loss of waterproofing integrity.</li> </ul> |
|----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|

For more guidance please refer to the 'Roofs – Flat Roofs' section.

### References and further guidance

#### References

- BS EN 1992-1-1 Eurocode 2: Design of concrete structures. General rules and rules for buildings
- BS 6229 - Flat roofs with continuously supported flexible waterproof coverings - Code of practice
- BS 8102 – Code of practice for protection of below ground structures against water ingress
- BS EN 12056-3 – Gravity drainage systems inside buildings - Roof drainage, layout and calculation.
- BS 8204-1 - Screeds, bases and in situ floorings. Concrete bases and cementitious levelling screeds to receive floorings – Code of Practice
- BS EN 13670 Execution of Concrete Structures

#### Guidance notes

- SWG2/12.13 – Property Care Association Podium Decks.

# 12.

## Roof Terraces and Balconies

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### Contents

|      |               |     |
|------|---------------|-----|
| 12.1 | Roof Terraces | 384 |
| 12.2 | Balconies     | 396 |



## Introduction

This section provides guidance on meeting the performance requirements for roof terraces.

For the purposes of Warranty, roof terraces are defined as an accessible amenity above ground level which is exterior to, and with direct access from a building which forms part of a roof or forms the entire roof to other occupied parts of a building.

Types of roof terrace situations covered by this section are:

- Terraces formed on warm decks.
- Terraces formed on inverted decks.

This section provides specific advice and requirements in respect of roof terraces and should be read in conjunction with the 'Roofs - Flat Roofs' section.

### 12.1.1 Compliance

Roof terraces shall be designed and constructed to meet the performance requirements of this section.

The general build up and specification of materials for a roof terrace shall satisfy the requirements of our 'Roofs – Flat Roofs' section.

### 12.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full set of detailed drawings including:
  - a. Plan showing direction of falls, and position of outlets and overflows.
  - b. Sections showing the roof terrace build up and how falls are to be created. Sectional details should show all components to be used in the roof terrace build up (insulation type and thickness, vapour control layer, waterproofing membrane/layers, etc.).
  - c. Site specific detailing for all junctions, outlets, threshold and upstand interfaces with the façade.
  - d. Details of the provision of pedestrian surface support structure (where appropriate).
  - e. Details of the provision of guarding including parapet walls and balustrading used as guarding. This should be designed in accordance with BS EN 1991-1-1 to resist horizontal loading.
  - f. Details of all fire stopping which should include specification and a detailed location layout drawing showing positioning of all fire stopping.
2. A third party product conformity certificate for the waterproofing membrane/layer that is proposed.
3. Details of all fixings, their frequency, fixing locations and method of fixing, including those for insulation and surfacing. Fixing methodology should be supported by appropriate wind uplift calculations.
4. Outline of method for testing the integrity of the waterproofing layer.
5. In all circumstances, the roof terrace membrane system will need to be installed by an approved contractor who is recognized by the manufacturer as competent. Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty surveyor.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 12.1.3 General design

Roof terrace design and construction shall be appropriate for the intended use.

Please note, for Warranty purposes, cold deck roof terraces are not acceptable.

Roof terraces can be formed on either a warm deck or an inverted warm deck. The following will provide some guidance on the general build-up and design principles.

The general build up and specification of materials for a roof terrace should also satisfy the requirements within our 'Roofs – Flat Roofs' section.

pg 385

- Where the penetration to form the outlet is made through the wall construction, which is constructed of steel frame care should be taken to prevent thermal bridging.
- Hopper construction should include a flashing apron and the hopper should be accessible for clearing debris on a regular basis.
- Parapets should satisfy the requirements of the 'External Walls – Parapets' section.

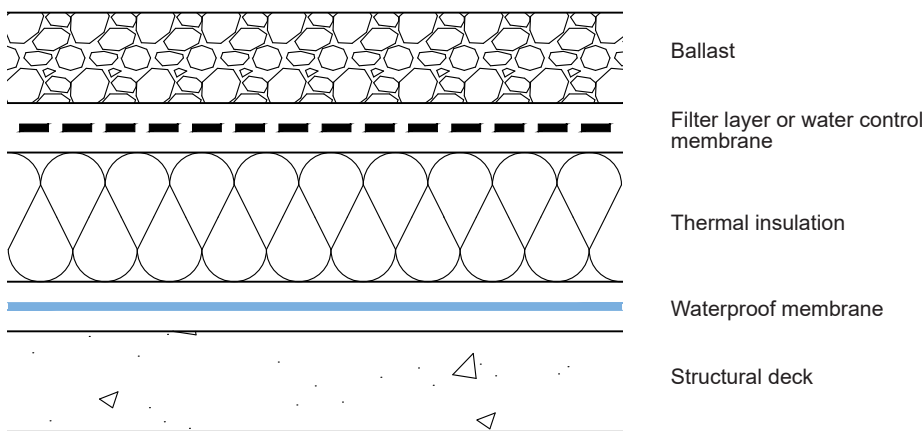
### General principles for inverted warm deck

#### Design

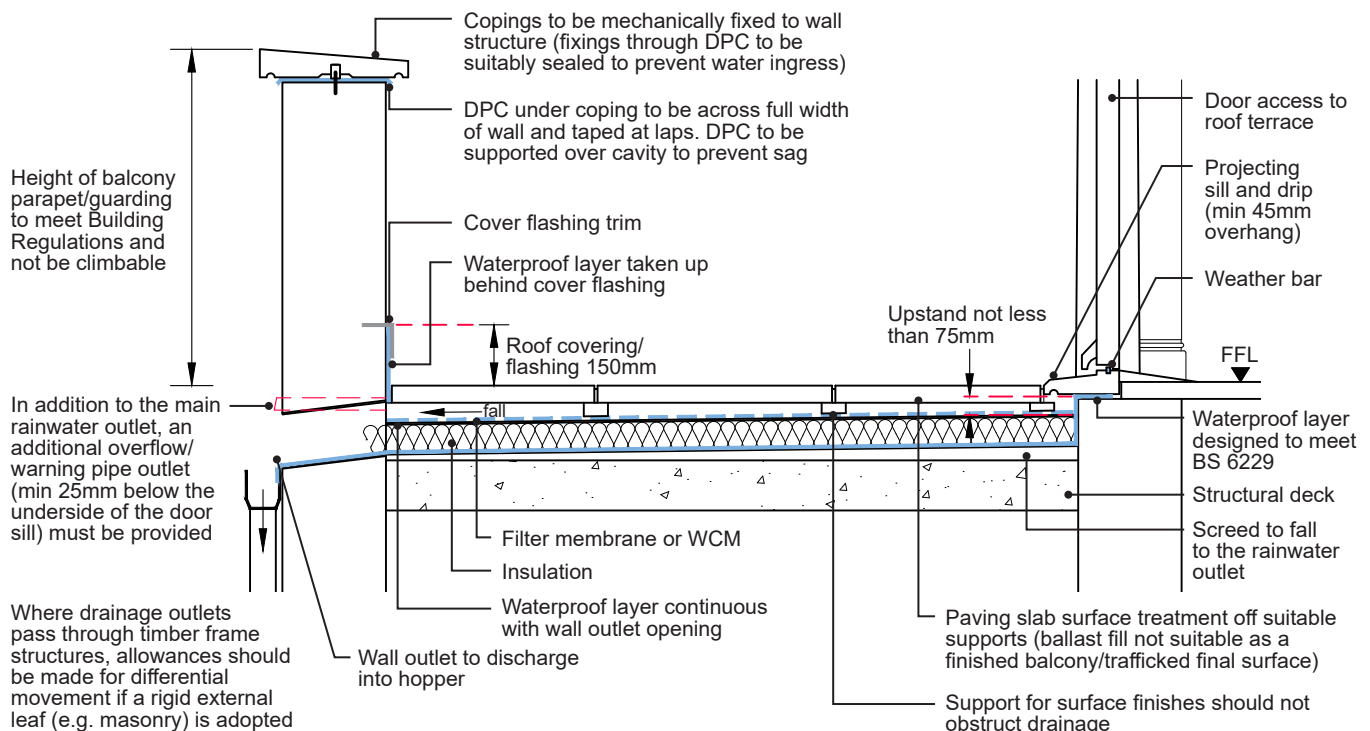
A variant of the warm deck roof terrace in which the principal thermal insulation is placed above the waterproof membrane, resulting in the waterproof membrane, structural deck and structural support being at a temperature close to that of the interior of the building. Generally, the principal insulation is secured by separate ballast (paving, gravel, or blue/green roof - minimum 80 kg/m<sup>2</sup>).

A filter membrane or water control membrane (WCM) should be provided to control mineral and organic material passing into and below the insulation joints. A WCM is recommended because it will provide improved rain water run-off, which may allow for a reduced thickness of insulation and reduced loading of ballast. If a WCM is included, it is essential that the drainage design facilitates the rapid transfer of rain water across the product and to rain water outlets.

#### General build-up



#### Inverted warm deck roof terrace



#### Notes

- Insulation above structural deck and waterproof layer to be suitable for exposure to moisture and of sufficient loading to compress the substrate and promote moisture migration to an outlet.
- Waterproof membrane must be laid to a fall - to a suitable outlet. All joints formed must be sealed in accordance with the manufacturer's requirements and not result in water being trapped/ponding.

- Membrane not to be laid in air temperatures less than 5°C. All membranes are to be fully bonded and a sample of peel tests should be undertaken as verification of workmanship.
- Where structural deck is constructed over accommodation below the design, construction should meet sound insulation requirements.
- Structural deck to be an engineered design for the loading/intended use which should be structurally stable over the lifespan of the building.
- Pedestals for pedestrian surfaces, and the loads they impose on the structure below should not exceed the expected designed loads. The compressive strength of the insulation, waterproof membrane and other materials within the roof terrace build up should be considered by the designer when specifying pedestal systems.
- A spreader plate or additional protection to any waterproof membrane will be required to protect the insulation under paving supports to spread loads to prevent sag and ponding.
- Where the penetration to form the outlet is made through the wall construction, which is constructed of steel frame care should be taken to prevent thermal bridging.
- Hopper construction should include a flashing apron and the hopper should be accessible for clearing debris on a regular basis.
- Parapets should satisfy the requirements of the 'External Walls – Parapets' section.

## Insulation for all roof terraces

For both warm and inverted roof terraces, the insulation should be suitable for the intended purpose. It should be specified to take account of the roof type, having regard to its load-bearing capacity and, where relevant, its water absorption characteristics.

Compressible materials cannot support imposed loads and are not suitable roof terraces.

Thermal insulation should support loads created by the waterproofing system, and any associated surface finishes. Where required loads created by ballast, systems facilitating access to foot traffic, and placement of plant or equipment may also need to be factored in.

Insulation in an inverted roof should also have high resistance to water absorption, freeze/thaw cycling and be shielded from UV light.

Any provision required to control interstitial condensation within the roof should be determined to the calculation method defined by BS 5250, but with ambient conditions set in BS 6229. The calculated maximum accumulation of moisture within thermal insulation should not exceed 350g/m<sup>2</sup> and there shall be no net accumulation in any annual cycle.

Please note, for guidance on thermal performance, installation of insulation, control of condensation and, air and vapour control layers please refer to the 'Roofs – Flat Roofs' section.

## Waterproof membranes

The chosen material should meet the requirements of the 'Roofs – Flat Roofs' section and be suitable for the proposed use case.

### 12.1.4 Structural design

Roof terrace structures shall be designed and constructed so that all loads are sustained and transmitted to supporting structure(s) without causing instability, deflection or deformation.

## Structural design and loadings

The structure of the roof terrace should be designed by an Engineer in accordance with the guidance provided in the 'Roofs – Flat Roofs' section. The Engineer must take the additional loads associated with the proposed use case into account.

## Additional design considerations

The roof terrace design should take account of possible differential movements within the slab/deck and at junctions with supporting structure, parapets, kerbs and upstands. Such movements might be caused by movement of the structural frame or by changes of temperature and moisture content.

A roof deck may be classed as air permeable and likely to allow internal air pressures to impinge on the roof system from below. Wind uplift pressure exerted on the underside of any layer of the construction (which is substantially air-impermeable), such as the vapour control layer or the waterproof layer. This should be resisted by adequate mechanical or fully bonded connections between the air impermeable layer and the deck. Particular consideration should be provided at corners of buildings or where funnelling may occur due to adjacent buildings or topography.

Where the terrace forms part of the entire roof of an occupied building, a continuous barrier to air leakage should be maintained.

### 12.1.5 Guarding, glazed barriers, balustrades and parapets

Roof terraces should have adequate provision for guarding to avoid the risk of falling and shall be appropriately designed by an Engineer so that all loads are sustained and transmitted to supporting structure(s) without causing instability, deflection or deformation.

## General design principles for guarding

Roof terraces should have adequate provision for guarding to minimise the risk of falling.

The Engineer should also consider the following where guarding is specified (including parapets and balustrades where they are used as guarding):

- Guarding should be designed in accordance with BS EN 1991-1-1 to resist horizontal loading.
- Guarding should not be easily climbable by young children.
- Guarding should be of an adequate height as required by the Building Regulations.
- Guarding should not impede on the drainage of the roof terrace.

Where balustrades are specified to be fixed into parapet walls, the Engineer must ensure stability and prevent overturning of the balustrade. End fixings into walls or returns may be needed to ensure stability.

Cavity trays and DPC's in balcony walls can create a slip plane that may limit the ability of the wall to resist horizontal forces. The Engineer should incorporate features to mitigate this risk if required (for example by incorporating a ring beam).

### Glazed barriers

Where glazed barriers are specified to act as guarding and to provide containment (for ensuring the occupants and objects are prevented from falling), it must meet the requirements of the Building Regulations.

Glazed barriers will require an Engineer with relevant experience to undertake a site specific design to ensure that the design of the guarding for the scheme is suitable and due diligence has been demonstrated. For glazed barriers the following criteria should be satisfied by the Engineer:

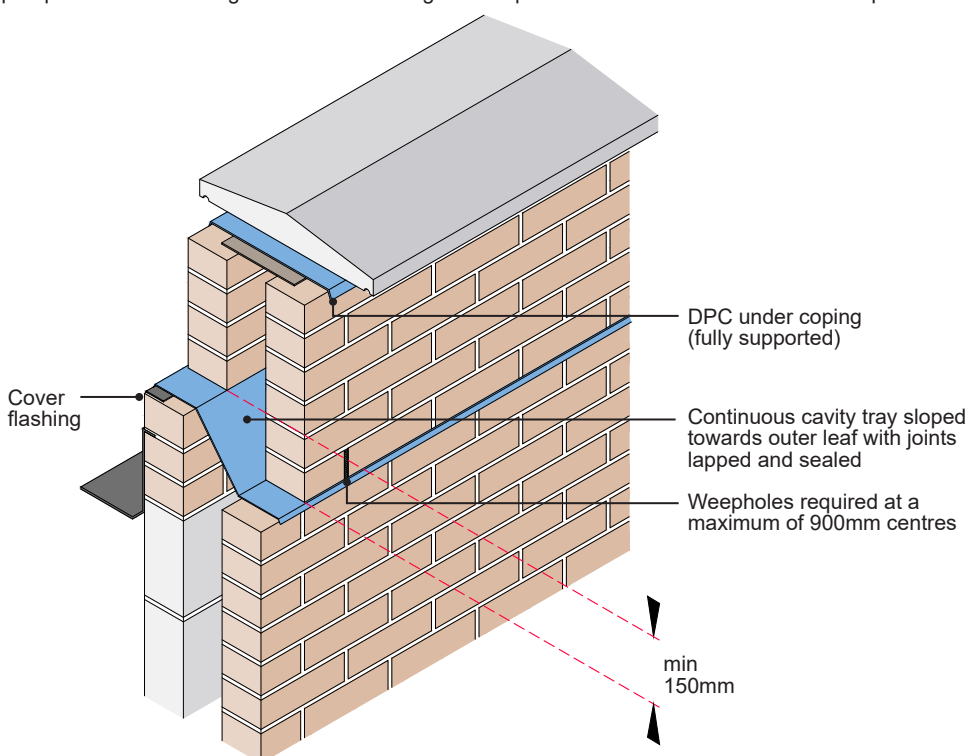
- The barrier/glass should have sufficient strength to resist the design loads with an appropriate factor of safety.
- The displacement of the barrier, under load, should be within acceptable limits for human comfort.
- The barrier/glass should have reasonable resistance to accidental impact.
- The post-failure behaviour of the glass in a barrier should be safe and, if necessary, failed glass should retain some residual strength to preserve life safety.
- The Engineer should clearly demonstrate how containment (for ensuring the occupants and objects are prevented from falling) of the glazing will be achieved.
- Consideration should be made for not solely relying on low level mechanical restraint into a base channel for glass infill panels. A secondary restraint fixing at high level should be considered by the Engineer.
- In buildings which exceed three storeys in height, 100% of toughened glazing should be formed and then heat soak tested in accordance with BS EN 14179-1. The glass must be permanently marked in accordance with BS EN 14179-1 and substantiated evidence of heat soak testing must be disclosed for all effected panes.
  - Alternatively where toughened glazing does not exceed 50kg in weight and where there is safe and easy access to remove and replace the glazing without the need for access scaffolding or fall arrest equipment, a methodology statement of how this will be undertaken should be provided.

### Parapets

Where parapets are specified, they should incorporate at least 3 lines of defence to protect against water penetration. The 3 lines of defence should include:

- The coping/capping.
- Supported DPC under the coping/capping.
- A cavity tray.

All parapets should be designed in line with the guidance provided in our 'External Walls – Parapets' section.



## Balustrade fixings and maintaining the weatherproof envelope

Guard rails and balustrades should ideally be mounted to the sides of the parapets, either internally or externally via face fixings into the parapet wall and not through the coping. This should be the preferred method as it prevents creating weak spots for water ingress.

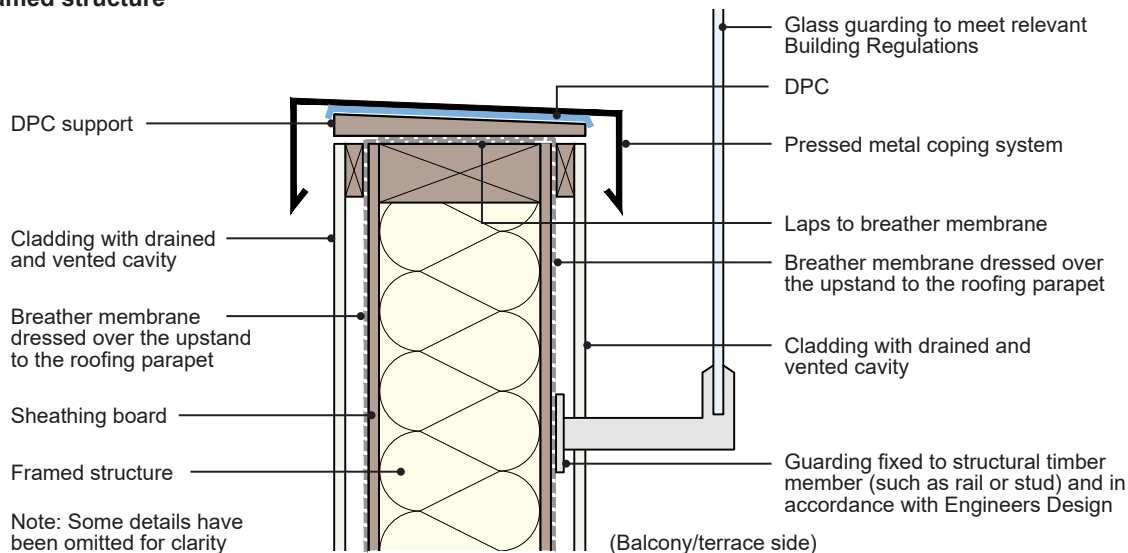
In addition, the following must be taken into account by the Designer:

- The copings weathered upper surface, projection and drainage function must be uninterrupted and unhindered by guarding provisions e.g. glazing channels which are recessed into and divide coping provisions should be avoided.
- Where this cannot be avoided, and any guarding over a coping arrangement is in continuous contact, the free drainage of the coping should not be impeded. In such instances, coping arrangements must incorporate a fall away from the obstruction to any outside edge.
- Where the guarding incorporates proprietary glazing and framing profiles, drainage provisions from glazing channels must be provided and kept free from obstruction. Particular attention should be paid to sealant pointing used where such profiles are in continuous contact with the upper surface of a coping system, as this area can often restrict drainage when incorrectly executed.
- Where the guarding, over a coping arrangement, is in continuous contact with the coping fixings which penetrate the coping arrangement, the fixings must only pass through a self-sealing butyl tape. Reliance on silicone is not acceptable.
- Guarding incorporating elements of glazing may need to be heat soak tested to BS EN 14179-1.

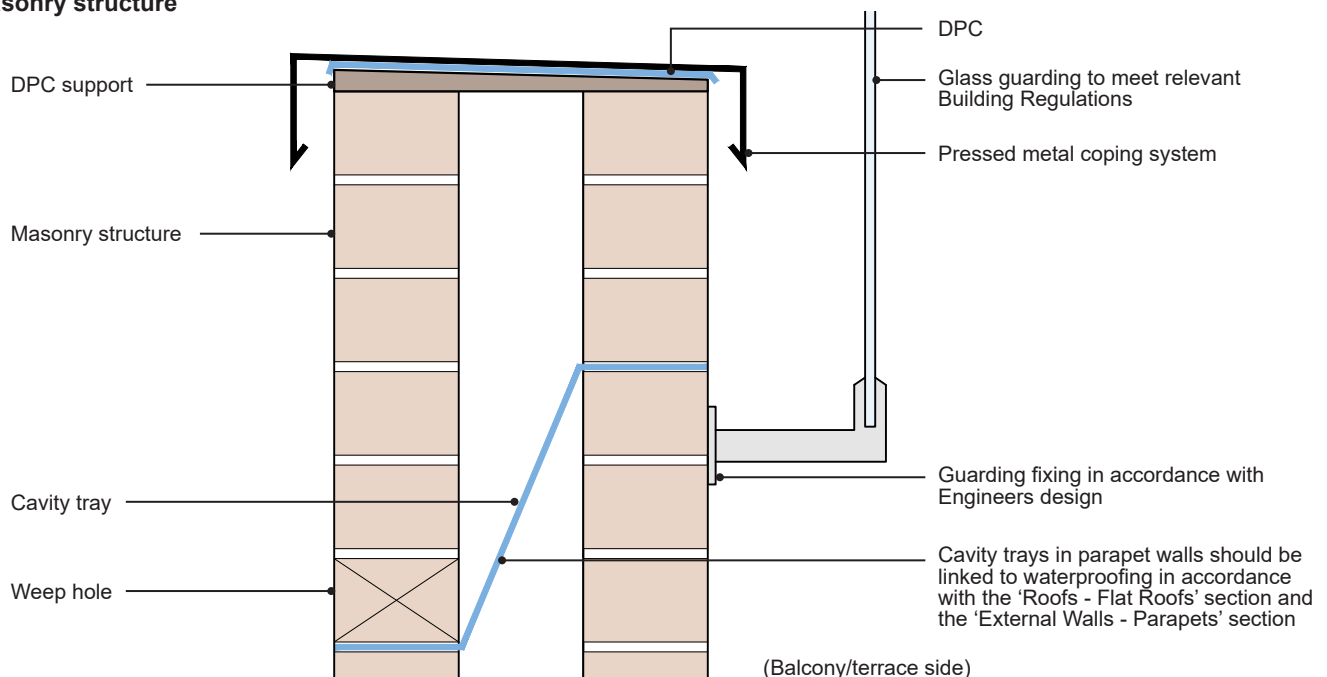
Where fixing of guard rails and/or balustrades through the waterproof membrane cannot be avoided, the fixings must be carefully specified to ensure they are robust and they do not comprise the waterproof membrane. Any penetrations through the waterproof membrane are to be sealed correctly in accordance with the product manufacturer's recommendations.

Materials used in coastal locations (and other aggressive environments must be suitable to resist corrosion).

### Framed structure



### Masonry structure





### 12.1.6 Detailing

Roof terrace waterproofing systems shall be appropriately detailed to ensure satisfactory performance against the effects of weather. Factors to be included are:

- Rain and snow.
- Wind and exposure.
- Movement – structural and thermal.

#### Upstands

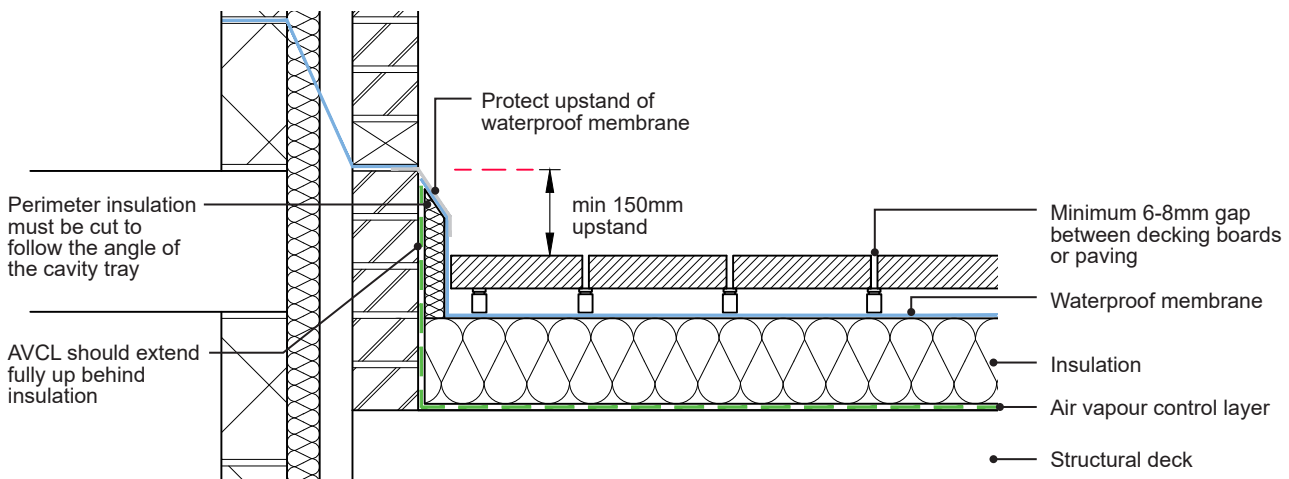
Where the roof terrace abuts a wall, the waterproofing layer must extend 150mm up the wall to form an upstand. The waterproofing layer must be situated under a cavity tray to ensure the cavity fully drains with weep holes being provided in masonry walls at 1m centres. The upstand height may be reduced to 75mm for level access threshold detailing as per the below guidance.

The total roof terrace zone depth should be assessed at critical points, to ensure there is enough space to provide a 150mm upstand to provide waterproofing protection above finished roof level. It is important that this minimum 150mm upstand is maintained at all points around the waterproofed area. A 75mm upstand may be permissible at door thresholds subject to review.

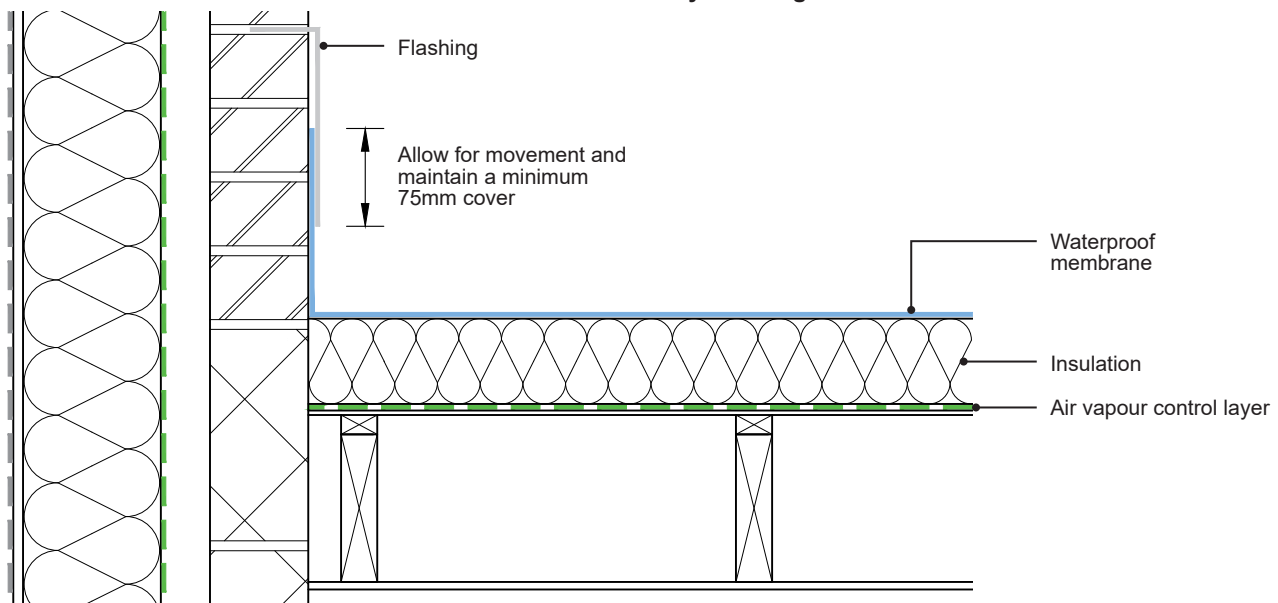
Downstands (of separate metal or other flashings) should lap the upstand by a minimum of 75mm.

Where a roof terrace is specified in conjunction with a blue roof build-up, threshold design must take account of the level of retained water (H-Max).

#### Upstand to decking and paving finishes



#### Allowance for movement where a timber frame with masonry cladding abuts a flat roof



Where a timber frame structure abuts a masonry structure, allowance should be made to accommodate movement in the timber frame and ensure the appropriate cover is maintained.

For detailing with parapet wall construction, see the 'External Walls - Parapets' section.

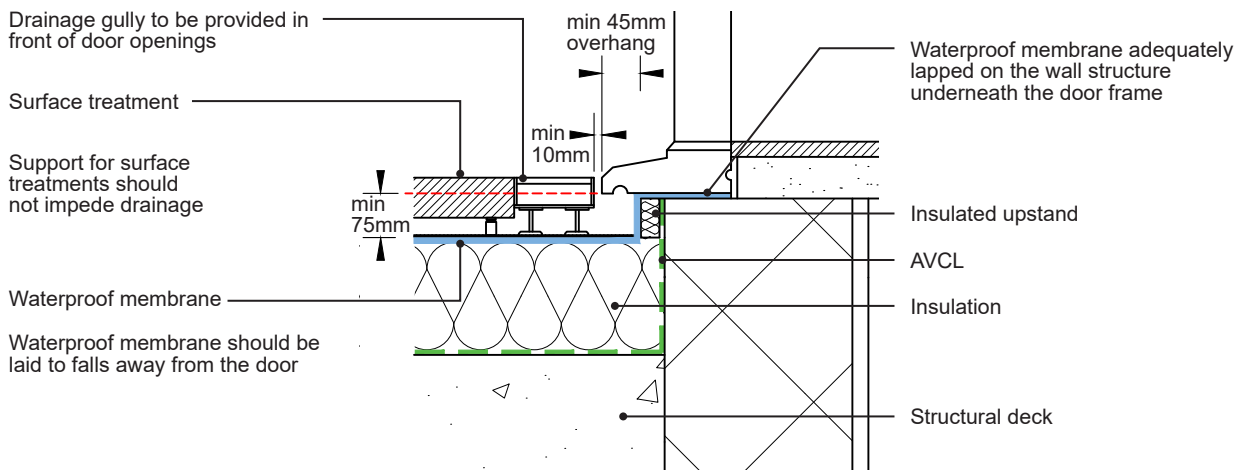
## Level threshold detailing

Where a door threshold is less than 150mm above the roof terrace drainage layer and there is a requirement for level access, the following provisions must be satisfied:

- A minimum 75mm upstand must be maintained under the projecting sill. This should be 75mm as measured from the waterproofing layer on a warm deck roof terrace and 75mm as measured from the water control membrane on an inverted warm deck roof terrace.
- The projecting sill must overhang by at least 45mm with an incorporated drip which is a minimum 30mm away from the upstand. Sills must be adequately supported to ensure no damage to the sill over the long term.

The following should also be considered for level access threshold detailing:

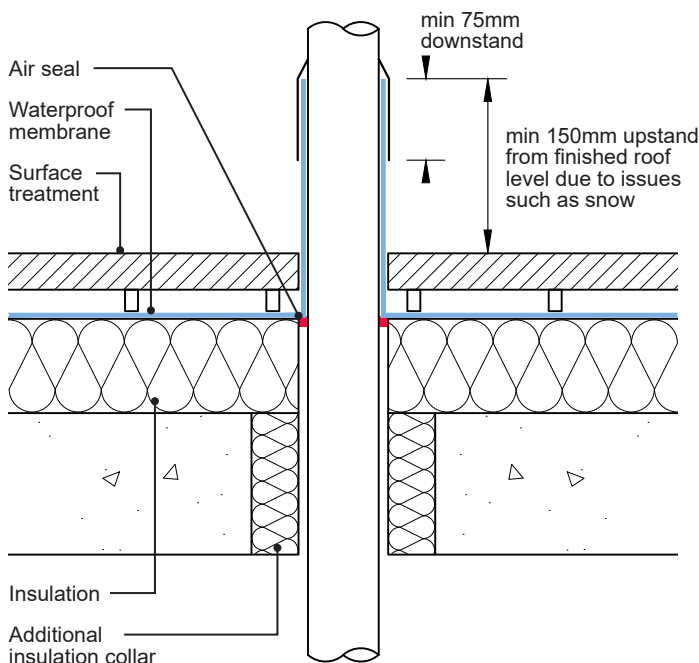
- Reliance on sealants as the sole means of protection from moisture ingress is not an acceptable approach.
- Minimum clearances are maintained to enable the waterproof membrane to be installed.
- Continuity of the membrane across the whole field area of the roof terrace. All terminations of the waterproof membrane at interfaces to other elements are to consider potential expansion and contraction of the membrane used.
- Thermal bridging is avoided through provision of continuity of the thermal line or thermal breaks as appropriate to minimise heat loss and condensation risk.



### Please note:

- For inverted warm deck roof terraces, the waterproof membrane should be situated under the insulation. For further details on build up, refer to the 'Roofs - Flat Roofs' section.

## Penetration through a roof terrace



### Notes:

- Upstands to extend 150mm above the finished roof level.
- Downstands (of separate metal or other flashings) should lap the upstand by a minimum 75mm.
- A chamfered fillet is required at the base of the upstand for certain types of waterproof membrane. Roof membrane manufacturer specification should be followed.
- An effective seal is required between the air vapour control layer and pipe. It is often difficult to dress a sheet material around a pipe. Star cut approaches should be avoided where possible and a proprietary top hat products are often the most suitable. The method for doing so should be stated in the contract drawings and/or specification.

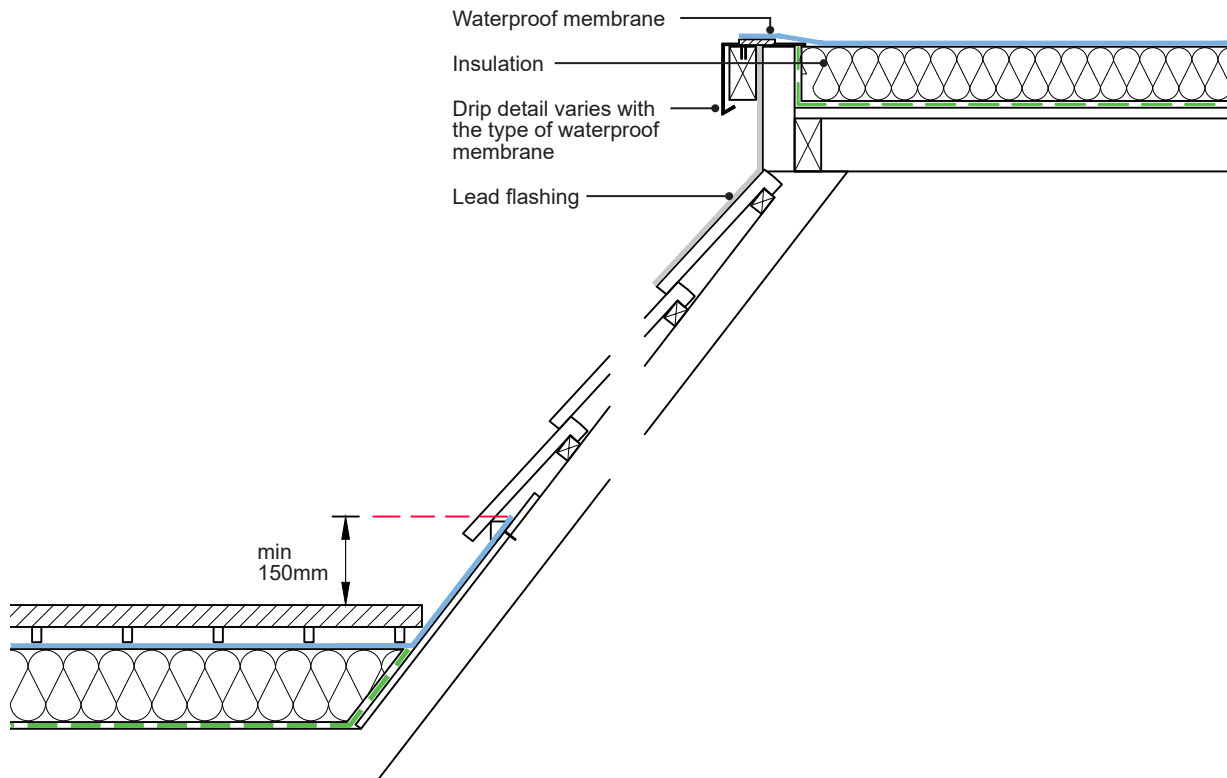


### Special design features

Special design features are essential, depending upon the generic type of waterproof membrane, including:

- Minimum clearances to enable the waterproof membrane to be installed.
- Termination of the waterproof membrane at interfaces to other elements.
- Supports.

### Principles: Flat roof interface to pitched roof



#### 12.1.7 Rainwater drainage

Roof terraces shall effectively drain rainwater from roof areas to a suitable drainage system. The waterproofing finish to a roof terrace shall have a minimum finished fall of 1 in 80 to facilitate rainwater drainage.

The designer should ensure that any obstructions (pedestals, support systems for paving slabs, cabling etc) below the finished pedestrian surface will not impede on the rainwater drainage performance.

Where the roof finish is to include paving on supports, consideration should be given to the height difference created by the falls and spacing of rainwater outlets so that the maximum height of paving supports is not exceeded, the minimum height of upstands is not affected or trip hazards created. On large balconies and roof terraces it may be necessary to increase the number of outlets in order to reduce maximum roof zone depth.

Any box or internal gutter included in a roof terrace must have a 1:80 fall to an outlet or outlets.

For further guidance on rainwater drainage and falls, please refer to the 'Roofs – Flat Roofs' section.

#### 12.1.8 Rainwater outlets

Rainwater outlets shall be appropriately sized, positioned and have the required capacity to deal with the expected rainfall intensity.

This guidance should be read in conjunction with guidance in the 'Roofs – Flat Roofs' section for falls, outlets and overflows.

The number and size of outlets required to deal with the expected rainfall intensity should be specified in accordance with BS EN 12056-3. They should be positioned to provide drainage to all areas of the roof terrace.

Roof terraces must have at least one outlet and an overflow to drain and warn of outlet/downpipe blockage and so avoid the risk of flooding or structural overloading.

Decking and/or paving should not impede on the drainage of water to rainwater outlets. To ensure adequate drainage, the designer should ensure the following:

- A 10mm gap between the façade and pedestrian surface is be provided to avoid run off water overly wetting the façade.
- As-built gaps between planks or slabs should be between 6mm to 8mm to achieve effective drainage.
- Spacers or supports to raise the decking and/or paving should not impede on the flow of rainwater to outlets.
- Cabling and pedestals below decking and/or paving slabs should not impede on the flow of rainwater to outlets.

Rainwater outlets should be readily accessible without damage of the pedestrian finish. This may be achieved by a suitably marked paving slab or demountable section of decking.

Rainwater outlets for inverted roofs should be of the dual height type, designed to maximise removal of rainwater at WFRL level.

## 12.1.9 Overflows

Overflows shall be provided and be adequately sized to avoid the risk of flooding to any roof terrace area.

This guidance should be read in conjunction with guidance in the 'Roofs – Flat Roofs' section for falls, outlets and overflows.

The capacity of the overflow should be not less than that of the outlet or combined outlets, and its discharge should be visible but directed away from the building.

Overflows should be conspicuously positioned for inspection and as close to the outlets as practicable to avoid rainwater build up on roofs.

The overflow level should be set at the design water level for the rainwater outlets, which in most instances is typically 30-35 mm above the outlet.

Where there is a sump included at the rainwater outlet position, the overflow should be set at the level of the lip into that sump. The level of overflows should be 25 mm below the underside of the any sill positions e.g. thresholds.

## 12.1.10 Control of work post waterproofing completion

Where required, work conducted after waterproofing system completion shall be appropriately managed and controlled to avoid a loss of waterproofing integrity.

### General

Where additional work is required to facilitate a follow on service or function, as far as practicable, any waterproofing work shall be executed by the Approved Installer of the waterproofing system. Where this cannot be accomplished, any work conducted by a third party shall be inspected and signed off by the Approved Installer when complete. The Warranty surveyor at their discretion may request evidence of this for record purposes.

Relevant additional work is considered to include:

- Installation of lightning protection.
- Installation or placement of mechanical, electrical and communication services.
- Installation or placement of renewables e.g. PV panels.
- Installation of safety equipment for access.

The placement of services and or equipment is considered a foreseeable function that can be factored in at design stage, and as such the Warranty provider requires that all work is included into the site specific design and specification.

### Surface attachment

Any form of attachment made to the surface of a waterproofing system (e.g. lightning protection pads or clips) must not compromise the integrity of the waterproofing system or diminish its longevity. The materials, inclusive of bonding adhesives, and methodology for attachment shall be confirmed as compatible with the waterproofing system by the waterproofing manufacturer.

### Service penetrations

If penetrations can be avoided and cabling and/or pipework suitably routed without penetrating the waterproofing system, then this is considered the preferred course of action. Where penetrations cannot be avoided, then they shall be formed to avoid water ingress and formed using appropriate detailing and materials.

Where ductwork is located on a roof:

- A 50mm clearance should be provided to horizontal ductwork to ensure it does not rest upon the waterproof membrane or roof finish.
- Entry/exit points should be suitably weathered without loss of integrity of the waterproof membrane – this shall include the formation of appropriate upstands in the waterproof membrane at risers, and include separate down stand or weathering flashing to be formed in ductwork.

### Equipment and plant installations

Loads from equipment, associated mounts or frames and any ballast shall appropriately transfer loads to the structure without damage to the waterproofing system. The placement of equipment and/or plant, and any associated proprietary framework systems or mounts onto the waterproofing system shall include all relevant protection measures to ensure that the risk of damage is avoided.

Where there is a requirement for structural fixings or mounts to penetrate through the waterproofing system and into the roof structure, installation requirements stipulated by the manufacturer of the associated equipment should be communicated to the waterproofing system manufacturer and installer to enable the design and execution of an appropriate waterproofing detail.

### Penetration from structural fixings or anchor points

Where there is a requirement for structural fixings or anchor points to penetrate through the waterproofing system and into the roof structure, installation requirements stipulated by the manufacturer of the associated equipment should be communicated to the waterproofing system manufacturer and installer to enable the design and execution of an appropriate waterproofing detail.

#### 12.1.11 Pedestrian surface finishes

The specification and installation of a pedestrian surface finish shall:

- Provide an appropriate level of protection to prevent damage to the waterproofing system.
- Be suitable for intended purpose.
- Not impede on the drainage of the roof terrace.
- The design should include protection to suit the anticipated conditions as appropriate.
- All pedestrian surfaces finishes should comply with the relevant Building Regulations in regards to combustibility requirements in regards to a relevant boundary.
- Pedestrian surface finishes and their supports should not impeded the ability for the terrace to drain to all outlets.
- The surface finish of all roof terrace areas should have a low slip potential (in wet and dry conditions) when tested to BS 7976.
- Supports or pedestals to pedestrian finishes should not be mechanically fixed through the waterproof membrane.

### Pedestrian finishes for terraces

| Finish                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Roof system type |          | Waterproof membrane type |                  |                |                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------|--------------------------|------------------|----------------|----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Warm             | Inverted | Single ply membrane      | Bitumen membrane | Mastic asphalt | Liquid applied |
| Porous concrete tiles adhered to waterproof membrane <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Y                | N        | N                        | Y                | Y <sup>2</sup> | Y              |
| Fired tiles bedded in screed and grouted <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Y                | N        | Y                        | Y                | Y <sup>2</sup> | Y              |
| Precast concrete paving slabs on adjustable supports <sup>3,4</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Y                | Y        | Y                        | Y                | Y              | Y              |
| Notes:<br><sup>1</sup> Product should be certified for use with waterproof membrane.<br><sup>2</sup> Consideration should be given to the effects of solar gain on the stability of mastic asphalt under point loading in this situation.<br><sup>3</sup> Paving support pad bearing area should be suitable for the compressive strength of the insulation under design loadings.<br><sup>4</sup> Bearers should not impede drainage, and should be sized to suit the compressive strength of the insulation under design loadings. |                  |          |                          |                  |                |                |

#### Non-access areas: stone ballast

Stone ballast for inverted warm deck roofs and ballasted warm deck roofs should be clean, rounded aggregate graded 20mm-40mm and as free from fines as practicable. Ballast should be applied over a protection layer on warm ballasted systems and over a filter layer or WCM on inverted warm roofs and suitably provided to prevent wind uplift.

#### Access areas: concrete paving slabs

Concrete paving slabs for use as walkways or as paving on terrace decks should conform to BS EN 1340, and be laid in accordance with the manufacturer's instructions.

It is recommended that concrete paving is laid on support pads as this allows adjustment, reducing risk of trip hazard. Recommendations are as follows:

- The height of support pads should not exceed the maximum recommended by the manufacturer.
- Provision for movement at perimeters should comprise either a 75mm margin of washed stone or a compressible rubberised fill. In either case drainage should not be obstructed and a suitable restraint trim should be used to ensure stone does not fall beneath the paving adjacent.
- Paving should not be cut.
- Paving should be firmly butted up against support pad separating pegs.
- Support pad separating pegs should provide clear space for rapid disposal of rain water between paving slabs.

#### Access areas: flexible walkway tiles

Evidence of the compatibility of the tile with the waterproof membrane is required.

## Pedestals

Where pedestals are specified to support pedestrian surface finishes (such as paving slabs), they should be:

- Appropriate for the intended purpose.
- Appropriate for the site specified conditions.
- Compatible with the waterproofing system, thermal insulation and all other components within the roof terrace build-up.

Pedestals, and the loads they impose on the structure below should not exceed the expected designed loads.

The compressive strength of the insulation, waterproof membrane and other materials within the roof terrace build up should be considered by the designer when specifying pedestal systems.

Where dead and/or live loads are anticipated to be high, there should be consideration for the use of a cover board underneath the waterproof layer and/or a rail system.

In addition, the pedestal should not create a risk of damage to the waterproofing (e.g. sharp edges).

### 12.1.12 Completion testing

Waterproofing systems for roof terraces shall be tested where required by the 'Roofs – Flat Roofs' section, when complete, to prove and demonstrate resistance to the passage of moisture.

For further guidance, please refer to the 'Roofs – Flat Roofs' section.

## Introduction

This section provides guidance on meet the performance requirements for balconies.

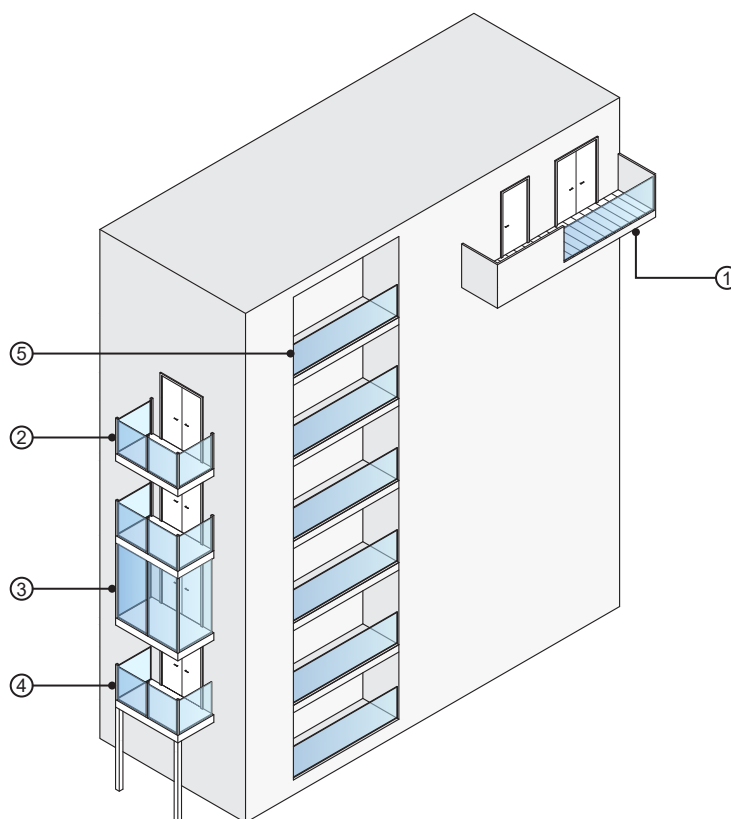
For the purposes of Warranty, a balcony is a building component which is an accessible external amenity platform above ground level which is exterior to and with direct access from a building.

A balcony can project beyond the walls of a building; it can be formed within a recess of a building; or it can be a hybrid of both as further explained in this section. A balcony does not form part of the thermal envelope, e.g. not forming a roof.

Balconies may take the form of:

1. **Access balcony:** providing pedestrian access to two or more dwellings. (Sometimes referred to as a 'walkway' or 'access deck').
2. **Projecting balcony:** an accessible external amenity platform affixed to the exterior of a building above ground level with direct access from a building.
3. **Enclosed balcony:** protected by a roof or balcony above, and with walls or weather screens to the sides, (sometimes referred to as a 'winter garden').
4. **Free-standing:** fully or partially supported, independent of the building structure.
5. **Inset balcony:** a balcony that is recessed inwards from the external wall line of a building but not above a habitable internal space (sometimes referred to as 'recessed balcony').

A 'balcony' formed over accommodation is a 'roof terrace', please see the 'Roof Terraces and Balconies – Roof Terraces' section.



### 12.2.1 Compliance

Balconies shall be designed and constructed to meet the performance requirements of this section.

### 12.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full set of detailed drawings including:
  - a. Balcony identification plan clearly indicating all balcony types e.g. projecting balconies, inset balconies, access decks/ walkways, Juliet balconies.
  - b. Plan showing direction of falls and position of outlets and overflows.
  - c. Details of all critical junctions including support of the threshold and any upstand interfacing with the façade.
  - d. Details of the provision of pedestrian surface support structure (where appropriate).
  - e. Details of the provision of guarding including parapet walls and balustrading used as guarding, should be designed in accordance with BS EN 1991-1-1 to resist horizontal loading.
  - f. Details of all fire stopping which should include specification and a detailed location layout drawing showing positioning of all fire stopping.
2. A detailed drainage strategy for all balconies.
3. A full structural design by an Engineer.
4. Details of fixings, their fixing locations and method of fixing, including those for surfacing materials.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

## 12.2.3 General design

The design and construction of balconies shall be appropriate for the intended use.

The designer must be aware of the specific scope of the applicable Warranty policy in context of the limitations of the Technical Manual guidance compared with additional requirements contained within other standards e.g. BS 8579, which may extend beyond the scope of our requirements. The designer may consider their own design aims, beyond the minimum requirements of the Technical Manual in any specification and in this instance BS 8579 may be consulted by the designer.

### List of standards

- BS 6229 Flat roofs with continuously supported flexible waterproof coverings. Code of practice.
- BS 8579 Guide to the design of balconies and terraces.

## 12.2.4 Structural design

Balconies shall be designed and constructed so that all loads are sustained and transmitted to supporting structure(s) without causing instability, deflection or deformation.

Balconies should be designed to meet the following requirements:

- Balconies should be designed to meet BS EN 1991-1-1, BS EN 1991-1-3, BS EN 1991-1-4 and BS 8579 for balconies. Due consideration of any added surfacing; paving slabs, decking boards etc. Snow loads should be assessed in accordance with BS EN 1991-1-3 + UK National Annex. Wind loads should be assessed in accordance with BS EN 1991-1-4.
- Balconies should be designed to address both short term and long-term deflection to provide an effective drainage strategy with no back falls or ponding.
- The resistance to wind uplift of the waterproof covering and finishes on a balcony should be assessed having regard to the dead weight of those materials and to the nature, type and disposition of their attachment to the slab or deck, in accordance with BS 8217 and BS EN 16002.
- Balconies should be designed to have adequate crack control/dimensional stability to avoid damage to directly applied AVCL and waterproofing layer, particularly liquid applied waterproofing.
- It is common for several designers to be involved in different elements of the balcony structural design; for example, interfaces with the main structure, guarding and balustrading design etc. There are risks associated with methods of procurement which introduce multiple interfaces. There should always be one party with a responsibility to assure that the final design, as a whole, is acceptable.

Balconies are usually designed to limited load capacities and as such additional excessive loads should be anticipated to avoid any potential structural failures. Examples include planters, gym equipment or using the balcony for storage purposes.

### Durability

All structural components must have a service life of at least 60 years unless otherwise stated.

Prefabricated balcony structures should have a third party product conformity certificate and have a service life of at least 60 years.

#### Timber durability

For Warranty purposes, timber should only be considered for projects up to 2.4m from the external ground level. Please note, the use of timber for non-structural components may be restricted by relevant Building Regulation and other legislative requirements.

Please refer to 'Appendix C' for further guidance on service life requirements for the use of timber in balconies.

All structural timber used should be stress graded. All such timber must be stamped as either 'DRY' or 'KD' (Kiln Dry). The use of ungraded, or 'green', timber is not acceptable.

The design should be in accordance with: The Code of Practice 'Balconies on new homes' published by TDCA, or an Engineer's design.

The balcony design should take account of possible differential movements within the slab/deck and at junctions with supporting structure, parapets, kerbs and upstands.

Note: Such movements might be caused by movement of the structural frame or by changes of temperature and moisture content.

### 12.2.5 Guarding

All balconies (including juliet balconies) shall be guarded to minimise the risk of falling.

#### General principles

The following should be considered where any type of guarding is specified:

- The guarding should meet the requirements of the relevant Building Regulations e.g. height requirements, guarding configuration requirements, etc.
- All guarding (including parapet walls and balustrading systems) should be designed in accordance with BS EN 1991-1-1 to resist horizontal loading.
- The guarding should be not prevent the balcony area from draining rainwater or overflows from functioning in the event of an outlet being blocked.

Note: Where guarding is attached to a climbable shelf, plinth or parapet, the guarding height (800mm) should be taken from the shelf, plinth or parapet.

#### Glazed barriers

Where glazed barriers are specified to act as guarding and to provide containment (for ensuring the occupants and objects are prevented from falling), it must meet the requirements of the Building Regulations.

Glazed barriers will require an Engineer with relevant experience to undertake a site specific design to ensure that the design of the guarding for the scheme is suitable and due diligence has been demonstrated. For glazed barriers the criteria should be satisfied by the Engineer:

- The barrier/glass should have sufficient strength to resist the design loads with an appropriate factor of safety.
- The displacement of the barrier, under load, should be within acceptable limits for human comfort.
- The barrier/glass should have reasonable resistance to accidental impact.
- The post-failure behaviour of the glass in a barrier should be safe and, if necessary, failed glass should retain some residual strength to preserve life safety.
- The Engineer should clearly demonstrate how containment (for ensuring the occupants and objects are prevented from falling) of the glazing will be achieved.
- Consideration should be made for not solely relying on low level mechanical restraint into a base channel for glass infill panels. A secondary restraint fixing at high level should be considered by the designer.
- In buildings which exceed three storeys in height, 100% of toughened glazing should be formed and then heat soak tested in accordance with BS EN 14179-1. The glass must be permanently marked in accordance with BS EN 14179-1 and substantiated evidence of heat soak testing must be disclosed for all effected panes.
  - Alternatively where toughened glazing does not exceed 50kg in weight and where there is safe and easy access to remove and replace the glazing without the need for access scaffolding or fall arrest equipment, a methodology statement of how this will be undertaken should be provided.

#### Masonry parapet walls

Please refer to the 'External Walls – Parapets' section for guidance on the construction of masonry parapet walls.

Cavity trays and DPCs can create a slip plane that may limit the ability of the parapet wall to resist horizontal forces. The Engineer should check the structural stability of the parapet wall and appropriate steps should be taken to mitigate this risk.

#### Balustrading and guard rails

Balustrading and guard rails should be fixed securely to a structure which can safely resist the potential forces acting on the guarding. The durability of balustrading and guard rails should be appropriate with particular attention paid to coastal areas where corrosion resistant materials should be chosen. Please refer to 'Appendix B – Coastal Locations' for further information.

Balustrades should not be fixed through the coping or capping. Balustrades should be fixed to the face of the wall. Please refer to the 'External Walls - Parapets' section for further guidance.

Fixings for balustrades must be carefully designed to ensure appropriate fixings are robust and any penetration through waterproof roof coverings is sealed correctly in accordance with the waterproof covering manufacturer's recommendations.

### 12.2.6 Drainage design

Balconies shall effectively drain rainwater away from the building. The following drainage approaches are suitable for Warranty:

- Positively drained.
- Free drained.
- Edge drained.

No other roofs or balconies should be designed to deliberately drain onto an edge or positively drained balcony.



## Positively drained

All inset or semi inset balconies must be positively drained. Other drainage approaches are not acceptable in this arrangement.

With a positively drained balcony design, water is collected on a waterproof surface and directed to a piped outlet into the wider drainage network. An over flow is used to warn of outlet/downpipe blockage and so avoids the risk of flooding to the balcony area.

A positively drained balcony design should be based upon calculations in accordance with BS EN 12056 Part 3. Rain water outlet capacity should be taken from properly certificated information provided by a manufacturer, the resulting number and layout of outlets should avoid the potential for obstruction, for example by the decking supports. Sub frames or pedestal deck systems must be designed to mitigate the potential risks of point loads on the waterproofing product which could cause localised degradation to the waterproofing system.

The drainage above the waterproof covering and below any raised decking finishes must not be restricted or blocked by the decking supports. The decking supports must allow free drainage of all areas of the roof to the designated outlets.

Rainwater outlets should be readily accessible without damage of the pedestrian finish. This may be achieved by a suitably marked paving slab or demountable section of decking.

The designer should ensure that any obstructions (pedestals, support systems for paving slabs, cabling etc) below the finished pedestrian surface will not impede on the rainwater drainage performance.

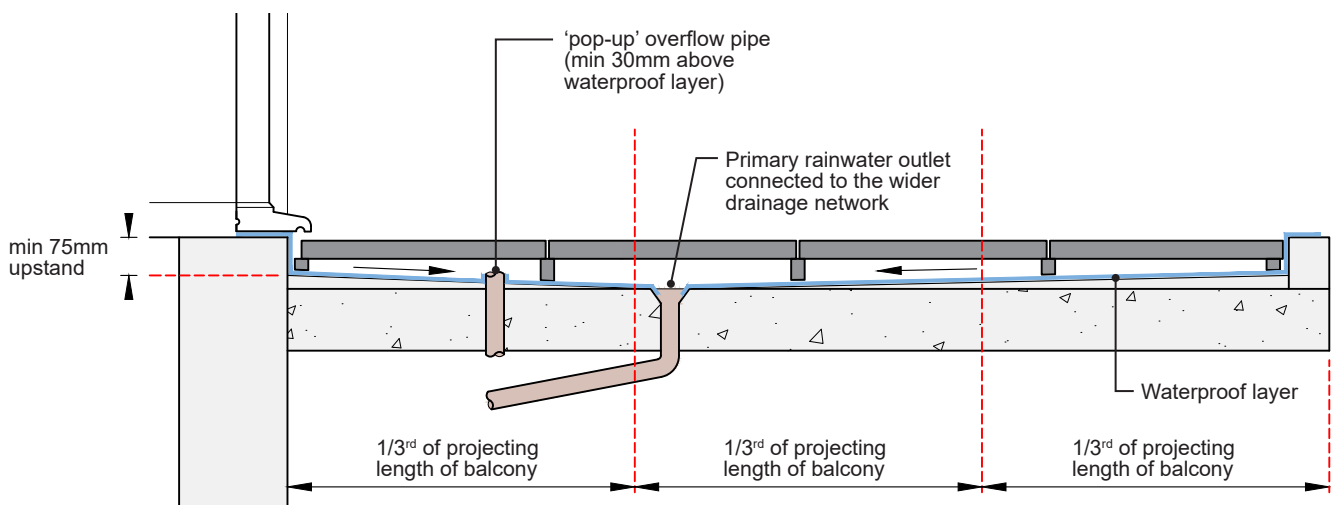
## Rainwater outlets

Where rainwater outlets are specified, they should satisfy the requirements of the 'Roofs – Flat Roofs' section.

The following should be confirmed by reference to the manufacturer's information or independent certification, as appropriate:

- Capacity in litres per second at a range of typical water heads.
- Method of attachment within the substrate.
- Material compatibility with the waterproof membrane.

The outlet should not be positioned adjacent to the threshold. It is recommended that the outlet is positioned at any point between the leading edge and 1/3 of the length of the balcony from the threshold as per the below detailing.



Red line shows 1/3<sup>rd</sup> of projecting length of balcony. Details relating to pedestrian surface and guarding omitted for clarity.

## Overflows

Where overflows are specified, they should satisfy the requirements of the 'Roofs – Flat Roofs' section.

A conspicuous overflow should be provided. It is recommended a pop up overflow pipe protruding 30mm above the waterproofing layer is provided. It should be positioned in the zone between the threshold and 1/3 of the projecting length along the balcony. It may be offset along this position but its height must be a minimum of 25mm below any thresholds.

Balconies which drain to a single internal outlet or combined outlets connected into a single downpipe, must be provided with a conspicuous overflow. Its function is to drain and warn of outlet/downpipe blockage and so avoid the risk of surcharging the upstand which can lead to moisture ingress. The capacity of the overflow should be not less than that of the outlet or combined outlets and its discharge should be visible but directed away from the building.



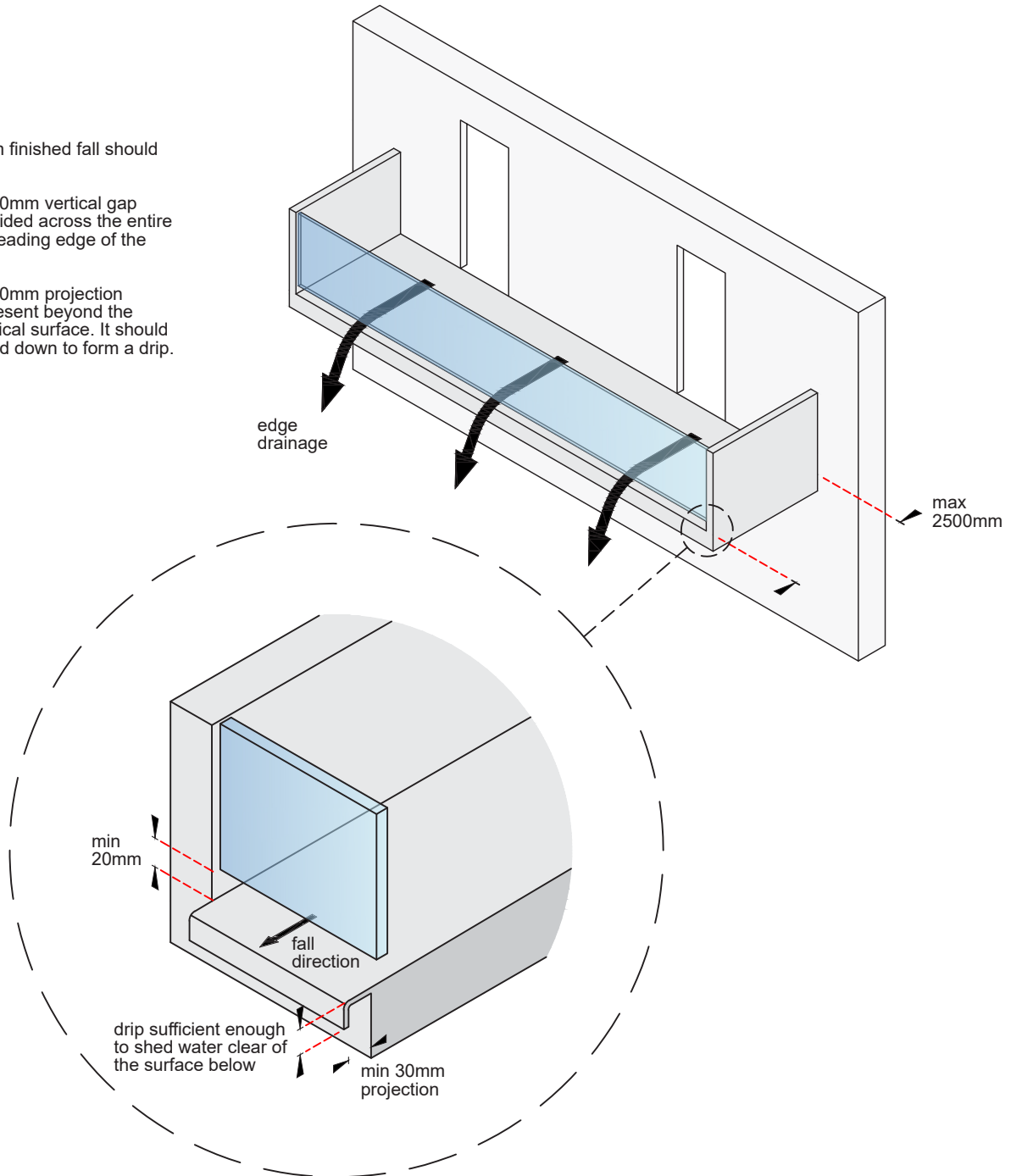
### Edge drainage

This is a design approach which allows water to quickly pass through a pedestrian surface through to a soffit collection tray or impervious surface laid to falls. Where it is then momentarily collected and drained away from the weatherproof envelope of the building so that it does not cascade onto another balcony and discharges to a lower level where the water is appropriately managed.

The minimum finished fall should be 1:80.

A minimum 20mm vertical gap must be provided across the entire width of the leading edge of the balcony.

A minimum 30mm projection should be present beyond the adjacent vertical surface. It should also be turned down to form a drip.



Where edge drainage is proposed, the following should also be considered:

- The minimum finished fall should be 1:80. Design falls should take account of any potential deflection and construction tolerances. In the absence of detailed calculations, this may necessitate design falls of twice the minimum finished falls (1:40 or 2.5%). Falls should follow the same direction as the cantilever of the balcony to prevent back falls in drainage or ponding as loads are applied.
- Chutes or pipes draining directly to an open area are not acceptable. Any edge draining approaches should ensure as much as practicable that drainage should not be interrupted, for example by any supporting structure or similar.
- Where decking boards are used at the pedestrian surface level, grooved decking boards should be orientated to promote the shedding of water at the leading edge of the projecting balcony.
- At the base of any stack of balconies, provision for landscaping drainage must be provided as part of the design to ensure that water does not pond at ground or podium level. Paths should be avoided in areas beneath balcony stacks that utilise an edge drained approach. Where paths cannot be avoided, a suitable protection method for pedestrians should be provided.

## Free drainage

Where a free draining approach is used, water is not collected on a membrane or impervious surface but allowed to dissipate through a number of perforations in the balcony substrate, meaning that any hydraulic head of water is avoided. The pedestrian surface is designed to ensure that water is not collected and stored in any way. The pedestrian surface and the water collecting surface are the same.

Where this approach is proposed:

- Balcony surfaces must be orientated to fall away from the building so that water cannot track back toward the building. Standing water is not acceptable.
- The support arms must be designed to:
  - Prevent water tracking along their underside toward the building. Where this risk is not managed, water may run down the façade, giving a greater likelihood of penetrative damp and staining.
  - Drip edge breaks in the support structure and component design to allow water to track away from the building will mitigate this risk.
- A structural upstand of not less than 75mm consisting of a fully bonded waterproof outer membrane that has a third party product conformity certificate for that use is to be provided where level thresholds are required.
- A 10mm gap between the façade and pedestrian surface is to be provided to avoid run off water overly wetting the façade. Supporting bracketry connections to the main building are to be sealed so that they are weathertight to any potential moisture ingress entering the building.
- Where the abutting walls are exposed to localised wetting (e.g. splashback of rainwater from any abutting free draining surface), the designer should consider the effects of this on the building fabric and select appropriate materials and protection measures.
- The free draining approach must meet all of the following criteria:
  - a. As-built gaps between planks or slabs should be between 6 mm to 8 mm to achieve effective drainage whilst minimizing the risk of discomfort to users with enhanced needs. This spacing must be closely controlled.
  - b. As-built gaps of 10 mm to 12 mm should be maintained around the perimeter of the pedestrian surface to facilitate good drainage and the sides of any balcony proposed must not abut the weatherproof envelope.
  - c. Where the design is to provide perforated draining, the position and sizing of the perforations or open grid should be consistently and regularly applied across the entire surface of the balcony. Openings, either perforated or linear, should provide a total free draining area of at least 5% of the overall surface area and provide a solution which ensures water is instantly dissipated from the pedestrian surface.
- Where non-combustible decking boards are used at the pedestrian surface level, grooved decking boards should be orientated to promote the shedding of water at the leading edge.
- The design should ensure that the supporting structure does not locally interfere with the drainage path or prevent free draining of the balcony area.

### 12.2.7 Creation of falls

Positively and edge drained balconies shall have a minimum finished fall of 1 in 80 to facilitate rainwater drainage.

This guidance should be read in conjunction with guidance in the 'Roofs – Flat Roofs' section on falls.

- Balconies should be designed to fall away from the building elevation.
- A minimum finished fall at any point of 1:80 (1.25%) should be achieved.
- Since adjoining roof planes at 1:80 will meet at a mitre of less than 1:80, the intended finished fall at such intersections should be considered at an early stage.
- Design falls should take account of any potential deflection and construction tolerances. In the absence of detailed a justification, this may necessitate design falls of twice the minimum finished falls (1:40 or 2.5%).
- The manufacturers' of certain waterproofing products have certification for their use in 'completely flat' or 'zero falls' applications. For Warranty purposes, all balconies must be designed to 1:80 falls to avoid backfalling.

Consideration should also be given to:

- The available upstand height at the high end of the falls. This may be a limiting factor on the length/size of the balcony/terrace area to be drained. If necessary additional rainwater outlets should be provided.
- Avoidance of ponding behind wide obstructions to the drained slope such as plant plinths. Additional rainwater outlets should be provided.
- Falls between rain water outlets along a perimeter.

Waterproof coverings of all types are tested for water absorption and water tightness as part of the third party product conformity certificate. However, the construction process, including the installation of components and the forming of seams, is clearly facilitated in dry, well-drained conditions.

### Creation of falls

Falls may either be created during the construction of the deck or by applied cementitious screeds. Cementitious screeds provide a stable substrate to mitred falls with minimal tolerances, and are recommended. Screeds should be in accordance with BS 8204.

Paving support systems must be designed so that they take into account the maximum height formed when considering the falls for the balcony.

### 12.2.8 Detailing of waterproofing layers

Where a waterproofing layer is specified for a balcony structure, it shall be detailed to prevent water ingress into the building.

The specification, installation and testing of waterproofing layers shall satisfy the 'Roofs – Flat Roofs' section.

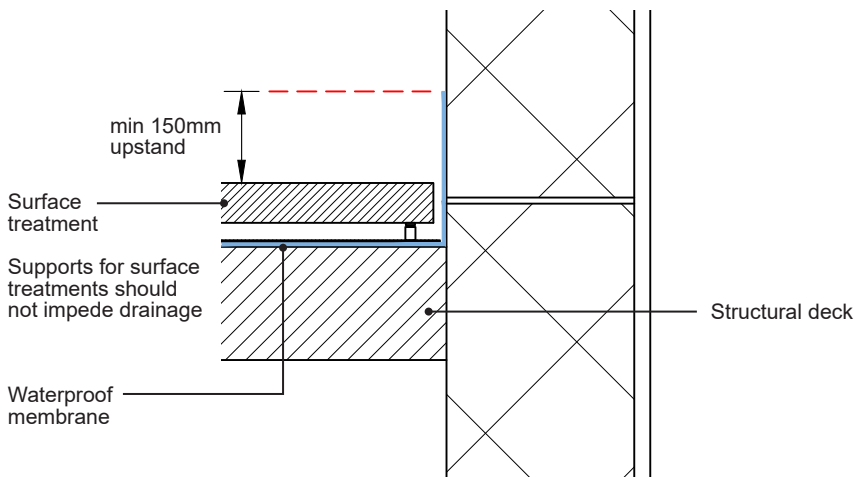
Care should be taken to prevent water ingress from the balcony area to any abutting internal spaces, the structure or building envelope to which the balcony structure is attached. Junctions with the main structure and threshold detailing should be considered during the design stage.

#### British and industry standards

The requirements of BS 6229 should prevail in respect of balconies irrespective of the type of waterproof membrane.

#### Upstands

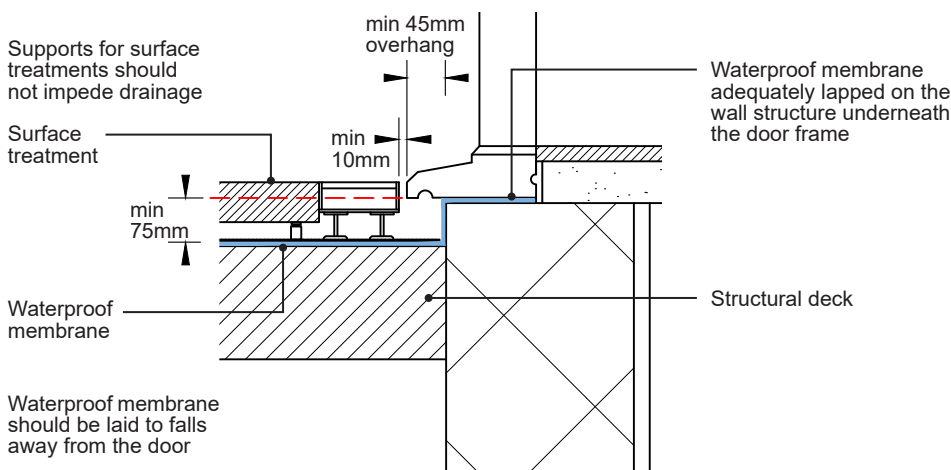
Where the balcony abuts against an external wall, the waterproofing layer should extend 150mm up the wall to form an upstand and protect any internal spaces. The waterproofing layer must be situated under a cavity tray to ensure the cavity fully drains with weep holes being provided in masonry walls at 1m centres. The upstand height may be reduced to 75mm for level access threshold detailing.



#### Level access threshold detailing

Where a waterproofing layer is used, a 75mm upstand should be formed with the waterproofing layer. The door threshold sill and drip should form a minimum 45mm overhang. A 10mm gap between the drainage gully and door threshold sill should be provided.

The same principles apply for off-site prefabricated balconies, the manufacturer should be consulted for specific detailing.



## 12.2.9 Slip resistance

Slip resistance should be appropriate for the intended usage of the surface, taking into account materials and surface textures.

Good slip resistance is usually afforded by a combination of effective surface drainage, selection of appropriate surfacing materials, and routine maintenance and cleaning.

The surface finish of all balcony areas should have a low slip potential (in wet and dry conditions) when tested to BS 7976.

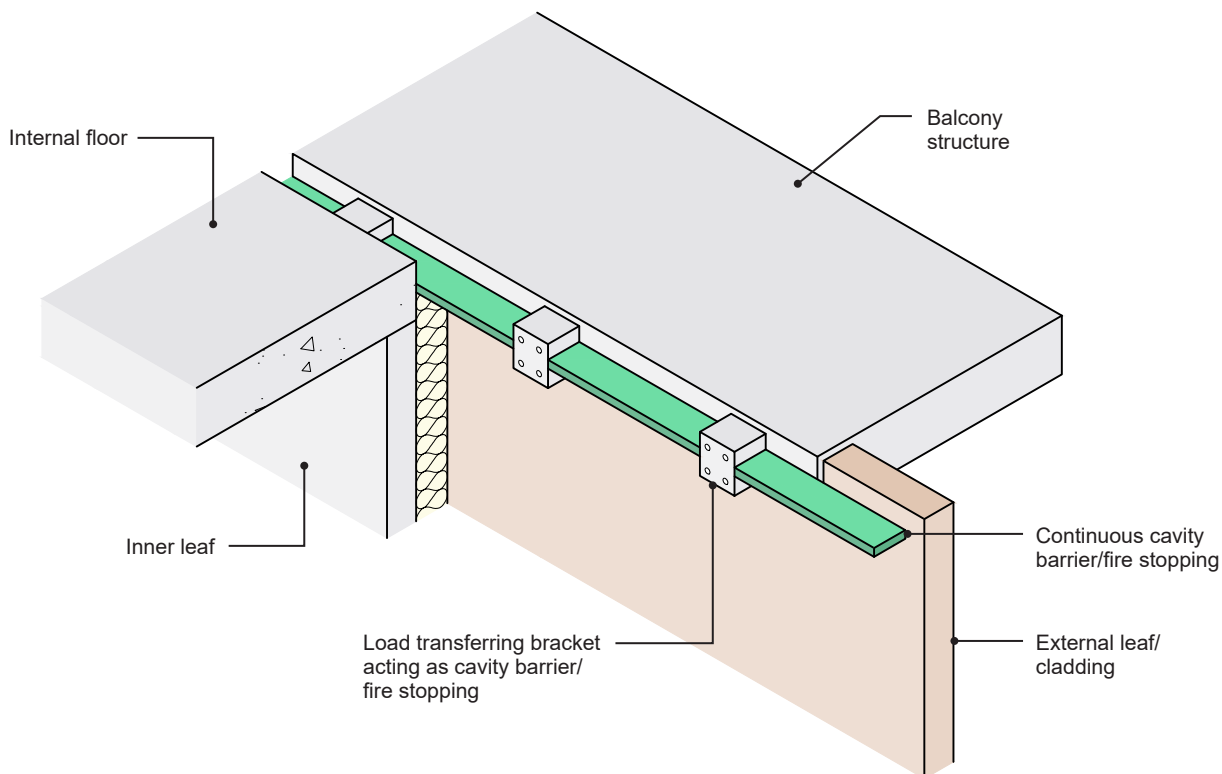
## 12.2.10 Fire considerations

Where applicable, balconies shall meet the relevant fire protection requirements in accordance with relevant Building Regulations.

In all circumstances, balconies must meet the requirements of the relevant Building Regulations in relation to any fire considerations.

Where enclosed balconies are proposed (either projecting or inset), the horizontal and vertical components separating one compartment from another is classed as a compartment wall or floor and therefore requires fire resistance from both sides (for compartment walls) and from the underside for compartment floors.

Balconies, whatever their type and construction, can have complex detailing around the junction with the external wall. The balcony and any of its components should not compromise the continuity of any cavity barriers or fire stopping. Where possible, balcony brackets that are fixed back to the inner leaf of a cavity wall should be located above or below any horizontal cavity barrier. Where this is not possible, the brackets should incorporate a means to ensure the continuity of fire separation (e.g. thermal wrapping). Any such brackets should only be used where appropriate fire test evidence is available from the manufacturer confirming it is fit for purpose. Evidence of this must be provided to the Warranty surveyor. Manufacturers' should be consulted for specific detailing and only competent contractors should be used for its installation.



## 12.2.11 Thermal bridging and cavity trays

Care shall be taken to prevent thermal bridging and any breaks in the cavity tray. Thermal breaks and cavity trays should be considered at design stage. It is the responsibility of the designer to ensure condensation risk is sufficiently mitigated.

Any thermal breaks specified between the balcony and the building structure should be durable, suitable for the intended purpose and have an appropriate third party product conformity certificate.



# 13.

## Chimneys and Flues

---

### Contents

|      |                      |     |
|------|----------------------|-----|
| 13.1 | Masonry              | 406 |
| 13.2 | Gas Flue Outlets     | 411 |
| 13.3 | False Chimney Stacks | 417 |

## Introduction

This section provides guidance on meet the performance requirements for masonry chimneys.

### 13.1.1 Compliance

The construction of masonry chimneys shall meet the performance requirements of this section.

### 13.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Design details indicating proposed chimney position, layout and height.
2. Details and specification of all materials to be used in the construction of a chimney (e.g. DPC, flashing, soakers, proposed flues, etc.).
3. Details of fire stopping in cavities around flue penetrations.
4. Details of fire places and hearths.
5. A copy of a commissioning certificate where applicable will be required at completion to be handed to the Warranty surveyor.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 13.1.3 Structural design and durability

Chimneys shall be designed and constructed to be structurally stable and constructed of materials which are be suitable for the site specific exposure and be suitable for the intended purpose.

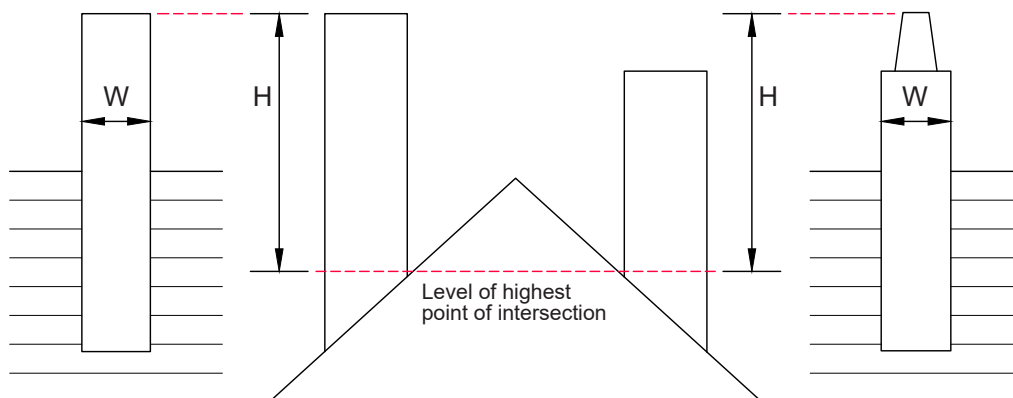
Masonry chimneys should be adequately bonded to, or supported by, the adjoining walls of the building.

Foundations to chimneys must:

- Be taken to the same depth as adjacent wall foundations.
- Resist uneven settlement caused by potential loadings.
- Where the chimney forms part of a wall, the foundation should project at least 150mm wider than the chimney base.

### Proportions for masonry chimneys

If a chimney is not provided with adequate support using ties or not securely restrained, its height (measured to the top of the chimney) should not exceed 4.5 times its least horizontal dimension when measured from the highest point of intersection with the roof surface (density of masonry must be a minimum of 1500kg/m<sup>3</sup>).



Key:

W - Is the least horizontal dimension of the chimney measured at the same point of intersection.

H - Is measured to the top of any chimney pot or other flue terminal.

## Durability

Bricks and blocks used in the construction of masonry chimneys must take consideration of weather exposure, resistance to frost and should be suitable for the intended purpose. Please refer to 'Appendix C' for guidance on appropriate selection of masonry products.

Mortar used within the chimney construction must:

- Take consideration of exposure to elements and frost.
- Be the strongest appropriate for the type of masonry unit.

Factory made insulated chimneys should have an operational life of at least 30 years and be designed in accordance with BS 4543 and BS EN 1859, and installed in accordance with BS 7566. Where a chimney is not directly over an appliance or opening, a soot box accessible for emptying should be formed.

### 13.1.4 Masonry chimneys in timber framed buildings

Masonry chimneys in timber framed buildings shall be appropriately detailed and specified to:

- Remain structural stable.
- Allow for differential movement between the masonry chimney and timber frame.
- Maintain the weather resistance of the weatherproof envelope.

Where masonry chimneys are proposed in timber framed buildings, the following should be considered:

- The effect on the structural stability of the timber frame.
- The effect of differential movement caused by timber shrinkage between the frame and the chimney and/or by thermal movement of the chimney in use. There should also be consideration for the impact of differential movement on flashings and weathering details.
- The integrity of the fire resistance of the timber frame when penetrated by the chimney breast or stack.
- The proximity of combustible materials (timber frames, sheathing and floor decks) to the flue and fire recess.
- The continuation of the sound insulation of compartment and separating walls when chimneys are adjacent or pass through to these walls.

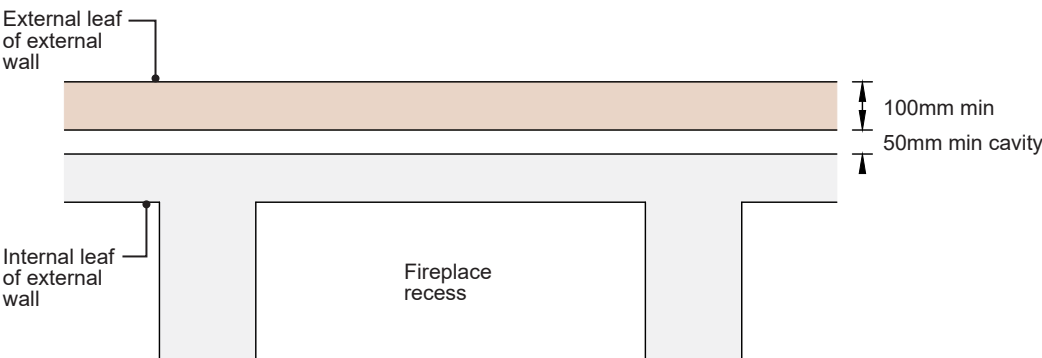
### 13.1.5 Weather resistance, flashings and trays

The design and construction of masonry chimneys shall resist damp penetration to the inside of the building and shall incorporate flashing and trays.

## Construction

If the chimney is in a severe exposure zone the cavity should extend around the outside of the stack and be continuous up to roof level, as per BS 5628, Part 3.

A 50mm cavity at the back of the chimney breast should be maintained to prevent rainwater penetration.



Where the chimney breast is gathered in, the lower projecting masonry should be protected with a suitable capping and cavity trays.

## Lead work

Lead sheet used for roofs, flashings and weatherings should, in terms of suitability, be in accordance with BS EN 12588 or a UKAS (or European equivalent) valid third party product conformity certificate which demonstrates adequacy and durability for use (see 'Appendix C - Materials, Products, and Building Systems').



### Corrosion of lead work

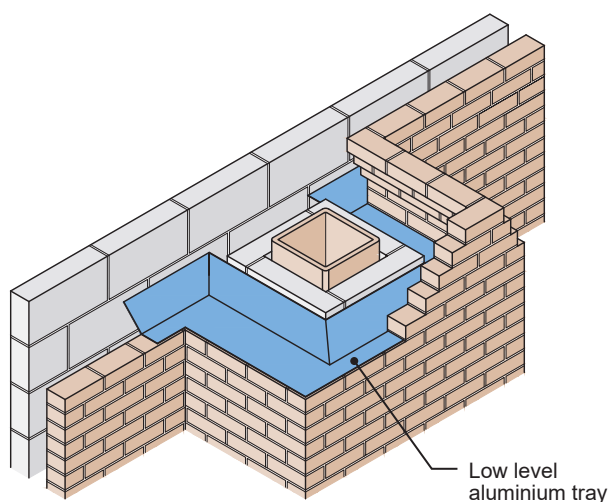
Where free lime from mortar comes into contact with lead trays or flashings (due mainly to the continual saturation of the brickwork) in areas such as chimneys:

- The lead should be protected from corrosion by the use of a thick coat of bitumen paint covering the faces likely to be in contact with the mortar.
- Lead work buried in mortar should be protected as per guidance issued by the Lead Sheet Training Academy. This treatment can also reduce staining of lead and brickwork.
- It is unnecessary to treat flashings buried only 40mm-50mm into mortar joints (cover flashings), as this close to the drying surface, the carbonation of free lime is rapid and there is no risk of corrosion in such circumstances.

### Chimney tray - low level

A chimney tray is required at low level where a cavity-walled chimney with brick shoulders is built onto an external wall. The tray prevents water that may enter the shoulders from penetrating to the inner leaf of the wall.

The material used is 1mm aluminium alloy sheet to BS EN 485-2; Aluminium and aluminium alloys. Sheet strip and plate, mechanical properties. This has a higher melting point than lead, so is suitable for installation close to a heat source.

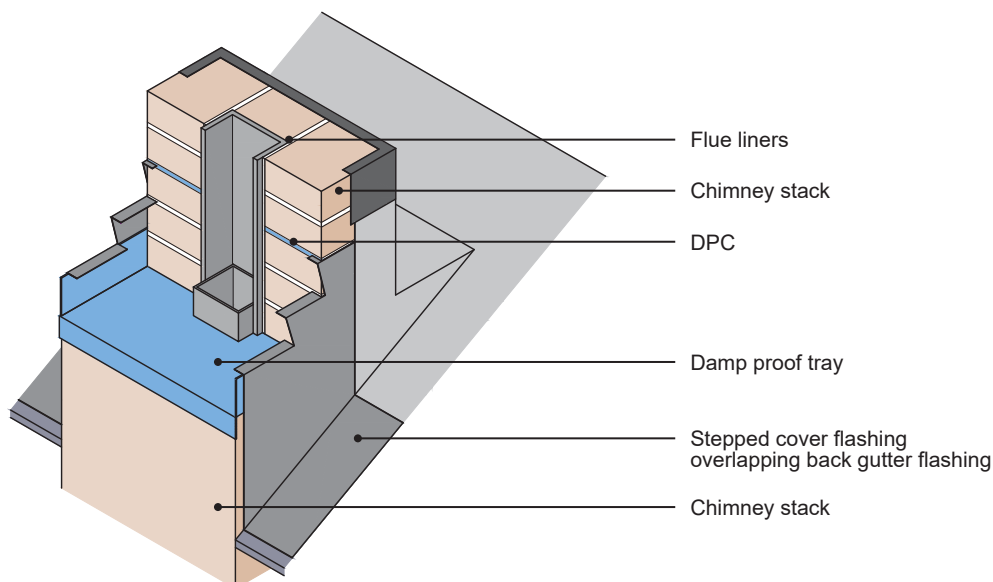


### Chimney tray - high level

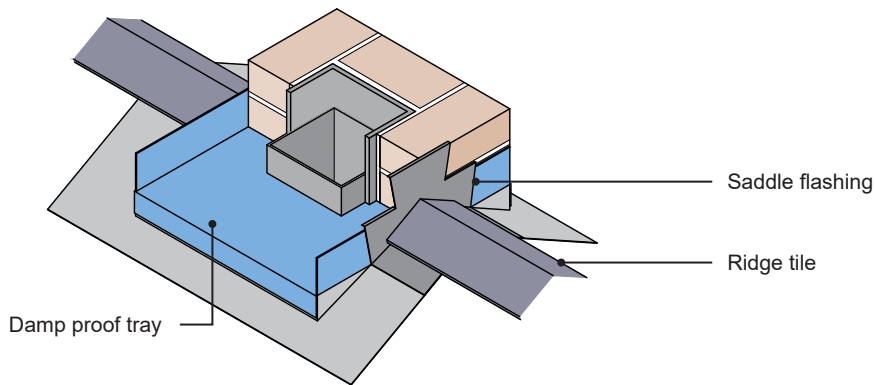
A high level tray will be required to prevent the entry of water at high level where a chimney rises through a pitched roof; suitable for new build or remedial work, this minimises disturbance to surrounding construction in remedial work.

The material used is lead sheet to BS EN 12588 Lead and lead alloys. Rolled lead sheet for building purposes. Code 4 as standard. Standard sizes are 800mm x 800mm, 900mm x 900mm, 950mm x 950mm, to suit either a 195mm square or 195mm diameter circular flue.

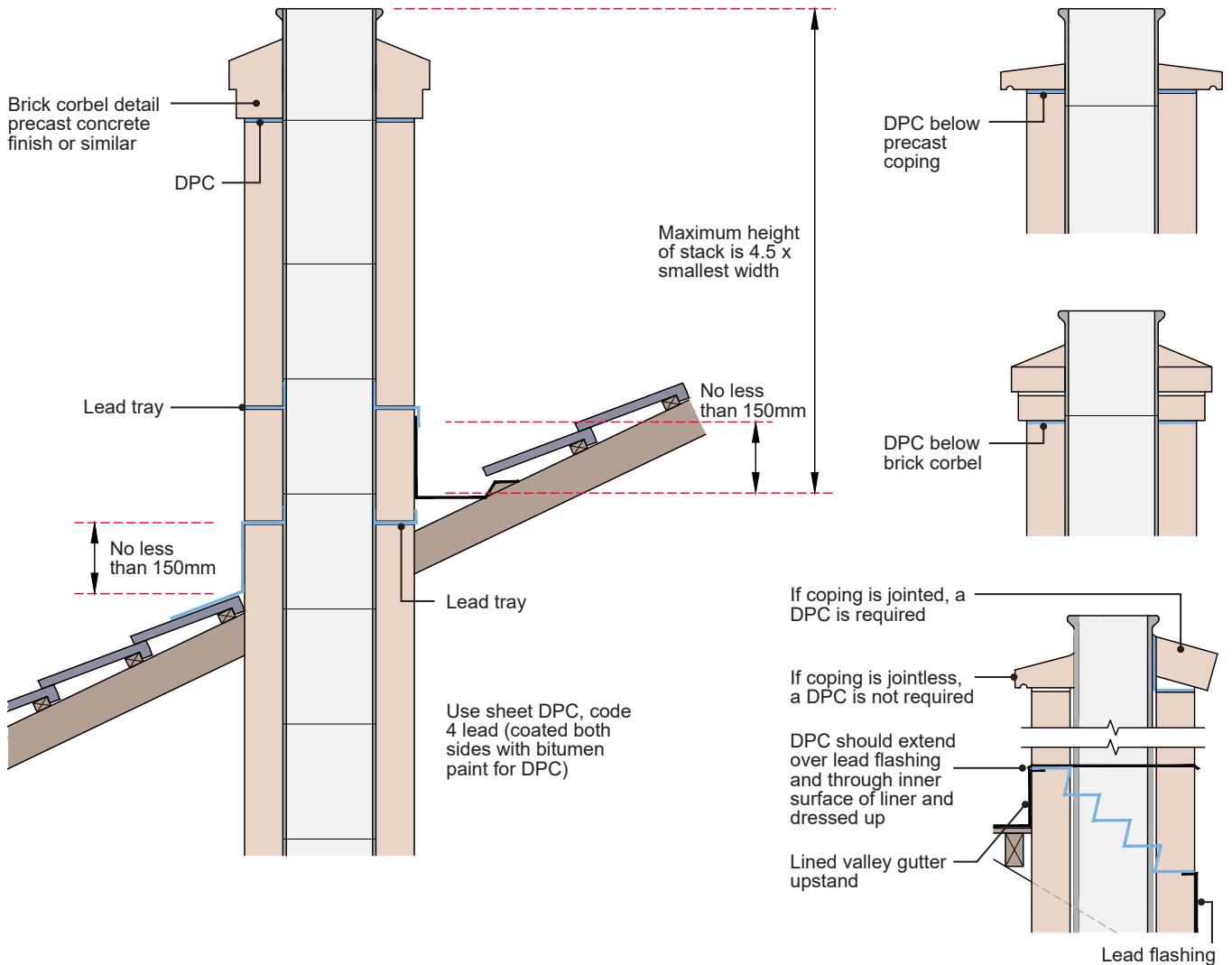
### Typical flashing for chimneys



## Flashings to chimneys at ridge



## Typical chimney details – Masonry



### 13.1.6 Render directly applied to masonry chimney

Render directly applied to a masonry chimneys shall be suitable for the site specific weather conditions and shall be appropriately detailed.

- Rendering to chimneys should only be carried out where the masonry contains little or no sulphates. An appropriate specialist sealer/ bonding key coat should be applied prior to applying the main coat of render.
- A proprietary alkaline resistant mesh should be embedded throughout the render, the key coat should provide a sound substrate and be compatible with the subsequent render system.
- A specialist render system and mortar should be employed for chimneys with a masonry background.
- The chimney which is to be rendered should be examined for excessive moisture content prior to rendering. This is particularly important where the masonry background has no upper limit on its soluble salt content, e.g. 'N' designation clay bricks.
- Ensure that all joints are finished flush with the surface to avoid shade variations.
- To minimise the potential for differential thermal movement and effects that the different suction that each type of background material may create; the section of walling to receive the render should be constructed using the same type and density of material throughout.
- To control suction always apply a specialist sealer key coat or suitable render preparatory coat. Allow a minimum of 48 hours for the key coat to fully dry before applying the next coat.
- It is recommended that throats or drips to chimneys should project beyond the finished faces to throw water clear, a minimum of 40mm to the drip.
- Angles, stop beads and jointing sections should be secured with drilled or shot-fired fixings, and not with gypsum plaster.

Please refer to the 'External Walls' section for further guidance.

### 13.1.7 Flue liners

Flue liners shall be suitable for the intended purpose.

Flue liners should be used as specified with sockets uppermost and jointed with fire-resisting mortar. Flue liners should be:

- Non-combustible.
- Reasonably smooth internally.
- Correctly jointed with mortar with the space between the liners and the brickwork filled with weak insulating concrete, unless the manufacturer recommends an alternative specification.
- Properly jointed at the junctions with the starter block or lintel and outlet terminal.

### 13.1.8 Coastal locations

Where chimneys are specified in a coastal location, they shall satisfy the performance requirements of 'Appendix B - Coastal Locations'.

For the selection of construction materials and additional design requirements that may apply in coastal locations please refer to 'Appendix B - Coastal Locations' and 'Appendix C - Materials, Products, and Building Systems'.

## Introduction

This section provides general guidance on meeting the performance requirements for gas flue outlets.

### 13.2.1 Compliance

The specification of gas flue outlets shall meet the performance requirements of this section.

A commissioning certification shall be provided for any work completed by an approved installer.

### 13.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of flue terminals and outlets.
2. Details of positioning of flue terminals and outlets.
3. A copy of a commissioning certificate will be required at completion to be handed to the Warranty surveyor.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 13.2.3 Flues

Flues shall be specified allow unrestricted passage for combustion gases between the fireplace or appliance and outlet. All flues shall be suitable for the intended purpose.

## Flues

Ensure that all gas flues terminate to the open air, i.e. flueblocks must terminate at an appropriate ridge vent or similar even where no appliance is fitted prior to the sale/occupancy of the property.

To demonstrate that flues comply with Building Regulations, reports showing that flues have passed appropriate tests are to be made available to the Warranty surveyor upon request.

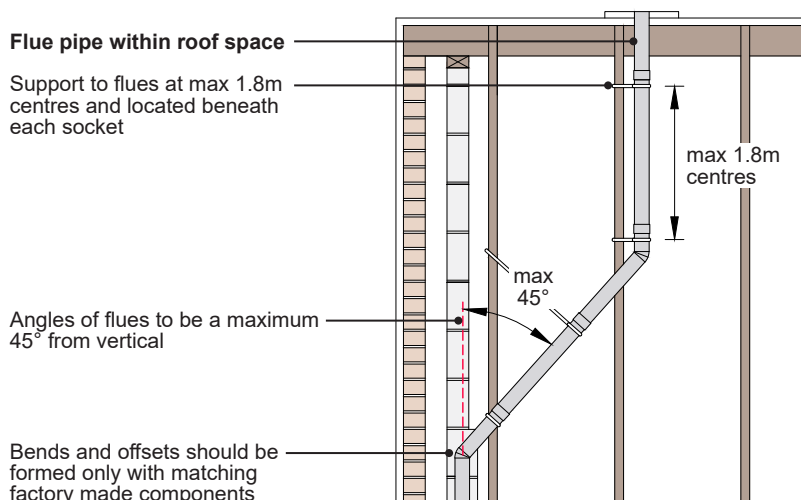
A suggested checklist for these reports is provided in Approved Document J (England and Wales).

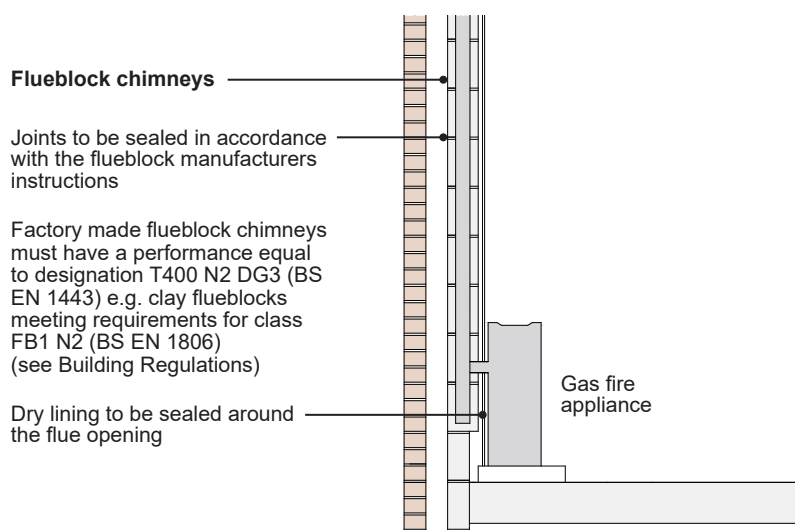
Special blocks are made to accommodate gas fire flues, which tend to be slightly thicker than normal units. When used in external cavity walls care should be taken not to reduce the clear cavity width below 50mm.

A notice plate containing safety information about any hearths and flues should be securely fixed in an unobtrusive but obvious position within the home.

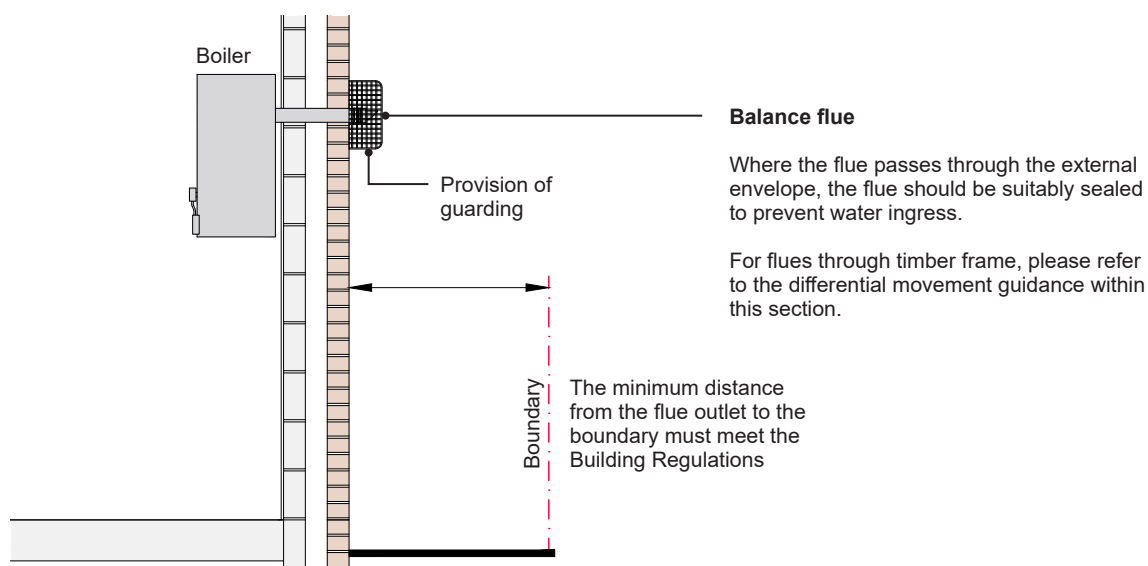
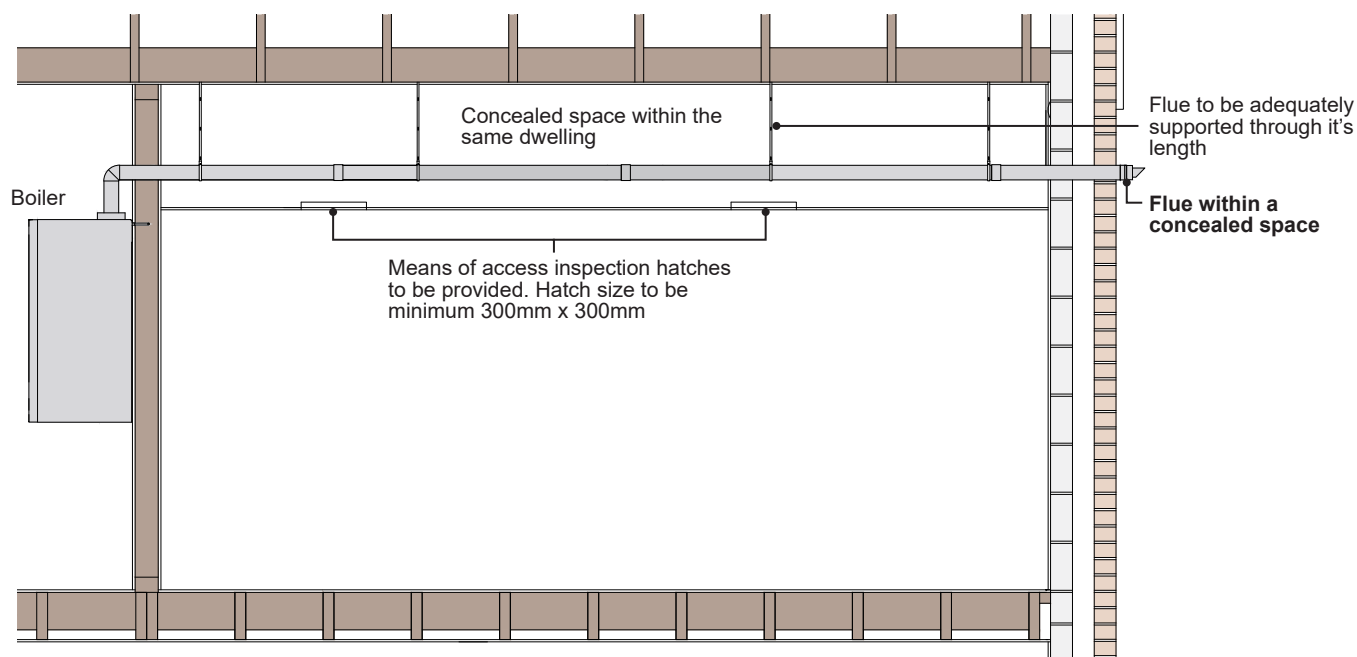
## Flue block chimneys in masonry cavity walls and flues for gas appliances

### Flue block chimneys in masonry cavity walls





### Flues for gas appliances



## Concealed flues

Where a flue is routed within a void, appropriate means of access should be provided to allow visual inspection of the flue.

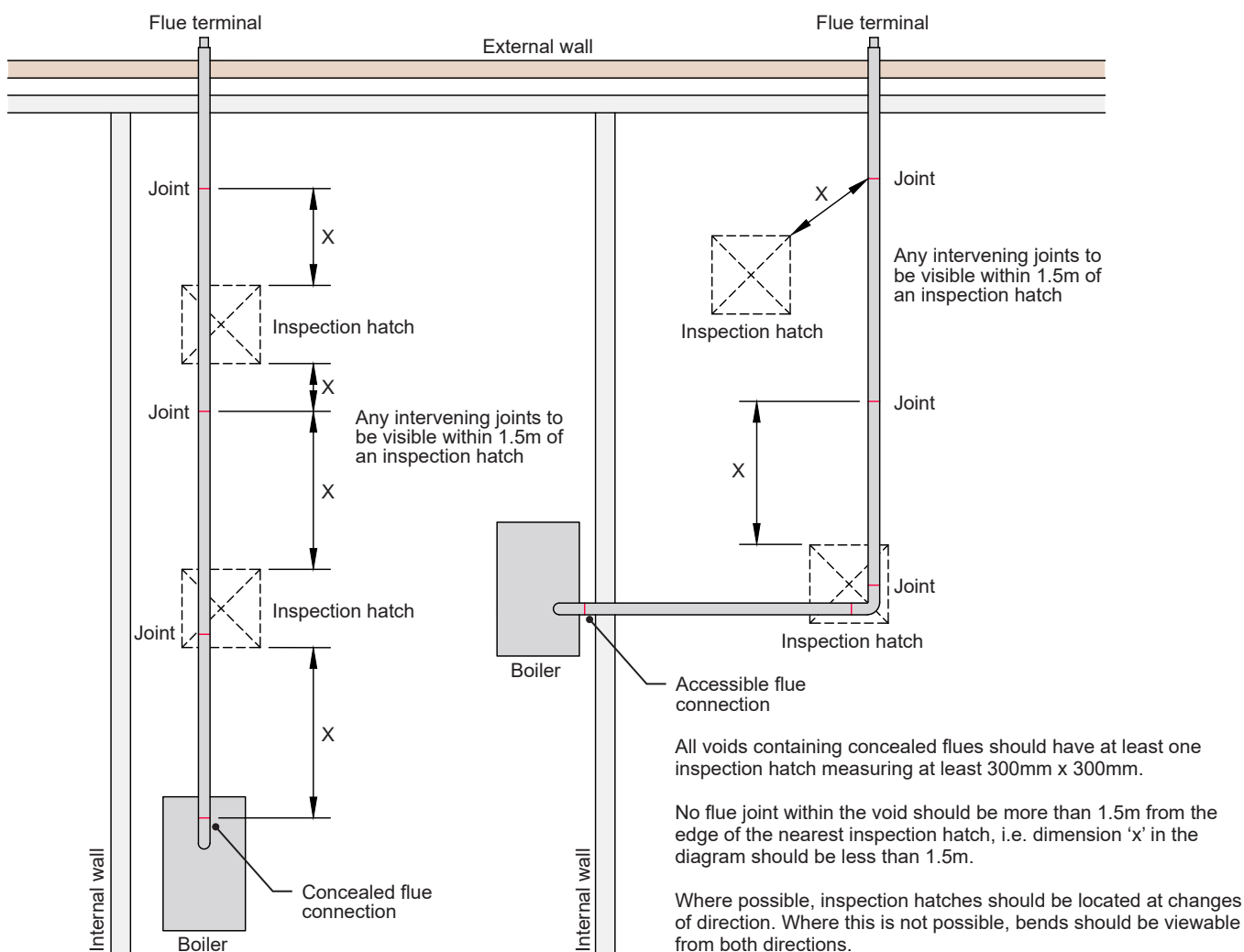
Means of access should be:

- Sufficiently sized and positioned to allow visual inspection to be undertaken of the flue.
- The access hatch should be at least 300mm x 300mm or larger where necessary, to allow sufficient access to the void to look along the length of flue.

Means of access should not:

- Pass through another dwelling since access for inspection may not always be available to that dwelling and flue system running through it (flues may pass through communal areas including purpose-designed ducts where inspection access is provided).
- Impair any fire, thermal or acoustic requirements of the relevant Building Regulations.

## Example locations of access panels for concealed flues



### 13.2.4 Adequate supply of combustion air

All combustion appliances shall be provided with an adequate supply of combustion air in accordance with the relevant Building Regulations and the appliance manufacturer's recommendations.

### 13.2.5 Separation from combustible materials

Fireplaces and flues shall be adequately separated from combustible materials in accordance with the relevant Building Regulations and the appliance manufacturer's recommendations.

### 13.2.6 Outlets and terminals

Outlets and terminals shall be adequately positioned to:

- Allow for combustion gases to discharge safely.
- Prevent the entry of combustion gases to the inside of the building.
- Prevent the ingress of moisture where they penetrate the weatherproof envelope.

#### Minimum separation distances for terminals in mm (England and Wales)

| Location |                                                                                          | Balance flue                          |                                                    | Open Flue                                                                     |                |
|----------|------------------------------------------------------------------------------------------|---------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------|----------------|
|          |                                                                                          | Natural draught                       | Fanned draught                                     | Natural draught                                                               | Fanned draught |
| <b>A</b> | Below an opening <sup>1</sup>                                                            | Appliance rated head input (net)      | 300                                                | Should not be used                                                            | 300            |
|          |                                                                                          | 0-7kW<br>>7-14kW<br>>14-32kW<br>>32kW | 300<br>600<br>1500<br>2000                         |                                                                               |                |
| <b>B</b> | Above an opening <sup>1</sup>                                                            | 0-32kW<br>>32kW                       | 300<br>600                                         | Should not be used                                                            | 300            |
| <b>C</b> | Horizontally to an opening <sup>1</sup>                                                  | 0-7kW<br>>7-14kW<br>>14kW             | 300<br>400<br>600                                  | Should not be used                                                            | 300            |
| <b>D</b> | Below gutters, soil pipes or drainpipes                                                  | 300                                   | 75                                                 | Should not be used                                                            | 75             |
| <b>E</b> | Below eaves                                                                              | 300                                   | 200                                                | Should not be used                                                            | 200            |
| <b>F</b> | Below balcony or car port roof                                                           | 600                                   | 200                                                | Should not be used                                                            | 200            |
| <b>G</b> | From a vertical drainpipe or soil pipe                                                   | 300                                   | 150 <sup>3</sup>                                   | Should not be used                                                            | 150            |
| <b>H</b> | From an internal or external corner or to a boundary alongside the terminal <sup>2</sup> | 600                                   | 300                                                | Should not be used                                                            | 200            |
| <b>I</b> | Above ground, roof or balcony level                                                      | 300                                   | 300                                                | Should not be used                                                            | 300            |
| <b>J</b> | From a surface or a boundary facing the terminal <sup>2</sup>                            | 600                                   | 600                                                | Should not be used                                                            | 600            |
| <b>K</b> | From a terminal facing the terminal                                                      | 600                                   | 1200                                               | Should not be used                                                            | 1200           |
| <b>L</b> | From an opening in the car port into the building                                        | 1200                                  | 1200                                               | Should not be used                                                            | 1200           |
| <b>M</b> | Vertically from a terminal on the same wall                                              | 1200                                  | 1500                                               | Should not be used                                                            | 1500           |
| <b>N</b> | Horizontally from a terminal on the same wall                                            | 300                                   | 300                                                | Should not be used                                                            | 300            |
| <b>P</b> | From a structure on the roof                                                             | N/A                                   | N/A                                                | 1500mm if a ridge terminal. For any other terminal, as given in BS5440-1:2008 | N/A            |
| <b>Q</b> | Above the highest point of intersection with the roof                                    | N/A                                   | Site in accordance with manufacturers instructions | Site in accordance with BS 5440-1:2008                                        | 150            |

<sup>1</sup>An opening here means an openable element, such as an openable window, or a fixed opening such as an air vent. However, in addition, the outlet should not be nearer than 150mm (fanned draught) or 300mm (natural draught) to an opening into the building fabric formed for then purpose of accommodating a built-in element, such as a window frame.

<sup>2</sup> Boundary as defined in paragraph 0.4 (4) of Approved document J. Smaller separations to the boundary may be acceptable for appliances that have been shown to operate safely with such separations from surfaces adjacent to or opposite the flue outlet.

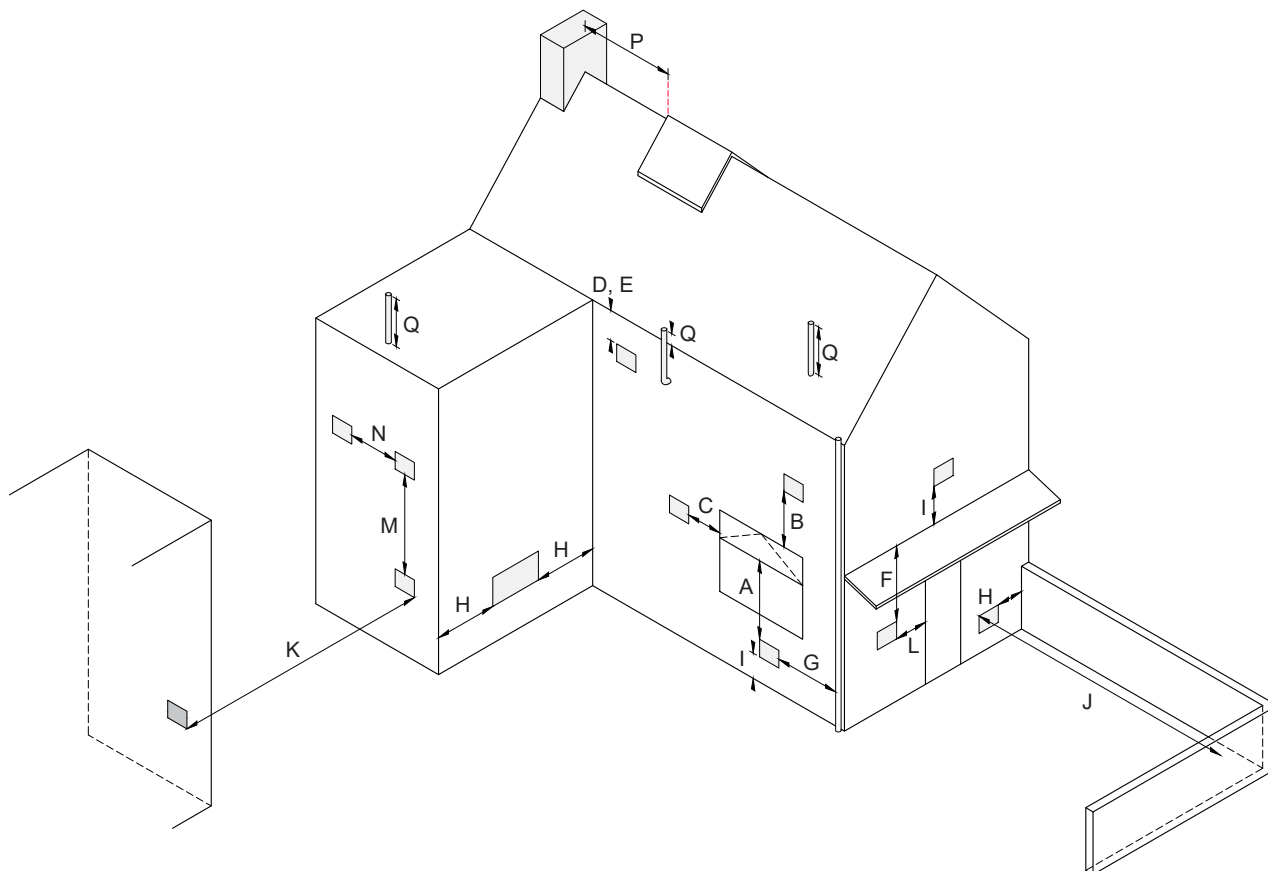
<sup>3</sup> This dimension may be reduced to 75mm for appliances of up to 5kW input (net).

Location of outlets from flues serving gas appliances (reproduced from Approved Document J Building Regulations England and Wales).

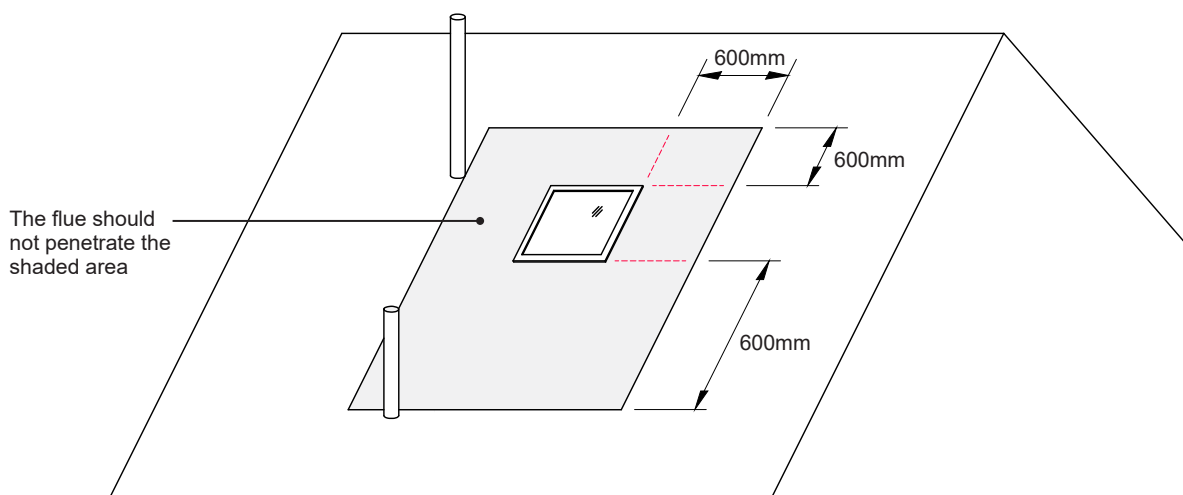
Requirements may differ in Scotland please refer to the Scottish Building Regulations for further information.

## Location of flue outlets

Flues serving gas appliances should be located as shown in the following images, and the Minimum separation distances for terminals in mm (England and Wales)'.



## Location of outlets near roof windows/openings, on pitched or flat roofs, from flues serving gas appliances



Reproduced from Approved Document J Building Regulations England and Wales.

## Guarding to flues

A flue outlet should be protected if persons could come into contact with it or if it could be damaged. If a flue outlet is in a vulnerable position, such as where the flue discharges within reach from the ground or a balcony, veranda or window, it should be designed to prevent the entry of any matter that could obstruct the flow of flue gases.

## Weathertightness

A proprietary cavity tray may be required to be inserted over the flue if the flue opening in the external wall is formed after the external wall is completed.



### Leadwork

Lead sheet used for roofs, flashings and weatherings should, in terms of suitability, be in accordance with this Technical Manual, or be in accordance with BS EN 12588 or a UKAS (or European equivalent) valid third party product conformity certificate which demonstrates adequacy and durability for use (see 'Appendix C - Materials, Products, and Building Systems').

#### 13.2.7 Differential settlement

Allowance should be made within the structure for differential settlement around flues, as well as ensuring the water tightness of the external envelope is maintained.

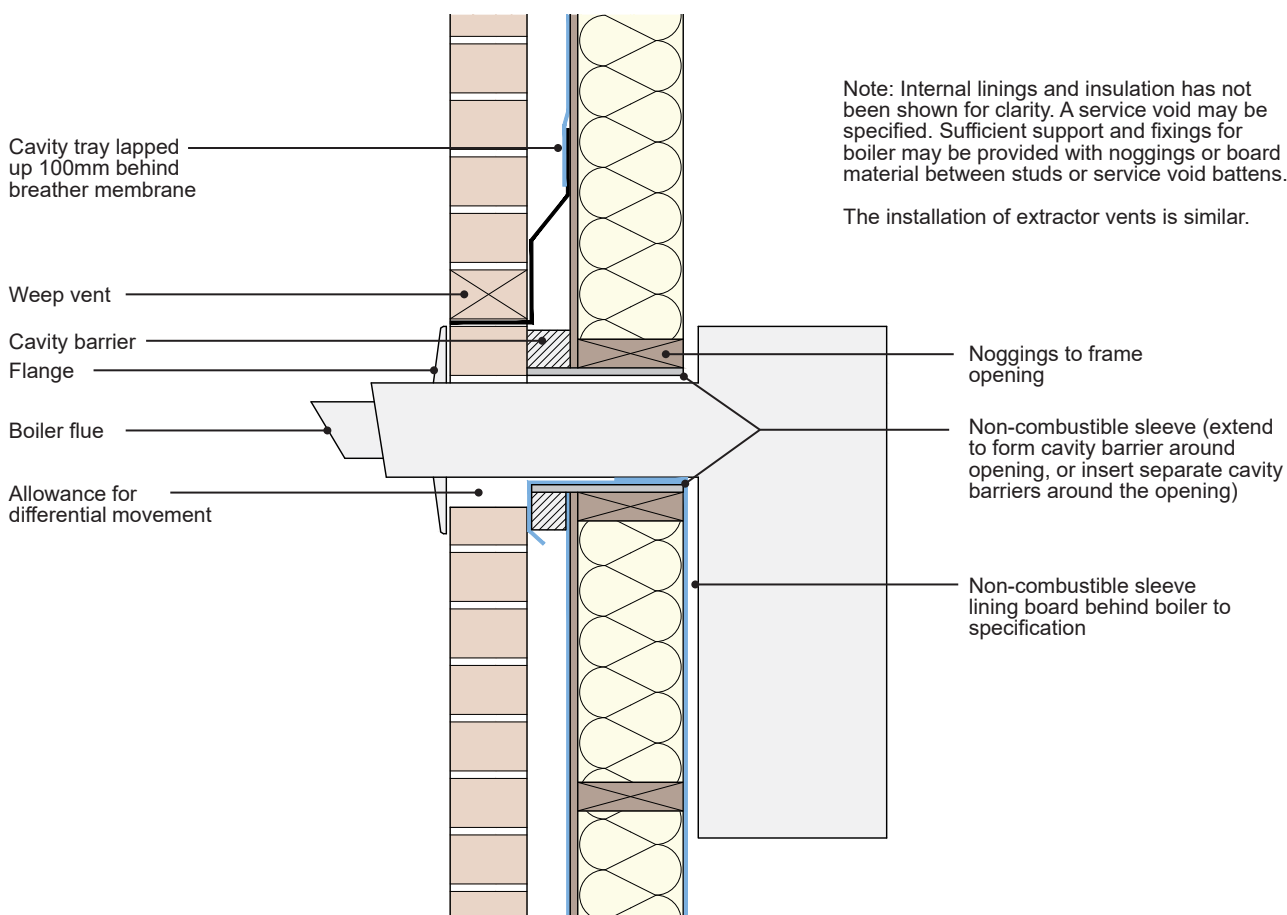
Where core drilling is used to create an opening in the external masonry cladding to timber frame or metal frame buildings; it should be ensured that suitable allowance is made for differential settlement within the external masonry.

The core drill hole created in masonry cladding, will have to be elongated downwards to allow for the timber frame shrinking and the flue pipe moving with it.

Care should be taken to ensure that the depth of the external flange is suitable to maintain weather tightness at the time of construction and once differential settlement has occurred.

Cavity trays should be provided where appropriate.

#### Differential movement at flue outlets in timber framed walls



## Introduction

This section provides general guidance for meeting the performance requirements for false chimney stacks.

For the purposes of Warranty, a false chimney stack refers to a pre-fabricated chimney stack constructed under factory conditions to give an appearance of a traditional brick built chimney. Please note, the guidance within this section only covers traditional brick finishes and does not cover finishes such as render.

### 13.3.1 Compliance

False chimney stacks shall meet the performance requirements of this section.

### 13.3.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Third party product conformity certificate acceptable to us for the proposed GRP chimney system.
2. Full fixing specification for the proposed GRP chimney system.
3. Design details of supporting roof structure, including but not limited to:
  - a. Details of proposed truss layout and design.
  - b. Details of proposed bracing.
  - c. Details of any cut-roof sections, including specification of materials relating to the structure in accordance with Eurocode 5.
  - d. Details of any supporting structural beams or lintels within the roof.
4. Details of proposed roofing felt, including manufacturer's third party product conformity certificate.
5. Details of proposed roof coverings including manufacturers specified fixing schedule for proposed external environment.
6. Details of proposed flashings, trays, soakers, etc.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 13.3.3 Specification

False chimney stacks shall be suitable for their intended purpose.

The following should be satisfied for false chimney stacks:

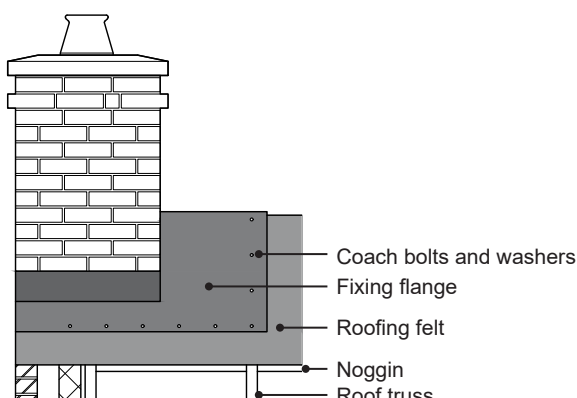
- They must have third party product conformity certificate to be acceptable for use.
- Where metal fixings are used within 5km of the coastal shoreline, they must be suitable for the location e.g. marine grade stainless steel.
- False chimney stacks should have a service life in accordance with the service life requirements set out in 'Appendix C'.
- The fixing/installation procedure must be followed as this forms the basis of the independent testing approval.

### 13.3.4 Installation

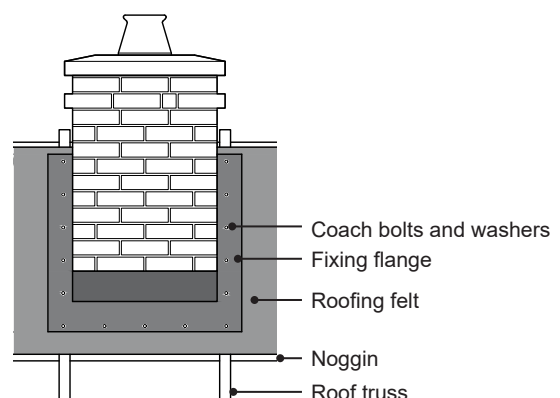
False chimney stacks shall be installed in accordance with the manufacturer's recommendations.

## Installation location

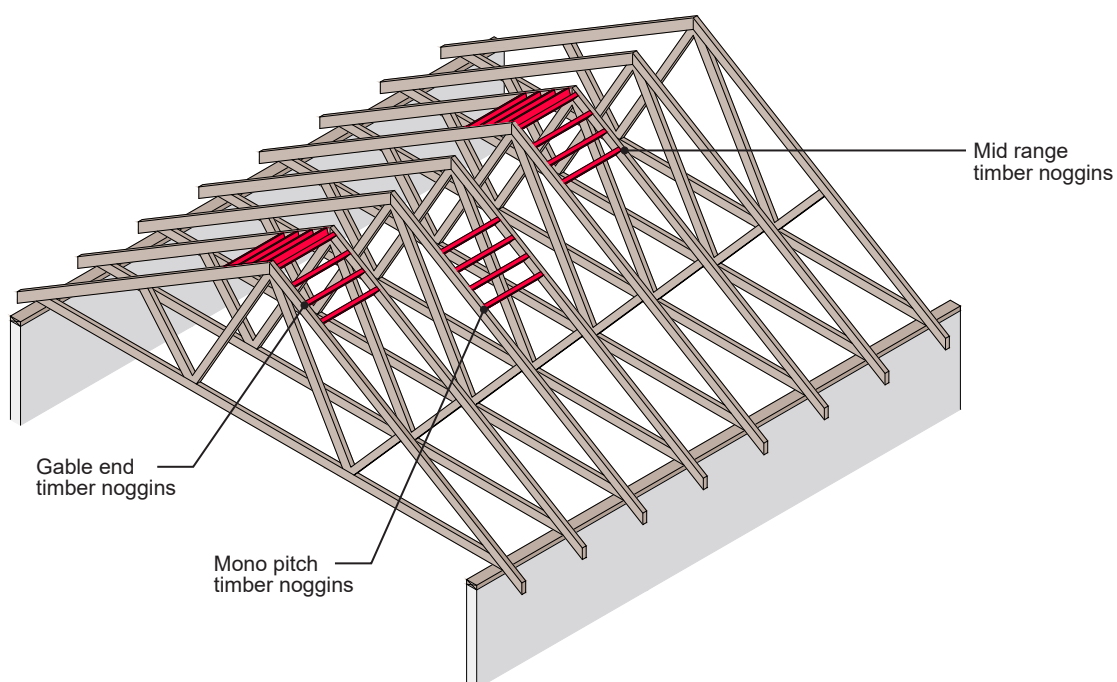
### Traditional masonry gable end installation



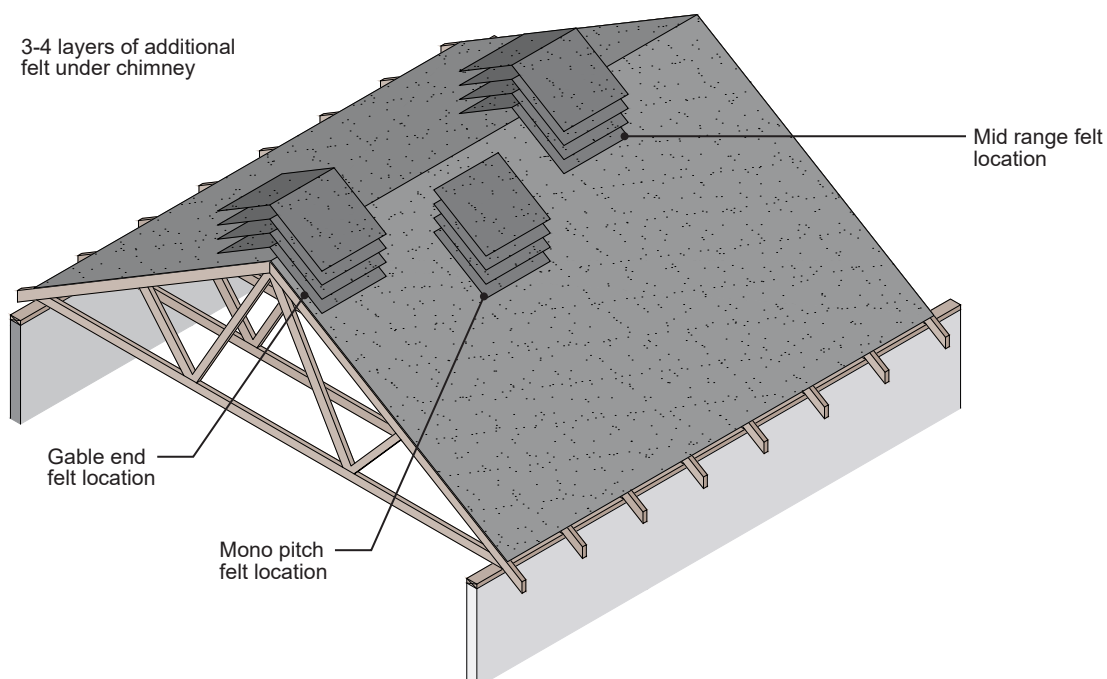
### Mono pitch installation



### Chimney noggin support location



### Additional roof felt location



For further guidance on roof structures and coverings, please refer to our section on 'Roofs'.

# 14.

## Driveways and Paving

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### Contents

|      |                      |     |
|------|----------------------|-----|
| 14.1 | Driveways and Paving | 420 |
|------|----------------------|-----|

## Introduction

This section provides guidance on meet the performance requirements for external driveways and paving. The guidance within this section only applies to a drive and pathway that leads to the principal entrance to the visitable dwelling/building.

For the purposes of Warranty, the principal entrance may be defined as 'the entrance to the individual dwelling that a visitor not familiar with the dwelling would normally approach (usually front door to a house or ground floor flat).

### 14.1.1 Compliance

The design, specification and installation of driveways and paving shall meet the performance requirements of this section.

### 14.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details and specifications of the proposed layouts.
2. Details indicating proposed drainage provision of those areas.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 14.1.3 Preparation of ground

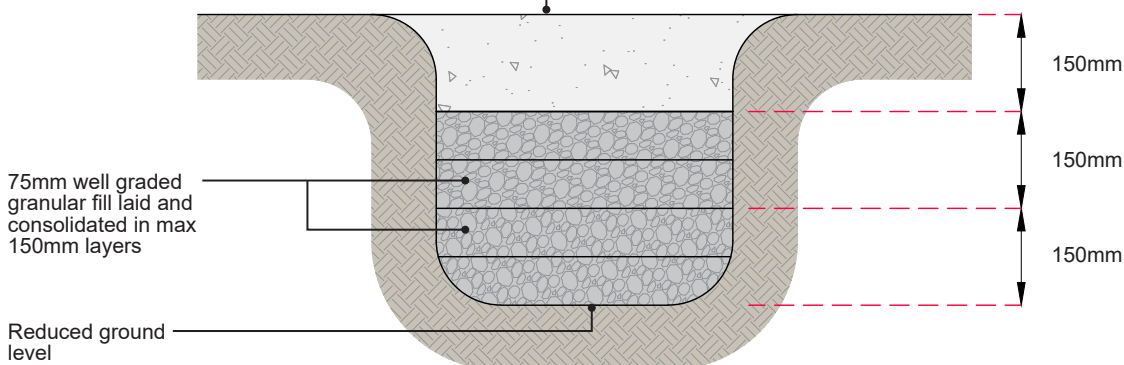
The ground shall be suitably prepared prior to any driveway or paving materials are laid.

The area to be surfaced should be prepared by stripping away all vegetation and organic material. Land drainage should be considered for ground that is saturated.

## Backfilling of trenches

Excavation trenches e.g. service trenches, should be backfilled with granular type material to the required level. The backfill should be compacted in layers no greater than 150mm, and the fill material should at least have the same bearing capacity as the adjacent ground.

Well graded crushed rock or concrete (max size of aggregate 75mm) or lean mix concrete



## 14.1.4 Driveway construction

Driveways shall be suitably design and installed to safely accommodate the intended loads. All materials shall be suitable for their intended use.

Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

### Sub-base materials

A suitable sub-base that is capable of supporting the finished surface material should be provided. Suitable sub-base material is considered as:

- Weak mix concrete ST1 (site mixed acceptable).
- Well graded crushed stone or recycled concrete (minimum aggregate size 75mm).

### Minimum thickness of sub-bases

The minimum thickness of sub-bases are indicated in the following table.

| Use of surface         | Min sub-base thickness | Comments                                                                    |
|------------------------|------------------------|-----------------------------------------------------------------------------|
| Pathway                | 75mm                   |                                                                             |
| Driveway (light duty)  | 100mm                  | Light domestic traffic                                                      |
| Driveway (medium duty) | 150mm                  | Suitable for carrying small lorries e.g. refuse, vehicles, or fuel delivery |

Crushed stone or recycled aggregate sub-bases should be well compacted to adequately support the pathway or drive (see the following table). Where the ground below the sub-base is weak or soft (typically <10% CBR), the sub-base should be designed by an Engineer.

### Suitable compaction of sub-bases

| Compactor type             | Compactor size             | Minimum number of passes |                |
|----------------------------|----------------------------|--------------------------|----------------|
|                            |                            | 100mm sub-base           | 150mm sub-base |
| Vibrating plate            | 1400-1800kg/m <sup>2</sup> | 8                        | Unsuitable     |
|                            | 1800-2000kg/m <sup>2</sup> | 5                        | 8              |
|                            | >2000kg/m <sup>2</sup>     | 3                        | 6              |
| Vibrator roller            | 700-1300kg/m width         | 16                       | Unsuitable     |
|                            | 1300-1800kg/m width        | 6                        | 16             |
|                            | 1800-2300kg/m width        | 4                        | 6              |
| Engine driven vibro-tamper | <65kg                      | 5                        | 8              |
|                            | 65-75kg                    | 3                        | 6              |
|                            | >75kg                      | 2                        | 4              |

### Minimum thickness of surfaces for drives and paths

| Surface type             | Material specifications          | Minimum thickness <sup>1</sup> |                  | British Standard |
|--------------------------|----------------------------------|--------------------------------|------------------|------------------|
|                          |                                  | Path                           | Drive            |                  |
| Macadam single course    | 40mm coated macadam              | 75                             | 75               | BS 4987          |
| BS 4987                  | Coarse asphalt 10mm nominal size | 60                             | 60               | BS 594           |
| Macadam two course       | Nominal 20mm coated macadam      | 60                             | 60               | BS 4987          |
|                          | Nominal 6mm wearing course       | 25                             | 25               | BS 4987          |
| Block paving             | Clay or calcium silicate         | 50                             | 50               | BS 6677          |
| Block paving             | Pre-cast concrete                | 60                             | 60               | BS 6717          |
| Concrete                 | Designated mix                   | 75                             | 100 <sup>2</sup> |                  |
| Pre-cast concrete paving | Dense concrete                   | 50                             | n/a              | BS 7263:1        |

<sup>1</sup> Drive minimum thickness assumes standard loadings for a typical family car. Additional thicknesses are required where increased loads are applied e.g. LGV vehicles.

<sup>2</sup> Drives increased to 150mm on poor ground or clay

### 14.1.5 Retaining walls

An Engineer shall design any retaining wall which provides support to the home and/or any path or driveway within the curtilage of such property giving access to the principal entrance.

Retaining walls are outside the scope of this guidance, however where a retaining wall provides support to the structure or the primary entrance to the property they should be designed by an Engineer.

Gabions, timber structures and other types of flexible retaining walls should not be specified to provide support to homes, garages, roads, drives, car parking areas or drainage systems.

For further information on retaining walls, please refer to the 'Foundations – Retaining Walls' section.

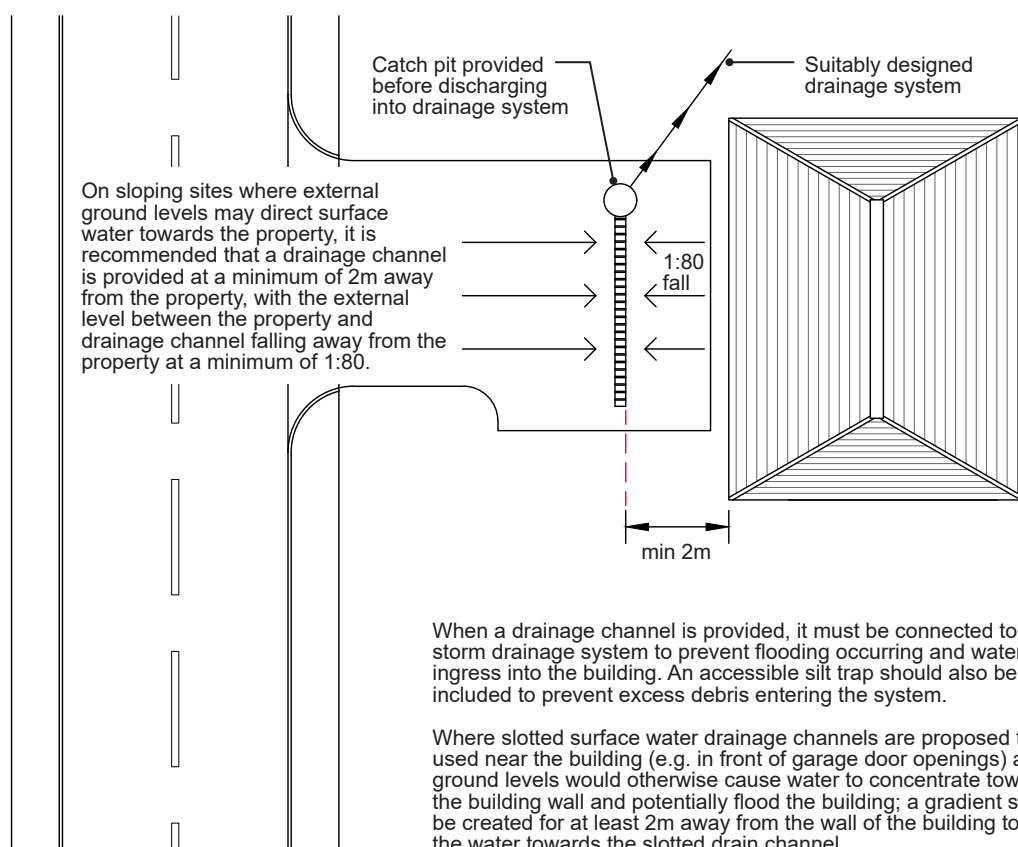
### 14.1.6 Drainage

Driveways and paving leading to the principal entrance of the home shall have adequate provision for rainwater drainage and disposal. Rainwater drainage shall discharge away from the home or to a suitably positioned drainage channel.

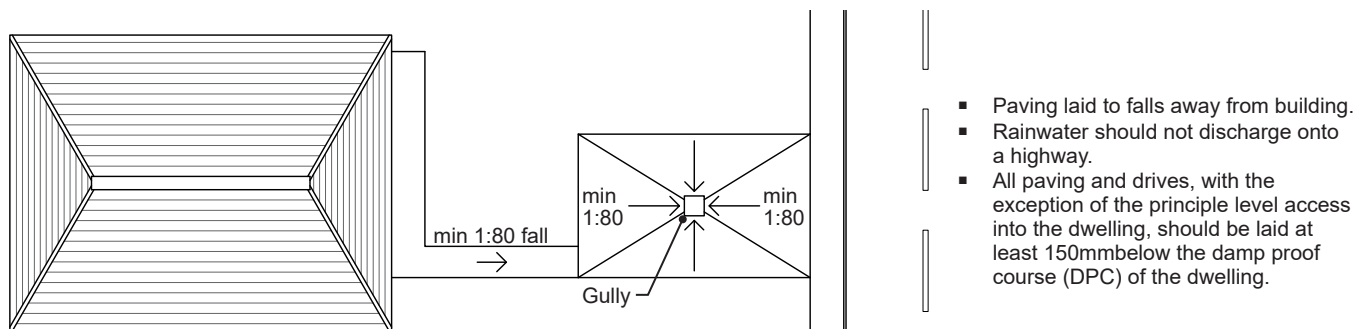
Please note, with the exception of a ramped access to a principle entrance door occurs, all paving and drives, should be laid at least 150mm below the damp proof course (DPC) of the dwelling.

Driveways and paving to the principal entrance should:

- Be effectively drained to prevent ponding of water adjacent to the building.
- Be laid to fall away from the building at a minimum of 1:80 and a maximum of 1:12.
- Either discharge into a trapped gully or drain to garden land that is well drained. Where Gullies are provided they should be trapped when discharging to a soakaway or combined drainage system (the approval of the statutory sewerage undertaker may be required).



## Typical drainage and gradients of access drives and paths

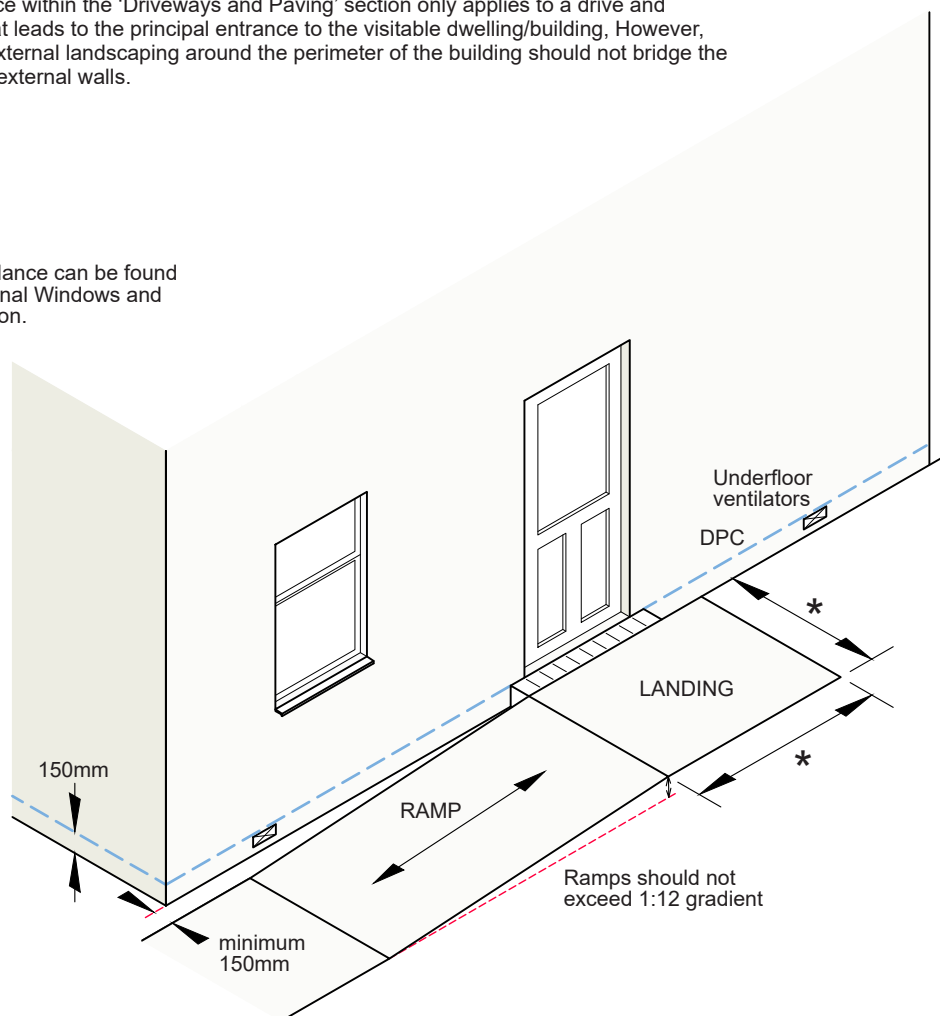


### 14.1.7 Level access requirements and DPC levels

The construction of the access landings and ramps shall not compromise the DPC in the external walls.

The guidance within the 'Driveways and Paving' section only applies to a drive and pathway that leads to the principal entrance to the visitable dwelling/building. However, generally, external landscaping around the perimeter of the building should not bridge the DPC in the external walls.

Further guidance can be found in the 'External Windows and Doors' section.



The construction of the access landings and ramps must not compromise the DPC in the walls. A recommended 150mm gap between the ramp and the external wall (as shown) should be provided.

\* See relevant Building Regulations for disabled ramp design and landing dimensions. Ramps should not exceed 1:12 gradient. Where the outside ground levels slope towards the property, an effective gully system should be provided to prevent flooding e.g. in front of garage doors.

Landing should be laid to a 1:60 fall in a single direction away from door.

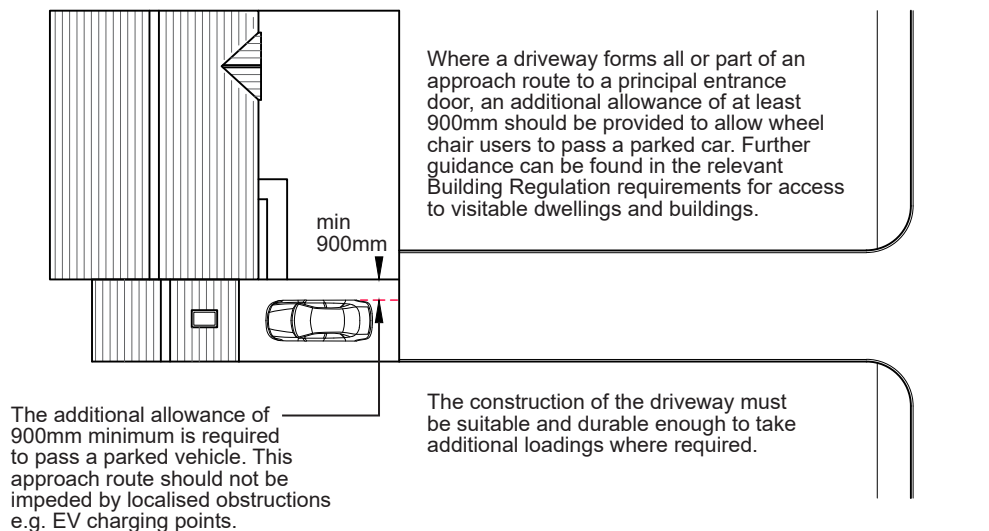
Where access requirements are required under relevant Building Regulations to the principal entrance of the visitable dwelling the ground surface of the defined approach route must be firm, even, smooth enough to be wheeled over, not covered by loose laid materials such as gravel and shingle and have a maximum cross-fall of 1:40.



### 14.1.8 Access requirements

External vehicular and pedestrian access routes to the principal entrance shall be designed and constructed to permit safe access from the highway.

Where a driveway for both pedestrian access and vehicular parking forms all or part of an approach route to a principal entrance door, there shall be adequate provision for access.



### 14.1.9 Tolerances for surfacing of paths and drives

Drives and paths shall satisfy the tolerance requirements within the guidance.

#### Flatness of drives and paths

Differences in the surface should not exceed  $\pm 10\text{mm}$  from a 2m straight edge with equal offsets. Some fracturing or weathering may also appear if using natural stone due to the make-up of the material. This tolerance applies to principal pathways and driveways to the dwelling that are required to meet relevant Building Regulation standards for access to visitable dwellings and buildings.

#### Drainage system covers

Drainage system covers in hard standing areas should line up neatly with the adjacent ground.

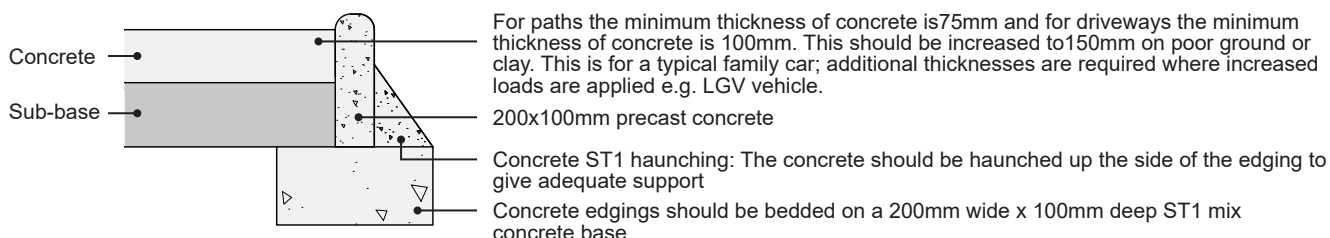
### 14.1.10 Edgings

Edgings shall be provided to paths and driveways to prevent movement or displacement. Edgings shall be laid to ensure that there are no excessive gaps and laid with smooth alignment along the top of the edging.

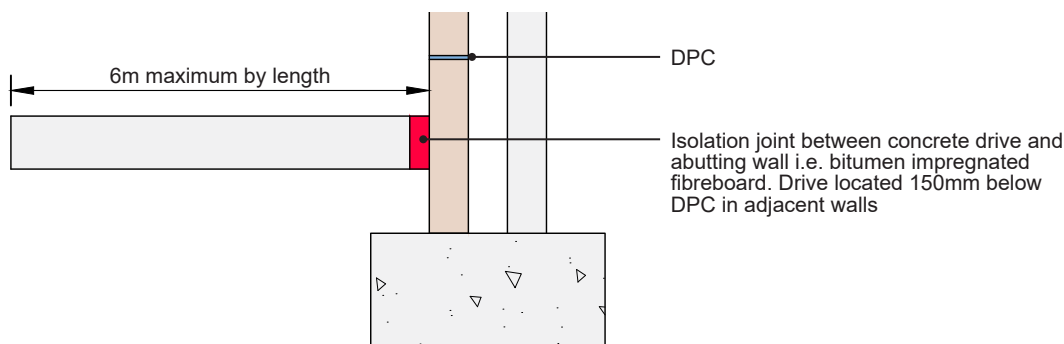
### 14.1.11 In-situ concrete

In-situ concrete shall be appropriate for the intended purpose and allow for movement.

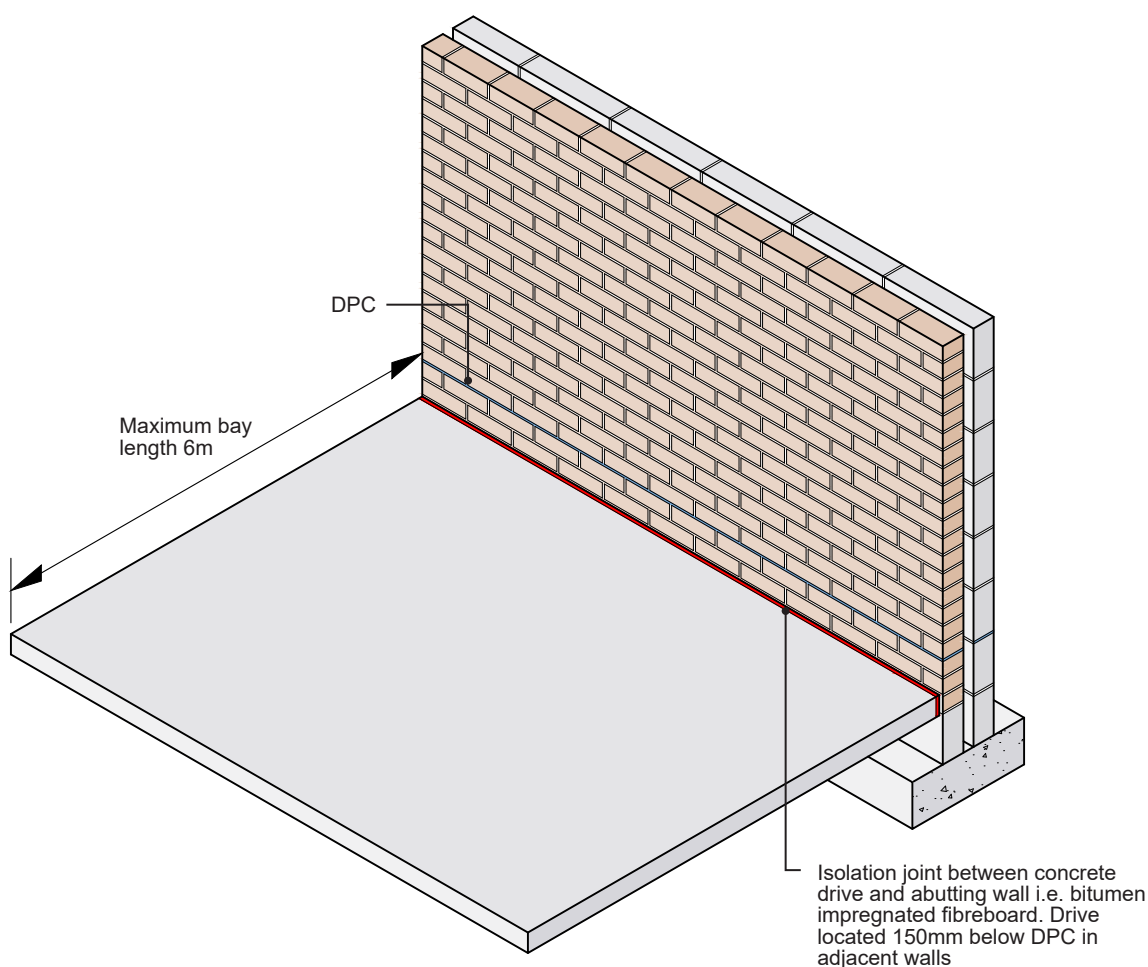
In-situ concrete should be laid in areas of  $20\text{m}^2$  maximum to allow for movement. Where abutting an adjacent structure, the concrete should be isolated using a flexible jointing material. Where the sub-base is well drained, it is recommended that the concrete is cast onto a damp proof membrane.



## Typical cast in-situ drive or path abutting the dwelling



## Isolation joint between in-situ concrete drive and abutting wall



### 14.1.12 Timber decking on access routes to the principal entrance

Timber decking on access routes to the principal entrance shall be durable, suitable for the intended purpose and appropriately specified by the designer. Timber decking on access routes shall also be adequately treated or finished to resist insect attacks.

### Limitations of guidance

The following guidance is applicable to timber decking that forms part of the principal entrance to the property.

This guidance is limited to decking that is no more than 600mm above the adjacent ground level. For decked areas which are 600mm and greater above the external ground level the guidance within the 'Roof Terraces and Balconies' section should be followed.

## Preparation of ground

The area to be surfaced should be prepared by stripping away all vegetation and organic material. Land drainage should be considered for ground that is saturated.

## Timber decking

Only timber naturally resistant to decay, or which can be treated by an industrial process to give long-term protection from decay, shall be used.

**Hardwoods:** Only use species rated as durable or moderately durable.

**Softwoods:** Only use species/components with natural durability or which have been treated in accordance with BS EN 335 to a 'Use Class' standard appropriate to their use i.e. 'Use Class 4' treatment for posts and other structural components in direct ground or freshwater contact, or 'Use Class 3' treatment for all components out of direct ground contact subject to frequent wetting.

Please note:

- Whitewood should not be used for posts embedded in the ground or for other elements (joists) in the ground or other non-permeable surface e.g. concrete slab.
- All cross-cuts, notches or large boreholes shall be treated on site with a suitable preservative. For full guidance on wood preservation specification, contact the Wood Protection Association.

## Timber grade (strength class): C16 minimum

The grade (strength class) of timber used for structural components such as posts, beams and joists shall be sufficient to cope with the loads placed upon it during its service life.

For decks below 600mm in height, the use of C16 timber is recommended.

Posts can be made from laminated sections, solid timber or round poles, and should have a load-bearing capability/size/spacing appropriate to the scale and end use of the structure. For extended life, the surface mounting of posts on precast piers or metal shoes is recommended.

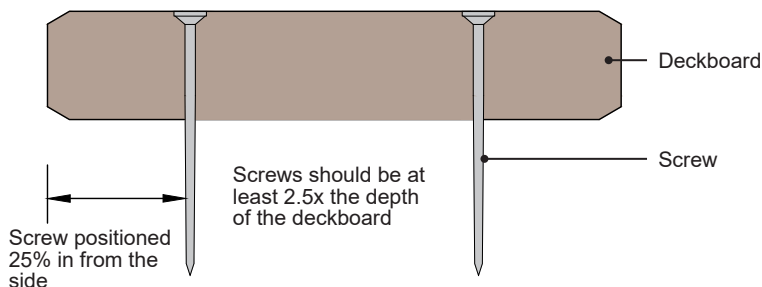
Notes:

- Do not exceed the recommended load and span for each strength class; for detailed recommendations, refer to span tables in TDA/TRADA Timber Decking: The Professionals' Manual.
- Use 'noggins'/blocking to strengthen frames where appropriate to prevent flexing.
- Timber moisture content at installation should be 20% maximum.

To minimise the effects of shrinkage, e.g. cupping, cracking, warping, etc. install timber as close as possible to the equilibrium moisture content of the site. For outdoor wood, moisture content varies from 19% in winter to 13% in summer in the UK. For best results, always install wood with moisture content lower than 20%. The stability of all wood used outdoors can be improved by the use of water-repellent treatments.

## Board fixing

- Fixing points at board ends shall be no closer than 25 mm to the board end and should always be pre-drilled to prevent splitting.
- On grooved boards the fixing point should always be at the bottom of a groove, flush with the surface of the wood.
- Screw heads should be countersunk level with the surface of the board.
- Pre drilling pilot holes will prevent splitting. Always drill pilot holes 2mm oversized when fixing hardwood boards.
- All metal fixings shall be made from corrosion-resistant materials, such as stainless steel, hot dipped, galvanised or other specialist coating. Before use, verify with the manufacturer that the fixings you have chosen are suitable for use with treated timber.
- Aluminium fasteners should not be used with treated wood. Prevent galvanic corrosion by using the same type of metal for both fixings and connectors.
- Screws should be at least two-and-a-half times the thickness of the board being fixed.
- All joist bearing points shall be secured by two screws positioned at the quarter points of the board i.e. 25% in from the side.
- Take care using high-pressure nail guns as they can damage timber.



## Board spacing

When laying timber decking boards:

- Allow for a 5mm minimum to 8mm maximum gap between board lengths.
- Where the board abuts a post, allow a 5mm gap.
- Where board ends meet, allow a 3mm gap.

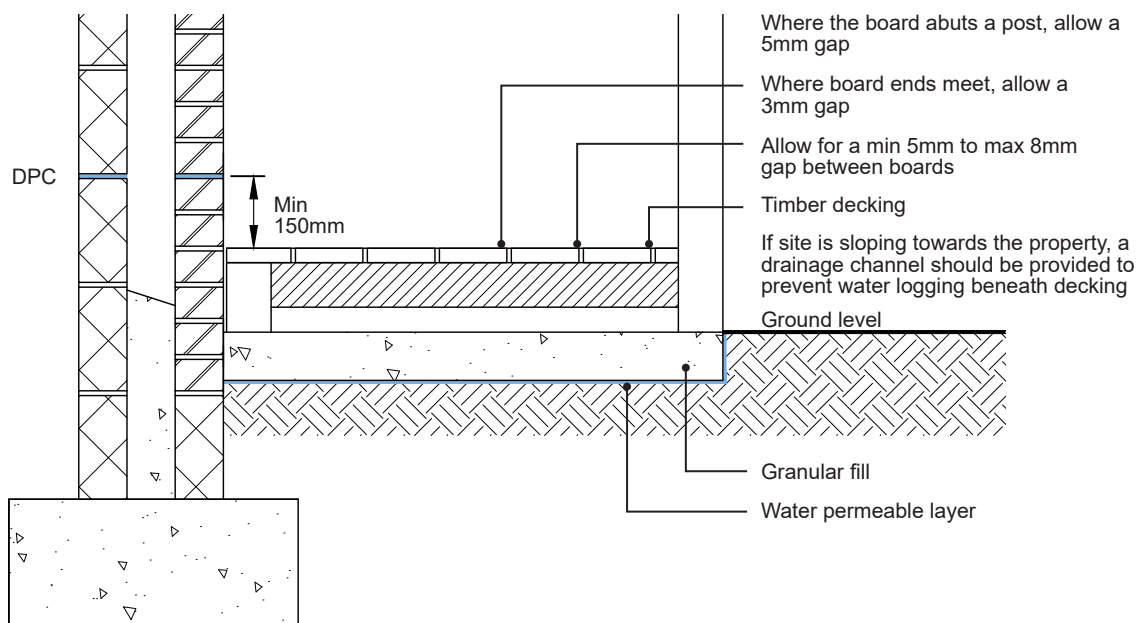
## Fall

To aid drainage, build a gentle fall of 1:100 into the deck, away from any adjacent property. Grooved deck boards are designed to assist the drainage of surface water, so lay them in the direction of the fall.

## Level threshold

For further guidance on the formation of level thresholds please see the 'External Windows and Doors' section.

## Timber decking



## Further specification references

- TDA/TRADA Timber Decking: The Professionals' Manual - second edition November 2006
- TDA Technical Bulletin TB 02: Statutory requirements
- TDA Technical Bulletin TB 04: Parapet design and construction
- TDA Technical Bulletin TB 08: Metal fixings
- TDA Code of Practice TDA/RD 08/01: Raised timber decks on new homes - desired service life 60 years
- Wood Protection Association: Timber Preservation Manual

## British Standards

The standards set out below all have a relevance to the creation of high-performance timber decks:

- BS EN 335-1 Use classes of wood and wood-based products against biological attack - Part 1: Classification of Use classes
- BS EN 335-2 Use classes of wood and wood-based products against biological attack - Part 2: Guide to the application of use classes to solid wood
- BS EN 335-3 Durability of wood and wood-based products - Definition of hazard classes of biological attack - Part 3: Application to wood-based panels
- BS EN 350-1 Durability of wood and wood-based products - Natural durability of solid wood - Part 1: Guide to the principles of testing and classification of the natural durability of wood
- BS EN 350-2 Durability of wood and wood-based products - Natural durability of solid wood - Part 2: Guide to natural durability and treatability of selected wood species of importance in Europe
- BS EN 351-1 Durability of wood and wood-based products - Preservative-treated solid wood - Part 1: Classification of preservative penetration and retention
- BS EN 351-2 Durability of wood and wood-based products - Preservative-treated solid wood - Part 2: Guidance on sampling for the analysis of preservative-treated wood
- BS EN 460 Durability of wood and wood-based products - Natural durability of solid wood: Guide to the durability requirements for wood to be used in hazard classes
- BS EN 599-1 Durability of wood and wood-based products - Performance of wood preservatives as determined by biological tests - Part 1: Specification according to hazard class
- BS 8417 Preservation of timber - Recommendations. Guidance for specifiers on the treatment of timber drawing on relevant sections of BS EN standards
- BS 5756 Specification for visual strength grading of hardwood
- BS 6105 Specification for corrosion-resistant stainless steel fasteners
- BS 6399-1 Loading for buildings. Code of Practice for dead and imposed loads
- BS 7359 Nomenclature of commercial timbers, including sources of supply
- BS 5268-2 Structural use of timber. Code of Practice for permissible stress design, materials and workmanship
- BS 6180 Barriers in and about buildings - Code of Practice
- BS 6399-1 Loading for buildings. Code of Practice for dead and imposed loads



# 15.

## Heating Systems

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### Contents

|             |                                                                      |     |
|-------------|----------------------------------------------------------------------|-----|
| <b>15.1</b> | Services Entering the Building                                       | 430 |
| <b>15.2</b> | Space and Water Heating Systems                                      | 433 |
| <b>15.3</b> | Other Forms of Heating Systems Including Low and Zero Carbon Systems | 438 |

## Introduction

This section provides guidance on meeting the Performance Requirements for services supplied to the building. This section covers utility services which enter and/or are within the building and not those parts installed by a utility provider.

### 15.1.1 Compliance

The design, specification and installation of services supplied to the building shall meet the performance requirements of this section.

### 15.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Detailing of how water ingress will be prevented with the passage of services into the building.
2. Detailing of how the structural stability of the building will be maintained with the passage of services into the building.
3. Commissioning certification.
4. Post installation/completion testing requirements.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 15.1.3 Services entering the building

Services entering the building shall be compliant with relevant approved codes of practice and industry standards to ensure safe operation.

All Services supplied to the building should be installed in accordance with the requirements of the utility provider.

For all other aspects of service installations supplied to the building, the relevant regulatory authority should be consulted and their guidance followed.

## Gas services supplied to the building

Pipework serving up to and including the emergency control valve and meter should be installed in accordance with the requirements of the gas transporter, gas supplier and primary meter owner.

### Penetrations from gas pipework

Installation of pipework must comply with relevant Approved Codes of Practice and Industry standards, such as those published by the Institution of Gas Engineers and Managers (IGEM) or Gas Safe Register (GSR).

Note: Where gas pipework is to be installed in timber frame, allowance must be made for differential movement – see the 'External Walls – Timber Frame' section.

## Electrical services supplied to the building

Mains and services cable installations up to and including the meter should be in accordance with the requirements of the Utility provider.

Items to be taken into account include:

- Locations and fittings of pipes and cable service entries should be protected where passing through the substructure.
- Services must be sleeved or ducted through structural elements (and not solidly embedded) to prevent damage. Fire stopping may also be required. Services should not be located in the cavity of an external wall, except for electricity meter tails.
- Services should only be buried in building fabric where permitted by relevant Codes of Practice.

### Penetrations from electrical cabling

Electrical services and installations must comply with the requirements of BS 7671 'Requirements for electrical installations' and comply with BS 6004 'Electric cables. PVC insulated and PVC sheathed cables for voltages up to and including 300/500 V, for electric power and lighting'.

Note: the passage of cabling under, against or within thermal insulation should be avoided, unless they have been appropriately sized and derated. Additionally, provision for separation should be made for any PVC covered cables to ensure they are not in contact with polystyrene insulation.

## Utility meters

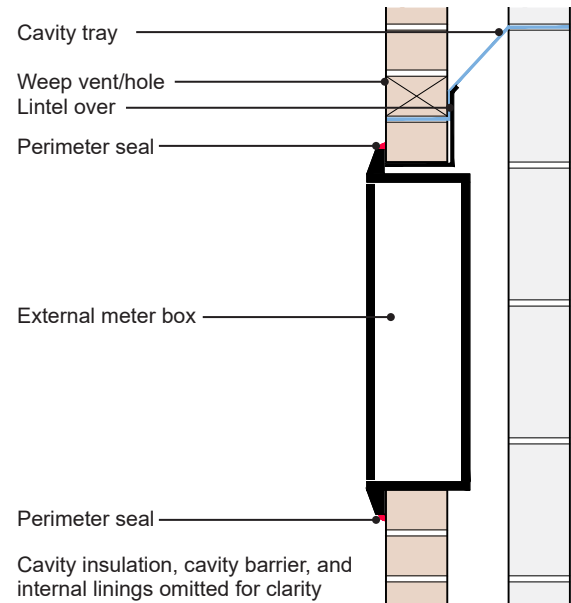
Domestic meters may be of the following type:

- Built-in to the outer leaf of the wall.
- Surface-mounted on an external wall.
- Semi-concealed: sunk into the ground adjacent to the outer wall.
- Individual, purpose-made compartments, in accordance with British Standards.

For further guidance, the respective Utility provider requirements should be followed in relation to type and acceptable installation of meter boxes e.g. installation height, external ductwork, fixing for connection purposes and they may recommend that reference is made to National Joint Utility Group Publications.

For Warranty purposes, any openings provided in walls for the installation of meters must be structurally sound, and their location must not create a structural instability where they are placed astride other structural openings e.g. doors and window openings. They must be provided with a lintel and increased wall tie frequency around the opening edges in line with the guidance in the 'External Walls' section.

The installation must also be suitably weatherproofed to prevent dampness entering the home by incorporating appropriate perimeter seals, a cavity tray and weep vents/holes above the opening.



### 15.1.4 Services entries and structural stability

Service entries in the fabric of the building shall not create a structural instability of the building.

Any excavation work should not undermine structural elements, e.g. foundations.

Penetrations through the structural fabric into the building must not create a structural instability or diminish the durability of the surrounding building fabric.

#### Chasing of masonry cavity walls

If chases in walls are necessary, their depth should not exceed:

- One-sixth the thickness of the single leaf for horizontal chases.
- One-third the thickness for vertical chases.

Hollow blocks should not be chased unless specifically permitted by the manufacturer.

#### Notches and drillings

Solid timber floor joists should not be excessively notched or drilled to allow the passage of services - further information can be found in the 'Upper Floors' section.

Services passing through 'Engineered floor joists' e.g. I-joists, open metal web joists, laminated beams, etc. must follow published guidance from the joist manufacturer.

Cutting or alteration of the flange of an engineered floor joist is strictly prohibited – where this occurs, the engineered joist must be replaced.

### 15.1.5 Service penetrations and weather resistance

Service penetrations shall be appropriately sealed to ensure adequate weather resistance is achieved.

Penetrations through the external weather proof envelope must be appropriately sealed to ensure suitable weather resistance is achieved. Any fittings, components and/or sealants provided for this purpose must be installed in accordance with the manufacturer's recommendations.



**15.1.6 Materials**

All materials shall be suitable for the intended purpose.

All materials should be suitable for the environment and ground conditions (such as contaminants and ground gases).

**15.1.7 Prevention of ground gases/contaminants entering the home**

Where ground gases/contaminants are present in the ground, the designer shall take precautions to prevent the gases/contaminants entering the home.

Incoming utilities should be specified to prevent the entry of ground gases/contaminants entering the home.

For further information on managing ground gases contaminants, please refer to the 'Ground Conditions – Managing Ground Contaminants' section.

## Introduction

This section provides guidance on meeting the performance requirements for space and water heating systems.

### 15.2.1 Compliance

The design, specification and installation of space and water heating systems shall meet the performance requirements of this section.

### 15.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A drawing package inclusive of schematics covering positions of appliances, plant, associated pipework and/or electrical cabling.
2. Manufacturer specification for all appliances and elements of plant.
3. A clear matrix document indicating interfacing systems and which manufacturer and/or installer is responsible for each system and the resultant interface(s).
4. Fixing schedules.
5. Specification for controls.
6. Commissioning certification.
7. Post installation/completion testing requirements.
8. An operation and maintenance manual for each system and interfacing elements.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 15.2.3 Space heating systems

The design and installation of space heating systems shall be compliant with the requirements of relevant Building Regulations and the guidance of relevant Approved Codes of Practice, and industry standards to ensure safe operation.

Where appropriate, space heating systems should comply with the following:

- BS EN 12828 'Heating systems in buildings. Design for water-based heating systems'.
- BS 8303 'Installation of domestic heating and cooking appliances burning solid mineral fuels'.
- BS 5410 'Code of practice for oil firing'.
- BSRIA guide BG 4/2011 'Underfloor heating and cooling'.
- EN 14336 'Heating systems in buildings. Installation and commissioning of water based heating systems.'

Where space heating is delivered via a domestic wet central heating systems and incorporates a gas fired boiler, reference should be made to BS 6798 'Specification for selection, installation, inspection, commissioning, servicing and maintenance of gas-fired boilers of rated input not exceeding 70 kW net'.

Any other space heating incorporating a wet central heating system should reference manufacturer's guidance for specification, installation, and commissioning.

Space heating appliances, including all components and controls, should be of a type approved by the relevant authority and their relevant equipment testing & approval schemes.

### 15.2.4 Performance of space heating systems

Any whole-house heating system shall be able to adhere to the design parameters as defined in the following guidance.

## Minimum internal temperatures

The following table provides minimum internal temperatures each room should be designed to based upon a well-insulated new build property.

| Location         | Temperature | Air changes               |
|------------------|-------------|---------------------------|
| Living room      | 21°C        | 0.5 per hour              |
| Dining room      | 21°C        | 0.5 per hour              |
| Kitchen          | 21°C        | 0.5 per hour <sup>1</sup> |
| Bedrooms         | 21°C        | 0.5 per hour              |
| Bed-sitting room | 21°C        | 0.5 per hour              |
| Bathrooms        | 22°C        | 0.5 per hour <sup>1</sup> |
| Hall and landing | 21°C        | 0.5 per hour              |
| Separate WC      | 21°C        | 1.5 per hour <sup>1</sup> |

<sup>1</sup> Where mechanical extract ventilation is to be installed in a room and the extract volume exceeds the natural infiltration, it is advisable to make due allowance for the air extracted from any connecting room or corridor.

### Notes

- The temperatures in this table are only design temperatures of the heating system. They are not operational temps which take other factors such as thermal comfort levels into account.
- For refurbishments and conversions, designers should use CIBSE Domestic Heating Design Guide Version 2020-01.
- The presence of open flued appliances may effect the rate of air change. Where this occurs, air change rates used for the design should be increased in accordance with BS EN 12831.
- Design temperatures should be verified by calculations and not by performance tests.
- The main living room should have a heating appliance or a heat output as part of a whole home heating system.

### Outdoor design temperatures

As for indoor temperature, it is important to select a outdoor design temperature that will ensure the heating system is adequately designed in any realistic worst-case conditions, while not over-sizing the system to the point of inefficiency.

Outdoor design temperatures for the latitude of the property's location should be based on CIBSE Domestic Heating Design Guide Version 2020-01.

### Low and zero carbon technologies

Space heating systems using low or zero carbon technologies only, e.g. Air source heat pumps, should also follow the guidance in the 'Heating Systems - Other Forms of Heating Systems Including Low and Zero Carbon Systems' section. Any designs using differing data values or system specific guidance than those given within this section must be fully rationalised within supporting calculations.

Any assessment of the performance of a space heating system must avoid comparisons with conventional heating systems e.g. gas boilers. If a systems performance must be measured, it should be done so against a comparable system benchmark using the same technologies to avoid misconceptions that these systems are not being as responsive or are failing to meet the required performance levels.

## 15.2.5 Design and installation of hot water services

The design and installation of hot water services shall be compliant with the requirements of the relevant Building Regulations and the guidance of relevant Approved Codes of Practice and industry standards to ensure safe operation, and be adequate for the demand and consumption.

Where appropriate, systems delivering hot water services should comply with the following:

- BS EN 806 Parts 1-5 'Specifications for installations inside buildings conveying water for human consumption'.
- BS8558 'Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complementary guidance to BS EN 806'.

### Provision for expansion

An expansion pipe is to be provided on vented systems for hot water.

### Unvented hot water systems

Unvented hot water systems should meet the requirements of BS EN 12897 and have a third party product conformity certificate where the unvented hot water system with a storage capacity greater than 15 litres is required by the design. Installation is to be completed by a competent person.

### Draining down facility

Hot water installations require the capability to be drained down.

## 15.2.6 Storage vessels and immersion heaters

Storage vessels shall be:

- Accessible for maintenance.
- Installed as per manufacturers recommendations.
- Insulated.
- Installed on an element of structure capable of supporting the load when filled.

Where an immersion heater is fitted, it shall be:

- Appropriate for the type of water supplied to the building.
- Thermostatically controlled.
- Accessible for maintenance.
- Fitted with an accessible on/off switch.

## 15.2.7 Protection against freezing

Cisterns, vent pipes, condense pipes and all water services in unheated spaces shall be insulated against freezing.

Insulation is not to be placed below a cold water tank where it can benefit from heat from beneath. Tanks that are raised need to be insulated on all sides in an unheated roof space.

Fully insulated bends and junctions are required, especially near openings to the outside air, such as the eaves. If possible, water pipes should not be located within a loft space where they could be affected by cold ventilation air.

## 15.2.8 Installation of services

All items shall be installed to ensure satisfactory operation.

Items to be taken into account include:

- Locations and fittings of pipes and cable service entries through the substructure.
- Services must be sleeved or ducted through structural elements (and not solidly embedded) to prevent damage.
- Fire stopping may also be required.
- Services should not be located in the cavity of an external wall, except for electricity meter tails.
- Only to be buried in screeds where permitted by relevant Codes of Practice.

For further guidance on electrical services, reference should be made to the 'Electrical Services' section.

### Jointing of service supply pipes and fittings

Proprietary joints should be made strictly in accordance with the manufacturer's instructions.

For metal pipes, only flux recommended by the pipe manufacturer should be used and all traces should be removed immediately after jointing. Flux containing lead are not acceptable.

Suitable clips or brackets are to be used to secure pipes and fittings. Fixings should be installed adequately and spaced to stop sagging but not restrict thermal movement.

Sufficient room should be allowed for thermal expansion and contraction to avoid damage and noise from pipe movement.

### Gas pipework contained within ducts

Ducts that contain gas pipework must be ventilated to ensure that any minor leakage of gas can be cleared to prevent a build-up reaching dangerous levels. For guidance on ventilation requirements, the installer should refer to BS 6891 'Specification for the installation and maintenance of low pressure gas installation pipework of up to 35 mm on premises'. Note: Ventilation of the duct should not be solely relied upon for mitigation in a major gas leak caused by a larger failure in the pipework.

Where gas pipework is contained within a duct which cannot be ventilated to the recommendations of the above standard, the provision of proprietary containment pipework – such as products which have a secondary outer cover to contain any escaping gas from the primary outer cover – should only be accepted where:

- Each end terminates to a point of safe and ventilated dispersal.
- The proprietary product has a recognised third party product conformity certificate or suitable testing to a recognised Approved Code of Practice or Standard.
- Its use within the installation complies with relevant Approved Codes of Practice and Industry standards, such as those published by the Institution of Gas Engineers and Managers (IGEM) or Gas Safe Register (GSR).

### 15.2.9 Pipework in walls

If the services are hidden in walls, they shall be positioned so that any significant cracking of the surface cannot occur.

A metallic tape should be applied to the pipework where plastic pipework is hidden within or behind wall surfaces, which would otherwise not be located by a metal detector. Some adhesives for metallic tapes may not be compatible with the pipework it is being attached to. Please refer to the manufacturers recommendations to ensure compatibility.

### 15.2.10 Services within floors

Where services are incorporated into floors they should be appropriately detailed to not effect the performance of the floor or service.

#### Services within structural floors

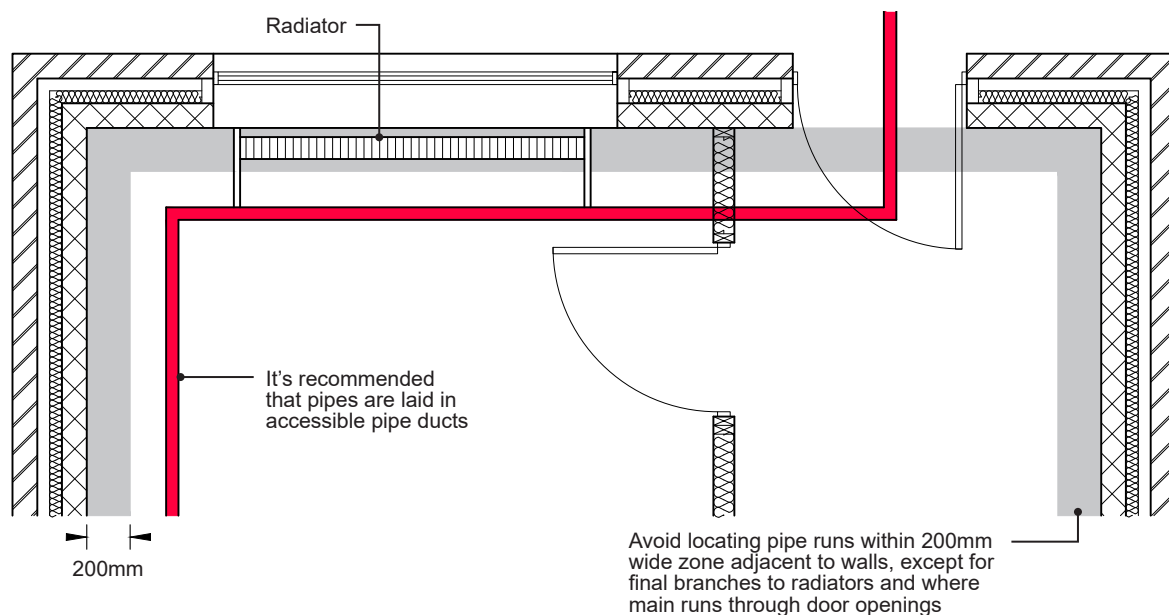
Services should not be incorporated within structural floors or structural screeds.

#### Pipework in non-structural floor screeds

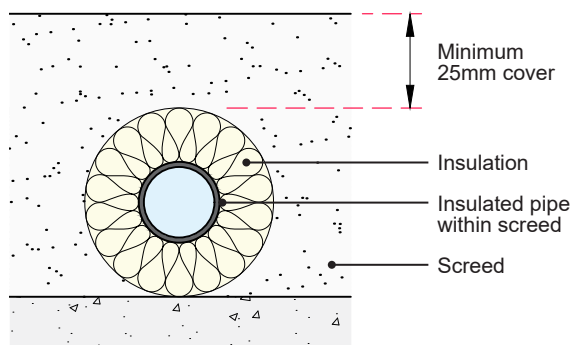
If the services are hidden in floors, they need to be positioned so that any significant cracking of the surface cannot occur. Where copper pipes are permitted in floor screeds, they should be:

- Sleeved or wrapped so that they can move freely along the length and at joints and bends.
- Jointed with capillary joints.

#### Recommended positioning of pipes in non-structural screeds



#### Positioning of pipes in non-structural screeds



Screed cover should be a minimum 25mm over the pipe and insulating materials. The screed thickness should still be at least 25mm where pipes cross over.

## 15.2.11 Fire stopping

Where fire stopping is installed around services that penetrate fire-resisting floors, walls or partitions, all fire sealing and fire stopping materials used must be fully compatible with the pipes and/or cabling. Guidance on compatibility should be sourced from the manufacturers of interacting materials in the first instance.

Further general information on this can be found in the 'Upper Floors' and 'Internal Walls' guidance.

## 15.2.12 Controls

Space heating and hot water service appliances shall be capable of being adequately controlled.

Space heating and hot water service appliances should have controls as determined by the heating design. Dependant on the chosen and specified system, such controls may include but are not limited to:

- Zone controls.
- Time and temperature controls.
- Boiler interlocks.
- Controls for space heating and controls for hot water.

## 15.2.13 Maintenance

Elements of any system that require periodic inspection and maintenance shall have adequate access provided.

All system installations should have safe access provided to all elements requiring routine inspection, periodic servicing/maintenance, repair and periodic functional checks in relation to performance inclusive of any switchgear, inverters, meters and controls in accordance with the manufacturer's recommendations.

## 15.2.14 Testing and commissioning

All systems shall be tested and commissioned in accordance with a commissioning schedule. A commissioning certificate is required for any work completed by an approved installer.

Evidence should be provided in the commissioning schedule for:

- Identification of the systems to be commissioned.
- Identification of commissioning activities for each area of the system and installation.
- A list of documentation requirements associated with the commissioning process.
- A list of documents which will be handed over at completion of testing and commissioning.

The testing and commissioning of the system must prove and demonstrate that the installation is in accordance with the certification requirements, the manufacturer's recommendations and the design.

Upon completion, the installer must provide a certificate to confirm that the system has been installed, tested and commissioned in accordance with the above.

## 15.2.15 Completion of works

Upon completion of work, an information pack shall be provided to the end-user.

Upon completion of work, the developer must provide evidence of an information pack, which includes:

- User instructions for the systems installed.
- Contact details for the manufacturer and installer.
- All information in relation to the key components installed.
- Maintenance and servicing requirements.
- Any Warranties and/or guarantees relating to appliances and associated kit.

## Introduction

This section provides guidance on meeting the performance requirements for the following low or zero carbon systems:

### Heat pumps

A device which takes heat energy from a low temperature source and upgrades it to a higher temperature at which it can be usefully employed for heating and/or hot water. Heat pumps may utilise different heat sources:

- Ground Source, where heat energy is extracted from the ground (e.g. from boreholes, horizontal trenches or aquifers).
- Air Source, where heat energy is directly extracted from ambient air.
- Water Source, in which heat energy is extracted from water (e.g. lakes, ponds or rivers).

### Wind turbines

Wind turbines use propeller-like blades of a turbine around a rotor, which spins a generator, which creates electricity into battery storage. Types may be:

- Roof mounted wind turbines.
- Micro domestic turbine.
- Pole-mounted wind turbines.

### Biomass systems

Biomass systems burn natural materials such as wood pellets, chips or logs to provide space heating and power to hot water services.

Alternative systems that follow the general principles of this sub section will be subject to specific agreement.

For guidance on Photovoltaic (PV) solar panels and solar thermal water heating, please refer to the 'Electrical Services - Photovoltaic (PV) Solar Panels' section.

## 15.3.1 Compliance

The design, specification and installation of low and zero carbon systems shall meet the Performance Requirements of this section and the following sections:

- Heating Systems – Services Entering the Building
- Heating Systems – Space and Water Heating Systems

## 15.3.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. A drawing package inclusive of schematics covering positions of appliances, plant, associated pipework and/or electrical cabling.
2. Manufacturer specification for all appliances and elements of plant.
3. A clear matrix document indicating interfacing systems and which manufacturer and/or installer is responsible for each system and the resultant interface(s).
4. Fixing schedules.
5. Specification for controls.
6. Commissioning certification.
7. Post installation/completion testing requirements.
8. An operation and maintenance manual for each system and interfacing elements.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 15.3.3 Design and specification

All low or zero carbon technology systems' and products shall have current certification confirming satisfactory assessment by an appropriate independent authority that is acceptable to our Warranty.

All low or zero carbon technology systems' and products shall be compliant with the requirements of relevant Building Regulations and the guidance of relevant Approved Codes of Practice, and industry standards to ensure safe operation.

Systems and products assessed through the Microgeneration Certification Scheme (MCS) will be acceptable for Warranty purposes, subject to:

Any electricity generating technologies with a capacity of up to 50kW and heat generating technologies with a capacity of up to 45kWth (including any method of attachment to the building) must:

- Be a part of a recognised competent person scheme and/or hold certification with the Microgeneration Certification Scheme (MCS), and
- Hold up-to-date qualifications and certifications to complete all required works to the heating system.

Designs and location of components should take account of:

- Internal and external noise.
- Vibration.
- Penetrations through the weather proof fabric.
- Positioning in relation to openings.
- Potential encroachment across defined access routes.
- Loading onto the structure, any system components requiring foundations or anchorage into structure must be designed by an Engineer.

Designs should ideally be supplied from one designer as a package and not as individual components or materials. However, where components from more than one manufacturer are used, they should be compatible to ensure the satisfactory design performance is achieved.

Note:

- Where a Low or zero carbon technology system is installed as a secondary system i.e. to contribute towards the primary space and water heating system to the building, they should be designed so that the overall heating system meets the performance requirements within 'Heating Systems – Space and Water Heating Systems'.
- Where a low or zero carbon technology system provides the main primary space and water heating system: users must be aware how the system works differently to a conventional heating system and be clearly explained to them on handover, to ensure how to run the system efficiently.
- Any assessment of the performance of a space heating system must avoid comparisons with conventional heating systems e.g. gas boilers. If a systems performance must be measured, it should be done so against a comparable system benchmark using the same technologies to avoid misconceptions that these systems are not being as responsive or are failing to meet the required performance levels.

On request, manufacturers of equipment shall be able to produce evidence of the operation of a documented quality control system that has been assessed and meets with the requirements of the Microgeneration Certification Scheme (MCS).

### Heat pumps

Assessment specific to equipment should be aligned with the relevant Microgeneration Certification Scheme and have evidence of UKCA/CE marking:

- MCS 007 - MCS Product Certification Scheme Requirements: Heat Pumps (Single Heat Pumps up to 45kWth).
- All installed equipment must carry the 'MCS Certification Mark'.

### Wind turbines

Assessment specific to equipment should be aligned with the relevant Microgeneration Certification Scheme and have evidence of UKCA/CE marking:

- MCS 006 - MCS Product Certification Scheme Requirements: Small Wind Turbines (up to 50kW output).

### Biomass systems

Assessment specific to equipment should be aligned with the relevant Microgeneration Certification Scheme and have evidence of UKCA/CE marking:

- MCS 008 - MCS Product Certification Scheme Requirements: Biomass.

### Microgeneration Certification Scheme (MCS)

All references to any Microgeneration Certification Scheme (MCS), and any associated guidance and/or literature produced by the MCS, is considered correct at the time of publishing.

As low and zero carbon technologies are a developing area of construction, users are advised to access and use the most up-to-date versions of this guidance when undertaking design, specification, installation and commissioning of any such systems. Please visit the Microgeneration Certification Scheme (MCS) website for further information.



It should also be noted that any other certification schemes or regulation bodies that are introduced in the future, and in addition to the Microgeneration Certification Scheme (MCS) may be acceptable for Warranty, but only when subject to agreement with the Warranty provider or we introduce supplementary information.

## 15.3.4 Installations and installer competency

All installers shall have current certification confirming satisfactory assessment by an appropriate independent authority.

All systems and components shall be installed to ensure satisfactory operation.

All installations must:

- Be carried out by certified installers, trained to an acceptable level for the system(s) being installed. Installers certified in accordance with the MCS installer standards or Competent Person Schemes will generally be acceptable.
- Follow installation information issued by the system manufacturer and system designer.
- Be able to prove and demonstrate a clear quality assurance procedure for the installation.

Where installation involves more than one installer e.g. where 2 or more different systems interface, a clear statement must be provided to clearly communicate which installer is responsible for each system and all associated interfacing. All parties involved should hold relevant and up-to-date qualifications and certifications to complete required works.

Installations or work to systems requiring the handling of fluorinated gas must use operatives that are F-Gas qualified and all individual operatives must have a qualification as an individual from an accredited organisation e.g. City and Guilds, Building Engineering Services Association (BESA), LCL Awards, Construction Industry Training Board (CITB).

Typically this will occur on Air Source Heat Pumps that are part of 'split systems' e.g. smaller outdoor units plus an indoor unit and may also incorporate a hot water cylinder.

All electrical installations must:

- Comply with BS 7671 'Requirements for Electrical Installations'.
- Be in accordance with the 'Electrical Services' section of this Technical Manual.

Electrical systems and installations which generate electricity and are connected to the mains should automatically disconnect when there is a mains power failure. This is to avoid them from feeding the network or local distribution system during a planned or unscheduled loss of mains supply.

All pipework installations must:

- Comply with relevant codes and standards or be independently assessed for their intended use.
- Use materials suitable for the intended purpose and provide satisfactory performance for the life of the system. Any refrigerant pipework should be of refrigerant quality copper pipe, or other material as recommended by the manufacturer.

Where there is a risk of pipes freezing, they should be insulated. The insulation material must be:

- Inert, durable, and resistant to the effects of moisture.
- In-line with relevant codes and standards or be independently assessed for their intended use.
- Incorporate a vapour control layer to prevent ice build-up when employed on refrigerant pipework.

Any system components fixed to the building structure must:

- Be fully designed and assessed by an Engineer with regards to the buildings ability to accept the loadings and prevent detrimental effects arising from additional loading, movement or vibration.
- Be in accordance with the manufacturer's recommendations in relation to the type, size, number, position and fitting tolerance of fixings.
- Utilise fixings made from durable materials in accordance with recognised standards.
- Not adversely affect the weather resistance of the building.
- Fixings, supports, bracketry and mounting frames for components should be capable of taking designated loads in accordance with the manufacturer's recommendations.
- Have adequate protection against corrosion. Where two metals are to be joined, they should either be compatible or isolated, to prevent bimetallic corrosion. Aluminium and aluminium alloys should not come into contact with cementitious material.

Any system components penetrating through the building structure/fabric must:

- Be formed and detailed to provide adequate weather resistance.
- Be sealed to limit air leakage and prevent moisture from reaching the interior or any part of the structure that could be adversely affected by its presence.
- Must be weatherproofed using appropriate flashings and fixings where detailing requires e.g. solar photovoltaic panels and pitched roofing.
- Not include weatherproofing details that rely solely on sealant.
- Be robustly formed and sealed to inhibit the passage of fire and smoke where deemed required by relevant Building Regulations.

## Heat pumps

All work carried out shall be executed in accordance with the relevant MCS Microgeneration Installation Standards:

- MIS 3005 D & MIS 3005 I Requirements for MCS Contractors undertaking the supply, design, installation, set to work, commissioning and handover of Microgeneration Heat Pump Systems, and
- Provide evidence that the system will meet a level of performance required by the relevant Building Regulations.

Installations or work to systems containing fluorinated gas must use operatives that are F-Gas qualified and all individual operatives must have a qualification as an individual from an accredited organisation e.g. City and Guilds, Building Engineering Services Association (BESA), LCL Awards, Construction Industry Training Board (CITB).

Typically this will occur on Air Source Heat Pumps that are part of 'split systems' e.g. smaller outdoor units plus an indoor unit and may also incorporate a hot water cylinder.

## General considerations

Radiators and pipework that are used with these systems are likely to be larger than that of traditional gas boilers.

As well as the size of pipework, pipe runs will need to follow the specific schematics issued by the designer of the system to ensure they deliver the flow rates expected. Changes of direction in pipework may give rise to a reduced flow rate where they do not follow the specific system schematics and specifications.

Over-sizing components can result in significantly reduced efficiency and therefore any equipment that forms part of a designed system will have been calculated to ensure that it is not oversized for its space heating load. For this reason, substitution of the specified equipment within a designed system must be avoided.

Similarly, the location and positioning of equipment should be exactly as illustrated upon schematics, notably where air flow is key around installed equipment and is also essential in avoiding clashes with other elements. It is also paramount to ensure that positioning allows for periodic maintenance to be carried out by providing sufficient access to installed equipment.

Any assessment of the performance of a space heating system must avoid comparisons with conventional heating systems e.g. gas boilers. If a systems performance must be measured, it should be done so against a comparable system benchmark using the same technologies to avoid misconceptions that these systems are not being as responsive or are failing to meet the required performance levels.

Key points of note are that radiators, when installed as part of heat pump systems, will feel cooler to the touch. This should not be considered as a failure of the systems performance where the designed room temperature is ultimately achieved within the designated response time for the space to achieve its target temperature.

Heating systems that incorporate heat pumps will typically use different approaches to managing temperatures, with simple on/off timer control of conventional space heating being replaced with controls that are more suited to the system e.g. 'setback' temperature strategy. This is where a limiting temperature (a temperature that you never want the conditioned space to fall below) is set for the system and a target temperature is also set (the temperature for use of the space at chosen points in the day, as per the specific design).

## Wind turbines

All work carried out shall be executed in accordance with the relevant guidance:

- MIS 3003 – Requirements for Contractors undertaking the supply, design, installation, set to work, commissioning and handover of Micro and Small Wind Turbine Systems.
- And, provide evidence that the system will meet a level of performance required by the relevant Building Regulations.

## Biomass systems

All work carried out shall be executed in accordance with the relevant guidance:

- MIS 3004 – Requirements for Contractors undertaking the supply, design, installation, set to work, commissioning and handover of Biofuel Heating Systems.
- MCS Guidance Document – Percussive Events Guidance.
- And, provide evidence that the system will meet a level of performance required by the relevant Building Regulations.

### 15.3.5 Controls

Low and zero carbon systems shall be capable of being adequately controlled.

Low and zero carbon systems should be provided with accessible controls to operate and regulate the system.

**15.3.6 Impact on the building structure**

Low and zero carbon system shall not impede on the structural stability of the building.

**Heat pumps**

Ground source heat pump systems must not undermine or otherwise impact on building foundations due to proximity or operation. Any system designs must be carried out alongside foundation designs and engage any relevant parties in the foundation design at an early stage.

A site specific calculation for assessment of loading will be required where equipment is mounted onto building fabric i.e. placed on a flat roof, or attached to an external wall. This is applicable even where an approved mounting system kit is utilised.

**Wind turbines**

Structural assessment must be provided to prove and demonstrate the structures ability to accommodate the additional loads transmitted from the associated mounting systems. Where wind turbines are pole mounted to or through fabric, the rotational effects creating by pole mounted equipment should also be considered.

**Biomass systems**

Structural assessment must be provided for the additional loads and any foundation requirements for the installation of heavy plant related to biomass equipment. For further guidance, please refer to the 'Foundations' section.

**15.3.7 Weather resistance of the weatherproof envelope**

Low and zero carbon systems shall not impede on the weather resistance of the weatherproof envelope.

Where equipment is attached to the building fabric it must be provided with detailing that does not allow rainwater enter the building or create staining. Where employed, weather shielding attachments must direct water away from the structure. Where services, cabling/pipework or product attachment creates a penetration of the weatherproof envelope, all detailing must be weather tight and should not solely rely on the use of sealants.

**15.3.8 Provision of ventilation for items of plant and equipment**

Where items of plant and equipment located there shall be adequate provision for ventilation as required by the manufacturers specification.

Where items of plant and equipment within enclosed spaces e.g. under stairs, they should be adequately ventilated to the manufacturers specification.

Where items of plant and equipment are located in a cold pitched roof void, please refer to the 'Roofs – Pitched Roofs' section.

In all instances, ventilation ducts, grilles should not impede on the structure or weather resistance of the weatherproof envelope.

All work should comply with the relevant requirements of the Building Regulations.

**15.3.9 Maintenance**

Elements of any system that require periodic inspection and maintenance shall have adequate access provided.

All system installations shall have safe access provided to all elements requiring inspection, periodic servicing/maintenance, repair and periodic functional checks in relation to performance inclusive of any switchgear, inverters, meters and controls in accordance with the manufacturer's recommendations.

The electrical installation should be capable of being isolated from all other electrical sources when required, for maintenance or testing.

## 15.3.10 Testing and commissioning

All systems shall be tested and commissioned in accordance with a commissioning schedule. A commissioning certificate is required for any work completed by an approved installer.

The testing and commissioning of the system shall prove and demonstrate that the installation is in accordance with the certification requirements, the manufacturer's recommendations and the design.

Upon completion, the installer must provide a certificate to confirm that the system has been installed, tested and commissioned in accordance with the above.

## 15.3.11 Completion of works

Upon completion of work, an information pack shall be provided to the end-user.

Upon completion of work, the developer must provide an information pack, which includes:

- A completed manufacturer's certificate from an acceptable independent assessment organisation, such as MCS or Competent Person Scheme that is acceptable to our Warranty.
- User instructions for the systems installed.
- Contact details for the manufacturer and installer.
- All information in relation to the key components installed.
- Details of the fuel type and source.
- Maintenance and servicing requirements.
- Any Warranties and/or guarantees relating to appliances, items of plant and associated kit.

## Expectations of the installed system

The information pack should clearly explain how to operate the system efficiently and provide a clear explanation on what to expect from the installed system. This is of particular importance for users whom are more accustomed to gas boiler systems and the differences they may experience in operation.

For clarity, these differences should identify if a system is likely to be not as responsive; radiators (if installed) feeling cooler to the touch albeit that rooms still reach the target temperature as designed and the differences in using an alternate means of control e.g. no provision of on/off timers to control space heating.

## Relevant standards

- BS EN 12975-1 'Thermal solar systems and components. Solar collectors'.
- BS EN 12976-1 'Thermal solar systems and components. Factory made systems'.
- BS EN 61215 'Terrestrial photovoltaic (PV) modules - design qualification and type approval'.
- BS EN 14511 Parts 1-4 'Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling'.
- BS EN 61400-1 'Wind turbines'.
- BS EN 61400-2 'Wind turbines. Small wind turbines'.
- BS EN 14785 'Residential space heating appliances fired by wood pellets'.
- BS EN 12809 'Residential independent boilers fired by solid fuel'.
- BS EN 303-5 'Heating boilers for solid fuels, hand and automatically fired, nominal heat output of up to 300kW. Terminology, requirements, testing and marking'.



# 16.

## Ventilation and Extraction

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### Contents

|      |                      |     |
|------|----------------------|-----|
| 16.1 | General Requirements | 446 |
|------|----------------------|-----|

## Introduction

This section provides guidance on meeting the Performance Requirements for ventilation and extraction systems specified within the home. The guidance in this section is for rapidly diluting indoor air pollutants and the extraction of water vapour within the home.

### 16.1.1 Compliance

The design, specification and installation of ventilation and extraction systems shall meet the performance requirements of this section.

### 16.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site.

This should include a detailed ventilation strategy defining the approach being taken, which may include, but not be limited to:

1. Fully detailed ventilation drawings, schedules and specification for the proposed system that indicate type, location, and associated flow rates for all contributing elements/devices.

Prior to commencement, the Warranty surveyor at their discretion may also request additional supporting information that demonstrates suitability for the use of any materials or systems contained within the above.

At completion, the installing contractor will be required to provide a copy of the commissioning certificate for each element of mechanical ventilation/extraction for inclusion into the homeowner's information pack, which should include the flow rate confirmation as per the designed strategy at point of completion.

### 16.1.3 Ventilation strategy

A suitable ventilation strategy shall be specified to facilitate the exchange of air at defined rates to and from the spaces contained within a building to combat the effects of water vapour.

All systems shall be:

- Durable.
- Robust.
- Suitable for the intended purpose.

The ventilation strategy may rely on a combination of natural ventilation, mechanical ventilation and purge ventilation.

The arrangement of natural ventilation and mechanical ventilation should be designed to facilitate the exchange of air at defined rates to and from the spaces contained within a building.

## Natural ventilation provision

Natural ventilation relates to air change occurring through formed openings whose operation is not reliant on mechanically driven elements (e.g. doors, windows and manually operated trickle vents) that function without the use of mechanically driven elements.

Where doors, windows and manually operated trickle vents are provided, they must be controllable and located to avoid undue draughts. They must also be designed to prevent moisture ingress from rainfall / snow.

They should be sized and operable in accordance with the relevant Building Regulations and the rates of ventilation should be consistent with the statutory guidance e.g. Approved Documents.

## Mechanical ventilation provision

This is purpose provided ventilation which is designed into the building to provide a quantifiable and controlled rate of ventilation e.g. mechanical background ventilators, intermittent extract fans, and continuous supply/recovery of air through mechanical systems (MEV and MVHR).

Where the designed ventilation strategy requires the inclusion of purpose provided ventilation, each element should be compliant with the respective part of relevant Building Regulations and the rates of ventilation should be consistent with the statutory guidance e.g. Approved Documents.

### Mechanical background ventilators

Where mechanical background ventilators are provided, e.g. humidistats etc., they must be controllable and located to avoid undue draughts. They should be adequately protected against adverse weather and moisture ingress.

## Intermittent and continuous extract fan units

Intermittently operated and continuously operated extract fans provide extract ventilation to remove odours and excessive humidity. Where the designed ventilation strategy requires the inclusion of mechanical extraction, it should be provided at rates compliant with the relevant Building Regulations and the rates of ventilation should be consistent with the statutory guidance e.g. Approved Documents.

## Continuous mechanical extract (MEV) systems and Continuous mechanical supply and extract systems with heat recovery (MVHR)

Where the designed ventilation strategy such a system, it should be designed and installed to be compliant with the relevant Building Regulations and the statutory guidance e.g. Approved Documents.

The system should be designed as a complete package, the performance of all materials and components should be considered to ensure compatibility and performance of the system.

The system should:

- Be designed to ensure that a satisfactory level of performance is achieved and in accordance with statutory guidance e.g. Approved Documents.
- Ensure even distribution of airflow taking account airflow resistance, including the bends and fittings.
- Have adequate fan capacity accounting for airflow resistance of the system.
- Airflow resistance should be calculated in accordance with BS EN 13141-2 and manufacturer's data.
- Have ductwork that is as direct as possible.
- Be installed in accordance with the design and manufacturers recommendations.

## Mechanical extraction rates

| Room                                         | Intermittent extract                      | Continuous extract |
|----------------------------------------------|-------------------------------------------|--------------------|
| Kitchen                                      | 30 l/s adjacent to hob or 60l/s elsewhere | 13 l/s             |
| Utility                                      | 30 l/s                                    | 8 l/s              |
| Bath/shower room/<br>Designated drying area* | 15 l/s                                    | 8 l/s              |
| Sanitary accommodation                       | 6 l/s                                     | 6 l/s              |
| *Applicable only in Scotland                 |                                           |                    |

## Purge ventilation provision

Purge ventilation relates to ventilation that provides a rapid delivery of fresh air to a space.

Purge ventilation should be provided in accordance with the relevant Building Regulations. Purge ventilation provision is required in each habitable room and should be capable of extracting a minimum of four air changes per hour (ach) per room directly to outside.

## Allowance for air movement

Ventilation strategies that rely upon air transfer throughout the dwelling, may require an undercut to internal doors.

Typically, this is required to be of minimum area 7600mm<sup>2</sup> in all internal doors above the floor finish which is equivalent to an undercut of 10mm for a standard 760mm width door. In such instances, the air transfer provision must be unrestricted after floor finishes have been laid (e.g. carpets should not encroach).

Note: Where fire doors are installed, reference must be made to the fire door certification for the size of allowable gaps.

### 16.1.4 Background ventilators

Where background ventilators are specified, they shall be suitable for the intended purpose and shall:

- Not damage the weatherproof envelope.
- Restrict the ability to open the window/door.
- Be controllable and located to avoid undue draughts.
- Be adequately protected against adverse weather and moisture ingress.

Where manually operated trickle vents are installed in windows and doors, they must be correctly specified for the location and should be installed so as not cause potential damage to render finishes or restrict the ability to open the window/door. Windows with operating mechanisms that can be set in 'night vent' positions are not accepted as meeting this requirement.

Where background ventilation is provided, whether it is manually operated or mechanically delivered, it must be controllable and located to avoid undue draughts. It should be adequately protected against adverse weather and moisture ingress.



### 16.1.5 Fan units and associated plant/kit

Any fan unit and associated plant/kit shall:

- Be fixed to a part of the building that can safely support all associated loads.
- Not damage the structure or weatherproof envelope.
- Be adequately protected against adverse weather and moisture ingress.

Any fan units and/or associated plant/kit (e.g. extraction fan units, MEV/MVHR units) should be adequately fixed to a part of the building that can support the load.

All elements should be fixed in accordance with the design and manufacturer's recommendations.

### 16.1.6 Controls

Ventilation and extraction systems shall be capable of being adequately controlled and operated.

All ventilation and extraction systems should be capable of being adequately controlled. The following should be considered by the designer:

- Any manual boost controls should be provided locally to the areas being served.
- In kitchens, any automatic controls must provide sufficient flow during cooking with fossil fuels (e.g. gas) to avoid build-up of combustion products.
- Ensure the system always provides the design ventilation rates.

Where MEV systems are installed:

- The fan units and controls should be easily accessible.
- Ducts and air valves should have either fitted filters or be accessible for cleaning.

### 16.1.7 Ductwork

Ductwork systems shall be adequately designed and installed, and:

- Be designed to meet the ventilation strategy.
- It shall not affect the structure or weatherproof envelope of the building.
- Be constructed using durable and robust materials which are appropriate for the intended purpose.

### Interfacing with building fabric

The route of ductwork should take account of other building elements and where it passes through structural elements, it should not adversely affect the structural performance of the building. Where alterations to structural elements are required, this should only be carried out in accordance with the manufacturer's recommendations, or be designed by an Engineer.

Floor joists should not be excessively notched or drilled to accommodate ductwork. Further information can be found in the 'Upper Floors' section.

Detailing should allow for thermal expansion and contraction to avoid damage and noise from ductwork movement. This may result in sleeved approaches through structural elements to prevent damage and the avoidance of solidly embedding ducts with mortar.

The route of ductwork should not adversely affect the fire performance of the building fabric. Fire performance should be in accordance with Building Regulations and in accordance with the guidance of the relevant statutory guidance e.g. Approved Documents.

Issues that should be taken into account include:

- Passage through compartmentation and/or protected routes.
- The integrity of walls and floors.
- Additional requirements for flats and apartments with a floor above 4.5m.
- Impact of outlets and ducting on the building fabrics fire performance.
- The use of dampers and fire stopping to mitigate the risks.

Where proprietary fire stopping systems are used around services that penetrate fire-resisting floors, walls or partitions, they should be installed using the manufacturer's recommendations.

Further information can be found in the 'Upper Floors' and 'Internal Walls' guidance.

### Layout, runs and junctions

Ductwork systems should be designed by a specialist and be installed in accordance with the manufacturer's guidance. The route of ductwork should not hinder the free flow of air or achievement of the required ventilation rates.

It is recommended that rigid ducts are used as far as practicable, and bends should generally be formed with proprietary rigid components.

Flexible ducting should only be used for final connections. Where utilised, installed ductwork lengths and sizing must be strictly in accordance with the design to avoid any loss or reduction in the designed ventilation rates. Installation should be straight and fully supported, without undulation or restrictions as result of compression or constriction.

Where flexible duct is used to form bends on an extract system, they should be restricted to a maximum of:

- Two for systems up to 30 l/s.
- One for extract rates higher than 30 l/s.

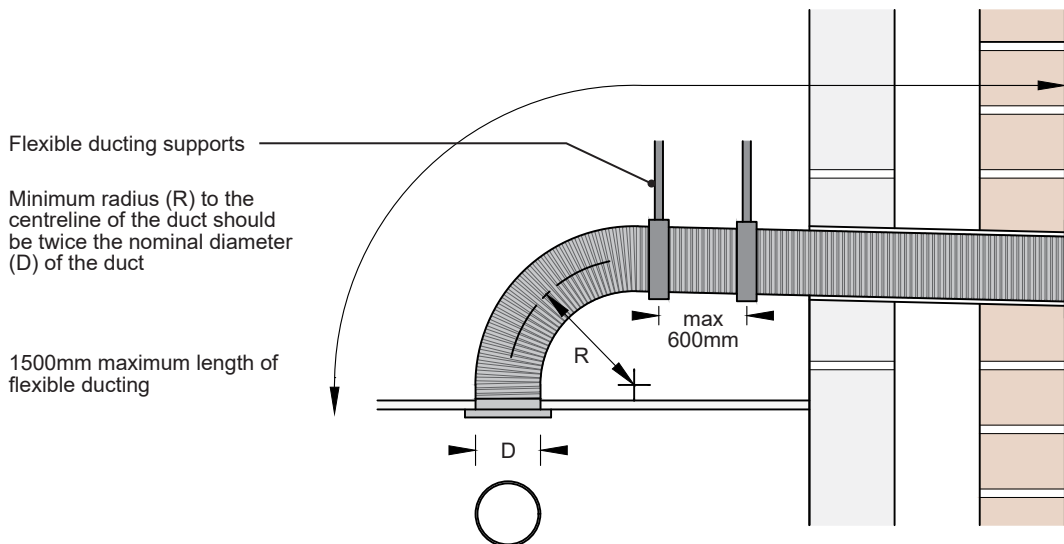
Ductwork should be securely fixed, and have adequate support throughout its length, with clips and supports for spaced at equal distances and in accordance with the ductwork manufacturer's recommendations.

All joints and connections should be mechanically fixed and sealed in accordance with ductwork manufacturer's guidance.

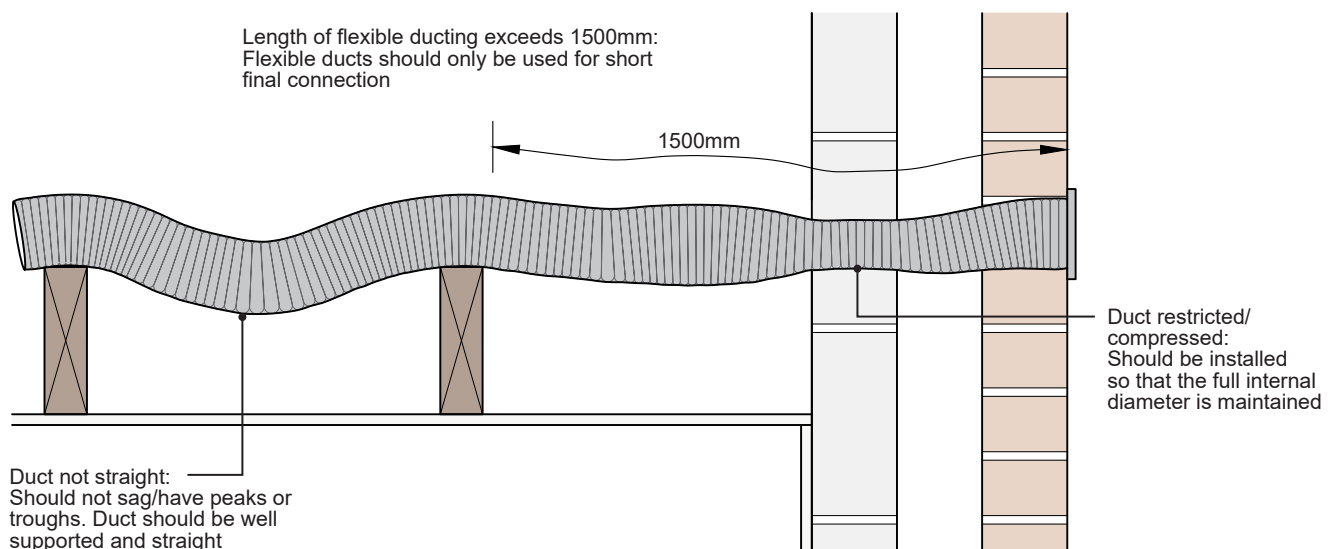
Ductwork should not be in direct contact with other surfaces, such as plasterboard ceilings, that may transfer noise to the home.

Where ductwork passes through an external wall, it should be positioned to slope slightly outwards to prevent water entering the building.

## Correct duct installation



## Incorrect duct installation



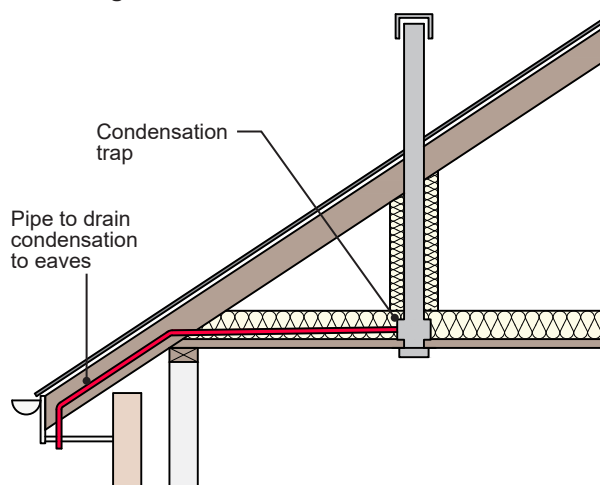
## Control of condensation

Where ductwork from extractor fans goes through unheated spaces such as roof voids, action should be taken to minimise the chance of condensation forming in the ducting and any consequential damage caused to finishes and the fan unit. To achieve this, ductwork should:

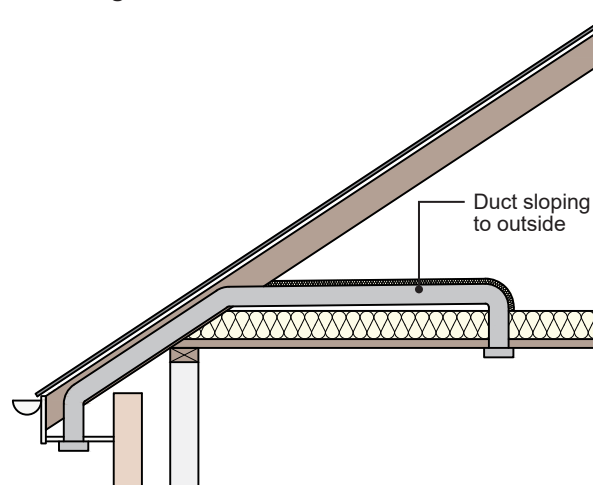
- Discharge to the outside air.
- Provide continuous insulation to the outside of the ductwork.
- Be laid to fall away from the fan.

The insulation type, thickness and thermal resistance should be included and documented within the any ventilation strategy and supporting designs. Alternatively, the ductwork can be fitted with a condensate trap that discharges to the outside or installing the duct to slope to the outside.

#### Insulating a vertical extract duct



#### Insulating a horizontal extract duct



#### Termination to outside air

Ventilation systems should terminate freely to open air and terminals should not adversely affect the performance of the ventilation system by restriction or resistance of air flow.

Airflow resistance data for terminals should be supplied by the manufacturer via testing in accordance with BS EN 13141-2.

Where terminals are located on external walls or pass through a roof structure, these should be adequately protected against adverse weather and moisture ingress.

Where used, extracted air must discharge directly to outside air and not terminate in a manner that may allow a return of the extracted air to an internal space e.g. extraction grilles in roof soffits directly above an opening window or within 500mm of a trickle vent.

Outlets should not discharge into courtyards, enclosures or architectural screens, and should be downwind of intakes where there is a prevailing wind direction.

The location of MVHR inlets shall be sited away from nearby pollution sources such as boiler flues, chimneys, ventilation extracts, SVP etc. An MVHR specialist should provide a design proposal for the specific location to confirm the system will function correctly.

#### Addition provisions for timber frame

In addition to general provisions for the installation of ductwork, the following are of particular note where they interact with external wall in timber frame construction:

- The routing and termination of ductwork should not affect the fire resistance of the structure.
- Penetrations through the Air and Vapour Control Layers should be tight fitting to reduce air leakage and the passage of moisture vapour.
- Adequate allowance for differential movement to occur where the duct passes through any external leaf e.g. masonry.
- Ducts that pass through the external wall cavity and provide an opening should be enclosed with a cavity barrier and protected with a cavity tray.

Further information can be found in 'External Walls – Timber Frame'.

### 16.1.8 Commissioning

All installations shall be completed by a technically competent person in a workmanlike manner and a commissioning certificate will be required for completed installations.

All installations should be completed by a technically competent person to a recognized scheme acceptable to us.

The measured rates should be as per the design intention. Where the rates are lower than those designed, an adjustment should be made to correct the system, and all air flows should then be re-tested.

At completion, the installing contractor will be required to provide a copy of the commissioning certificate for each element of mechanical ventilation/extraction for inclusion into the home owner's information pack, which should include the flow rate confirmation as per the designed strategy at point of completion.

# 17.

## Electrical Services

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### Contents

|      |                                |     |
|------|--------------------------------|-----|
| 17.1 | Mains                          | 452 |
| 17.2 | Photovoltaic (PV) Solar Panels | 458 |

## Introduction

This section provides guidance on meeting the performance requirements for electrical services. This section covers utility services which enter and/or are within the building and not those parts installed by a utility provider.

### 17.1.1 Compliance

The design, specification and installation of electrical services shall meet the performance requirements of this section.

For guidance on services entering the building, please refer to the 'Heating Systems' section.

### 17.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

## Design

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Schematic layout drawing identifying locations of all elements relating to the electrical system e.g. outlets, switches, distribution boards, and any associated equipment.
2. The location and type of ancillary components that are connected to the electrical system e.g. those used for fire safety, power points to ventilation systems and associated controls.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

## Installation

The installing contractor will be required to demonstrate, in a clearly understandable format, that the installation provides an adequate level of performance. As a means to demonstrate this, the installing contractor must:

1. Be registered with a Competent Person Scheme to prove and demonstrate that their work complies with the relevant Building Regulations.
2. Issue testing and commissioning certification for each installation at completion.

### 17.1.3 General provision for installation

All electrical installations shall:

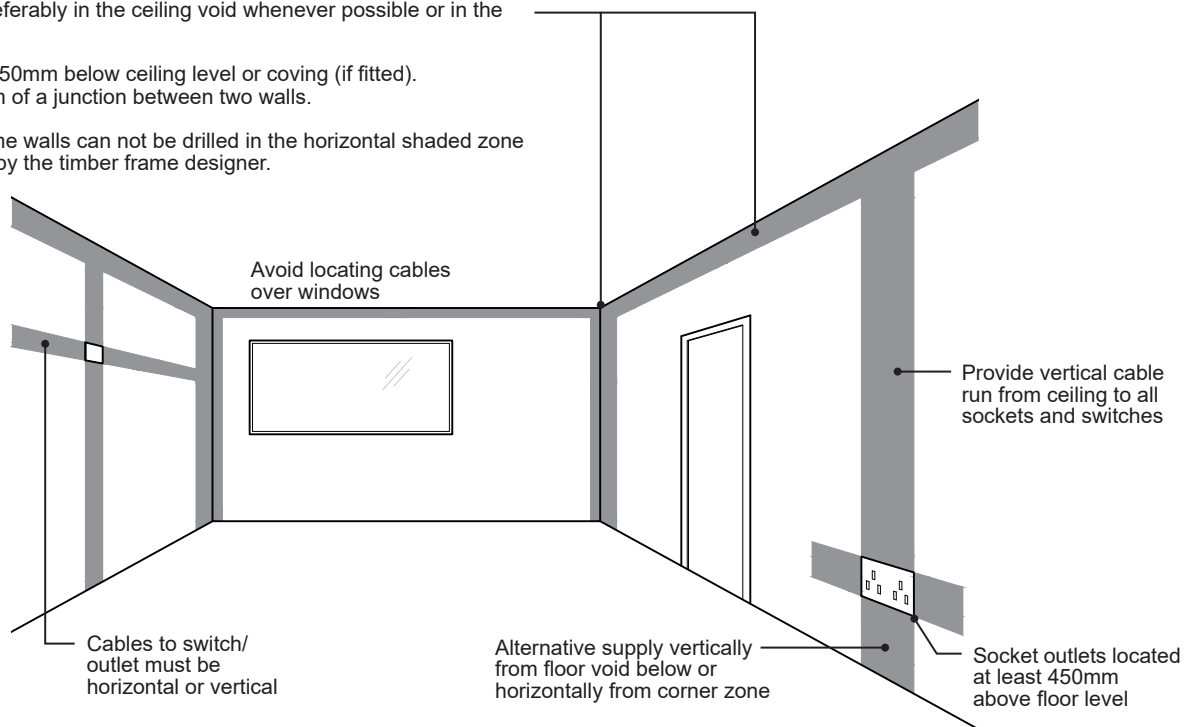
- Be in accordance with the relevant Building Regulations and BS 7671.
  - Be carried out by a suitably qualified professional.
  - Be provided with a commissioning certificate.
  - Not adversely affect the structural stability of the building.
  - Prevent the entry of hazardous ground substances, external moisture or vermin.
- A suitable electrical service of the appropriate size for normal domestic use shall be provided.
  - PVC-covered cables should not be in contact with polystyrene insulation.
  - Electrical cables should not be diagonal, and their locations should be in accordance with the following image and current relevant Building Regulations.
  - Cables routed within the shaded zones must be in accordance with BS 7671 (see the following image).

## Safety zones for electrical cables in walls

Locate cables preferably in the ceiling void whenever possible or in the shaded zone:

- Horizontally 150mm below ceiling level or coving (if fitted).
- Within 150mm of a junction between two walls.

Note: Timber frame walls can not be drilled in the horizontal shaded zone unless designed by the timber frame designer.



## Supplementary earth bonding

For domestic situations, supplementary bonding is required in areas of increased risk, which are rooms containing a bath or shower. It is not required within kitchens, utility rooms or washrooms.

Supplementary bonding is not required to the pipes or metal fittings attached where plastic pipes are used within a bathroom or shower room.

This also applies where short lengths of metal pipes connected to bathroom fittings are attached to plastic pipes.

Supplementary bonding is still required to electrical equipment such as electric showers or electric heaters. This type of bonding must also be connected to the protective conductor of all circuits supplying electrical equipment in the bathroom.

## Supplementary bonding in a bathroom - plastic water supply pipe installation

The protective conductors of all power and lighting points within the zones must be supplementary bonded. The bonding connection may be to an earth terminal of a switch or accessory supplying equipment.

Circuit protective conductors may be used as supplementary bonding conductors.

Supplementary bonding of short lengths of copper pipe installed where the pipes are visible is not necessary.

## Supplementary bonding in a bathroom - metal water supply pipes

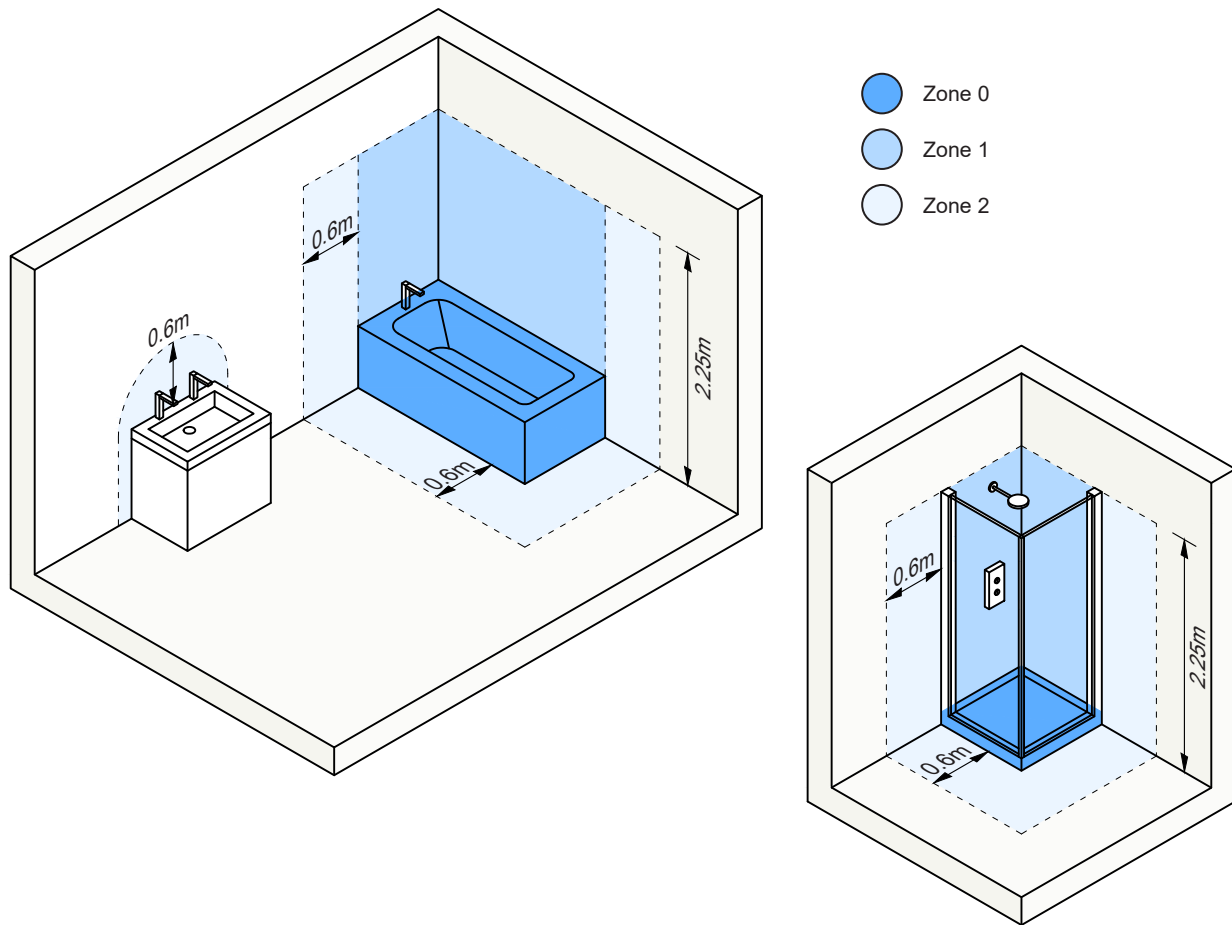
The protective conductors of all power and metal lighting points within the zones must be supplementary bonded to all conductive parts in the zones including metal waste, water and central heating pipes, metal baths, and shower basins.

Circuit protective conductors may be used as supplementary bonding conductors.

Metal baths not connected to a metal building structure do not require supplementary bonding if all metal pipes connected to them have been bonded.

Connection to pipes to be made with BS 951 clamps (complete with "Safety Electrical Connection" label).

### Bathroom zones



#### Description of zone 0

Zone 0 is the interior of the bath tub or shower basin.

#### Description of zone 1

Zone 1 is the area directly above zone 0, up to a height of 2.25m above a bath or to the height of the maximum reach of the shower head.

#### Description of zone 2

Zone 2 is the area beyond zone 0 and zone 1, extending 0.6m horizontally and up to 2.25m vertically.

Note: This is general guidance only. Refer to 'BS 7671 Requirements for Electrical Installations' for specific requirements.

### Services in framed walls

In addition to general provisions for the installation of services, the following are of particular note for timber frame construction external walls:

- The routing and termination of services should not affect the fire resistance of the structure.
- Electrical services are to be rated for their location with consideration for insulation.
- Service penetrations through the VCL should be tight fitting to reduce air leakage and the passage of moisture vapour.
- Avoid running electrical services in the external wall cavity, except for meter tails.
- Services should be protected with metal plates if they pass within 25mm from face of stud.
- Adequate allowance for differential movement to occur without causing damage should be provided for rigid services rising vertically through a building.
- Services that pass through the external wall cavity and provide an opening (such as meter boxes) should be enclosed with a cavity barrier and protected with a cavity tray.

Please refer to the 'Internal Walls' and 'Upper Floors' sections for further guidance.

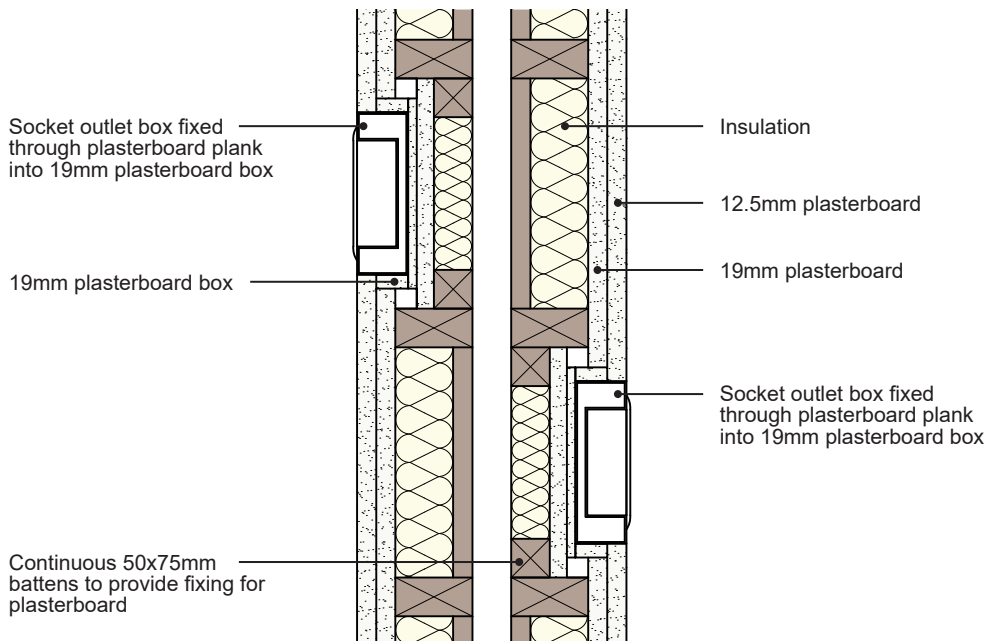
## Chasing of masonry walls

If chases in walls are necessary, their depth should not exceed:

- One-sixth the thickness of the single leaf for horizontal chases.
- One-third the thickness for vertical chases.

Hollow blocks should not be chased unless specifically permitted by the manufacturer.

## Staggered services on party walls (section plan view)



Please note: The installation services within a party wall should not compromise the sound or fire resistance.

## Notching and drilling

Floor joists shall not be excessively notched or drilled. Please refer to the 'Upper Floors' section for further guidance.

## Concealed services

If the services are hidden in walls or floors, they should be appropriately protected.

## Prevention of ground gases/contaminants entering the home

Where ground gases/contaminants are present in the ground, the designer shall take precautions to prevent the gases/contaminants entering the home.

Incoming utilities should be specified to prevent the entry of ground gases/contaminants entering the home.

For further information on managing ground gases contaminants, please refer to the 'Ground Conditions – Managing Ground Contaminants' section.

## Commissioning certificate

The installing contractor will be required to demonstrate, in a clearly understandable format, that the installation provides an adequate level of performance. As a means to demonstrate this, the installing contractor must:

1. Be registered with a Competent Person Scheme to prove and demonstrate that their work complies with the relevant Building Regulations.
2. Issue testing and commissioning certification for each installation at completion.



### 17.1.4 Socket outlets and switches

Sockets and switches shall be conveniently positioned and in accordance with the relevant regulations, codes and standards.

#### Number of socket outlets required per room

Rooms should be provided with the following 13a outlets:

| Room               | Number of 13A outlets | Comments                                                                                                                                                                                                                                  |
|--------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Kitchen/Utility    | 8                     | <ul style="list-style-type: none"> <li>Where separate kitchen and utilities are provided, each room should have at least 4 outlets.</li> <li>Where appliances are provided, three outlets should be available for general use.</li> </ul> |
| Dining room        | 4                     |                                                                                                                                                                                                                                           |
| Living/family room | 8                     | Two outlets should be near the TV aerial outlet.                                                                                                                                                                                          |
| Main bedroom       | 6                     |                                                                                                                                                                                                                                           |
| Other bedrooms     | 4                     |                                                                                                                                                                                                                                           |
| Landing            | 2                     |                                                                                                                                                                                                                                           |
| Hall               | 2                     |                                                                                                                                                                                                                                           |

Note: the above refers to individual socket outlets e.g. a double socket would count as 2 outlets.

Socket outlets are to be conveniently positioned in close proximity to the TV aerial and telephone outlets, thus allowing for electrical equipment including TVs etc.

Where open plan or mixed used spaces are provided, allowances applicable to each space in the above table should be combined and applied across the mixed use area. For example, a mixed use area incorporating living and dining areas would require 12 outlets in total. 4 outlets serving the dining room and 8 serving the living room, with at least 2 outlets being provided near to TV aerial outlets.

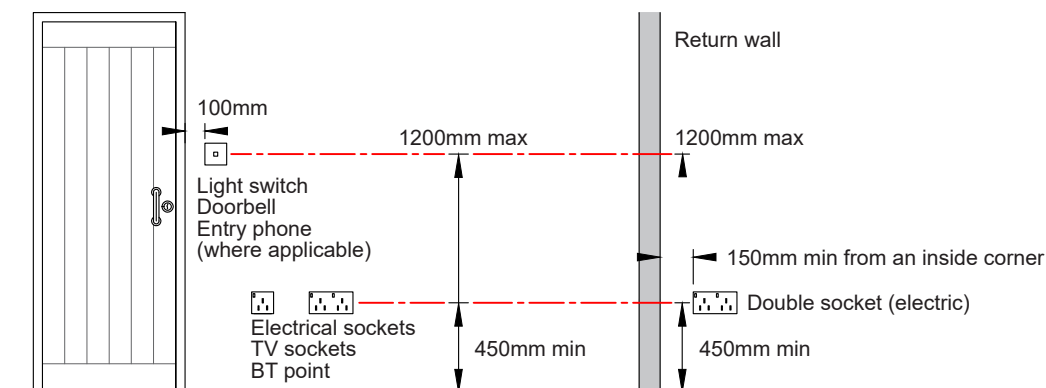
#### Positioning of sockets and switches

Sockets and switches should be positioned in accordance with the relevant Building Regulations.

Consumer units should be mounted so that the switches are between 1350mm and 1450mm above finished floor level.

Distances from inside corners are shown as a minimum requirement for Warranty. It should be noted that an increased distance may need to be provided to comply with development specific requirements for access and use of the building to comply with relevant Building Regulations.

#### Heights of wiring accessories and setting out sockets in proximity to internal walls



For clarity, the maximum and minimum height dimensions illustrated are measured to their centre line from finished floor level.

#### Cooking

Cooking appliances provided to the cooker space in a dwelling must be suitably switched and terminated with a minimum 30a electricity supply.

If a cooker panel is provided, it needs to be positioned to the side of the cooker space. A 13a socket outlet shall be positioned at the cooker space where a gas supply is provided to the dwelling.

#### Gas appliance

Where a gas appliance requires an electrical supply, a suitably fixed spur or socket outlet shall be provided.

## 17.1.5 Cabling penetrating the weatherproof envelope and structure

Where cabling (electrical, co-axial etc) penetrates the weatherproof envelope it shall be appropriately sealed to prevent water ingress into the property.

Cabling which penetrates elements of structure or structural members shall be appropriately detailed to not impede on the structural performance of the structure or structural members.

## 17.1.6 Light fittings

At least one fixed lighting outlet shall be provided to all rooms. Areas greater than 25m<sup>2</sup> are to be provided with two fixed lighting outlets.

Halls, landings and staircases are to be provided with lighting outlets and two-way switches.

Down lighters and other flush-fitting attachments should not be installed through a ceiling if the ceiling is providing part of the required acoustic insulation or fire resistance to the property.

If down lighters are provided to ceilings below roof voids (excluding thatched roofs), precautions are to be taken to ensure that no fire risk is caused by the proximity of other materials.

Passive infrared (PIR) sensors are to be used in common and external areas.

## 17.1.7 Fire stopping

Fire stopping is required around services that penetrate fire-resisting floors, walls or partitions.

If proprietary systems are used, they should be installed using the manufacturer's recommendations.

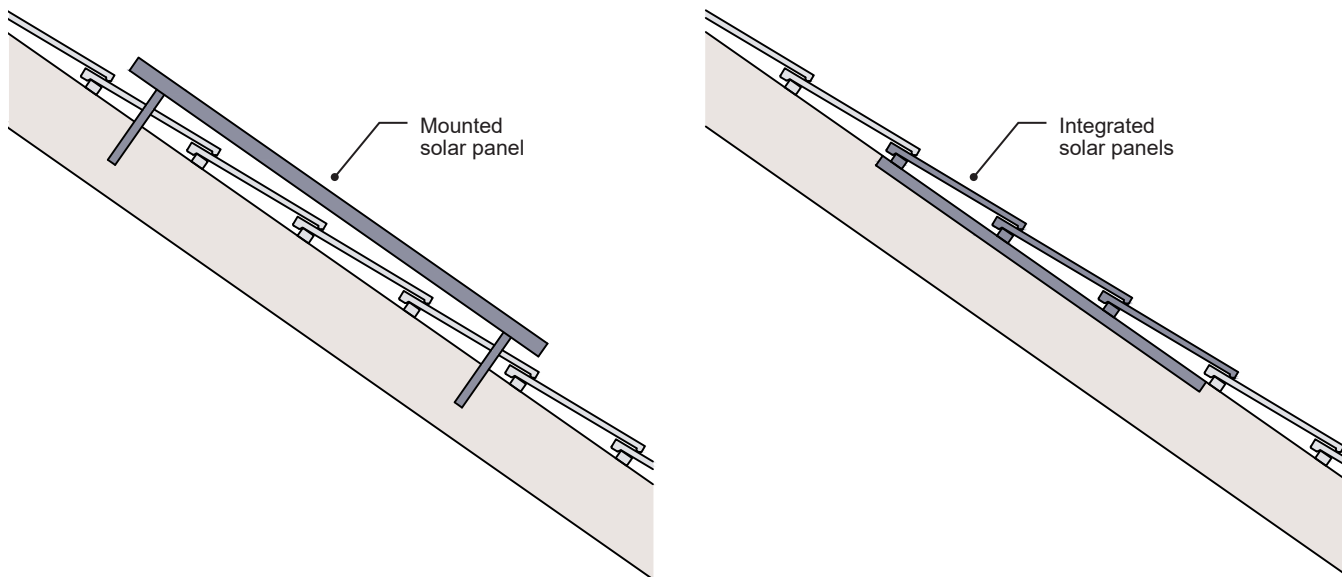
Please refer to the 'Internal Walls' and 'Upper Floors' sections for further guidance.

## Introduction

This section provides guidance on meeting the performance requirements for Photovoltaic (PV) solar panels which generate electricity from sunlight. This section covers utility services which enter and/or are within the building and not those parts installed by a utility provider.

Photovoltaic (PV) solar panels systems use module arrays to generate electricity from sunlight which are either mounted on a roof(s) and/or walls using either mounting systems or integrated to be a part of the roof covering using proprietary flashing kits to form the main weather proof barrier. Module types include:

- Monocrystalline or polycrystalline silicon PV modules.
- Amorphous thin film PV modules.
- Bespoke building-integrated PV modules - PV glazing, PV façade units or PV shading units.
- Hybrid PV modules.



### 17.2.1 Compliance

The design, specification and installation of PV solar panels shall meet the performance requirements of this section in respect of:

- Meeting relevant standards.
- Product certification.
- Installer/operative competency.

### Relevant standards

PV solar panels should satisfy the requirements of relevant Building Regulations and the following codes and standards:

- BS EN 61215-1 0 Terrestrial photovoltaic (PV) modules. Design qualification and type approval.
- BS EN 61215-2 Terrestrial photovoltaic (PV) modules. Design qualification and type approval - Test procedures.
- BS EN 60068 Environmental testing.
- BS EN IEC 61730 Photovoltaic (PV) module safety qualification.
- BS EN IEC 62108 Concentrator photovoltaic (CPV) modules and assemblies. Design qualification and type approval.
- MCS 005 Product Certification Scheme Requirements: Solar Photovoltaic Modules.
- MCS 012 The Roof Fixing Standard (Product).
- MIS 3001 - The Solar Thermal Standard (Installation).
- MCS 3002 The Solar PV Standard (Installation).
- MIS 3012 The MCS Battery Standard (Installation).
- PAS 63100 Electrical installations — Protection against fire of battery energy storage systems for use in dwellings.

### Product certification

PV solar panels (and any associated battery storage equipment) should have current certification confirming satisfactory assessment by an appropriate third party authority such as the MCS.

Assessment specific to equipment should be aligned with the relevant Microgeneration Certification Scheme:

- MCS 005 - MCS Product Certification Scheme Requirements: Solar PV Modules.
- MCS 012 – MCS Product Certification Scheme Requirements: Pitched Roof Installation Kits.
- MCS 017 – MCS Product Certification Scheme Requirements: Bespoke Building Integrated PV Products.
- MCS 004 - MCS Product Certification Scheme Requirements: Solar Collectors.

All installed equipment must carry the 'MCS Certification Mark'.

Other third party product conformity certificates may be acceptable where they are considered suitable by the Warranty provider.

**Installer/operatives competency**

Installers and operatives of PV solar panels should be competent and familiar with the system being installed and must either be MCS certified or be certified to a standard acceptable to the Warranty provider.

**17.2.2 Information to be provided**

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Confirmation of which manufacturer and/or installer is responsible for each system and interface.
2. Full set of drawings including interface details.
3. Details of PV solar panels. This should include:
  - a. Manufacturer's specifications.
  - b. Product certification.
  - c. Details of flashing kits and other weather components for the system.
4. Structural calculations for the roof structure which clearly show the loadings from the PV solar panels have been taken into account.
5. Wind and snow load calculations.
6. Details of their site specific fixing methodology including type and spacings for clips and fixings.
7. Where battery storage units are to be located in a cold roof void, the following should be provided:
  - a. Confirmation from the system manufacturer that the battery units can be stored in a cold roof void.
  - b. Confirmation from the system manufacturer that the area has sufficient ventilation to prevent overheating of the battery unit.
  - c. Confirmation from the building designer that the presence of the battery storage unit will not have an impact on the ventilation strategy of the pitched roof structure.
  - d. Confirmation from the Engineer that the structural calculations for the roof structure has taken the presence of the battery storage units into account.
  - e. Where services pass through the weatherproof envelope, appropriate weatherproof detailing should be provided.
8. Where roof integrated PV solar panel systems are specified, details of the ventilation strategy for the pitched roof structure in accordance with the guidance in this section and the 'Roofs – Pitched Roof Structures' section should be provided.
9. Commissioning certification.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

**17.2.3 System design**

PV solar panels shall be designed, specified and installed to ensure the structural stability and weatherproof envelope of the building is not effected. Factors to be taken into account include:

- |                                 |                                      |                                  |
|---------------------------------|--------------------------------------|----------------------------------|
| ■ Impact on building structure. | ■ Fixings and fixing specifications. | ■ Coastal locations.             |
| ■ Weather resistance.           | ■ Durability.                        | ■ Battery storage.               |
| ■ Compatibility.                |                                      | ■ Fire performance requirements. |

**Impact on the building structure**

Structural assessment should be provided to prove and demonstrate the structures ability to accommodate the additional loads transmitted from the PV modules, associated mounting systems, and any battery storage placements on or within the roof structure or associated voids.

Any assessment should also consider the potential loads created by wind and snow. For each site the imposed wind and snow loads should be derived using the procedures within Eurocode 1 (BS EN 1991-1). Wind loads vary considerably across the UK and are influenced by factors such as site altitude, building height and local topography.

Recognised test data commissioned for the specific purpose of determining the wind loads on such systems should be used to create any calculations.

**Weather resistance**

Where equipment is attached or mounted to the building fabric, it must be provided with detailing that does not allow rainwater to enter the building fabric via structural connections, cabling or pipework penetrations. All detailing must be weather tight and should not solely rely on the use of sealants.

All detailing must be strictly in accordance with manufacturer's guidance and be fully resolved before any installation work is commenced. It must be fully weather tight and should not solely rely on the use of sealants.

**PV solar panels on flat roofs**

Flat roof PV module arrays that are supported on a framework must incorporate suitable protection to the flat roof waterproofing and be designed alongside flat roof drainage provision. Support structure and any associated system i.e. ballasted bases must not create an imposition to the drainage of the flat roof or compromise the waterproof roof covering.

### Compatibility

---

PV solar panels should be specified and installed so as to not adversely affect the performance of the building to which they are fixed to. Where multiple systems are specified, they should be compatible with each other.

Where roof integrated PV solar panel systems are specified, their flashing kits and ancillary components must be compatible with the primary roof covering.

Roof underlays/membranes must not have their function or service life reduced or affected by the presence of the PV panel in service.

### Ventilation considerations for roof integrated PV solar panel systems

For the purposes of Warranty, we consider roof integrated PV solar panel systems as an air impermeable roof covering, even where the surrounding roof covering is classed as air permeable, the entire roof should be considered as impermeable.

For guidance on ventilation strategies for air impermeable pitched roof coverings, please refer to the 'Roofs – Pitched Roof Structures' section.

Roof integrated PV solar panel system manufacturers may require a larger ventilated air space to their underside to increase ventilation and cooling of the panel.

Where a LR underlay is specified, the manufacturer of the roof integrated PV panel system must confirm the underside of their system has a sufficient coating or protection to prevent corrosion.

Ventilation paths provided by counter battens to avoid the detrimental effects of condensation within the batten space should not be impeded in their function by the completed installation of the inset PV panels, flashing kits or associated cabling.

### Fixings and fixing specifications

---

PV solar panel systems and any associated flashing kits must be fixed in accordance with the manufacturer's requirements using their specified proprietary fixings. The fixings should be durable and suitable for the location.

The fixing of the system must be suitably designed by an Engineer, be site specific for the geographical location and capable of resisting the dead loads, snow loads, wind loads and imposed loads applicable to the roof and its location. Wind loads vary considerably across the UK and are influenced by factors such as site altitude, building height and local topography.

### Roof integrated PV solar panel systems

Where a roof integrated PV solar panel system manufacturer requires a larger ventilated air space to the underside of the inset PV panel, any increase to counter batten depths to accommodate larger ventilated voids must be fully factored into the wind uplift calculations for the system installation. Fixings securing the counter battens through to the rafters must be of sufficient strength and length and correctly spaced so as to resist dead loads, wind loads and imposed loads.

Any associated wind uplift calculations conducted by the manufacturer of the primary roof covering must include the interfaces with the roof integrated PV solar system, and any provision for additional fixings for the primary roof covering at its junctions around the roof integrated PV system.

All tiles and slates around the roof integrated PV solar panel system should be treated as a perimeter tile/slate and be fixed in accordance with the site specific fixing methodology.

### Durability

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Where roof integrated PV solar panel units form part of the weather proof envelope they must achieve the same service life as the roof covering (25 years).

### Coastal locations

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Where used in coastal locations, additional provisions will be required due to the aggressive environmental conditions that components will be exposed to. The designer must demonstrate all components used are suitable for such an environment. Please refer to 'Appendix B' of the Technical Manual for further guidance.

### Battery storage

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Where battery storage is provided, they should be designed, specified and installed by a competent person and in line with IET Code of Practice for Electrical Energy Storage Systems, BS 7671 18th Edition wiring regulations, PAS 63100 and other applicable standards or regulations applicable at the time.

The following should be considered where battery storage is provided:

- The installation should be in line with MIS 3012, PAS 63100 and manufacturer's installation instructions.
- The battery must meet the relevant IPX rating for the proposed location the battery is to be situated.
- Structural assessment must be provided to prove and demonstrate the structures ability to accommodate the additional loads transmitted from the battery on or within the roof structure or associated voids.
- Battery storage units should not be located where there is a foreseeable danger of flood or water inundation.

In all situations, the battery should be located in an area that has sufficient ventilation to prevent overheating.

For guidance on the installation of plant and equipment (such as battery storage units) within a pitched roof void, please refer to the 'Roofs - Pitched Roof Structures' section of the Technical Manual.

### Fire performance requirements

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Panels and all associated components inclusive of fixings must meet the fire performance requirement of the relevant Building Regulations.

#### 17.2.4 Access

The designer shall provide the provision for access for cleaning, inspection, maintenance, and repair or replacement for the PV solar panel system.



# 18.

## Cold Water Supply

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### Contents

|      |                                                        |     |
|------|--------------------------------------------------------|-----|
| 18.1 | Cold Water Supply to Plumbing, Boilers, and Appliances | 464 |
|------|--------------------------------------------------------|-----|



## Introduction

This section provides guidance on meeting the performance requirements for cold water supply to plumbing, boilers and appliances. This section covers utility services which enter and/or are within the building and not those parts installed by a utility provider.

### 18.1.1 Compliance

Cold water services shall satisfy the performance requirements of this section.

### 18.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Locations of cold water pipe runs and detailing where they pass through components within the building fabric.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 18.1.3 Cold water services

Cold water services shall:

- Provide an adequate supply of cold water to each building.
- Be fed from below ground and insulated to prevent freezing.
- Be installed to satisfy the requirements of the relevant Building Regulations.
- Have suitable provisions for draining down.

## General requirements

Cold water systems may have provision for storage or be directly connected to the main supply. Drinking water needs to be supplied directly from the main supply.

Cold water pipes and storage cisterns located in roof spaces and other unheated areas should be appropriately insulated to the relevant standards.

Cold water storage cisterns will require the capacity specified in the design. Suitable support should be given for the cistern filled with water.

To stop the cistern bottom being deformed, permanent support is to be given where necessary. Adequate materials for support platforms are:

- Softwood boarding.
- Marine plywood.
- Chipboard type P5.
- Oriented Strand Board type OSB3 to British Standards.

All water tanks should be accessible. Gangway boarding is required to each cistern opening from the roof space access. An area of 1m<sup>2</sup> of boarding is to be provided next to cisterns to permit routine maintenance.

Water storage cisterns should be protected from contamination by a rigid, close-fitting cover (which is not air tight) that excludes light and insects.

Holes should be formed with a cutter in the positions shown in the design.

Overflows in warning pipes should be no less than 19mm diameter and situated 25mm from the shut off water level in the cistern. The pipe may dip below the water level in accordance with water regulations. Alternatively, the pipe should terminate vertically downwards, or a tee should be fitted horizontally at the discharge end.

## Draining down facility

Cold water installations require the capability to be drained down.

## 18.1.4 Materials

Materials shall:

- Be suitable for the intended purpose.
- Be durable.
- Be robust.
- Be constructed using non-hazardous materials.

Materials that are safe and minimise the risk of corrosion are to be used for pipes and fittings for water services. The recommendations of the water supplier with regard to materials and fittings should be followed.

It may be necessary to fit aluminium protector rods in areas where the corrosion of copper cylinders occurs. These are to be fitted during manufacture, in accordance with the relevant British Standards.

All materials should be suitable for the environment and ground conditions (such as contaminants and ground gases).

## 18.1.5 Installation

The installation of cold water services shall:

- Not affect the performance of any structural elements or the weatherproof envelope of the building.
- Prevent the entry of hazardous ground substances, external moisture or vermin.
- Be appropriately protected and sleeved to prevent damage.

### Installation of building services

All items should be installed to ensure satisfactory operation.

Items to be taken into account include:

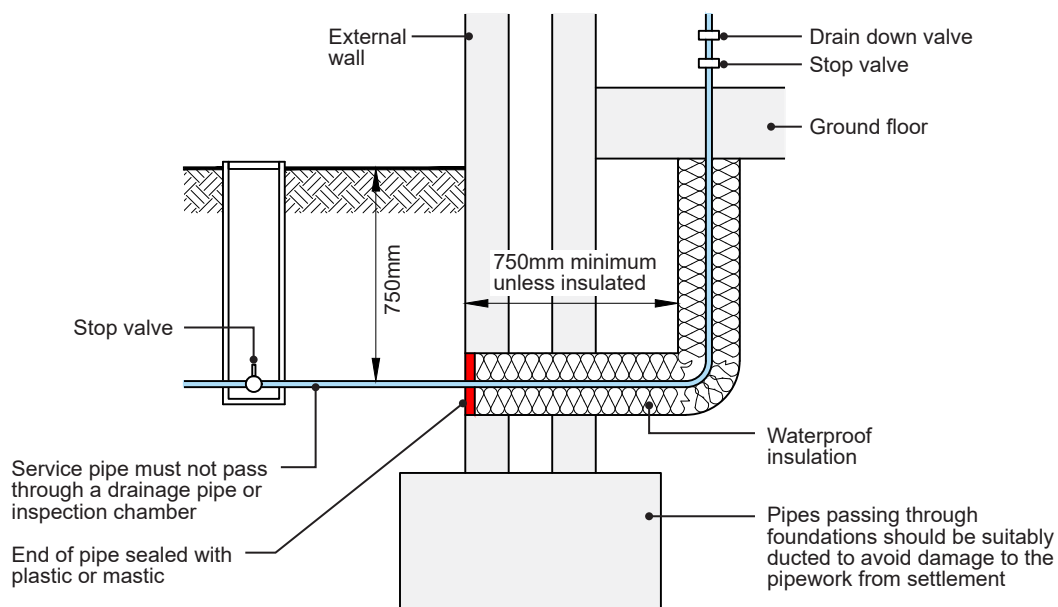
- Locations and fittings of pipes and cable service entries through the substructure.
- Services must be sleeved or ducted through structural elements (and not solidly embedded) to prevent damage. Fire stopping may also be required. Services should not be located in the cavity of an external wall, except for electricity meter tails.
- Only to be buried in screeds where permitted by relevant Codes of Practice.

Where copper pipes are permitted in floor screeds, they should be:

- Sleeved or wrapped so that they can move freely along the length and at joints and bends.
- Jointed with capillary joints.

A metallic tape should be applied to the pipework where plastic pipework is hidden within or behind wall surfaces, which would otherwise not be located by a metal detector.

### Installation of incoming water services



### Jointing of pipes and fittings

Proprietary joints should be made strictly in accordance with the manufacturer's instructions.

Only fluxes recommended by the pipe manufacturer should be used, and all traces should be removed immediately after jointing. Fluxes containing lead are not acceptable.

Suitable clips or brackets are to be used to secure pipes. Fixings should be installed adequately and spaced to stop sagging but not restrict thermal movement. Where needed, pipes should have adequate falls.

Sufficient room should be allowed for thermal expansion and contraction to avoid damage and noise from pipe movement.

### Notches and drillings

Floor joists should not be excessively notched or drilled. Please refer to the 'Upper Floors' section for further guidance.

### Taps

Cold taps should be located to the right of the hot water tap.

### Concealed services

If the services are hidden in walls or floors, they need to be positioned so that any significant cracking of the surface cannot occur.

### Chasing of masonry cavity walls

If chases in masonry walls are necessary, their depth should not exceed:

- One-sixth the thickness of the single leaf for horizontal chases.
- One-third the thickness for vertical chases.

Hollow blocks should not be chased unless specifically permitted by the manufacturer.

Please refer to the 'Internal Walls' section for further guidance.

### Services within or beneath floors

Protection through wrapping or ducting is necessary when pipes are situated under floor screeds. Thermal expansion allowances are to be made, especially at changes of direction.

The insulating material around the pipework needs to be a minimum of 25mm in thickness. The screed thickness should still be at least 25mm where pipes cross over.

### Fire stopping

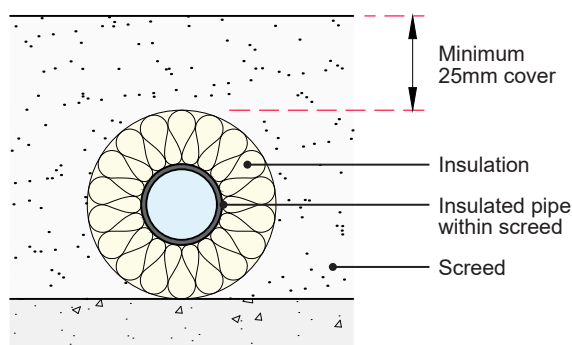
Fire stopping is required around services that penetrate fire-resisting floors, walls or partitions. If proprietary systems are used, they should be installed using the manufacturer's recommendations.

Please refer to the 'Internal Walls' and 'Upper Floors' sections for further guidance.

### Supplementary bonding

Where required the pipework should be fitted with supplementary earth bonding.

### Positioning of pipes in screeds



### Prevention of ground gases/contaminants entering the home

Incoming utilities should be specified to prevent the entry of ground gases/contaminants entering the home.

For further information on managing ground gases/contaminants, please refer to the 'Ground Conditions - Managing Ground Contaminants' section.

# 19.

## Garages

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### Contents

|      |                       |     |
|------|-----------------------|-----|
| 19.1 | Non-habitable Garages | 468 |
|------|-----------------------|-----|

## Introduction

This section provides guidance on meeting the performance requirements for garages. The guidance within this section is limited to non-habitable integral, attached and detached garages.

### 19.1.1 Compliance

Garages shall meet the performance requirements of this section. The guidance within this section is limited to non-habitable integral, attached and detached garages.

### 19.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

Evidence to show garages are:

1. Able to sustain and transmit all normal loads to the ground without affecting their own stability or that of the housing unit (or any adjacent buildings) by excessive deflection or deformation that would adversely affect the appearance, value and serviceability of the building or the housing unit.
2. They provide an acceptable and durable external surface and are not adversely affected by harmful or toxic materials in the atmosphere or from the ground.
3. They encourage the rapid discharge of moisture due to rain or snow from their surfaces to suitable gutters and down pipes, or to some other form of collection and discharge that prevents moisture from re-entering the garage, where it might have adverse effects.
4. In the event of fire, they resist fire spread to the housing unit and to adjacent buildings.
5. They are provided with sufficient locks or other devices to resist unauthorised entry.
6. Where additional services installations are installed within the garage but where they serve the main dwelling, (such as central heating boilers or electrical or plumbing installations), these must comply with the relevant additional guidance contained in this Manual.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 19.1.3 Structural design

Garages shall be able to sustain and transmit all normal loads to the ground without affecting their own stability or that of the housing unit (or any adjacent buildings).

The structural designs should satisfy the requirements of the relevant Building Regulations.

### 19.1.4 Services within a garage

Where services or appliances are sited within an non-habitable garage they shall be in accordance with relevant regulations in relation to:

- Water services
- Provision of electricity
- Installation of boilers and heating appliances

#### Water services

- The rising main should not be located within the garage.
- Pipes must have suitable protection against freezing.
- Any water supply or outlet must have suitable provision for isolating and draining down.

#### Provision of electricity

All electric installations should comply with BS 7671.

#### Installation of boilers and heating appliances

Installation of boilers and heating appliances should be in accordance with relevant statutory regulations.

## 19.1.5 Foundations

Foundations shall be constructed so that loads are adequately transferred safely to the ground.

Please refer to the 'Ground Conditions' and 'Foundations' sections for further guidance.

### Attached/integral garages

Attached/integral garages should have the same foundations as the home unless an Engineer has catered for any differential movement between the main home and the garage in their design (movement joints in the foundations may be required).

## 19.1.6 Garage floors

Garage floors shall be able transmit intended loads safely and be fit for their intended purpose. The following should be taken into account:

- Construction type.
- Protection against ground gases.
- Preventing dampness entering habitable parts of the home.
- Floor drainage.
- Ventilation.

### Construction type

The ground floor construction should be appropriate to the ground conditions. Please refer to the 'Ground Floors' section for further information. Garage floors should also satisfy the below:

#### Ground bearing

- Floors should have a minimum concrete thickness of 100mm and bear onto a suitable sub-base.
- The concrete should be float finished (not tamped) and to at least a GEN3 grade. As the garage is not a habitable space some surface imperfections of the floor finish are acceptable.

#### Suspended floors

- Where the depth of fill exceeds 600mm, a suspended floor should be adopted.
- Where suspended floors are to be installed to areas with higher potential point loads such as garages, additional reinforcing of the screed will be required to distribute loads effectively.
- This reinforcing should be of at least an 'A' mesh quality, and the screed should be thick enough to give an appropriate depth of cover.

### Protection against ground gases

Where the garage is attached / integral to a dwelling, and the dwelling requires gas prevention measures to be provided, the ground floor and wall structures shall be designed and constructed to ensure adequate protection against ground gases emanating from the ground below.

A site investigation should be carried out which:

- Identifies any contaminants, **and**
- Provide recommendations.

Please refer to the 'Ground Conditions' section for further guidance.

### Preventing dampness entering habitable parts of the home

The guidance within this section applies to garages and as such it would be reasonable to expect that some dampness within the garage floor construction will occur.

#### Attached and integral garages

Where attached and integral garages are specified, the design should ensure dampness from the floor does not enter habitable parts of the home.

### Floor drainage

Garage floors shall be laid to falls so as to promote the dispersion of water out of the garage area. A step may also be required between the garage and the main house to satisfy the relevant Building Regulations.

### Ventilation

Where a suspended garage floor is specified, the void beneath may be unventilated unless ventilation is specifically required. Unventilated sub-floor voids can be accepted where:

- The floor has adequate durability.
- The ground under the floor is well drained.
- There is no chance of soil gas build up within the void.

Where attached and integral garages are specified, they should not interrupt the sub-floor ventilation below suspended floors of the house.

### 19.1.7 Walls

External and internal garage walls shall safely transmit intended loads to the foundations without undue movement. Garage walls shall:

- Be structurally stable above ground.
- Be structurally stable for walls retaining ground.
- Be able to reasonably resist rainwater penetration and groundwater.
- Be appropriately designed to accommodate openings.

The following guidance relates to garages not greater than 36m<sup>2</sup> in area. For larger structures, the guidance within the 'External Walls' section should be followed.

Where garages incorporate timber framed elements, the garage walls should satisfy our 'External Walls – Timber Frame' section.

#### Structural stability above ground

The following should be considered for single skin garage walls:

- All garage walls should be a minimum 90mm thick.
- The height of the wall should not exceed 3m to the wall plate.
- Movement joints may need to be considered between homes and attached and integral garages.

#### Piers

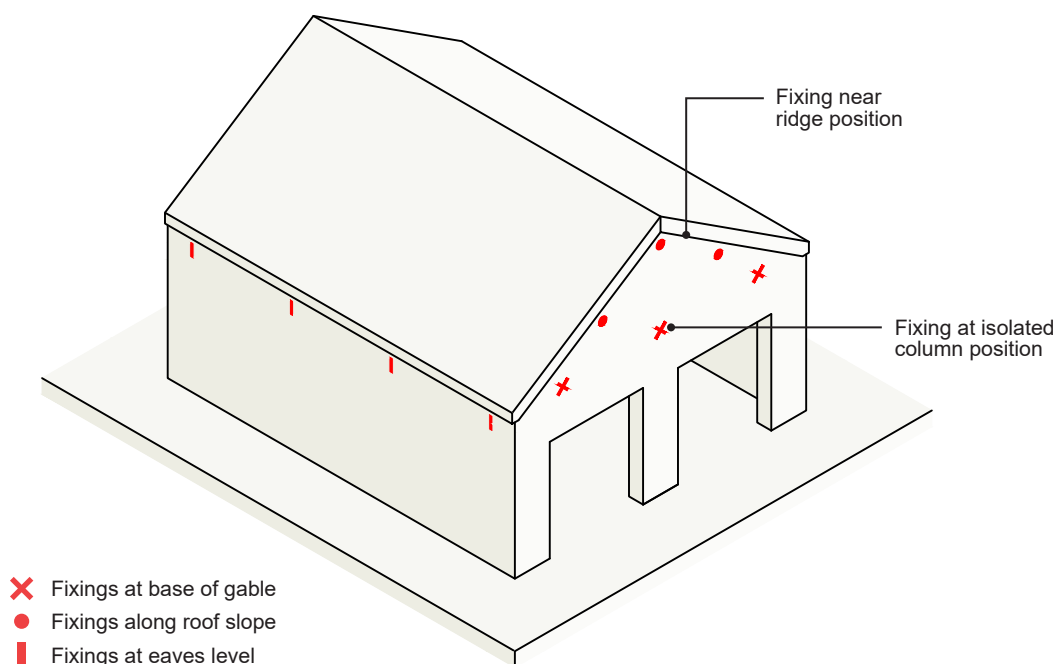
- Piers should be located in single leaf walls up to 200mm thick and which are greater than 2.5m in length or height and which do not contain a major opening. In addition, piers should be located:
  - At corners, unless buttressed by a return of at least 390mm.
  - At intermediate centres not exceeding 3m.
- Either side of a major opening e.g. garage door.
  - Piers should also:
    - Be built off a suitable foundation.
    - Be adequately bonded to the wall. Where ties are used to connect piers to walls, they should be flat, 20×3mm in cross section, be made of durable metal, be placed in pairs and be spaced at not more than 300mm centres vertically.
    - Extend the full height of the wall.

#### Lateral restraint

All garage walls should have adequate lateral restraint against wind loading at ceiling and verge level in accordance with the Engineers design.

Lateral restraint of walls can be provided by:

- Lateral restraint straps, **or**
- Restraint type joist hangers (at ceiling joist level), **or**
- Gable ladders (at verges) **or**
- Alternatively, other forms of restraint proven by an Engineer can be accepted.



For further information on lateral restraint, please refer to the 'External Walls – External Masonry Walls' section.

## Walls retaining ground

Garage walls retaining ground should be designed by an Engineer and should consider lateral forces, ground water and surcharges. For further guidance see 'Retaining walls and below ground slabs' guidance within this section.

## Moisture resistance

Where attached and integral garages are specified, the design should ensure dampness from the walls does not enter habitable parts of the home.

As garages are non habitable, single leaf 100mm walls may be considered acceptable providing the following provisions are met:

- Walls are pointed both internally and externally.
- Walls should be provided with a suitable DPC located at least 150mm above ground level.

Please note, where 100mm single leaf walls are specified, the walls may be prone to some damp penetration which should be considered as normal.

## External door and window openings

### Size and location of openings

The size and location of openings should ensure the structural stability of the wall is not comprised. The following should be considered by the designer:

- There should only be one or two major openings which should be restricted to one wall only. Their aggregate width should be not greater than 5.0 m and their height should be not greater than 2.1 m.
- There should be no other opening within 2.0 m of a wall containing a major opening.
- The aggregate size of openings in a wall not containing a major opening should not exceed 2.4m<sup>2</sup>.
- There should be not more than one opening between piers. Unless there is a corner pier the distance from a window or door opening to a corner should be not less than 390 mm.
- Proprietary lintels should be provided over all openings. Lintels should safely support the applied loads, be of the correct type and size, and be suitable for the location and exposure. For further guidance on lintels, please refer to the 'External Walls – External Masonry Walls' section.

### External window and door specification

The specification and installation of external windows and doors should meet the requirements of the 'External Windows and Doors' section. Installation of garage vehicular doors should meet the requirements of the manufacturer.

### Positioning of garage vehicular doors

Where practical, the positioning of the garage vehicular door should be positioned so rainwater is directed into a drainage channel which is connected to a suitable outfall.

This should be in addition to any drainage requirements for the driveway. Refer to the 'Driveways and Paving' section for further details.

## Security

The design and specification of external doors and windows which provide access into a dwelling or into a building containing a dwelling, should satisfy the requirements of the relevant Building Regulations to ensure the system is classified and tested to the appropriate burglar resistance class. This includes secondary access doors including vehicular garage doors and pedestrian garage doors for attached garages.

### 19.1.8 Retaining walls and below ground slabs

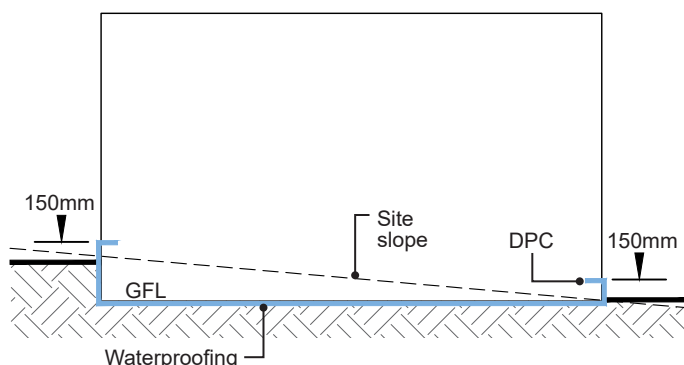
The effects of ground water shall be considered by the designer where:

- Any part of the garage structure retains earth, and
- Any areas of the floor construction are located below adjacent external ground levels.

As there is an accepted level of moisture ingress that can occur through above ground masonry in garage construction, an environmental grade 1B under BS 8102 would be considered acceptable for any below ground structure.

Where any part of the garage structure retains earth and any area of floor construction is located in excess of 150mm below adjacent ground levels, the requirements of the 'Waterproofing Below Ground Storeys and Structures' section should be satisfied.

Any below ground waterproofing protection should be continuous and terminate at the level of a DPC, located 150mm above external ground levels.



Further guidance on environmental grades and waterproofing protection systems may be found within the 'Waterproofing Below Ground Storeys and Structures' section.



**19.1.9 Roofs**

Roofs shall be weathertight and be designed to transfer intended loads safely to the structure below.

Please refer to the 'Roofs' section for further guidance.

The roof should be braced at rafter level, horizontally at eaves level, and at the base of any gable by roof decking, rigid sarking or diagonal timber bracing, as appropriate, in accordance with BS 8103-3.

Roofs should encourage the rapid discharge of moisture from their surfaces to suitable gutters and down pipes, or to some other form of collection and discharge that prevents moisture from re-entering the garage, where it might have adverse effects. For further guidance, please refer to the 'Drainage' section.

The design should consider suitable precautions where attached and integral garages abut against the home and between stepped garages. These may include:

- Flashings and weatherproofing that can accommodate differential movement.
- Provision of cover flashings.
- Cavity trays that divert water to the external surface of the roof.

**19.1.10 Heat loss from dwelling areas**

Walls and intermediate floors shall be adequately insulated to prevent undue heat loss from dwelling areas to any unheated attached or integral garages.

Walls and intermediate floors separating an unheated attached or integral garage from the dwelling areas should satisfy the thermal requirements of the Building Regulations. Designers should provide adequate information to demonstrate this.

**19.1.11 Resistance to fire spread**

Garages shall be constructed using elements capable of resisting fire spread to the home, linked buildings or adjacent buildings where applicable and shall be designed in accordance with the relevant Building Regulations.

These elements may include (but not limited to):

- Walls
- Intermediate floors
- Fire doorsets
- Roofs

**Fire resisting separating elements**

Each element (and any associated junctions, interfaces and penetrations) should have the appropriate fire resistance in accordance with relevant Building Regulations.

**Fire doorsets**

Fire doorsets between a dwelling and attached/integral garage must be half-hour fire resisting, be fitted with a self-closer.

Where an internal wall is required to fulfil a fire resisting function, any fire doorset installed in it must maintain the period of fire resistance of the internal wall and the following must be satisfied:

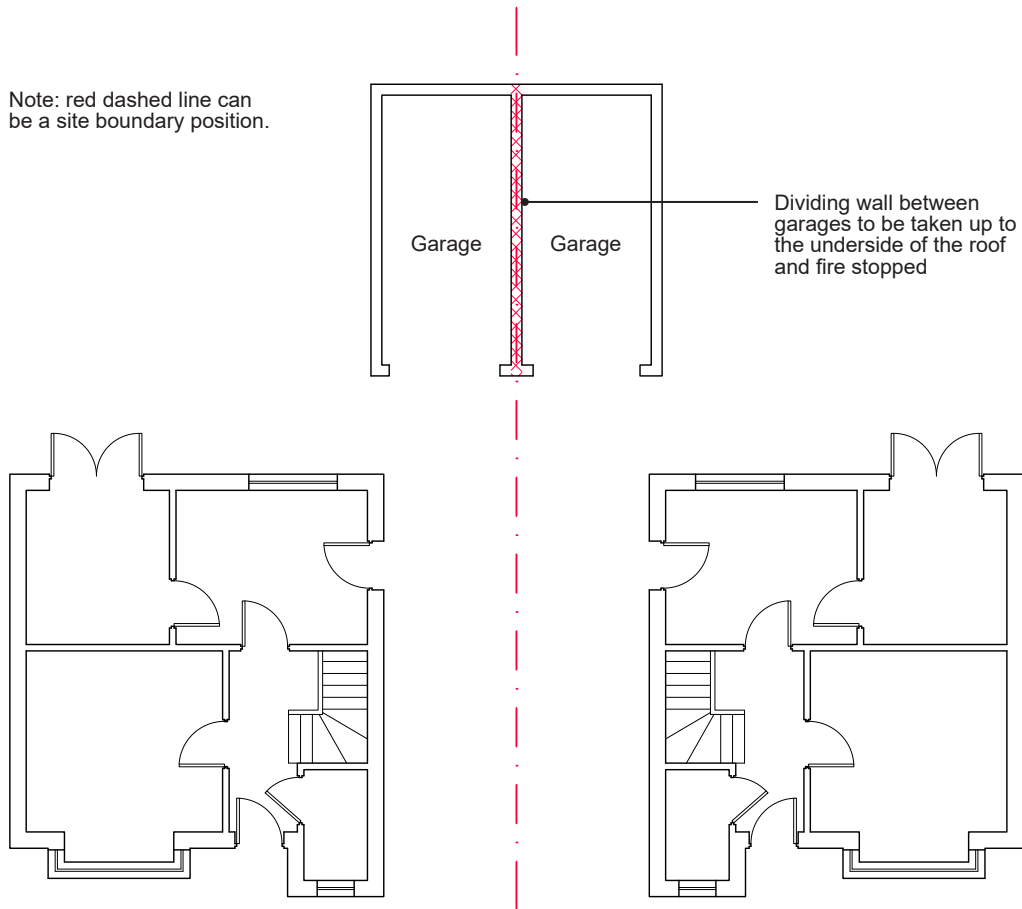
- The fire door and frame must be installed as a combined tested fire doorset (as defined in the Building Regulations) and not made from either different untested components or components from different products which were not tested together.
- Proof of fire test performance to be available to demonstrate meeting the requirements of the relevant Building Regulations.
- Suitable approved linear gap sealing systems must be utilised to protect the frame and supporting construction gap. These should be applied subject to the conditions contained in the relevant fire test certification.
- The fire doorset must be installed as per manufacturer's instructions and the test certificate criteria.

**Linked buildings**

Additional information for fire separation between garages on a boundary is provided below. Please note examples 1, 2 and 3 are for guidance purposes only, in all situations compliance with the appropriate relevant Building Regulations should be achieved.

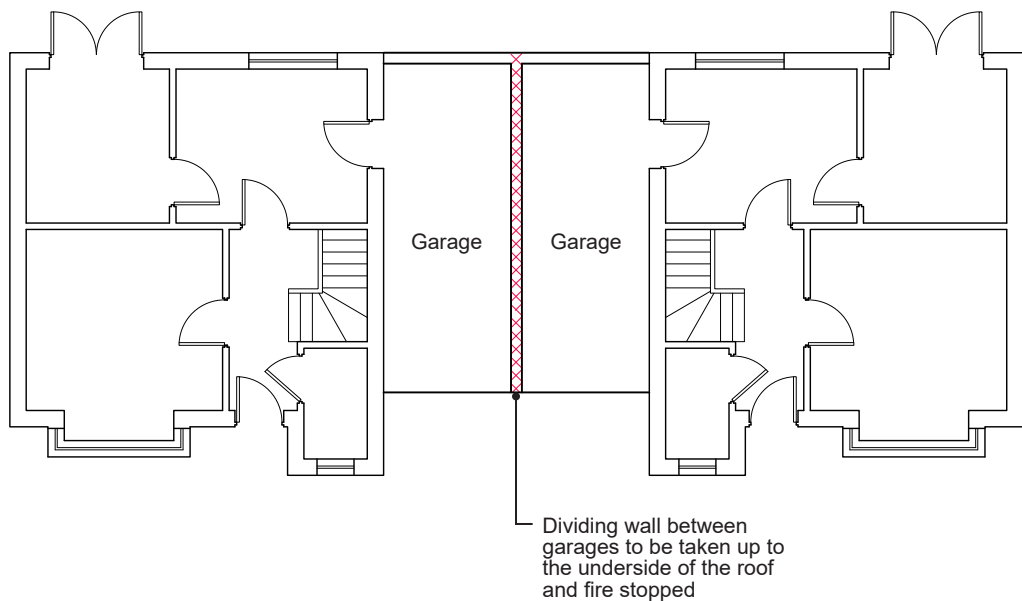
## Example 1: Linked detached garages

The dividing wall (also boundary) forms a compartment situation between two properties and must be taken up to the underside of the roof covering and fire stopped.



## Example 2: Linked to dwelling and linked to another garage across boundary

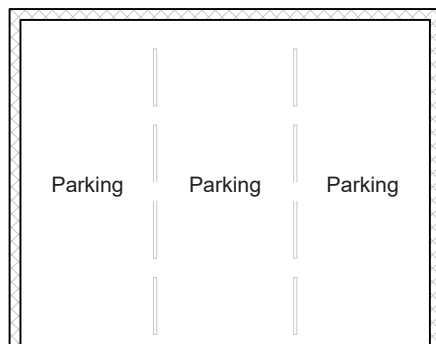
The dividing wall (on the boundary) forms a compartment situation between two properties and must be taken up to the underside of the roof covering and fire stopped.



**Example 3: Allotted car park with no legal boundary between bays (undercroft or linked carport)**

Where no ownership boundary exists and there are only allotted parking bays, there is no requirements for compartment walls.

Note: red dashed line can be a site boundary position.

**Fire stopping**

Fire stopping should be in accordance with the relevant Building Regulations. For further guidance on fire stopping refer to the 'Internal Walls' section.

# 20.

## Tolerances

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### Contents

|      |            |     |
|------|------------|-----|
| 20.1 | Tolerances | 476 |
|------|------------|-----|

## Introduction

This section provides an overview of our tolerance requirements for various building elements.

A more stringent tolerance may be stated within an existing National or European standard, however, for the purposes of Warranty, where we have identified a tolerance requirement, this would be deemed suitable to meet our Functional Requirements.

We only measure tolerances which are identified within this section.

### 20.1.1 Tolerances for external walls

External walls shall satisfy the tolerances outlined within the following guidance.

## Masonry

### Introduction

- During construction, masonry units should be laid to ensure the wall will be adequately plumb, straight on plan and straight in section.
- Tolerances and appearances should be considered for the entire wall not individual elements of the construction.
- Assessment should be made in daylight conditions, and from a minimum 10m distance from the element.
- Fair-faced masonry should be completed to a reasonable level, ensuring texture, finish and appearance are consistent.
- A reasonable appearance for single leaf 102.5mm brick walls should be to have one finished side only. A neat and tidy finish should be applied to the other side.
- Mortar blemishes can occur on individual masonry units.
- Efflorescence is naturally occurring in certain types of masonry. Its affects are not harmful and the residue will generally disappear of its own accord over time.
- Certain masonry products specified within the design have features and marks inherent to their fabrication.
- Minor shrinkage may occur within masonry components.
- For fair face natural and cast stonework, finishes should be reasonably uniform in colour and texture.
- Fungal growth, and colour variation may occur due to mitigating factors such as the orientation of the wall, shading, and even pollution.

### Brick imperfections

Imperfections (such as cracks, chips, or any other damage) in bricks should not be greater than 15mm (in diameter) and shall be avoided where possible. For the purposes of Warranty, the presence of imperfections will only be considered an issue where it:

- Affects the structural stability of the property.
- May lead water ingress to the inside of the property.
- Affects the durability of the masonry unit.

Please note: certain masonry products specified within the design have features and marks inherent to their fabrication which may be in excess of 15mm (in diameter).

### Tolerances for external facing masonry

External facing masonry includes:

- Facing brickwork and blockwork.
- Natural stone.
- Cast rough faced masonry.

| Location of measurement                                                                                                                                                                                                                                                               | Tolerance                                                                                                                                                                                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Mortar bed joint</b>                                                                                                                                                                                                                                                               | Level of bed joints should be +/- 8mm in any 5m length of wall.<br><br>The thickness of a mortar bed should not vary from the average thickness of the next eight successive joints by +/- 1.5mm.            |
| <b>Mortar perpend joint</b>                                                                                                                                                                                                                                                           | Centre lines of perpend should be with +/- 15mm of the centre line to the next 5 successive perpend joints.                                                                                                  |
| <b>Straightness in plan</b>                                                                                                                                                                                                                                                           | The wall must be relatively straight in plan. A maximum of +/- 8mm deviation in any length of wall up to 5m.                                                                                                 |
| <b>Straightness in section<sup>1</sup></b>                                                                                                                                                                                                                                            | The maximum deviation is +/- 8mm in any storey height, up to a maximum of 3m high.                                                                                                                           |
| <b>Plumb in section</b>                                                                                                                                                                                                                                                               | The maximum deviation from plumb in any storey height up to 3m, is a maximum of 8mm.<br><br>Any walls over 3m in height should be a maximum of 8mm from plumb in any storey, and no more than 12mm in total. |
| <b>Exterior window reveal</b>                                                                                                                                                                                                                                                         | The maximum deviation is 4mm per 1m straight edge.                                                                                                                                                           |
| <sup>1</sup> The method of measurement for fair faced natural masonry and cast rough faced masonry is different to that of fair faced brickwork and blockwork. Please see the additional requirements for the measurement of fair faced natural masonry and cast rough faced masonry. |                                                                                                                                                                                                              |

## Mortar bed joints

Masonry bed joints should be satisfactorily straight, with the line of level taken along the top side of the brick or block.

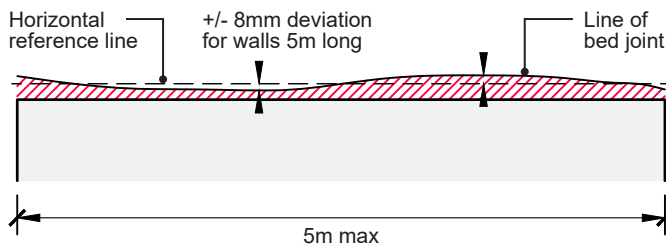
- Level of bed joints should be  $\pm 8\text{mm}$  in any 5m length of wall, **and**
- The thickness of a mortar bed should not vary from the average thickness of the next eight successive joints by  $\pm 1.5\text{mm}$ .

Measure and add 8 successive bed joints and divide by 8 to determine the average size:

$$11+11+12+9+10+10+12+9 = 84$$

Divide 84 by 8 = 10.5mm

Therefore, the acceptable range of the bed joint below the 8 measured bed joints is 9-12mm.



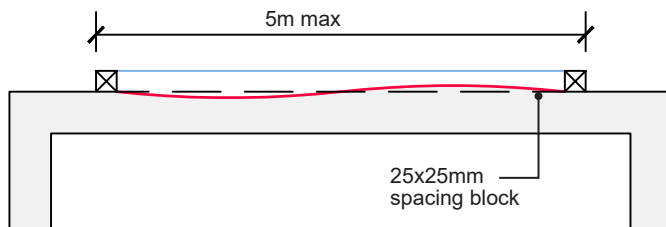
## Mortar perpend joints

Vertical alignments of perpend joints should not deviate from the perpendicular to an extent which impairs the structural stability of the wall.

- Centre lines of perpends should be with  $\pm 15\text{mm}$  of the centre line to the next 5 successive perpend joints, **and**
- Perpend joints within masonry panels between openings may be offset to accommodate setting-out. The perpend joints within the panel should not cumulatively displace more than the above tolerance.

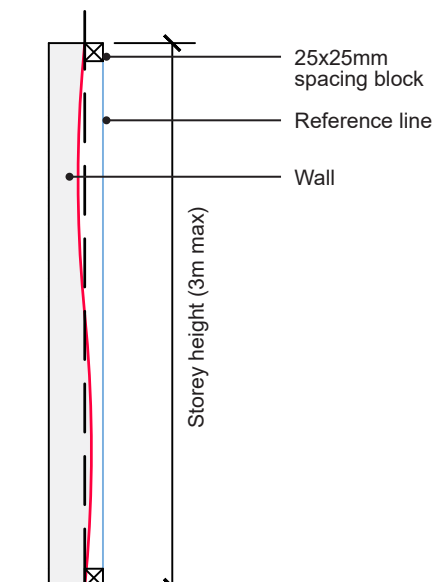
## Method of measurement for straightness in plan for fair faced brickwork and blockwork

- The wall must be adequately straight in plan. A maximum of  $\pm 8\text{mm}$  deviation in any length of wall up to 5m.



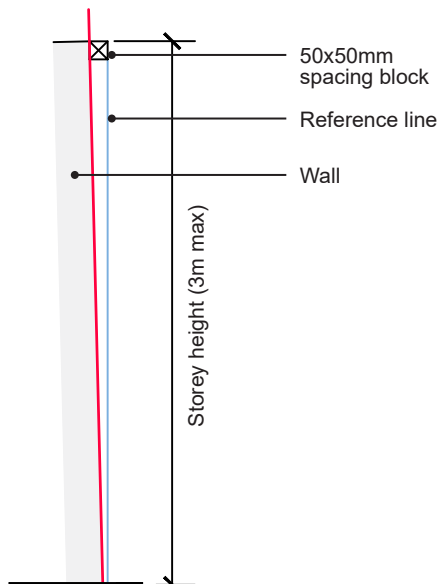
## Method of measurement for straightness in section for fair faced brickwork and blockwork

- The maximum deviation is  $\pm 8\text{mm}$  in any storey height, up to a maximum of 3m high.



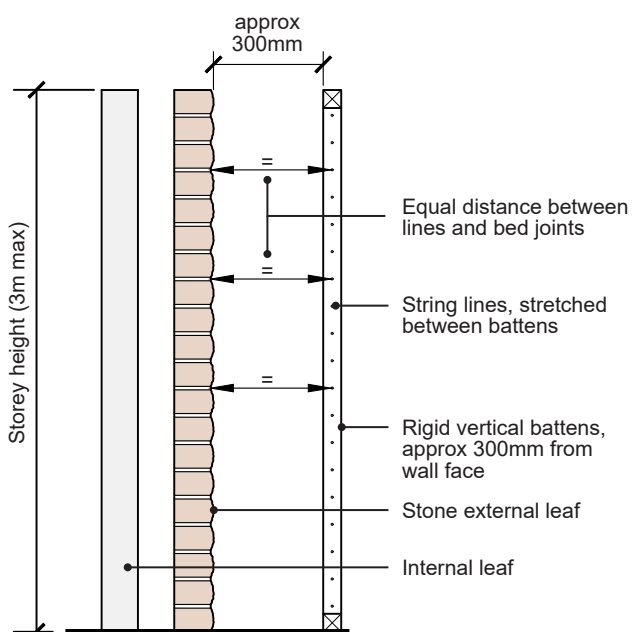
**Method of measurement for plumb in section for fair faced brickwork and blockwork**

- The maximum deviation from plumb in any storey height up to 3m, is a maximum of 8mm.
- Any walls over 3m height should be a maximum of 8mm from plumb in any storey, and no more than 12mm in total.
- Using 50mm spacing blocks the line of the masonry face in plumb must be between 42mm and 58mm from the reference line.

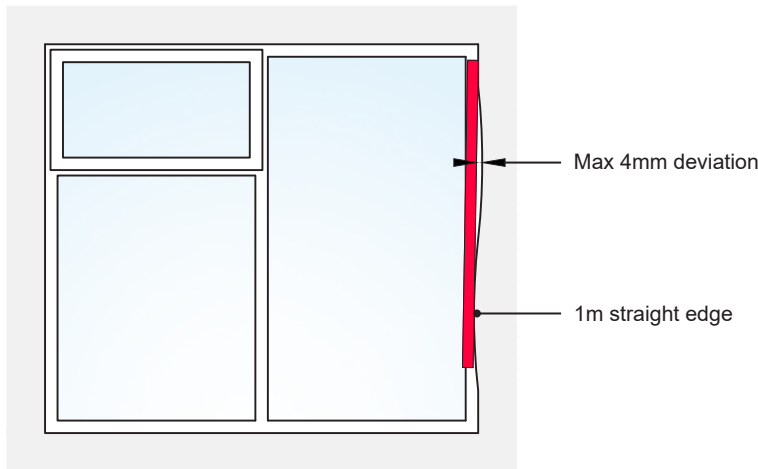
**Measurement of fair faced natural stone masonry and cast rough faced stone masonry**

Rather than attempt to use the uneven face of the wall to determine tolerance, the finished face of the bed joint will provide the datum. This is based on the masonry units having a minimum 100mm mortar bed width, achieved at initial laying. For the purpose of tolerance measurement, this cannot be raked or pointed to reinstate tolerance.

- Temporary but rigid battens at the building angles are to be erected approximately 300mm away from the wall face.
- Lines are to be stretched between the battens.
- There should be a constant distance maintained between the line and the bed joint subject to the permissible deviations.



### Exterior window reveal



### Render and cladding

#### Render

- Render should be applied to achieve a consistent texture, finish, and colour in line with the designers proposed specification. Some variations in colour appearance may occur due to variation in suction of the background surface to the render, along with orientation of the wall.
- Completed and set render should be free from crazing (crazing is defined within BS EN 13914-1 as being short, irregular and very fine cracks up to approximately 0.2mm in width). It is worth noting that some localised hairline cracking is likely to occur in traditional, and proprietary render systems. Limited cracking and crazing should not impair the performance of the home.
- Patching and other such repairs may be visible but they should be inconspicuous as possible in application.
- Where the render coat includes features such as bell-casts then tolerances are not applicable at these locations.
- The surface of the render should be within a maximum of  $\pm 4$ mm vertical and horizontal deviation when measured with a 5m straightedge.

#### Curtain walling

Design should allow for the line, level, plumb and plane of the completed curtain wall to be within the acceptable tolerances of:

- Line:  $\pm 2$ mm in any one storey height or structural bay width, and  $\pm 5$ mm overall.
- Level:  $\pm 2$ mm of horizontal in any one structural bay width, and  $\pm 5$ mm overall.
- Plumb:  $\pm 2$ mm of vertical in any one structural bay width, and  $\pm 5$ mm overall.
- Plane:  $\pm 2$ mm of the principle plane in any one storey height or structural bay width, and  $\pm 5$ mm overall.

#### Rainscreen cladding systems

Design should allow for the line, level, plumb and plane of the completed rainscreen cladding systems to be within the acceptable tolerances of:

- Line:  $\pm 3$ mm in any one storey height or structural bay width.
- Level:  $\pm 3$ mm of horizontal in any one structural bay width.
- Plumb:  $\pm 3$ mm of vertical in any one structural bay width.
- Plane:  $\pm 3$ mm of the principle plane in any one storey height or structural bay width.

#### Tile hanging

The uniform appearance is to be maintained for panels of tile hanging, especially at abutments. No significant variations in finish or colour should be present.

#### Timber cladding

Variations in colour to uncoated timbers exposed to weather conditions are to be expected, the rate and extent of which may vary.

#### Brick slip cladding

Tolerances for the finish of brick-slip cladding should meet the same as those listed for fair-faced masonry.

#### Cast and real stone

Finishes should be reasonably uniform in colour and texture.

Efflorescence, fungal growth, and colour variation may occur due to mitigating factors such as the orientation of the wall, shading, and even pollution.



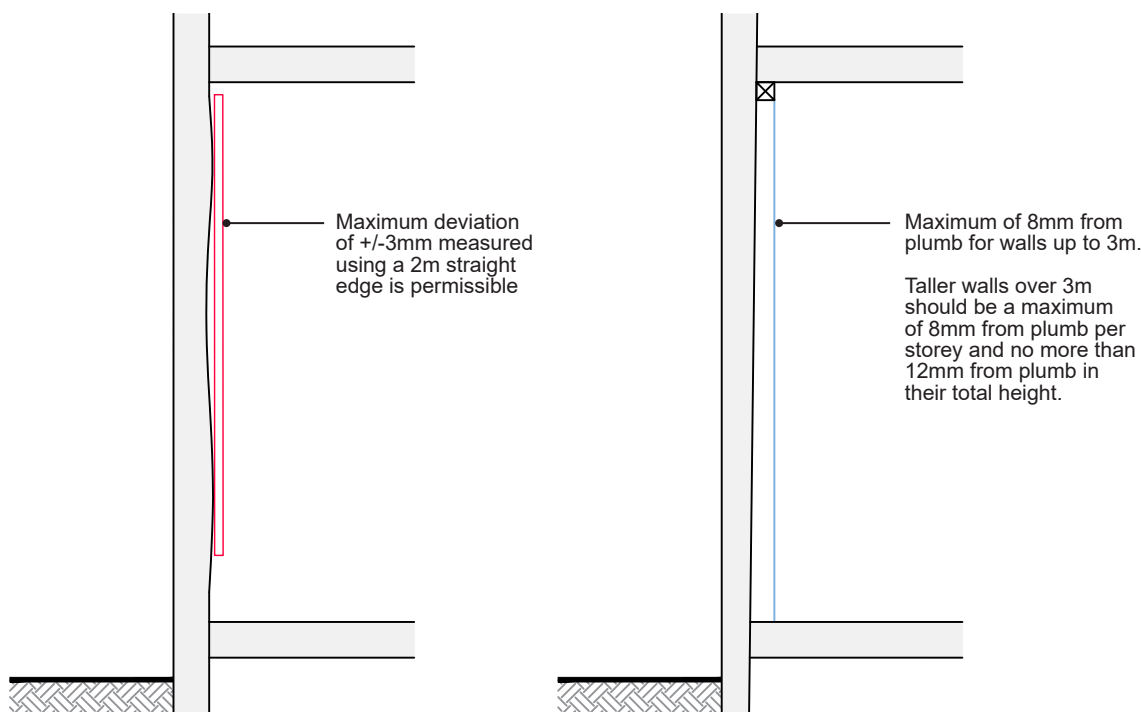
### 20.1.2 Tolerances for internal walls

Internal walls shall satisfy the tolerances outlined within the following guidance.

#### Introduction

- The wall must be relatively flat. Maximum deviation of  $\pm 3\text{mm}$  measured using a 2m straight edge is permissible.
- The wall must be relatively plumb. Maximum of 8mm from plumb for walls up to 3m. Taller walls over 3m should be a maximum of 8mm from plumb per storey and no more than 12mm from plumb in their total height.
- Allowances should be made for minor textural differences around switches and such fittings.
- Board joints should not be readily visible.
- Max  $\pm 3\text{mm}$  surface deviation when measured using a 450mm straight edge.
- Viewed from a distance of at least 2m in natural daylight (no artificial lighting to be used).
- Jointing tape should not be visible within the finished surface.
- Some cracking (up to 2mm wide) may occur at wall, floor and ceiling junctions, due to shrinkage and differential movement of materials.

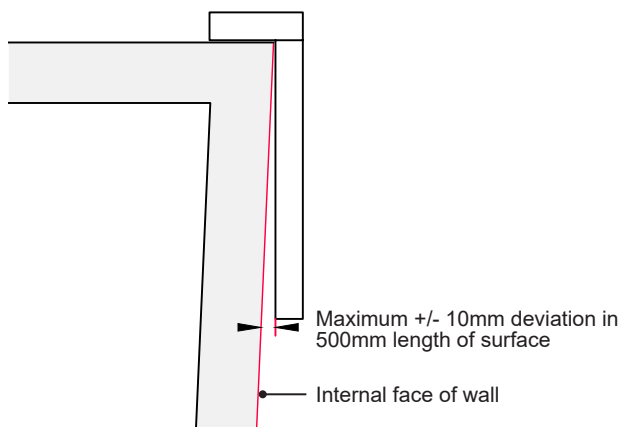
#### Flatness and plumb of internal walls



#### Outer corners to internal walls

Setting out of corners, duct casings (larger than 250mm), and associated framing should be:

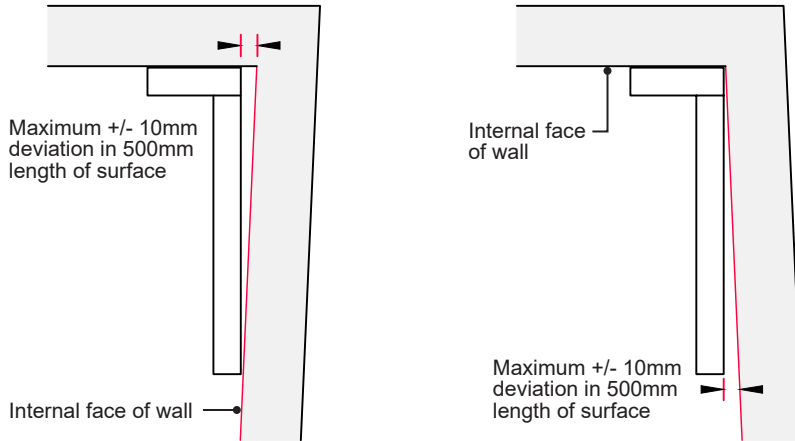
- Square.
- Neat and tidy.
- Provided with appropriate decorative finish to their surface.
- Maximum  $\pm 10\text{mm}$  deviation in 500mm length of surface.



## Internal corners of internal walls

Setting out of corners, duct casings, and associated framing should be:

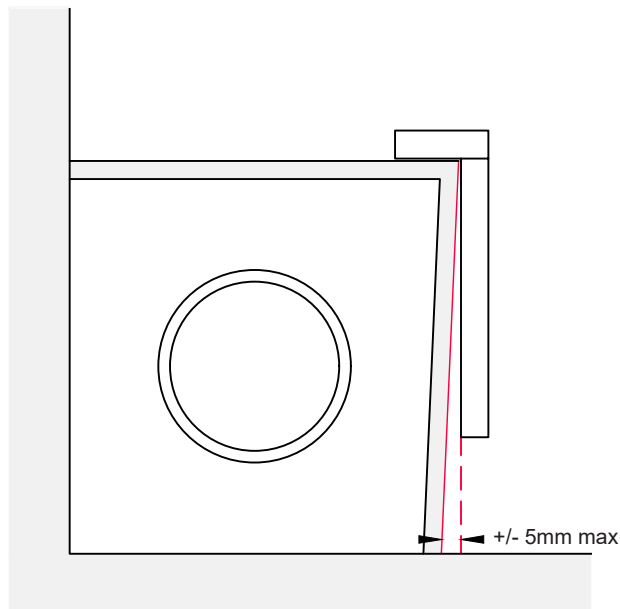
- Square.
- Neat and tidy.
- Provided with appropriate decorative finish to their surface.
- Maximum +/- 10mm deviation in 500mm length of surface.



## Service ducts (up to 250mm)

Setting out of corners, duct casings, and associated framing should be:

- Square.
- Neat and tidy.
- Provided with appropriate decorative finish to their surface.
- Maximum +/- 5mm deviation in 250mm length of surface relating to the boxing of the service duct (for lengths of wall over 250mm please refer to the requirement for outer corners to internal walls).

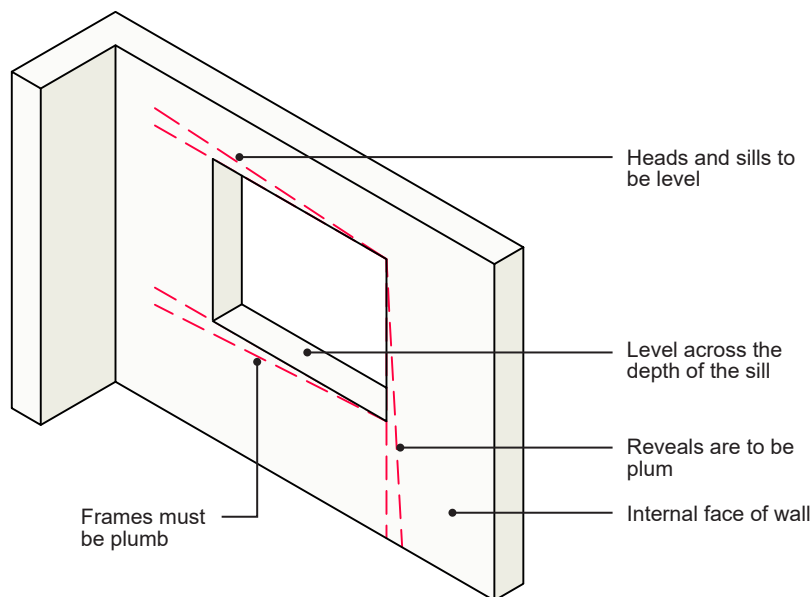


### Internal openings (for reveals) for windows and doors

Internal openings must be:

- Flat along the length of sills and boards with maximum deviation of  $\pm 3\text{mm}$  in every 2m.
- Heads and sills to be level, with a maximum deviations of 3mm out of level for openings up to 1.5m; where openings are longer than 1.5m then this deviation may be increased to maximum 5mm out of level.
- Reveals are to be plumb, with a maximum deviation of  $\pm 3\text{mm}$  for openings up to 1.5m high; where reveals exceed 1.5m high then a maximum deviation of  $\pm 5\text{mm}$  is permissible.
- Level within  $\pm 3\text{mm}$  across the depth of the sill, measured from the face of the frame (tiled sills may be intentionally laid to a fall to allow moisture run-off).
- Reveals are to be square with a maximum deviation of  $\pm 5\text{mm}$  for reveals up to 250mm deep (deeper reveals should refer to external corners).

Note: also see Tolerances for window and door frames.



### 20.1.3 Tolerances steel frame and timber frame

Steel and timber frame structures, and substructures where they are fixed down to shall satisfy the tolerances outlined within the following guidance.

Please note, where the framed structures have lightweight cladding systems attached, the following tolerances may be too great for the external finish. This should be taken into account by the specifier.

#### Steel frame: wall panel erection tolerances

##### Site tolerances

It is essential that the accuracy of setting out foundations and ground beams are checked well in advance of materials being delivered to site.

For accurate erection of the frame the following tolerances are required at the level of the base of the wall frame:

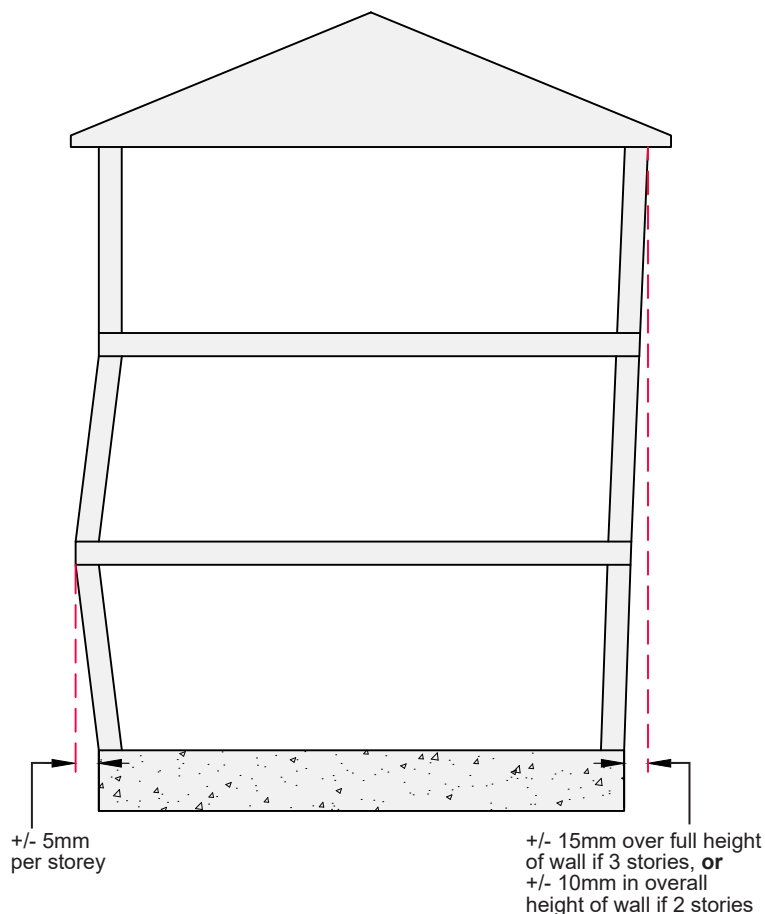
- Length of wall frame:  $\pm 10\text{mm}$  in 10m.
- Line of wall frame:  $\pm 5\text{mm}$  from outer face of plate.
- Level of base of wall frame:  $\pm 5\text{mm}$  over complete wall line.

##### Metal stud framework

The wall panel usually consists of a head rail, base rail (sole plate) and possibly horizontal noggins at mid-height, together with vertical wall studs.

Vertical tolerances are:

- $\pm 15\text{mm}$  in overall height of wall 3 storey, or
- $\pm 10\text{mm}$  in overall height of wall 2 storey, or
- $\pm 5\text{mm}$  in storey height (approx. 2.5m).



## Timber frame: wall panel erection tolerances

### Manufacturing tolerances

The following are our manufacturing tolerances that timber frame manufacturers' must adhere to:

- Length:  $\pm 3\text{mm}$ .
- Height:  $\pm 2\text{mm}$ .
- Diagonals should be equal, acceptable deviation is  $\pm 5\text{mm}$ .
- Opening dimensions:  $\pm 5\text{mm}$ .

### Sub structure

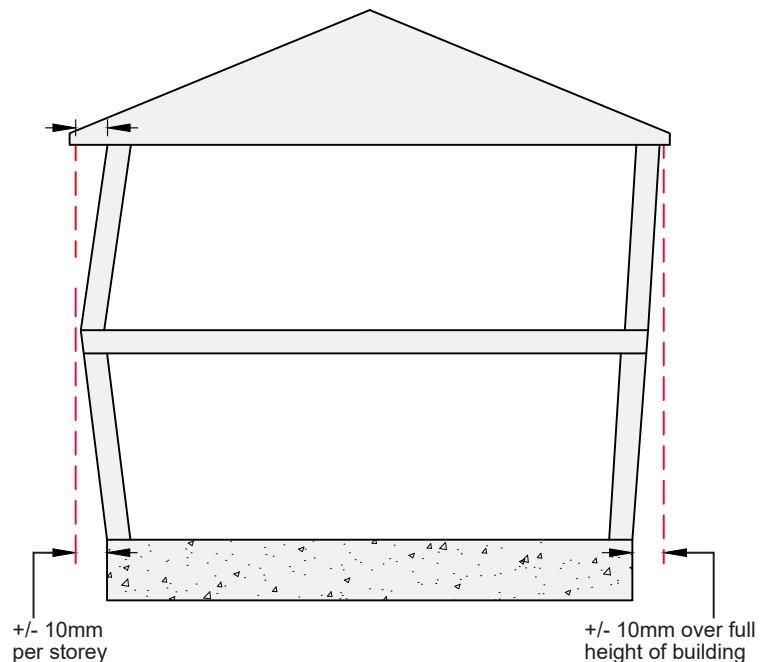
It is important that the tight tolerances for timber frame are understood, getting the location and level of the sub-structure correct is one of the most important parts of the build process. The sub-structure or upstands that support the timber frame should be set out to the dimensions noted on the timber frame drawings:

- Within  $\pm 10\text{mm}$  in length, width and line.
- Diagonals should be within  $\pm 5\text{mm}$  up to  $10\text{m}$ , and  $\pm 10\text{mm}$  more than  $10\text{m}$ .
- Levelled to  $\pm 5\text{mm}$  from datum.

### Location

Sole plates should:

- Be levelled to  $\pm 5\text{mm}$  from datum.
- Not overhang or be set back from the substructure by more than  $12\text{mm}$  on a  $89\text{mm}$  sole plate and  $20\text{mm}$  for a  $140\text{mm}$  sole plate.
- Be set out within  $\pm 10\text{mm}$  in length and in line within  $\pm 5\text{mm}$ , as defined by the timber frame drawings.
- Diagonals should be within  $\pm 5\text{mm}$  up to  $10\text{m}$ , and  $\pm 10\text{mm}$  for more than  $10\text{m}$ .



### Wall panel erection tolerances

Wall panels should be erected to the following tolerances:

- $\pm 10\text{mm}$  from plumb per storey height.
- $\pm 10\text{mm}$  from plumb over the full height of the building.
- $\pm 3\text{mm}$  from line of sole plate, with maximum  $\pm 5\text{mm}$  deviation from drawing.
- $\pm 5\text{mm}$  from line at mid height of wall panel.
- Inside faces of adjacent wall panels should be flush.
- Adjacent wall panels should be tightly butted.
- The sole plate and base rail faces should be flush.

## 20.1.4 Tolerances for internal floors and ceilings

Internal floors and ceilings shall satisfy the tolerances outlined within the following guidance.

### Floor flatness and levels

The effects of normal drying out / shrinkage of floors (timber and concrete) may result in minor differences in level and can result in squeaking of materials as they move against each other which might not be able to be eliminated entirely.

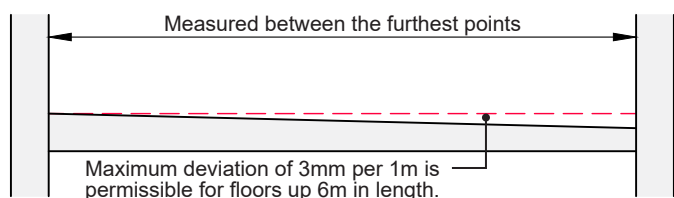
- Floors must be relatively level. Maximum deviation of  $3\text{mm}$  per  $1\text{m}$  is permissible for floors up to  $6\text{m}$  in length.
- The floor must be relatively flat. Maximum deviation of  $\pm 5\text{mm}$  is permissible using a  $2\text{m}$  straight edge with equal offsets.
- Floors over  $6\text{m}$  horizontal length are permitted to have a maximum deviation of  $20\text{mm}$  across their length.

### Floor deflection limits

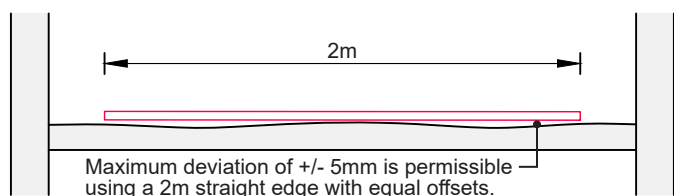
The deflection limit must be  $0.003 \times$  the span with a maximum deflection of  $14\text{mm}$  where strutting is provided and  $12\text{mm}$  where strutting is not provided. This is based on the total and imposed loads for combined bending and shear.

The Engineer must ensure that the design of the floor construction does not deflect greater than the above tolerances, unless the relevant BS or EN design code requires the deflection to be smaller.

### Level of floor



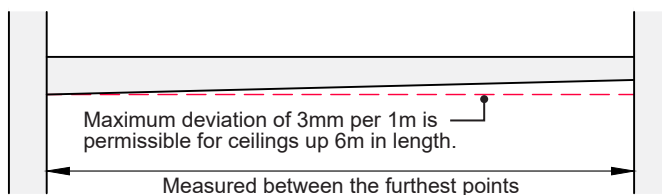
### Flatness of floor



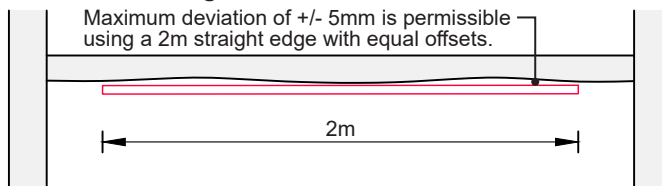
### Ceiling flatness and levels

- Ceilings must be relatively level. Maximum deviation of 3mm per 1m is permissible for ceilings up 6m in length.
- The ceiling must be relatively flat. Maximum deviation of +/- 5mm is permissible using a 2m straight edge with equal offsets.
- Ceilings over 6m horizontal length are permitted to have a deviation of 20mm across their length.
- Some cracking (up to 2mm wide) may occur at wall, floor and ceiling junctions, due to shrinkage and differential movement of materials.

#### Level of ceiling



#### Flatness of ceiling



### 20.1.5 Tolerances for window and door frames

Windows and doors shall satisfy the tolerances outlined within the following guidance.

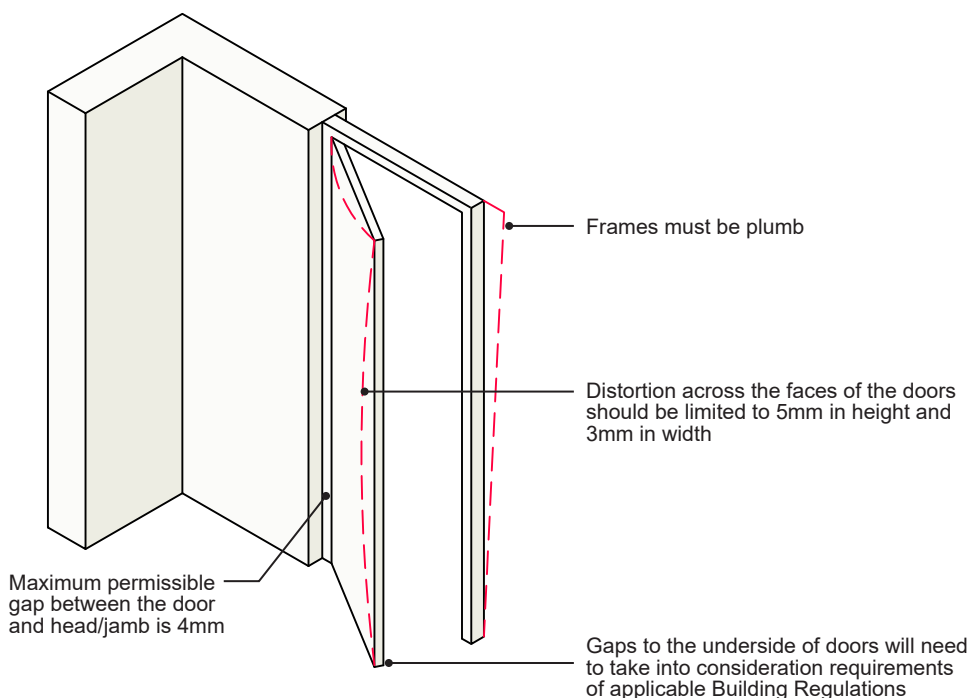
#### Doors

All doors should be installed in accordance with the manufacturers' guidance and recommendations. Door installations should adhere to Building Regulatory requirements for Fire & Ventilation.

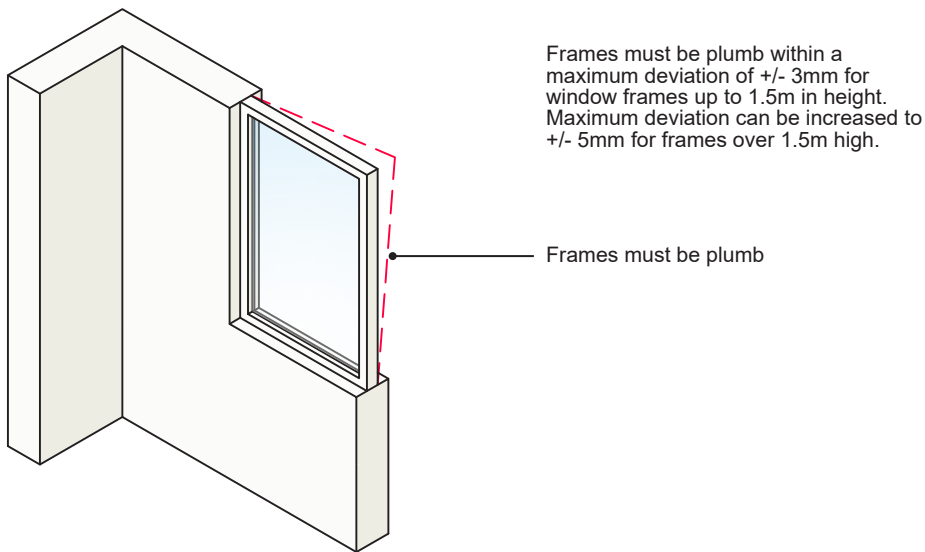
- Frames must be plumb within a maximum deviation of +/-5mm over the total height to the frame.
- Maximum permissible gap between the door and head/jamb is 4mm.
- Where double doors meet the gap at the stiles should be within 4mm.
- Distortion across the faces of the doors should be limited to 5mm in height and 3mm in width.
- Gaps to the underside of non fire doors will need to take into consideration requirements of applicable Building Regulations. However, the maximum permissible gap should be between 10mm and 22mm from the underside of the door to the unfinished floor.

Note: These dimensions are without prejudice to satisfactory performance in terms of weather tightness, exclusion of draughts and fire resistance where appropriate.

#### Door frames



## Windows frames



## Glazing

Glass must meet the visual assessment criteria of CWCT Technical Note 35 (TN 35). The total number of faults permitted in a glass unit shall be the sum total of those permitted by the relevant BS EN Standard for each pane of glass incorporated into the unit concerned.

Acceptable faults include:

- Fine scratches not more than 25mm long.
- Bubbles or blisters.
- Hairlines or blobs.
- Minute particles.

When assessing the appearance of glass:

- The viewing distance used shall be the furthest stated in any of the BS EN Standards for the glass types incorporated in the glazed unit. In the event of doubt, the viewing distance shall be 2m (3m for toughened, laminated, or coated glass).
- The viewing shall commence at the viewing distance, and shall not be preceded by viewing at a closer distance.
- The viewing shall be undertaken in normal daylight conditions, without use of magnification.
- The above does not apply within 6mm of the edge of the pane, where minor scratching is acceptable.

## Scratches and abrasions to window and door frames

Scratches on the frames of external doors and windows and factory finished door and window components should not have conspicuous abrasions, or scratches when viewed from a distance of 0.5m.

- Surface abrasions caused during the building-in process should be removed in accordance with the manufacturer's instructions, which may include polishing out, re-spraying or painting.
- In rooms where there is no daylight, scratches should be viewed in artificial diffused light from fixed wall or ceiling outlets and not from portable equipment.

## Joint sealants

Sealants must be tool finished in order to:

- Remove any blisters and irregularities within the product.
- Achieve a compressed and smooth, neat finish within its surface.

### 20.1.6 Finishes and external elements

Finishes and external elements shall satisfy the tolerances outlined within the following guidance.

#### Skirting

- The gap between the floor (without coverings) and the bottom face of the skirting should not exceed 5mm at the time of completion. It should be noted that the gap may increase due to normal drying out, shrinkage, or deflection (particularly to timber floors).
- It is possible that there will be joints in skirtings on long walls. When viewed from a distance of 2m in daylight, joints will need to show a consistent appearance.
- It is anticipated that there will be some initial shrinkage of the skirting after occupation of the building.

#### Fitted furniture

- Fitted furniture with doors and drawers should be aligned vertically, horizontally and in plan.
- Factory finished components should not have conspicuous abrasions or scratches when viewed in daylight from a distance of 0.5m.
- Function as designed by the manufacturer.
- Adjacent doors and/or drawers with any gaps between them should be consistent.
- At the intersection of adjacent worktops, there should not be a visible change in level.

#### Painted and varnished surfaces

- All surfaces should be reasonably smooth as practicably possible when viewed in daylight from a 2 metre distance and not by shining any artificial light onto the surface.
- Significant nail holes, cracks and splits should not be seen and should be filled to reduce their visible appearance.
- Colour, texture and finish should be reasonably consistent and any joints are to be filled where necessary. Although it should be noted that some variations can occur.
- External finishes may dull over time depending on a number of factors.
- Some seeping of resin from knots is a natural occurrence that may cause paintwork discolouration both internally and externally.

#### Sanitary ware

Sanitary fittings should be free from conspicuous abrasions, scratches and chips when viewed from a distance of 0.5m in general daylight. Where sanitary ware is provided in windowless accommodation the items should be viewed in artificial lighting from the fixed wall or ceiling provisions (not from portable equipment).

#### Wall tiling

Courses should be straight and even to form a plane and regular surface, especially around fittings and fixtures.

- There should be no cut or unfinished tiles at exposed edges or external corners.
- Joints should be even and cut neatly.
- Spacing should be sufficient to allow for expansion.
- Up to sanitary fittings and fixings, the sealing method should be in accordance with the design and account for movement.
- Proprietary water-resistant grouting should be used in accordance with the manufacturer's recommendations.
- Appropriately designed movement joints should be:
  - Built into tiling at centres at a maximum of 4.5m, vertically and horizontally.
  - Provided at vertical corners in large tiled areas.
  - Located at junctions where there are variations in surfaces or backgrounds.
  - 1-2mm where tiles are without spacer lugs.
- Grouting should be:
  - As specified in the design, including mix and colour.
  - Cement-based epoxy resin or a proprietary product.
  - Waterproof in and around shower enclosures and where tiling can be saturated.

#### Radiators and similar appliances

Appliances displayed in and about the home should be:

- Free from cracks, holes, and splits.
- Have any joints filled consistent to the main material.
- Reasonably uniform in colour, texture and finish.

#### External plastic and UPVC materials (other than windows and doors)

Materials such as fascias, soffits, meter boxes, etc. should be provided to meet the following:

- Be reasonably smooth in their finish. Free from nail holes, any cracks or splits.
- All joints to be sympathetically filled to replicate the main material.
- Be reasonably uniform in colour, texture, and finish.

## Drives and paths

- Surface variation should not exceed +/-10mm from a 2m straight edge with equal offsets. However, it should be accepted that localised falls into gullies and channels are acceptable.
- Design and construction should be completed to minimise the potential for standing water. Sixty minutes after rainfall has ceased, areas of temporary standing water should be no deeper than 5mm, nor exceed 1m<sup>2</sup> in area. Temporary standing water should not be present adjacent to entrance doors.
- Some fracturing or weathering may also appear if using natural stone due to the make-up of the material. This tolerance applies to principle pathways and driveways to the building that are required to meet the standards of Part M (Access to and use of buildings).

## Drainage and system covers

Drainage system covers in hard standing areas should line up neatly with the adjacent ground.

## Pitched roof coverings

Coverings should have an aesthetically suitable appearance.

Tiles and slates should:

- Be reasonably uniform, with a consistent texture and finish.
- Be selected from mixed packets to avoid excessive colour banding.

It should also be accepted that:

- Some minor blemishes can occur within the surfaces of the tile or slate.
- Variations in colour, texture, and finish can occur within tiles and slates, especially when natural quarried items.
- Efflorescence is to be expected.

### 20.1.7 Tolerances for garages

Garages shall satisfy the tolerances outlined within the following guidance.

Garages shall be constructed to achieve an acceptable appearance. The floors, walls, and roofs should be built to appropriate tolerances.

- Garages are not considered habitable spaces.
- Gaps up to 2mm wide may be experienced in unplastered blockwork. Caused by thermal movement and/or shrinkage.
- Garage floors may be installed with falls provided in order to either assist with drainage, or to satisfy the requirements of the Building Regulations.





# 21.

## MMC Systems

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### Contents

|      |                                                       |     |
|------|-------------------------------------------------------|-----|
| 21.1 | General Requirements                                  | 490 |
| 21.2 | Requirements for Volumetric MMC Systems               | 497 |
| 21.3 | Requirements for Closed Panel Timber Frame Systems    | 501 |
| 21.4 | Requirements for Closed Panel Light Gauge Steel Frame | 504 |
| 21.5 | Requirements for Structural Insulated Panel Systems   | 508 |
| 21.6 | Requirements for Insulated Concrete Formwork (ICF)    | 512 |

## Introduction

This section is applicable to Modern Methods of Construction 'Systems' as described below. The descriptions and terms used are aligned with the definition framework set out by Government in relation to 'Modern Methods of Construction'.

### System situations covered by this section

This section is applicable to the following MMC systems:

- Category 1 – Volumetric.
- Category 2 - Panelised - panels which have any factory fitting of an Air and Vapour Control Layer (AVCL), and/or any factory fitting of internal or external wall linings e.g. plasterboard, cladding.
- Category 2 - Structurally Insulated Panel Systems (SIPs).
- Category 2 - Insulated Concrete Formwork (ICF).
- Hybrid situations – systems using combinations of any of the above.

Please note:

1. MMC items can be '2D or 3D (panels or volumetric) and primary structural or non-structural elements'. However for the purposes of this Manual, this section is only covering 2D or 3D panel or volumetric 'systems'. For other MMC products, components and systems, please refer to 'Appendix C'.
2. Developers, designers, and system manufacturers should engage early with the Warranty provider to understand the Warranty requirements for each project.
3. The project delivery team should demonstrate to the Warranty provider that individual and organisational competence and skills are in place to deliver a MMC System that is appropriate for the scope and complexity of the proposal.

### 21.1.1 Compliance

Any system defined by the Warranty provider as an MMC System shall meet the performance requirements of the 'MMC systems' section and any other requirement in Technical Manual determined by the Warranty provider to be relevant to the scope of use.

All Information submitted in support of any MMC system should prove and demonstrate that in the process of manufacture and in its final and fixed position within the building structure, the MMC system will:

- Meet the Functional Requirements stated within the Technical Manual.
- Meet with the additional Performance Requirements stated within this section for the specific MMC system, and any overlapping sections of the Technical Manual which are determined by the Warranty provider to be relevant to the scope of use.

### 21.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section and any other section(s) of the Technical Manual considered relevant by the Warranty provider.

A full set of design drawings and specifications should be made available to the Warranty provider. In addition, the MMC System information provided should include:

- A system name.
- A full and accurate description of the system.
- The scope and limitations for its use.
- Information that demonstrates the attainment of the level of performance required by the Warranty provider as defined by all relevant Performance Requirements.

The following table provides a summary of what information is required based on the type of MMC system.

|                                                                    | Volumetric Cat 1  | Timber frame closed panel | LGSF closed panel | SIP panels        | ICF               |
|--------------------------------------------------------------------|-------------------|---------------------------|-------------------|-------------------|-------------------|
| Formal name of system                                              | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Manufacturers name and address                                     | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| System manual - including limitations on storey height             | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| QA procedures                                                      | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Specification                                                      | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Repair strategy                                                    | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Photographs of factory and system assembly                         | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Transportation details                                             | ✓                 | ✓                         | ✓                 | ✓                 | X                 |
| Site photographs showing various stages of system erection         | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| ALL design drawings including plans, elevations and fixing details | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Structural calculations                                            | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Product accreditations for all proposed elements of the system     | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Heating designs                                                    | ✓                 | X                         | X                 | X                 | X                 |
| Ventilation designs                                                | ✓                 | X                         | X                 | X                 | X                 |
| SAP calculations                                                   | ✓                 | X                         | X                 | X                 | X                 |
| U Value calculations                                               | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Psi calculations                                                   | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Condensation risk analysis                                         | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Factory accreditations                                             | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Industry membership accreditations                                 | ✓                 | ✓                         | ✓                 | X                 | X                 |
| Third party product conformity certificate                         | X                 | X                         | X                 | ✓                 | ✓                 |
| Fire tests for all elements                                        | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Façade water tests                                                 | Possibly required | Possibly required         | Possibly required | Possibly required | Possibly required |
| Sound tests/ Robust Details                                        | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |
| Training of design, manufacturing and erection teams               | ✓                 | ✓                         | ✓                 | ✓                 | ✓                 |

The Warranty provider, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

### 21.1.3 Appraisal of systems

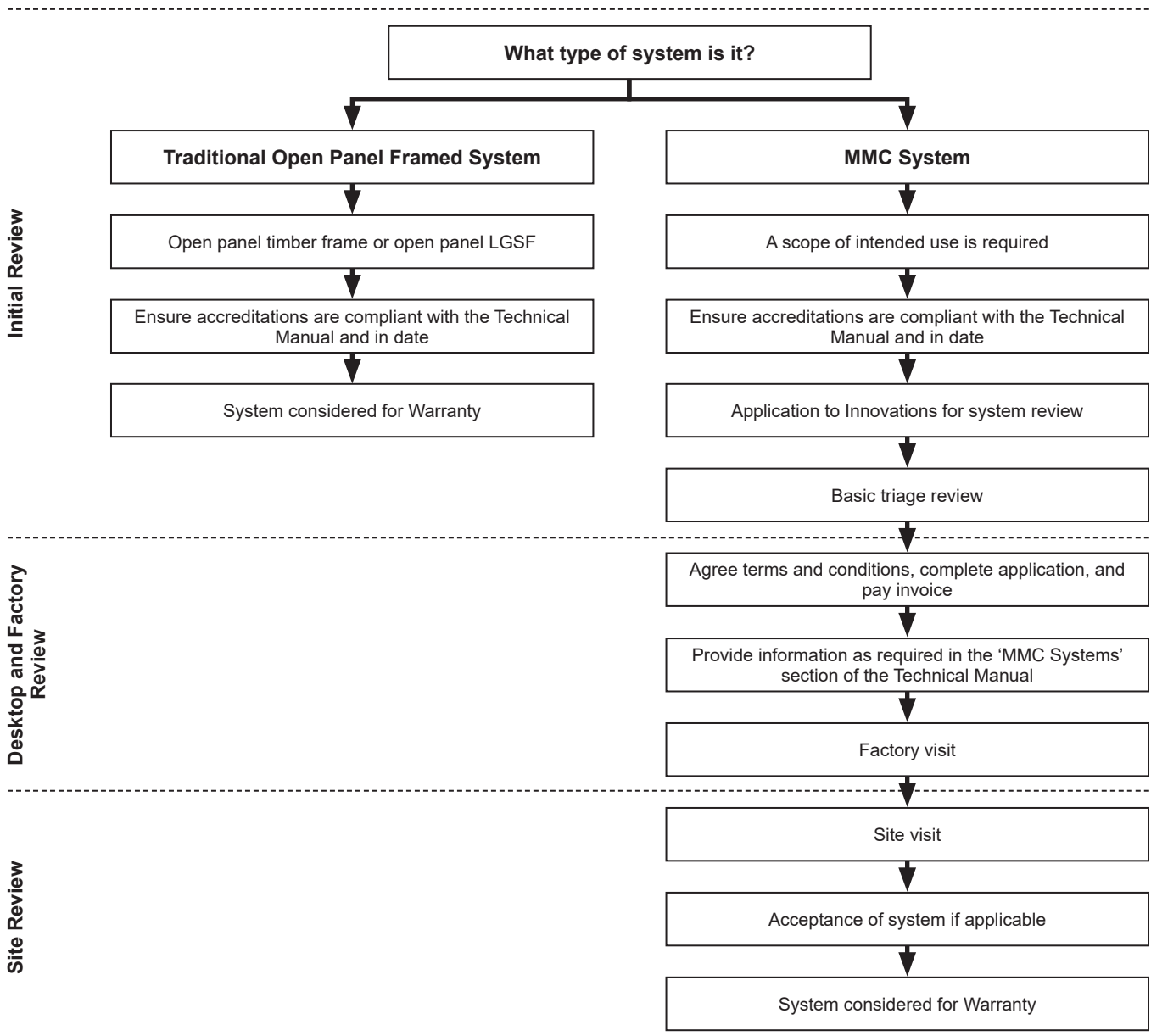
All MMC systems defined within this section shall be the subject of the review procedure as determined by the Warranty provider.

All information provided by the manufacturer of the system should adequately prove and demonstrate that both in its manufactured form and when installed into its final and fixed position as part of the building structure, the system is:

- Resistant to the structural loads and stresses related to any manufacturing, storage, transportation and erection procedures.
- Resistant to water penetration and robust to the effects of weather.
- Able to meet the Statutory structural design and loading requirements for each project.
- Constructed from materials possessing the required levels of durability and longevity.
- Capable of meeting the relevant Functional Requirements of the Technical Manual, and the levels of performance required as defined by all relevant Performance Requirements.
- Demonstrate that the system will be compliant with all relevant statutory requirements e.g. Building Regulations.

The proposed system will then be subject to a Warranty review by our Innovations team to determine if the proposal meets the Functional Requirements set out in this Technical Manual.

The Developer and Designer should also clearly identify at Warranty submission stage what type of MMC System is proposed. See the following flow chart:



### 21.1.4 Structural design requirements

The MMC system shall:

- Meet the requirements of relevant<sup>1</sup> standards and the Building Regulations.
- Safely support and transmit intended loads to the foundations without causing instability, unintended deflection or deformation.
- Be structurally capable of withstanding any forces whilst being transported and lifted in position.

Notes:

<sup>1</sup> As either outlined within the 'MMC Systems' section or as determined to be relevant by the Warranty provider.

All information provided by the manufacturer of the MMC system should adequately prove and demonstrate appropriate structural integrity and robustness. The designs should address the risk of:

- Collapse to the whole structure, or any part thereof.
- Disproportionate collapse in the event it is subjected to accidental or intentional damage.
- Deformations or deflection beyond a stated design parameter or limitation provided within the relevant section(s) of the Technical Manual.
- Deformations or deflection, designed or otherwise, leading to the damage of other parts of a building structure, its fabric, any installed fixtures, fittings or equipment.

The information provided should contain specific project details, including:

- Detailed drawings to include - plans, elevations, sections, all junctions and all fixing details.
- Detailed supporting structural information from an Engineer - relevant drawings, calculations, fixing details for all connections and any specific sequencing.
- Detailed specification of all products used, and any supporting communications, approvals or confirmations granted to the system in relation to performance e.g. third party product conformity certificates.
- Any supporting communications, approvals or confirmations granted to the system in relation to compliance with statutory requirements e.g. Building Regulations.

### 21.1.5 Durability of materials

The durability, longevity and compatibility of materials used to create the MMC system shall be appropriate for the intended purpose and meet with the minimum service life requirements set by the Warranty provider for the relevant build element.

All information provided by the manufacturer of the MMC system should adequately prove and demonstrate appropriate performance of materials used in the manufacture of a system. For further information on suitability of materials, please refer to 'Appendix C'.

The information provided should include:

- Detailed drawings in relation to aspects of installation.
- Manufacturers product literature.
- Any supporting communications, approvals or confirmations granted to the system in relation to performance and testing e.g. third party product conformity certificates relevant to the proposed scope of use.
- Any supporting communications, approvals or confirmations granted to the system in relation to compliance with statutory requirements e.g. Building Regulations.

### 21.1.6 Manufacturing and quality management

MMC System manufacturers shall provide evidence of a fully certified Quality Management system (QMS) acceptable to the Warranty provider.

All information provided by the manufacturer should adequately prove and demonstrate that appropriate Quality Management Systems (QMS) are in place for the system and cover all relevant operations such as:

- Design and specification.
- Materials procurement.
- Factory production, storage and transportation.
- Site works and monitoring.
- Site installation and handover.
- Training and competence.

The information provided should include details of the audited and certified Quality Management System covering:

- Management of procedures associated with design and specification.
- Management of procedures associated with materials procurement.
- Management of procedures used in the factory production and manufacture of the system.
- Management of the procedures associated with storage, transportation and erection of the completed system.
- Management of procedures used to manage, audit and maintain up-to-date training records.

### 21.1.7 Storage and transportation

MMC system manufacturer's shall provide information in relation to the storage and transportation of materials used in the manufacturing of the system and the completed system itself demonstrating avoidance of issues relating to damage, distortion and degradation.

All information provided by the manufacturer should include:

- Identification and address of the storage facility (where different to the production facility).
- Detailed procedures and expected environmental conditions related to the storage of materials used in the manufacture of the system.
- Detailed procedures and expected environmental conditions related to the storage of a completed system component, with particular attention to prevention of any deterioration of in-service performance, distortion or moisture ingress – both at a designated storage facility off-site and storage compounds on-site.
- Detailed information around the transportation of the system from the designated facility to the finished location on the site inclusive of an example of a completed delivery document detailing 'as delivered' quality checks completed by the delivery team and handover to the installing contractor and/or site team.

### 21.1.8 Installation and erection

MMC System manufacturers shall provide information in relation to the installation and erection of the completed system demonstrating avoidance of issues relating to damage, distortion and degradation.

All information provided by the manufacturer should include:

- Detailed procedures associated with the erection and installation of the system on site, inclusive of required Quality Assurance procedures required pre, during and post erection e.g. test and inspection plans, approval of installed works.
- Detailed procedures for temporary protection for foreseeable environmental conditions occurring during or post the erection of a completed system, with particular attention to prevention of any deterioration of in-service performance, distortion or moisture ingress.
- A detailed repair strategy document detailing specific foreseeable repairs to structure and weatherproofing elements that may be required during erection or post erection of a system. It should also contain procedures for unforeseen events and the process that installing operatives should follow to report, remediate and close out repairs to the system.
- An example of a completed document that will be provided to a site after a completed erection or installation e.g. a 'sign off' sheet.

MMC systems should be capable of withstanding the normal loads associated with site handling, lifting operations and installation.

Please note - the Warranty provider will not accept the use of panels which are damaged beyond the agreed limitations detailed within an agreed repair strategy.

### 21.1.9 Training and competence

Manufacturers shall provide evidence of training given to installing operatives and contractors for the MMC system to prove and demonstrate competence.

All information provided by the manufacturer should include:

- Evidence of all certified and audited training programmes associated with the MMC system.
- Details of any Quality Management System to a recognised standard being used to manage, audit and maintain up-to-date training records.
- Detailed procedures covering how the Warranty provider and/or any representative of the Warranty provider may request the details of approved installing operatives for the system.
- An example of a completed training record which suitably displays information related to aspects of design, manufacturer and erection/installation of the system.

### 21.1.10 Moisture and weather resistance

The system shall be capable of resisting the detrimental effects of moisture and weather.

All information provided by the manufacturer of the MMC system should adequately prove and demonstrate appropriate performance against the risks associated with:

- Weather exposure and geographical location.
- Interaction and interfacing with the weather resisting envelope e.g. seals, joints and connective detailing.

The information provided should include:

- Detailed drawings to include - plans, elevations, sections, all junctions and all fixing details.
- Detailed specification of all products used, and any supporting communications, approvals or confirmations granted to the system in relation to performance e.g. third party product conformity certificates.

The designer must incorporate appropriate detailing to prevent any detrimental effects of moisture and weather in accordance with the relevant sections of the Technical Manual. With wall panels for example, the designer should review the 'External Walls – Claddings' section. The cladding system should also take account of shrinkage and thermal movement of the structure.

### 21.1.11 Regulatory compliance

The MMC system as manufactured and in its final and fixed position shall satisfy the Building Regulations in relation to:

- Fire resistance and the provision of cavity barriers.
- Thermal performance.
- Sound resistance.

#### Fire resistance and the provision of cavity barriers

The designer should ensure the MMC system and all associated components attain a level of fire performance determined in accordance with the relevant Building Regulations.

The provision of cavity barriers should be in accordance with the 'External Walls' section and the relevant Building Regulations.

#### Sound resistance

MMC systems should have appropriate sound resistance in accordance with the Building Regulations.

#### Thermal performance

Thermal insulation should be specified correctly and installed to avoid damp, interstitial condensation and thermal bridging issues occurring within the wall makeup. The overall insulation value of the wall should meet the requirements of relevant Building Regulations. The following should be taken into account:

- Specification.
- Thermal insulation should have an appropriate third party product conformity certificate.
- Location.
- Thermal bridging.

Evidence of the above may be achieved through third party accreditation or test reports. In all circumstances, these should be in relation to the site specific conditions (such as wall makeup etc).

### 21.1.12 Hybrid situations

Where the MMC system comprises of a hybrid situation as defined within the guidance, the system shall meet the performance requirements of the 'MMC Systems' section and any other requirement within this Technical Manual determined by the Warranty provider to be relevant to the scope of use.

#### Definition of a hybrid system

The definition of a hybrid system for the purpose of Warranty is:

A situation that results in a combination of any of the systems as defined at the start of the 'MMC Systems' section or, a situation that includes a site built element which is integral to the erection and overall performance of a singular MMC system, or, a combination of MMC system(s).

#### General requirements

As a hybrid situation may incorporate the use of multiple MMC system across a range of elements of construction e.g. floor, four walls and a ceiling, the applicable sections of the Technical Manual should be determined by the Warranty provider upon initial appraisal.

Each MMC system used within a hybrid situation should have information submitted to prove and demonstrate compliance with the Performance Requirements outlined within its relevant 'MMC Systems' section(s), and any other section deemed applicable by the Warranty provider.

The construction methodology, fixings and associated materials used in combining multiple MMC system(s) within a design should prove and demonstrate a suitable performance, and be supported by appropriate technical data, specific designs and calculations where appropriate.

Where a hybrid situation creates an inability to determine a suitable approach to attain Warranty acceptance, either due to no appropriate section or stated relevant tolerances being detailed by the Technical Manual, the requirements should be determined by the Warranty provider accordingly using available and recognised industry guidance.



The Warranty provider in some circumstances may require supplementary information from an appropriate and independent specialist or professional in the form of an independent report in order to determine Warranty risk.

The installation of a fixture, fitting or building service e.g. a window or door, the running of cabling, pipework or ducting within any MMC system should meet the Performance Requirements set by the relevant section(s) of the Technical Manual, such as:

- External Windows and Doors.
- Heating Systems.
- Ventilation and Extraction.
- Electrical Services.
- Cold Water Supply.

## Introduction

This section provides additional specific Warranty requirements for MMC Systems determined by the Warranty provider as being 'volumetric'. It should be read in conjunction with the 'MMC Systems - General Requirements' at the start of this section.

The Warranty provider considers volumetric MMC systems to be a three-dimensional structure which is fabricated offsite in a factory environment used to form all or part of the basic structure of a building. Volumetric units may incorporate varying degrees of offsite fabrication and finish, including internal and external linings, external claddings, windows and doors, internal finishes, concealed insulation, membranes, internal services, internal fixtures and fittings and fire-stopping.

### 21.2.1 Compliance

Volumetric MMC shall meet the performance requirements of the 'MMC Systems' section and any other requirement within this Technical Manual determined by the Warranty provider to be relevant to the scope of use.

For a volumetric MMC system, information submitted should prove and demonstrate compliance with the Performance Requirements outlined in this section and any other section(s) considered by the Warranty provider to be relevant to the scope of use.

In addition to this section, the applicable section(s) of the Technical Manual considered relevant by the Warranty provider in relation to the materials and manufacture of a module(s) will be dictated by the type of construction methodology adopted.

Where the modules use methodology that has no appropriate section or stated relevant tolerances, the requirements should be determined by the Warranty provider accordingly using available and recognised industry guidance. The Warranty provider in some circumstances may require supplementary information from an appropriate and independent specialist or professional in the form of an independent report in order to determine Warranty risk.

### 21.2.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

For further information on information to be provided for volumetric systems, please refer to the 'MMC Systems – General Requirements' section.

### 21.2.3 Structural design requirements

Volumetric MMC systems shall:

- Meet the requirements of relevant<sup>1</sup> standards and the Building Regulations.
- Be designed and constructed so that all loads are sustained and transmitted to supporting structure(s) without causing instability, unintended deflection or deformation.
- Be structurally capable of withstanding any forces whilst being transported and lifted in position.

Factors to be considered are:

- Wind loading.
- Imposed loading.
- Structural movement.
- Openings and penetrations.
- Fixing/attachment of ancillary structures and plant or equipment.

Notes:

<sup>1</sup> As either outlined within the 'MMC Systems' section or as determined to be relevant by the Warranty provider.

## General

Volumetric systems should be designed and constructed so that combined dead, imposed and wind loads are sustained and transmitted to supporting and/or adjoining structure(s) without causing instability, deflection or deformation of any part of the building.

Modules should have:

- Adequate interconnection at all module joints and at all junctions with interfacing structure.
- Adequate bearing and support onto any supporting structure.

Bearing dimensions and connections should be carried out in accordance with the Engineers specification.

The Engineer should design in accordance with the principles of relevant standards, such as:

- BS EN 1990 Eurocode – Basis of structural and geotechnical design.
- BS EN 1991-1-1 Eurocode 1: Actions on structures - General actions - Densities, self-weight, imposed loads for buildings.
- BS EN 1991-1-2 Eurocode 1: Actions on structures - General actions - Actions on structures exposed to fire.
- BS EN 1991-1-3 Eurocode 1: Actions on structures - General actions – Snow loads.
- BS EN 1991-1-4 Eurocode 1: Actions on structures - General actions – Wind actions.

### Wind loading

Volumetric systems should withstand wind pressure and suction, and be capable of transferring wind forces where required by structural design.

Structures completed using volumetric modules should be:

- Adequately restrained and supported at interconnections between modules and by any supplementary load bearing structure e.g. foundations, columns, core structures.
- Adequately secured to each other and to any supporting or interconnecting structures.
- Effectively strapped, braced and strutted to withstand the effects of wind loading e.g. uplift force, lateral force, suction force.

In all situations, a calculation of wind load to BS EN 1991-1-4 should be undertaken by a suitably competent person. Engineers should design structural connections and fixing methodology to resist the site specific wind loads.

### Imposed loading

Volumetric MMC systems should be designed to withstand all dead loads and imposed loads. It should remain structurally stable and capable, and remain within designed and acceptable performance limits. Loadings should not impede the service life, structural performance and/or the functionality of the module.

Engineers should take account of any potential use and functionality of the module(s) with regards to imposed loading, and withstand the effect accordingly through appropriate structural design and material selection.

### Structural movement

Where movement joints are required within modules or structural movement is factored into the larger building structure, they should be designed by an Engineer. The rate of expected movement, type of movement joint(s), the materials used and their locations should be communicated and factored into any overall designs for all relevant aspects e.g. structural performance, weather and water tightness.

### Openings and penetrations

Structural openings (e.g. rooflights or vents, staircase openings, lift overrun shafts) and penetrations created by services through any part of the module should be designed by an Engineer.

### Fixing/attachment of ancillary structures and plant or equipment

Any item fixing into and/or through an element of the modules structure should not impede the overall structural performance, and should not damage or reduce durability or stability of the element. The structural fixings for any element which imposes a load or structural stress (e.g. rotation) should be designed by an Engineer to ensure fixings are robust and are suitable for the performance required.

Fixings should only be located into an element of structure capable of providing the required support and restraint to any imposed and/or operational loading and/or structural stress created by the element being fixed.

## 21.2.4 Durability of materials

The materials used to create a volumetric system shall be appropriate for the intended purpose and meet with the minimum service life set by the Warranty provider.

### Durability

All materials used in the manufacture and erection of a volumetric system should be appropriately tested for their intended purpose. Designers should refer to 'Appendix C' of the Technical Manual for guidance for the requirements of the Warranty provider in relation to an acceptable format and extent of required testing.

All materials should be resistant to the detrimental effects of moisture that may occur during transportation, associated site storage and erection works.

On completion, the materials used to complete on-site connectivity and interfacing between modules should be suitable for the moisture loads of the building in occupation and operation, and the site exposure at the final fixed geographical location.

All materials used within or attached to a module should be robust and resist foreseeable conditions of transportation and erection. Materials and their associated fixing strategies should be designed and executed to ensure damage to the system is avoided e.g. detachment or damage from lifting/loading/manoeuvring modules into position.

## Service life

The minimum service life for a volumetric MMC system as a load bearing structural element is 60 years. Fixings used to connect or attach elements of structure in the process of manufacture or site erection of a module(s) should have an equal minimum life expectancy of 60 years.

Service life requirements for elements not performing a structural function can be found within 'Appendix C'.

### 21.2.5 Manufacturing and quality management

Volumetric MMC system manufacturers shall provide evidence of a fully certified Quality Management system (QMS) acceptable to the Warranty provider.

All information provided by the manufacturer should adequately prove and demonstrate that appropriate Quality Management Systems (QMS) are in place in accordance with the guidance provided within the 'MMC Systems – General Requirements' section.

Evidence of an audited and certified system to ISO 9001 should also be provided.

### 21.2.6 Storage and transportation

Volumetric MMC system manufacturer's shall provide information in relation to the storage and transportation of materials used in the manufacture of the system and the completed system itself demonstrating avoidance of issues relating to damage, distortion and degradation.

For further information, please refer to the 'MMC Systems – General Requirements' section.

### 21.2.7 Installation and erection

Volumetric MMC System manufacturers shall provide information in relation to the installation and erection of the completed system.

For further information on installation and erection, please refer to the 'MMC Systems – General Requirements' section.

### 21.2.8 Training and competence

Volumetric MMC system manufacturers shall provide evidence of training given to installing operatives and contractors for the MMC system to prove and demonstrate competence.

The erection of volumetric MMC system should be carried out by operatives who have been fully trained by the manufacturer. Evidence of this should be provided upon request.

All work should be carried out in strict accordance with the:

- The Engineers design and specification.
- The manufacturers installation guidance.

Contractors responsible for the erection of a volumetric MMC system should comply with the manufacturers requirements for ISO 9001 as part of the overall design package.

For further information, please refer to the 'MMC Systems – General Requirements' section.

### 21.2.9 Moisture and weather resistance

Volumetric systems shall be capable of resisting the detrimental effects of moisture and weather.

Volumetric MMC systems should have a weather resistant design that adequately protects it from the effects of moisture and the site exposure at the final fixed geographical location.

The design should demonstrate provision of appropriate methodology and material layers to resist and protect the completed construction from the effects of moisture acting upon the fabric, and from moisture loads created by building use and occupation.

Designers should refer to the relevant sections of the Technical Manual for guidance on how the volumetric system will be capable of resisting the detrimental effects of moisture and weather.

Where the modules use methodology that has no appropriate section or stated relevant tolerances, the requirements should be determined by the Warranty provider using available and recognised industry guidance. The Warranty provider in some circumstances may require supplementary information from an appropriate and independent specialist or professional in the form of an independent report in order to determine Warranty risk.

External cladding material installed onto a module for weather protection, should include:

- A drained and ventilated cavity which is appropriately sized for the cladding material and exposure conditions experienced at the final fixed geographical location.
- The provision of DPCs and cavity trays at openings and penetrations.
- Weathertight detailing appropriate to exposure.

Modules that are manufactured to include the installation of a fixture within a formed opening e.g. window or door, or an external penetration e.g. a duct or pipe should include:

- The provision of DPCs and cavity trays at openings.
- Weathertight seals.
- Weathertight detailing appropriate to exposure.

## Introduction

This section provides additional specific Warranty requirements for MMC Systems determined by the Warranty provider as being 'Category 2 Closed Panel Timber Frame'. It should be read in conjunction with the 'MMC Systems - General Requirements' section.

The Warranty provider considers closed panel situations to be where the completed panel fabrication results in concealment of key aspects of construction, due to the installation of AVCL layers or linings within or onto the panel internally or externally.

### 21.3.1 Compliance

Any closed panel timber frame system shall meet the performance requirements of the 'MMC Systems' section and any other requirement within this Technical Manual determined by the Warranty provider to be relevant to the scope of use.

Information submitted for a closed panel timber frame system should prove and demonstrate compliance with:

- This section.
- The 'MMC Systems – General Requirements' section.
- Any other sections of the Technical Manual the Warranty provider considers relevant.

Closed panel timber frame systems should also generally meet the requirements of the 'External Walls – Timber Frame' section. Where the closed panel timber frame system incorporates a cladding system, render systems, spandrel panels or parapets, the panel should also satisfy the requirements of the relevant 'External Walls' sections.

In addition, where closed panel timber frame systems incorporate the installation of fixtures and services (such as windows, doors, cabling and pipework), the panel should also satisfy the relevant sections of the Technical Manual.

### 21.3.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

For further information on information to be provided for closed panel timber frame systems, please refer to the 'MMC Systems – General Requirements' section.

### 21.3.3 Structural design requirements

The closed panel timber frame system shall:

- Meet the requirements of relevant<sup>1</sup> standards and the Building Regulations.
- Be designed and constructed so that all loads are sustained and transmitted to supporting structure(s) without causing instability, unintended deflection or deformation.
- Be structurally capable of withstanding any forces whilst being transported and lifted in position.

Factors to be considered are:

- Wind loading.
- Imposed loading.
- Structural movement.
- Openings and penetrations.
- Fixing/attachment of ancillary structures and plant or equipment.

Notes:

<sup>1</sup> As either outlined within the 'MMC Systems' section or as determined to be relevant by the Warranty provider.

Closed panel timber frame systems should satisfy the structural design requirements of an open panel timber frame system as specified in the 'External Walls – Timber Frame' section. In addition, the following should be considered for closed panel timber frame systems by the designer:

- Foreseeable loads from transportation and site operations.
- Structural connections and interconnection at joints and junctions.
- Fixing/attachment of ancillary structures and plant or equipment should not compromise structural performance.

### 21.3.4 Durability of materials

The materials used to create the closed panel timber frame shall be appropriate for the intended purpose and meet with the minimum service life set by the Warranty provider.

Materials used in closed panel timber frames should be:

- Tested for their intended purpose.
- Robust and able to withstand foreseeable conditions.
- Resistant to moisture damage during transportation, storage, and erection.

For further information, the designer should refer to Appendix C for requirements for material and component suitability.

### Service life

The minimum service life for a closed panel timber frame system as a load bearing structural element is 60 years. Fixings and support systems used to connect or attach elements of structure in the process of manufacture or site erection of a panel(s) should have an equal service life of 60 years.

Fixings and support systems used to connect or attach elements listed above should have a life expectancy that is equal or greater than the associated element.

Service life requirements for elements not performing a structural function can be found within 'Appendix C'.

### 21.3.5 Manufacturing and quality management

Closed panel timber frame manufacturers shall provide evidence of a fully certified Quality Management system (QMS) acceptable to the Warranty provider.

All information provided by the manufacturer should adequately prove and demonstrate that appropriate Quality Management Systems (QMS) are in place in accordance with the guidance provided within the 'MMC Systems – General Requirements' section.

Manufacturers should also provide evidence of membership in one of the following schemes:

- BM TRADA Q-Mark Timber Frame Elements Certification Scheme.
- CATG - Frame Mark.
- Gold or silver membership in the STA.
- Other relevant third party quality assurance schemes.

In addition, manufacturers should also provide evidence of an audited and certified system to ISO 9001.

### 21.3.6 Storage and transportation

Closed panel timber frame system manufacturer's shall provide information in relation to the storage and transportation of materials used in the manufacture of the system and the completed system itself demonstrating avoidance of issues relating to damage, distortion and degradation.

Stored materials should be protected from damage and deterioration with the following taken into account:

- Materials being stored on appropriate racking systems.
- Stored inside an enclosure to allow protection from moisture.
- Unwrapped if tightly bound in polythene and loosely recovered with a waterproof membrane to allow ventilation.
- Handled and stored with particular consideration to moisture damage where insulation and an Air and Vapour Control Layer (AVCL) is incorporated.
- Specific requirements for timber components:
  - Stored below 20% moisture content.

Completed panels should be protected from damage and deterioration with the following taken into account:

- Storing completed panels in stillages, off the ground, and secure.
- Protecting projecting elements with materials like foam padding.
- Storage inside an enclosure with protection from moisture and adequate ventilation.
- Special consideration for moisture damage when insulation and AVCL are present.

For further information on storage and transportation, please refer to the 'MMC Systems – General Requirements' section.

## 21.3.7 Installation and erection

Closed panel timber frame system manufacturers shall provide information in relation to the installation and erection of the completed system.

For further information on installation and erection, please refer to the 'MMC Systems – General Requirements' section.

## 21.3.8 Training and competence

Manufacturers shall provide evidence of training given to installing operatives and contractors for the system to prove and demonstrate competence.

Erectors should have membership of one of the following schemes/organisations listed below:

- The BM TRADA Q-Mark Timber Frame Elements Certification Scheme.
- Gold or silver members of the STA.
- CATG - Frame Mark.
- Other relevant third party quality assurance scheme.

Contractors responsible for the erection of a closed panel timber frame should comply with the manufacturers requirements for ISO 9001 and any requirements set by an industry membership schemes listed above.

## 21.3.9 Moisture and weather resistance

The system shall be capable of resisting the detrimental effects of moisture and weather.

A closed panel timber frame should have a weather-resistant design to protect it from moisture and site exposure.

Required material layers include:

- Air and vapour control layers.
- Breathable membranes.

Additional requirements for weather protection include:

- An appropriate cladding system with a drained and ventilated cavity.
- DPCs and cavity trays at openings and penetrations.
- Weathertight detailing and seals.

These measures should be incorporated in accordance with the 'External Walls – Timber Frame' section and any other relevant sections of the Technical Manual.



## Introduction

This section provides additional specific Warranty requirements for MMC Systems determined by the Warranty provider as being 'Category 2 Closed panel light gauge steel frame (LGSF)'. It should be read in conjunction with the 'MMC Systems - General Requirements' section.

The Warranty provider considers closed panel LGSF situations to be where the completed panel fabrication results in concealment of key aspects of construction, due to the installation of AVCL layers or linings within or onto the panel internally or externally.

### 21.4.1 Compliance

Any closed panel LGSF system shall meet the performance requirements of the 'MMC Systems' section and any other requirement within this Technical Manual determined by the Warranty provider to be relevant to the scope of use.

Information submitted for a closed panel LGSF system should prove and demonstrate compliance with:

- This section.
- The 'MMC Systems – General Requirements' section.
- Any other sections of the Technical Manual the Warranty provider considers relevant.

Closed panel LGSF systems should also generally meet the requirements of the 'External Walls – Light Gauge Steel Frame' section. Where the closed panel LGSF system incorporates a cladding system, render systems, spandrel panels or parapets, the panel should also satisfy the requirements of the relevant 'External Wall' sections.

In addition, where closed panel LGSF systems incorporate the installation of fixtures and services (such as windows, doors, cabling and pipework), the panel should also satisfy the relevant sections of the Technical Manual.

### 21.4.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

For further information on information to be provided for closed panel LGSF systems, please refer to the 'MMC Systems – General Requirements' section.

### 21.4.3 Structural design requirements

The closed panel LGSF system shall:

- Meet the requirements of relevant<sup>1</sup> standards and the Building Regulations.
- Be designed and constructed so that all loads are sustained and transmitted to supporting structure(s) without causing instability, unintended deflection or deformation.
- Be structurally capable of withstanding any forces whilst being transported and lifted in position.

Factors to be considered are:

- Wind loading.
- Imposed loading.
- Structural movement.
- Openings and penetrations.
- Fixing/attachment of ancillary structures and plant or equipment.

Notes:

<sup>1</sup> As either outlined within the 'MMC Systems' section or as determined to be relevant by the Warranty provider.

## General

Structures should be designed and constructed so that combined dead, imposed and wind loads are sustained and transmitted to supporting and/or adjoining structure(s) without causing instability, deflection or deformation of any part of the building.

The Engineer should design in accordance with the principles of relevant standards, and their associated UK National Annex documents, such as:

- BS EN 1990 Eurocode – Basis of structural and geotechnical design.
- BS EN 1991-1-1 Eurocode 1: Actions on structures - General actions - Densities, self-weight, imposed loads for buildings.
- BS EN 1991-1-2 Eurocode 1: Actions on structures - General actions - Actions on structures exposed to fire.
- BS EN 1991-1-3 Eurocode 1: Actions on structures - General actions – Snow loads.
- BS EN 1991-1-4 Eurocode 1: Actions on structures - General actions – Wind actions.
- BS EN 1993-1-1 Eurocode 3: Design of steel structures – General rules and rules for buildings.

The structural design of any closed panel light gauge steel frame (LGSF) system should be conducted in accordance with relevant standards, such as:

- BS EN 1993-1-3 Eurocode 3 — Design of steel structures Part 1-3: Cold-formed members and sheeting.

Designs should include for:

- Wind, roof and floor loading.
- Loads created by wall linings, cladding or fixtures fixed within or onto the panel as manufactured.
- Structural connections e.g. within the panels, panel-to-panel, panel to other structure.
- Foreseeable loads from transportation and site operations e.g. lifting, placement.

Closed panels should have adequate interconnection at all jointing with each other and at all junctions with any other interfacing structure. Closed panels should be provided with appropriate bearing and support where it bears onto any supporting walls or intermediate beams. Bearing dimensions and connections should be carried out in accordance with the Engineers specification.

Any approaches taken and materials used to provide racking resistance in the closed panel light gauge steel frame (LGSF) should be clearly expressed within the calculations.

Structural properties of materials used in the manufacture and erection of closed panel light gauge steel frame (LGSF) panels should be in accordance with guidance in 'External Walls – Open Panel Light Gauge Steel Frame'.

## Wind loading

Structures should withstand wind pressure and suction, and have adequate interconnection with supporting structure.

Closed panels should be:

- Supported by adequately restrained load bearing structure e.g. foundations, sub-structure, beams.
- Effectively strapped, braced and strutted to withstand the effects of wind loading e.g. uplift force, lateral force, suction force.
- Secured to the supporting structure.

In all situations, a calculation of wind load to BS EN 1991-1-4 should be undertaken by a suitably competent person. Engineers should design structural connections and fixing methodology to resist the site specific wind loads.

## Imposed loading

Structures should be designed to withstand all dead loads and imposed loads, and remain structurally stable and capable to the levels determined by design. Loading should not impede the service life of the closed panel structure, its structural performance and/or the associated functionality.

Engineers should take account of any foreseeable imposed loading such as those created by guarding, and/or attachment of plant and equipment to a completed structure incorporating the use of a closed panel, and withstand the effect accordingly through appropriate structural design and material selection.

## Structural movement

Where movement joints are required, they should be designed by an Engineer. The rate of expected movement, type of movement joint(s), the materials used and their locations should be communicated to the closed panel manufacturer for inclusion into the design process where required.

## Openings and penetrations

Structural openings (e.g. windows, doors) and penetrations created by services through any part of the closed panel should be designed by an Engineer.

## Fixing/attachment of ancillary structures and plant or equipment

Any item (e.g. guarding, Juliet balconies, items of plant or equipment) fixing into and/or through a closed panel should not impede the overall structural performance, and should not damage or reduce durability or stability.

The structural fixings for any element should be designed by an Engineer to ensure fixings are robust and are suitable for the performance required. Fixings should only be located into an element of structure capable of providing the required support and restraint to any imposed and/or operational loading, and/or structural stress created by the element being fixed.

Structural fixing(s) for such elements should be fully protected by the final weatherproofing elements on completion. Penetrations created by these elements should be detailed and sealed in accordance with the manufacturer's recommendations.

### 21.4.4 Durability of materials

The materials used to create the closed panel LGSF system shall be appropriate for the intended purpose and meet with the minimum service life requirements set by the Warranty provider.

#### Durability

All materials used in the manufacture and erection of a closed panel LGSF should be appropriately tested for their intended purpose. Designers should refer to 'Appendix C' of the Technical Manual for guidance for the requirements of the Warranty provider in relation to acceptable format and extent of required testing.

All materials should be resistant to the detrimental effects of moisture that may occur during transportation, associated site storage and erection works. On completion, the materials should be suitable for the moisture loads of the building in occupation and operation, and the site exposure associated with the closed panel timber frame at the final fixed geographical location.

All materials used within or attached to a closed panel LGSF should be robust and resist foreseeable conditions of transportation and erection. Materials and their associated fixing strategies should be designed and executed to ensure damage to the system is avoided e.g. detachment or damage from lifting/loading/manoeuvring panels into position.

#### Service life requirements

The minimum service life requirements of a closed panel LGSF panel as a load bearing structural element is 60 years. Fixings and support systems used to connect or attach elements of structure in the process of manufacture or site erection of a closed panel LGSF should have a minimum life expectancy of 60 years.

Service life requirements for elements not performing a structural function can be found within 'Appendix C'.

Fixings and support systems used to connect or attach elements listed above should have a life expectancy that is equal or greater than the associated element.

### 21.4.5 Manufacturing and quality management

Closed panel LGSF system manufacturers shall provide evidence of a fully certified Quality Management system (QMS) acceptable to the Warranty provider.

Closed panel LGSF systems shall be provided with an SCI stage 1 certificate, or evidence of a third party system approval (UKAS or equivalent).

An independent Engineer with suitable experience and Professional Indemnity insurance shall review the site specific design and calculations in accordance with the stage 1 SCI certificate.

#### Quality management system

All information provided by the manufacturer should adequately prove and demonstrate that appropriate Quality Management Systems (QMS) are in place in accordance with the guidance provided within the 'MMC Systems – General Requirements' section.

Manufacturers should also provide evidence of an audited and certified system to ISO 9001.

#### SCI Stage 1 Certification

Closed panel LGSF systems should be provided with an SCI stage 1 certificate, or evidence of a third party system approval (UKAS or equivalent). Please note, actual wall makeup, components, individual products used for the external waterproof, thermal and fire resistant envelope, are outside the scope of the SCI Stage 1 assessment. These elements will still need to meet the requirements of this Technical Manual.

#### Independent Engineer verification

An independent Engineer with suitable experience and Professional Indemnity insurance should review the site specific design and calculations in accordance with the stage 1 SCI certificate.

### 21.4.6 Storage and transportation

Closed panel LGSF system manufacturer's shall provide information in relation to the storage and transportation of materials used in the manufacture of the system and the completed system itself demonstrating avoidance of issues relating to damage, distortion and degradation.

Stored materials should be protected from damage and deterioration with the following taken into account:

- Materials being stored in appropriate racking systems.
- Stored inside an enclosure to allow protection from moisture.
- Unwrapped if tightly bound in polythene and loosely recovered with a waterproof membrane to allow ventilation.
- Handled and stored with particular consideration to moisture damage where insulation and an Air and Vapour Control Layer (AVCL) is incorporated.

Completed panels should be protected from damage and deterioration with the following taken into account:

- Completed panels being stored in stillages holding them off the ground and secure.
- Stored inside an enclosure to allow protection from moisture and adequate ventilation.
- Projecting elements being provided with protection e.g. foam padding materials.
- Handled and stored with particular consideration to moisture damage where insulation and an AVCL are incorporated.

For further information on storage and transportation, please refer to the 'MMC Systems – General Requirements' section.

## 21.4.7 Installation and erection

Closed panel LGSF system manufacturers shall provide information in relation to the installation and erection of the completed system.

For further information on installation and erection, please refer to the 'MMC Systems – General Requirements' section.

## 21.4.8 Training and competence

Closed panel LGSF system manufacturer's should provide evidence of training given to installing operatives and contractors for the system to prove and demonstrate competence.

Construction of the closed panel LGSF system should be carried out by operatives trained by the manufacturer to erect their system, and be experienced with the work required by this type of system.

All work should be carried out in strict accordance with the:

- The Engineers design and specification.
- The manufacturers installation guidance.

Contractors responsible for the erection of a closed panel LGSF system should comply with the manufacturers requirements for ISO 9001 and any requirements set by an appropriate industry membership scheme.

## 21.4.9 Moisture and weather resistance

The closed panel LGSF system shall be capable of resisting the detrimental effects of moisture and weather.

The closed panel LGSF system should have a weather resistant design that adequately protects it from the effects of moisture and the site exposure at the final fixed geographical location.

Any closed panel LGSF system should include material layers that resist and protect the timber frame panel from the effects of moisture acting upon the fabric, and moisture loads created by building use and occupation. These layers are considered as:

- Air and vapour control layers.
- Breathable membranes.

Any closed panel LGSF system that is manufactured with an external cladding material for weather protection, should include:

- A drained cavity which is appropriately sized for the cladding material and exposure conditions experienced at the final fixed geographical location.
- The provision of DPCs and cavity trays at openings and penetrations.
- Weathertight detailing appropriate to exposure.

Any closed panel LGSF panel that is manufactured and includes the installation of a fixture within a formed opening e.g. window or door, or an external penetration e.g. a duct or pipe should include:

- The provision of DPCs and cavity trays at openings.
- Weathertight detailing appropriate to exposure.
- Weathertight seals.

Designers should refer to the relevant sections of the Technical Manual for guidance on how to incorporate each of the above measures.

## Introduction

This section provides additional specific Warranty requirements for MMC Systems determined by the Warranty provider as being 'Structural Insulated Panel systems (SIPs)'. It should be read in conjunction with the 'MMC Systems - General Requirements' section.

The Warranty provider considers a SIP to be where an insulating foam core is sandwiched between two structural facings to create structural panels.

Subject to system appraisal, these systems may be acceptable for Warranty for use in structures up to 4 stories in height (subject to any national height restriction) including the ground storey. SIPs may be considered for use as:

- A load bearing inner leaf of an external cavity wall.
- An internal load bearing wall.
- An intermediate floor.
- A pitched roof structure.

### 21.5.1 Compliance

Any SIP shall meet the performance requirements of the 'MMC Systems' section and any other requirement within this Technical Manual determined by the Warranty provider to be relevant to the scope of use.

Information submitted for a SIP system should prove and demonstrate compliance with:

- This section.
- The 'MMC Systems – General Requirements' section.
- Any other sections of the Technical Manual the Warranty provider considers relevant.

Where the SIP system incorporates a cladding system, render systems, spandrel panels or parapets, the panel should also satisfy the requirements of the 'External Walls' section.

In addition, where SIP systems incorporate the installation of fixtures and services (such as windows, doors, cabling and pipework), the panel should also satisfy the relevant sections of the Technical Manual.

The Warranty provider will only conduct appraisals on a SIPs that has a valid and current UKAS accredited (or European equivalent) third party product conformity certificate.

### 21.5.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

For further information on information to be provided for SIP systems, please refer to the 'MMC Systems – General Requirements' section.

### 21.5.3 Structural design requirements

The SIP system shall:

- Meet the requirements of relevant<sup>1</sup> standards and the Building Regulations.
- Be designed and constructed so that all loads are sustained and transmitted to supporting structure(s) without causing instability, unintended deflection or deformation.
- Be structurally capable of withstanding any forces whilst being transported and lifted in position.

Factors to be considered are:

- Wind loading.
- Imposed loading.
- Structural movement.
- Openings and penetrations.
- Fixing/attachment of ancillary structures and plant or equipment.

Notes:

<sup>1</sup> As either outlined within the 'MMC Systems' section or as determined to be relevant by the Warranty provider.

## General

Structures should be designed and constructed so that combined dead, imposed and wind loads are sustained and transmitted to supporting and/or adjoining structure(s) without causing instability, deflection or deformation of any part of the building.

The Engineer should design in accordance with the principles of relevant standards, such as:

- BS EN 1990 Eurocode – Basis of structural and geotechnical design.
- BS EN 1991-1-1 Eurocode 1: Actions on structures - General actions - Densities, self-weight, imposed loads for buildings.

- BS EN 1991-1-2 Eurocode 1: Actions on structures - General actions - Actions on structures exposed to fire.
- BS EN 1991-1-3 Eurocode 1: Actions on structures - General actions – Snow loads.
- BS EN 1991-1-4 Eurocode 1: Actions on structures - General actions – Wind actions.

The structural design of any SIPs should be undertaken by an Engineer with relevant and demonstrable experience of the system. Structural calculations should be conducted in accordance with the system manufacturers design guidance literature and in demonstrate compliance with 'Eurocode 5: Design of timber structures General Common rules and rules for buildings.', and any relevant UK National Annexes.

Designs should include:

- Wind, roof and floor loading.
- Racking resistance.
- For all loads relating to heavy wall attachments, wall ties or support systems for finishes and/or further building fabric e.g. masonry, cladding, fixing systems.
- Structural connections e.g. within the panels, panel-to-panel, panel to other structure.

Structural Insulated Panel systems (SIPs) should have adequate interconnection at all jointing with each other and at all junctions with any other interfacing structure. SIPs should be provided with appropriate bearing and support where it bears onto any supporting walls or intermediate beams. Bearing dimensions and connections should be carried out in accordance with the Engineers specification.

Structural calculations should be supplemented by SIPs production drawings provided by the manufacturer.

## Wind loading

Structures should withstand wind pressure and suction, and have adequate interconnection with supporting structure.

SIPs should be:

- Supported by adequately restrained load bearing structure e.g. foundations, sub-structure, beams.
- Secured to the supporting structure. Effectively strapped, braced and strutted to withstand the effects of wind loading e.g. uplift force, lateral force, suction force.

In all situations, a calculation of wind load to BS EN 1991-1-4 should be undertaken by a suitably competent person. Engineers should design structural connections and fixing methodology to resist the site specific wind loads.

The cladding system proposed for use with any SIP system in its final and fixed location should also be designed by the Engineer with assistance and guidance from the SIP system manufacturer. For any cladding system, the SIP system manufacturer should provide evidence of suitability of both the cladding and any anchors or wall ties for use with their SIP system.

The Engineer and manufacturer should also provide the on-site testing regime for all fixings used to attach and/or anchor the chosen cladding system which should include pull-out or destructive testing of anchors in accordance with the guidance relevant to the substrate and fixing methodology.

## Imposed loading

Structures should be designed to withstand all dead loads and imposed loads, and remain structurally stable and capable to the levels determined by design. Loading should not impede the service life of the SIP system, its structural performance and/or the associated functionality.

Engineers should take account of any foreseeable imposed loading such as those created by guarding, and/or attachment of plant and equipment to a completed structure incorporating the use of the SIP system, and withstand the effect accordingly through appropriate structural design and material selection.

## Structural movement

Where movement joints are required, they should be designed by an Engineer. The rate of expected movement, type of movement joint(s), the materials used and their locations should be communicated to the SIP system manufacturer for inclusion into the design process where required.

## Openings and penetrations

Structural openings (e.g. windows, doors) and penetrations created by services through any part of the SIP system should be designed by an Engineer.

## Fixing/attachment of ancillary structures and plant or equipment

Any item (e.g. guarding, Juliet balconies, items of plant or equipment) fixing into and/or through a SIP system should not impede the overall structural performance, and should not damage or reduce durability or stability.

The structural fixings for any element should be designed by an Engineer to ensure fixings are robust and are suitable for the performance required. Fixings should only be located into an element of structure capable of providing the required support and restraint to any imposed and/or operational loading, and/or structural stress created by the element being fixed.

Structural fixing(s) for such elements should be fully protected by the final weatherproofing elements on completion. Penetrations created by these elements should be detailed and sealed in accordance with the manufacturer's recommendations.



### 21.5.4 Durability of materials

The materials used to create a Structural Insulated Panel system (SIPs) shall be appropriate for the intended purpose and meet with the minimum service life set by the Warranty provider for the relevant build element.

#### Durability

All materials used in the manufacture and erection of a SIP should be appropriately tested for their intended purpose. The Warranty provider will only accept statements regarding durability of a SIP system that are supported by a valid and current UKAS accredited third party product conformity certificate.

Timber sections that are used in the erection of the SIPs on site e.g. sole plates, and/or any timber section used to execute detailing that bridges a cavity e.g. cavity closure should be preservative-treated in accordance with BS 8417:2024 Preservation of wood - Code of practice.

#### Service life requirements

The minimum service life requirements for a SIP as a load bearing structural element is 60 years. Fixings and support systems used to connect or attach elements of structure in the process of manufacture or site erection of a SIP system should have a minimum life expectancy of 60 years.

Service life requirements for elements not performing a structural function can be found within 'Appendix C'.

Fixings and support systems used to connect or attach elements listed above should have a life expectancy that is equal or greater than the associated element.

### 21.5.5 Manufacturing and quality management

SIP system manufacturers shall provide evidence of a fully certified Quality Management system (QMS) acceptable to the Warranty provider.

All information provided by the manufacturer should adequately prove and demonstrate that appropriate Quality Management Systems (QMS) are in place.

Evidence of an audited and certified system to ISO 9001 should be provided.

Evidence of membership of one of the following schemes/organisations listed below is also required as proof and demonstration to cover the design, manufacturing and erection a Structural Insulated Panel system:

- The BM TRADA Q-Mark Timber Frame Elements Certification Scheme.
- Gold or silver members of the STA.
- CATG - Frame Mark.
- Other relevant third party quality assurance scheme.

### 21.5.6 Storage and transportation

SIP system manufacturer's shall provide information in relation to the storage and transportation of materials used in the manufacture of the system and the completed system itself demonstrating avoidance of issues relating to damage, distortion and degradation.

All information provided by the manufacturer should include panel demarcation giving the production date and time, panel dimensions and process order number, along with the relevant third party accreditation 'logo' where possible.

Stored materials should be protected from damage and deterioration with the following taken into account:

- Materials being stored off the ground on an adequate number of level bearers.
- Stored inside an enclosure to allow protection from moisture and adequate ventilation.
- Unwrapped if tightly bound in polythene and loosely recovered with a waterproof membrane to allow ventilation.
- Timber components should be stored below 20% moisture content.
- Handled and stored with particular consideration to moisture damage - provision should be made for ensuring the panels are provided with temporary weather protection during storage, erection and until the waterproof envelope is completed and weathertight.

Complete systems should be protected from damage and deterioration with the following taken into account:

- Delivered in shrink-wrap, with edge protectors and banded packaging used for initial transit and temporary protection.
- Stored inside an enclosure to allow protection from moisture and adequate ventilation.
- Supported by clear instructions in relation to maximum stacking heights for panels.
- Supported by clear instructions on the type, size, spacing and arrangement of bearers in under and/or in between panels to provide support, and safeguard against distortion of the panel.
- Appropriately protected where they feature projecting elements e.g. foam padding materials.

In all instances, provision should be made for ensuring any erected SIPs structure is provided with temporary weather protection until the waterproof envelope is completed and weathertight.

For further information on storage and transportation, please refer to the 'MMC Systems – General Requirements' section.

## 21.5.7 Installation and erection

System manufacturers shall provide information in relation to the installation and erection of the completed system.

For further information on installation and erection, please refer to the 'MMC Systems – General Requirements' section.

## 21.5.8 Training and competence

Manufacturers shall provide evidence of training given to installing operatives and contractors for the system to prove and demonstrate competence.

Erectors should have membership of one of the following schemes/organisations listed below:

- The BM TRADA Q-Mark Timber Frame Elements Certification Scheme.
- Gold or silver members of the STA.
- CATG - Frame Mark.
- Other relevant third party quality assurance scheme.

Contractors responsible for the erection of a Structural Insulated Panel system should comply with the manufacturers requirements for ISO 9001 and any requirements set by an industry membership schemes listed above.

## 21.5.9 Moisture and weather resistance

The SIPs shall be capable of resisting the detrimental effects of moisture and weather.

The SIPs should have a weather resistant design that adequately protects it from the effects of moisture and the site exposure at the final fixed geographical location.

The SIPs or any associated timber section/element (e.g. soleplate) should not be installed less than 150 mm above external finished ground level and should incorporate a damp proof course (DPC) material to resist passage of moisture from any supporting and/or adjoining structure.

The SIPs should include material layers that resist and protect the panel from the effects of moisture acting upon the fabric, and moisture loads created by building use and occupation. These layers are considered as:

- Air and vapour control layers.
- Breathable membranes.

The Structural Insulated Panel system (SIPs) should include a drained and ventilated cavity which is appropriately sized for the cladding material and exposure conditions experienced at the final fixed geographical location. It should include for:

- The provision of DPCs and cavity trays at openings and penetrations.
- Effective weathertight detailing appropriate to exposure.

The design and weatherproofing of parapets, whether they occur at the junction with a roof, roof terrace or balcony will not form part of any system appraisal. These elements will be the subject of a site-by-site appraisal of risk based upon various aspects e.g. site exposure, the type of cladding material and the methodology adopted for rainwater disposal where rainwater systems pass through any panel and/or associated building fabric.

Designers should refer to the relevant sections of the Technical Manual for guidance on the specification and how to incorporate each of the above measures.



## Introduction

This section provides additional specific Warranty requirements for MMC Systems determined by the Warranty provider as being 'Insulated Concrete Formwork (ICF)'. It should be read in conjunction with the 'MMC Systems - General Requirements' section.

The Warranty provider considers ICF to be:

- Expanded Polystyrene (EPS) Panels – these systems are available as two EPS panels which connect using metal or plastic ties to form the block.
- Expanded Polystyrene (EPS) Moulded – on site these systems arrive as pre-formed blocks.
- A similar system to the above which is acceptable to us.

Subject to system appraisal, these systems may be acceptable for Warranty for use in loadbearing and non-loadbearing internal, separating, and external walls above ground up to a maximum of three storeys in height, including the ground level storey.

These systems are not acceptable for Warranty provision for use in below ground situations. The definition of a below ground situation is:

- A building storey wholly or partially below ground e.g. basement.
- Lower ground storeys partially below ground e.g. semi-basements, split levels with voids, stepping slabs.
- Lift pits.

### 21.6.1 Compliance

Any ICF system shall meet the Functional Requirements of the Technical Manual and meet all relevant Performance Requirements determined by the Warranty provider to be relevant to the scope of use.

Information submitted for a ICF systems should prove and demonstrate compliance with:

- This section.
- The 'MMC Systems – General Requirements' section.
- Any other sections of the Technical Manual the Warranty provider considers relevant.

Where the ICF system incorporates a cladding system, render systems, spandrel panels or parapets, their inclusion should also satisfy the requirements of the 'External Walls' section.

In addition, where ICF systems incorporate the installation of fixtures and services (such as windows, doors, cabling and pipework), their inclusion should also satisfy the relevant sections of the Technical Manual.

The Warranty provider will only conduct appraisals on a ICF system that has a valid and current UKAS (or European equivalent) accredited third party product conformity certificate.

### 21.6.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

For further information on information to be provided for ICF systems, please refer to the 'MMC Systems – General Requirements' section.

### 21.6.3 Structural design requirements

The ICF system shall:

- Meet the requirements of relevant<sup>1</sup> standards and the Building Regulations.
- Be designed and constructed so that all loads are sustained and transmitted to supporting structure(s) without causing instability, unintended deflection or deformation.
- Be structurally capable of withstanding any forces whilst being transported and lifted in position.

Factors to be considered are:

- Wind loading.
- Imposed loading.
- Structural movement.
- Openings and penetrations.
- Fixing/attachment of ancillary structures and plant or equipment.

Notes:

<sup>1</sup> As either outlined within the 'MMC Systems' section or as determined to be relevant by the Warranty provider.

## General

Structures should be designed and constructed so that combined dead, imposed and wind loads are sustained and transmitted to supporting and/or adjoining structure(s) without causing instability, deflection or deformation of any part of the building.

The structural design of any ICF system should be undertaken by an Engineer with relevant and demonstrable experience of the system. Structural calculations should be conducted in accordance with relevant standards and any relevant UK National Annexes, such as:

- BS EN 1990 Eurocode - Basis of structural and geotechnical design.
- BS EN 1991 Eurocode 1 – Actions on Structures – all relevant parts.
- BS EN 206 Concrete – specification, performance, production and conformity.
- BS 8500 Concrete – Complementary British Standard to BS EN 206.
- BS EN 934-2 – Admixtures for concrete, mortar and grout.

Reference should be made to the requirements of the system manufacturer, and designs should include for:

- Wind, roof and floor loadings.
- Loads created by claddings or fixtures fixed onto or into the completed construction.
- Structural connections to interacting build elements e.g. to foundations, intermediate floors, walls, roofs, balconies, beams, lintel, posts.
- Type of concrete mix and specification inclusive of grade, aggregate size, admixtures, slump and consistence.
- The design of the steel reinforcement e.g. vertical, horizontal, tying wire type, cover.

## Wind loading

Structures should withstand wind pressure and suction, and have adequate interconnection with supporting structure.

The ICF system should be:

- Supported by adequately restrained load bearing structure e.g. foundations, sub-structure.
- Secured to the supporting structure.
- Effectively detailed to withstand the effects of wind loading e.g. uplift force, lateral force, suction force.

In all situations, a calculation of wind load to BS EN 1991-1-4 should be undertaken by a suitably competent person. Engineers should design structural connections and fixing methodology to resist the site specific wind loads.

The cladding system proposed for use with any ICF system should also be designed by the Engineer with assistance and guidance from the ICF system manufacturer. For any cladding system, the ICF system manufacturer should provide evidence of suitability of both the cladding and any anchors or wall ties for use with their ICF system.

The Engineer and manufacturer should also provide the on-site testing regime for all fixings used to attach and/or anchor the chosen cladding system which should include pull-out or destructive testing of anchors in accordance with the guidance relevant to the substrate and fixing methodology.

## Imposed loading

Structures should be designed to withstand all dead loads and imposed loads, and remain structurally stable and capable to the levels determined by design. Loading should not impede the service life of the ICF system, its structural performance and/or the associated functionality.

Engineers should take account of any foreseeable imposed loading such as those created by guarding, and/or attachment of plant and equipment to a completed structure incorporating the use of an ICF system, and withstand the effect accordingly through appropriate structural design and material selection.

## Structural movement

Where movement joints are required, they should be designed by an Engineer. The rate of expected movement, type of movement joint(s), the materials used and their locations should be communicated to the ICF system manufacturer for inclusion into the design process where required.

## Openings and penetrations

Structural openings (e.g. windows, doors) and penetrations created by services through any part of the ICF system should be designed by an Engineer with assistance and guidance from the ICF system manufacturer.

## Fixing/attachment of ancillary structures and plant or equipment

Any item (e.g. windows, doors, guarding, Juliet balconies, items of plant or equipment) fixing into and/or through an ICF system should not impede the overall structural performance, and should not damage or reduce durability or stability.

The structural fixings for any element should be designed by an Engineer to ensure fixings are robust and are suitable for the performance required. Fixings should only be located into an element of structure capable of providing the required support and restraint to any imposed and/or operational loading, and/or structural stress created by the element being fixed.

Structural fixing(s) for such elements should be fully protected by the final weatherproofing elements on completion. Penetrations created by these elements should be detailed and sealed in accordance with the manufacturer's recommendations.

Reference should be made to the requirements of the system manufacturer, and designs should include for:

- Methodology and specification for heavy wall attachments, wall ties or support systems for finishes and/or further building fabric e.g. masonry, cladding, fixing systems. This specification should include clear statements in relation to the 'anchoring' substrate for any fixings – typically fixing methodology utilises the concrete core or proprietary components cast into the core to receive the fixings.
- Methodology and specification for fixtures e.g. windows and doors.

### 21.6.4 Durability of materials

The materials used to create the Insulated Concrete Formwork (ICF) system shall be appropriate for the intended purpose and meet with the minimum service life requirements set by the Warranty provider for the relevant build element.

#### Durability

All materials used in the manufacture and erection of an ICF system should be appropriately tested for their intended purpose. The Warranty provider will only accept statements regarding durability of an ICF systems that are supported by a valid and current UKAS accredited third party product conformity certificate.

#### Service life requirements

The minimum service life requirements for a ICF system as a load bearing structural element is 60 years. Fixings and support systems used to connect or attach elements of structure in the process of manufacture or site erection of a ICF system should have a minimum life expectancy of 60 years.

Service life requirements for elements not performing a structural function can be found within 'Appendix C'.

Fixings and support systems used to connect or attach elements listed above should have a life expectancy that is equal or greater than the associated element.

### 21.6.5 Manufacturing and quality management

System manufacturers should provide evidence of a fully certified Quality Management system (QMS) acceptable to the Warranty provider.

All information provided by the manufacturer should adequately prove and demonstrate that appropriate Quality Management Systems (QMS) are in place for the system and cover all relevant operations. Please refer to the 'MMC Systems – General Requirements' section for further information.

The ICF system manufacturer is responsible for auditing the suppliers of concrete materials that are exclusively nominated as sole suppliers to their system.

The Warranty provider requires that any concrete used within any ICF system is sourced from a third party accredited supplier registered to either:

- 'The Quality Scheme for Ready Mixed Concrete' (QSRMC), or
- BSI Kitemark Certification.

Evidence will be required from the concrete supplier on a site-by-site basis, and will be supplied to Warranty surveyor.

### 21.6.6 Storage and transportation

System manufacturers shall provide information that demonstrates avoidance of issues relating to damage, distortion and degradation of any components used in the erection of the ICF system.

All system components should be delivered to site and stored in a manner that allows the Warranty provider to easily identify the system and its components. Any components or materials that form part of the system should be clearly labelled with:

- The ICF system manufacturer's name.
- Clear demarcation of the UKAS accredited third party product conformity body, and the certificate number.

Storage should appropriately control the risks associated with damage, distortion and degradation of any components, and should be in accordance with the manufacturers guidance. This may include:

- Appropriate protection – polyethylene wrapping.
- Appropriate storage conditions - stored upright, on pallets or flat ground and away from solvents or materials containing volatile organic compounds.

## 21.6.7 Installation and erection

System manufacturers shall provide information in relation to the installation and erection of the completed ICF system.

All information provided by the manufacturer should include:

- Details of the Engineer responsible for overseeing erection of the ICF system.
- Detailed procedures associated with the erection and installation of the system on site, inclusive of required Quality Assurance procedures required pre, during and post erection e.g. test and inspection plans.
- Detailing design for temporary support works required during concrete filling, and until the concrete has gained sufficient strength to allow the wall to become stable.
- Detailed procedures for temporary protection for foreseeable environmental conditions occurring during or post the erection of a completed system, with particular attention to prevention of any deterioration of in-service performance, distortion or moisture ingress.
- A detailed repair strategy document detailing specific foreseeable repairs to structure and weatherproofing elements that may be required during erection or post erection of a system. It should also contain procedures for unforeseen events and the process that installing operatives should follow to report, remediate and close out repairs to the system.
- An example of a completed document that will be provided to a site after a completed erection or installation e.g. a 'sign off' sheet.

The Warranty provider expects demonstrable Quality Control and effective management of ICF system erection, and such measures should include:

- Accurate levelling of the foundation and initial setting out of the propping, which should prevent the need for significant adjustments to be made once ICF system erection commences.
- Stable formwork arrangement designed by an Engineer, and be in place during the construction process. This support system should be designed to give lateral support during the pouring of the concrete and at the curing stage, sufficiently resisting the loads imparted on the system by wet concrete, wind loads and other construction loads acting on both faces of the wall.
- Clear methodology statements in relation to concrete placement e.g. continuity, pour sequencing and progression around the building structure, pour heights, and compaction method e.g. use of a vibrating poker.
- Measures and procedures to ensure full compaction of concrete. Any checking process requiring the removal of a section of IFC insulation to observe and inspect areas of concrete should be supported by the guidance of the manufacturer.
- Clear programmed timescales for the removal of support work, stating time periods and conditions required to attain concrete strength, and the completed constructions stability.

## 21.6.8 Training and competence

Manufacturers shall provide evidence of training given to installing operatives and contractors for the system to prove and demonstrate competence.

Construction of the system should be carried out by operatives trained by the manufacturer to erect their ICF system, and experienced with the concreting works required by this type of system.

All work should be carried out in strict accordance with the:

- The Engineers design and specification.
- The manufacturers installation guidance.

Contractors responsible for the erection of an ICF system should comply with the manufacturers requirements for ISO 9001 and any requirements set by an industry membership schemes.

## 21.6.9 Moisture and weather resistance

The Insulated Concrete Formwork (ICF) system in its completed state shall be capable of resisting the detrimental effects of moisture and weather.

### Weather resistance

Any completed work incorporating a ICF system should have a weather resistant design that adequately protects completed building fabric from the effects of moisture and the site exposure at the final fixed geographical location.

Insulated Concrete Formwork (ICF) systems are only acceptable for Warranty when they include:

- A drained residual cavity, **and**
- A weather resistant outer skin, cladding material or system.

Further guidance on the required sizing of the residual cavity and performance of the weather resistant outer skin, cladding material or system e.g. masonry, cladding, and render can be found within the relevant parts of the 'External Walls' section of the Technical Manual.

The expected service life performance associated with that approach should be in accordance with 'Appendix C' guidance, and be appropriate for the site exposure at the final fixed geographical location.

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**Condensation**

Any completed work should be designed and constructed using recognised construction principles aligned with appropriate industry guidance (e.g. BS 5250, BRE Report BR 262), and use appropriate materials to adequately limit the risk of surface and interstitial condensation occurring on or within completed building fabric.

All construction junctions, formed within the ICF system and with any other element of structure, and/or fixture or fitting should be designed using recognised construction principles aligned with appropriate industry guidance e.g. BS 5250, and in accordance with the guidance of the system manufacturer.

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**Damp-proofing and weatherproofing**

Any completed work should be designed and constructed to ensure moisture is not transmitted into any internal areas.

The damp proofing of the wall constructed from the ICF system should be continuous with the damp proof membrane provided in the floor, and be specified and detailed in accordance with the system manufacturers guidance.

The design and installation of DPC's and cavity trays should be designed and executed in accordance with the relevant guidance provided within 'External Walls' section of the Technical Manual.

At window and door openings, detailing should incorporate appropriate proprietary materials e.g. DPC material, compressible material, gasket seals, EPDM materials to form a robust and functional weathertight seal. Applied sealants e.g. mastic may form part of the detailing to create any weathertight seal, but should not be the only means of weather protection between the frame component and the surrounding building fabric e.g. masonry, cladding, render finishes.

Where lean-to and flat roof abutments, parapets, and balconies are form part of any project, these elements should be the subject of site specific designs by the ICF system manufacturer.

# 22.

## Conversions and Retained Elements

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### Contents

|       |                                                |     |
|-------|------------------------------------------------|-----|
| 22.1  | General Requirements                           | 518 |
| 22.2  | Retained Foundations                           | 520 |
| 22.3  | Retained Basements and Below Ground Structures | 522 |
| 22.4  | Retained Ground Floors                         | 524 |
| 22.5  | Retained Drainage                              | 528 |
| 22.6  | Retained External Walls                        | 530 |
| 22.7  | Retained Framed Structures                     | 536 |
| 22.8  | Retained Internal Walls                        | 538 |
| 22.9  | Retained Intermediate Floors                   | 540 |
| 22.10 | Retained External Windows and Doors            | 542 |
| 22.11 | Retained Roofs                                 | 543 |
| 22.12 | Retained Chimneys and Flues                    | 545 |

## Introduction

The 'Conversions and Retained Elements' section is applicable to any project that includes, either wholly or partially, any:

- Conversion of an existing building to facilitate a change of use.
- The retention of existing structure or building fabric, which is then built upon, modified or re-purposed.

Typically work to convert, retain, modify and/or re-purpose a building or elements of a building occur where an existing building:

- Undergoes a material change of use.
- Undergoes refurbishment.
- Has a façade retained.
- Retains minor or major parts of an existing structure.

Any retained elements which are not covered by this section shall be the subject to an appraisal by the Warranty provider to assess their suitability and potential impact on the provision of Warranty.

We may decline to offer the cover of Warranty for certain buildings where they are affected by conditions or restrictions imposed by other factors (e.g. conservation, planning) which are considered by us to prevent or restrict the achievement of the required levels of performance for Warranty.

The following are examples of situations that may not be considered suitable for Warranty cover:

- Listed buildings.
- Scheduled and ancient monuments.
- Cob construction.
- Through wall oak/timber frame, where the timber extends from the exterior to the interior – so the main structure is exposed to the external environment.
- Ornate internal decorations that must be retained.
- Wattle and daub.
- Former agricultural buildings.

### 22.1.1 Compliance

Any work completed to convert an existing building and/or retain existing structure or building fabric, which is then built upon, connected to, modified or re-purposed shall:

- Meet the Functional Requirements of the Technical Manual, and
- Meet all Performance Requirements as determined by the Warranty provider to be relevant to the intended use.

Where an aspect of work is encountered, and a Performance Standard and/or associated guidance does not exist in this section or other sections of the Technical Manual, this should be raised with the Warranty provider at the earliest opportunity.

### 22.1.2 Project assessment process

Any project deemed by the Warranty provider to include work defined within this section shall be the subject of an appraisal process to assess the proposal in relation to underwriting criteria. Technical conditions shall be satisfied by the developer to the satisfaction of the Warranty provider.

Any project deemed by the Warranty provider to include work defined within this section should be subject to an assessment process referred to as a 'Refurbishment Assessment' conducted by the Warranty provider on the building(s) to ascertain if the scheme represents a warrantable risk to the Insurer.

Where new work is proposed, it should follow the guidance for those elements in the applicable sections of this Technical Manual, for example, new cavity masonry construction that abuts an existing solid wall construction should be designed and constructed in accordance with the 'External Walls – External Masonry Walls' section of the Technical Manual.

### 22.1.3 Specialist appraisals

Specialist appraisals submitted to the Warranty provider shall be executed by a competent and qualified person with relevant knowledge and experience.

Any appraisal should include a site inspection by the specialist/expert who should issue a written report that can be used by the Warranty provider during any insurance risk determination. Where required, this should be extensive and assess all relevant elements. In some instances, investigations may need to be intrusive and include sampling of materials.

The evaluations should:

- Factor in all existing and additional impacts resulting from additional works.
- Determine the condition of the materials e.g. concrete, masonry, and an assessment that the materials have a residual service life of not less than that stated in 'Appendix C - Materials, Products, and Building Systems' section.
- Determine the performance of all retained elements and their ability to perform under any on-going or new use.
- Appraise the findings of any historical records, previous assessments and any relevant surveys considered applicable to the retained element.

Where there are issues and defects identified by an appraisal, the assessment should include:

- Clear determination of the cause.
- Reference to any completed investigations carried out used to identify an issue.
- Proposed mitigation and/or structural remediation works to correct the effects of the issue to the performance levels set by the Warranty provider.

## 22.1.4 Testing of external and internal services

Any services to be retained should be suitably tested and reported upon by a specialist.

Any testing should include a site inspection by the specialist/expert who should issue a written report that can be used by the Warranty provider during any insurance risk determination. Where required, this should be extensive and assess all relevant elements. In some instances, the investigation and subsequent report may need to be supplemented by a video survey.



## 22.2.1 Specialist appraisal

Retained foundations shall be appraised by an Engineer.

Structural appraisals of foundations should be carried out in accordance with the 'Conversions and Retained Elements – General Requirements' section.

Foundations should be fully evaluated by a competent and qualified Engineer with relevant knowledge and experience to determine reaction and expected performance in relation to existing, new additional or differing loads, and/or actions.

The structural appraisal should demonstrate all foundations to be structurally adequate for the existing and new additional loading, suitable for the type of building they are supporting and have a residual service life of not less than 60 years.

This appraisal should confirm and address the risks associated with:

- Foundation depth and type.
- Undermining due to new floor structures or building services.
- Ground conditions.
  - Soil type.
  - Settlement.
  - Heave.
  - Dissolution features.
- Trees adjacent to buildings.

A detailed analysis supported by comprehensive structural designs and calculations should be provided supported by soil samples to determine the plasticity of the ground and the extent of the root intrusion beneath or around the building.

## 22.2.2 Structural performance

Retained foundations shall transfer both existing and new loads to the ground without causing undue movement. Items to be considered include:

- Condition of existing foundations.
- Changes in loading.
- Ground movement.
- Aggressive ground conditions.
- Proximity of new foundations or drains.

### Retained foundations

Foundations are load bearing structural elements providing support to the Home. All retained foundations should achieve a residual service life of not less than 60 years, unless specifically agreed otherwise with the Warranty provider.

Foundations should have adequate capacity to support the existing and any additional loads being applied.

The Engineer should consider any proposed increased loading on the structure and foundations, alterations to existing load paths and any alterations to the existing stability of the building.

Where the existing foundations are inadequate, and/or there is evidence of structural movement, and/or the proposals are to increase the load on the foundations, an Engineer should design a suitable solution, which should certify a residual service life of 60 years once the remedial works have been satisfactorily completed. This must be discussed with the Warranty provider prior to implementation.

The materials forming the foundation should possess the required strength and be in an appropriate condition to perform the function of a foundation for the duration of the service life required. Reference should be made to 'Appendix C - Materials, Products, and Building Systems' section.

Acceptable materials, specification and construction methodology should be in accordance with the 'Foundations' section of this Technical Manual.

### New foundations

Any new foundation should be in accordance with the 'Foundations' section of this Technical Manual.

## 22.2.3 Underpinning work

Where required, underpinning shall be designed by an Engineer.

Where the existing foundations are inadequate, and/or there is evidence of structural movement, and/or the proposals are to increase the load on the foundations, an Engineer should design a suitable solution, which should certify a residual service life of 60 years once the remedial works have been satisfactorily completed.

Proposals for underpinning should be prepared by an expert and be in accordance with BS 8004.

Where trees are within proximity to an existing structure, the potential risk of movement must be fully assessed. A detailed analysis supported by comprehensive structural designs and calculations should be provided supported by soil samples to determine the plasticity of the ground and the extent of the root intrusion beneath or around the building.

Underpinning will only be accepted where it is supported by a full structural design with calculations and that the superstructure is assessed for differential movement. Movement joints should be provided between existing and underpinned/new foundations.

## 22.3.1 Specialist appraisal

Retained structural elements to any basement or below ground structure shall be appraised by an Engineer.

Structural appraisals should be carried out in accordance with the 'Conversions and Retained Elements – General Requirements' section.

Specifically in relation to basements and below ground structures, the condition of all existing structural elements including foundations, walls and floors should be fully evaluated by an Engineer with relevant knowledge and experience to determine how retained below ground structures will react to new additional or differing loads, and/or actions.

Where the addition of waterproofing protection is proposed, the system choice and installation methodology should be appraised by the Engineer, and any evaluation provided should include determination on:

- The effects of any new lateral pressure or force created on the walls and floors by waterproofing barriers applied to structure.
- The effects of new drainage strategies that may lead to changes in the surrounding soil water content that may lead to shifts in soil pressure and may result in foundation settlement.

## 22.3.2 Structural performance

Retained structural elements to any below ground storey or structure including foundations, walls and floors shall transfer existing and new loads to the ground without causing undue movement and be suitable for the intended purpose.

All load bearing structural elements providing support to the home should have a service life of not less than 60 years. The determination of structural performance should consider existing and new situations in relation to:

- Vertical loading, horizontal loading and surcharges.
- The influence of site features such as nearby trees, topography and/or ground characteristics.
- Structural movement.

Analysis of the structural performance in relation to applied loadings should be considered in the design of the structure and should be co-ordinated with the design of the waterproofing, and should include for:

- Loading from the superstructure and other parts of the building.
- Lateral forces from retained ground, ground water and surcharges.
- Ground movement and the effect of trees.
- Buoyancy and ground heave.
- Temporary loading conditions e.g. the effects of site traffic, proximity of heavy plant placement.
- Movement limitations of proposed waterproofing materials.

## 22.3.3 Waterproofing performance

Waterproofing of a basement or below ground structure shall appropriately protect building fabric, and where required, prevent the passage of water and moisture from the ground entering the building.

### Waterproofing of new basements and/or below ground structures

Any new basements and/or below ground structures included as part of the conversion or refurbishment of a building should be in accordance with the 'Waterproofing Below Ground Storeys and Structures' section of this Technical Manual.

### Waterproofing of existing basements and/or below ground structures

Waterproofing is required to protect an existing basement or below ground structure to retain or create:

- Habitable space, **or**
- Non-habitable space to house plant or equipment deemed critical to the support of habitation.

In a:

- A building storey wholly or partially below ground e.g. basement, **or**
- Lower ground storeys partially below ground e.g. semi-basements, split levels with voids, stepping slabs.

In such instances, all waterproofing should be designed and executed in accordance with the 'Waterproofing Below Ground Storeys and Structures' section of this Technical Manual.

The 'Waterproofing Below Ground Storeys and Structures' section of the Technical Manual should also be used where the conversion or refurbishment of a building involves the retention of existing building fabric which does not require the protection of an intended use or space, but requires waterproofing protection of a material or element to:

- Improve or enhance durability against the effects of water and moisture, **or**
- To safeguard a materials structural integrity.

## **Waterproofing of existing basements and/or below ground structures in buildings with planning restrictions**

Where such restrictions exist, the Warranty provider should be informed as soon as practicable.

Due to the extent of buildings that could be considered for conversion and refurbishment, we may decline to offer the cover of Warranty when planning restrictions (e.g. listed buildings, conservation conditions) prevent the required waterproofing grade being achieved due to an inability to apply waterproofing methods and materials to a level that meets the Functional Requirements and Performance Requirements set by Warranty.

## **Existing basements and/or below ground structures with pre-existing waterproofing protection**

For situations where a basement or below ground structure has pre-existing waterproofing protection and falls into one of the above-described situations, the protection provided should be equal to the level afforded by a newly installed system or product.

Determination of the condition and such performance levels should be provided by a competent and qualified person such as a Certificated Surveyor of Structural Waterproofing (CSSW) with relevant knowledge and experience.

Waterproofing system appraisals should be carried out in accordance with the 'Conversions and Retained Elements – General Requirements' section.

### **22.3.4 Condensation control in retained ventilated voids**

Where the basement or below ground structure functions as a ventilated void, it shall incorporate relevant damp proof protection and ventilation.

Where basements or below ground structures, as converted or retained, are to serve ground floor storey floors as sub-floor ventilation voids, they should be in accordance with the relevant guidance within 'Ground Floors' section of the Technical Manual.

They should be appropriately protected against damp and moisture and be constructed of materials that are suitably robust and durable.

For the purposes of Warranty, retained ventilated voids are considered non-habitable, and should not be used as storage areas, plant rooms or equipment rooms. They should be made inaccessible except for maintenance where required.

Services (e.g. cables, pipes, ducts) may be located within the voids providing they are appropriately restrained, suitably protected from the sub-floor environment and do not impede the primary function e.g. providing ventilation.

Where services pass-through compartmentation within the sub-floor void, they should be in accordance with the requirements of the Building Regulations e.g. fire stopped.

Where access is provided to the sub-floor void for the purpose of periodic inspection, it should be provided via suitable access hatches from a common area and restricted only to operatives conducting maintenance.

Routes of access that pass-through compartmentation within the sub-floor void should be in accordance with the requirements of the Building Regulations.

**22.4.1 Specialist appraisal**

Retained ground floor construction shall be appraised by an Engineer.

Structural appraisals should be carried out in accordance with the 'Conversions and Retained Elements – General Requirements' section.

The condition of all retained existing ground floors should be fully evaluated by a competent and qualified person with relevant knowledge and experience to determine their condition in accordance with our Warranty requirements.

Where retained ground floors cannot satisfy our Warranty requirements, they should be removed and replaced in accordance with the 'Ground Floors' section of this Technical Manual.

All surveys that provide supplementary information in support of any determination of the performance of a retained ground floor should be undertaken by either a RICS Chartered Building Surveyor, or a Certificated Surveyor in Dampness in Buildings.

Surveys should be undertaken in line with the principles contained within the Joint Position Statement (JSP2022) titled 'Investigation of moisture and its effects on traditional buildings'.

**Structural report**

A full structural appraisal of the retained structure by an Engineer is required, to confirm that the ground floor and associated elements of support are structurally sound and will meet the requirements of Warranty.

The report should confirm the structural integrity of the retained structure and its capacity to support the existing and any additional loads being applied. The inspection should be fully intrusive and assess all structural elements.

Where defects are identified, structural remediation works should be specified by an Engineer.

**Damp survey reports**

A damp survey may be required to assess the current provision and functionality of damp proofing to the retained elements and investigate moisture levels of the retained elements.

**Adequacy of cross ventilation to all sub-floor voids**

A specialist appraisal should confirm the adequacy of cross ventilation provision to all sub-floor voids for suspended floors.

**Timber survey reports**

A timber condition survey may be required where structural timber components are retained. All retained timbers will need to be intrusively assessed, logged and any remedial treatment noted. Consideration should also be given to the ground conditions, subfloor ventilation, sleeper walls, and potential future risk of fungal decay and insect attack to the timbers.

Where timbers are built into masonry, all individual timbers will be required to be either exposed for full inspection or core drilled to assess the condition of the timber ends.

The report must confirm the condition of all retained timbers, and a marked-up drawing is required to identify all timbers and areas where treatments are required. Any remedial treatments must come with an insurance backed guarantee that covers the works for a minimum period of 10 years and be undertaken by a member of the Property Care Association.

**Retained suspended timber floors**

The specialist appraisal should confirm the adequacy of trimming to hearths, strutting of joists and elements of support to other elements of construction e.g. to internal walls.

A timber condition survey should be provided in accordance with the guidance provided within this section.

**Suspended concrete floors**

Suspended concrete floors should be assessed to confirm they are suitable for retention. Any floors in poor condition or showing signs of significant damage should be removed and replaced with new in accordance with the 'Ground Floors' section.

**Filler joist floors**

Filler joist floors can be retained subject to confirmation from an Engineer with appropriate experience of such floors that they are in sound condition and will meet the Performance Requirements. It would be expected that core samples are taken, and the joists are inspected for corrosion.

## 22.4.2 Structural performance

Retained ground floors shall be durable, be structurally capable and able to transfer loads to the substructure or ground without excessive movement. Items to be considered are:

- Type of floor construction.
- Existing and new loadings.
- The condition any retained materials.

### Retained existing ground floors

Ground floors are load bearing structural elements providing support to the Home. All retained ground floors should achieve a service life of not less than 60 years, unless specifically agreed otherwise with the Warranty provider.

The materials forming the ground floor construction should possess the required strength and be in an appropriate condition to perform the function of a ground floor for the duration of the service life required. Reference should be made to 'Appendix C - Materials, Products, and Building Systems' section.

Where damaged components are to be replaced, the materials used should be appropriate for the intended use and attain the required service life.

All ground floors should have adequate capacity to support the existing and any additional loads being applied. It should be free of any structural distress or movement. Any floors in poor condition or showing signs of significant damage should be removed and replaced with new in accordance with the 'Ground Floors' section.

In all cases, acceptable materials, specification and construction methodology should be in accordance with the 'Ground Floors' section of this Technical Manual.

#### Guidance specific to existing ground bearing floors

Only existing concrete floors are considered suitable for refurbishment - any stone, earth or tiled floors should be removed and replaced with a new concrete floor. Existing stone or tiled floor covering may be used as a decorative finish only.

#### Guidance specific to existing suspended timber floors

Any work to improve weak or excessively notched or holed timber structural components should be supported by an Engineers design and specification.

### New ground floors

Any new ground floor should be in accordance with the relevant guidance provided within the 'Ground Floors' section.

## 22.4.3 Protection from moisture

Retained ground floors shall have appropriate resistance to the passage of moisture to the inside of the building.

### Retained existing ground floors

Any retained ground floor should have appropriate resistance to the passage of moisture.

#### Guidance specific to existing ground bearing floors

Ground bearing slabs should have a damp proof membrane (DPM), and its presence, material type and condition should be confirmed by an appropriate survey.

If concrete ground bearing slabs lack appropriate protection, a new DPM linked to the damp proof course (DPC) should be provided. Where existing slabs are cut for new drainage runs/service voids, it is not considered acceptable to conduct repairs to the existing DPM and a new DPM must be installed.

Any remedial treatment required must be appropriate to the type of construction, independently tested/approved and provided with a 10-year insurance-backed guarantee. Remedial DPM treatments must be installed by a member of the Property Care Association and the guarantee must cover workmanship and materials. A copy of the guarantee should be provided for our records upon completion of any remedial treatment carried out.

Appropriate materials and performance levels for DPM's and DPC's should be in accordance with the 'Ground Floors' section of this Technical Manual.

#### Guidance specific to existing suspended floors

The void beneath the suspended floor must be clear to allow a free flow of air within the void.

Appropriate levels of ventilation and protection from moisture should be achieved, and functionality of the sub-floor void should be confirmed by an appropriate survey. Any survey should consider:

- Solum type.
- The provision for ventilation.
- Moisture protection at any floor member bearing points.
- The presence of sleeper walls and their condition.
- The presence of standing water and drainage provisions.
- The presence of debris, vegetation and items liable to decay within the void.

Where the ground levels have previously been raised as a result of landscaping or access routes, ventilation points or airbricks can be obstructed or blocked which may prevent effective cross ventilation to the sub floor void. In such instances, changes to external ground levels must be made.

Suspended timber floors should have a fully functional and effective sub-floor void with a minimum depth of 150mm measured from the top of the solum at its highest point to the underside of the lowest timber.

Where timber is not adequately protected from the effects of moisture e.g. at bearing points onto supporting structure, appropriate damp proofing protection will need to be installed to ensure an adequate level of durability is achieved.

Where debris, vegetation or items liable to decay are found in a sub-floor void, they should be removed.

Reference should be made to the 'Ground Floors' section of this Technical Manual for further details regarding sub-floor requirements in relation to construction methodology and ventilation. If these requirements cannot be met due to the nature of the building, any alternative provision needs to be agreed with the Warranty provider.

Existing timber floors are required to be cross ventilated; this is often an issue where the existing building is to be split up into various building compartments. In such cases a ventilation strategy should be considered and may include options for cross ventilation such as:

- Air bricks.
- Vertical stack pipes that provide ventilation to the floor.
- Mechanical ventilation systems.

In all cases consideration should be given to the passage of fire and sound.

#### Filler joist floors

Rooms affected by high humidity as a result of their use or potential areas where water spillage can occur, e.g. wet rooms, bathrooms, ensuites, kitchens, utility rooms should not be constructed where filler joist floors are present.

Particular attention should also be paid to ensuring that the floor remains dry during the conversion, and this could include providing a temporary covering if removal of the existing roof is necessary.

#### New ground floors

Any new ground floor should be in accordance with the relevant guidance provided within the 'Ground Floors' section of this Technical Manual.

### 22.4.4 Protection from contaminants

Retained ground floors shall have appropriate resistance to the passage of contaminants to the inside of the building.

Ground bearing or suspended ground floors, whether newly constructed or existing, should have appropriate resistance to the passage of contaminants to the level required by the Building Regulations.

For Warranty purposes, the relevant guidance provided within the 'Ground Conditions' section of this Technical Manual should be used. Its use however is without prejudice to any future Policy determination in relation to situations and contaminants that are not covered under Warranty.

### 22.4.5 Thermally upgrading existing floors

Where thermal upgrading is required, the materials used, and the design and installation methodology shall be appropriate for the intended purpose.

Where ground floors are thermally upgraded, the effects of condensation, the potential for thermal bridging and changes in the movement of moisture should be considered and appropriately resolved within designs and specification.

Execution of any new work must meet the requirements detailed within the 'Tolerances' section of the Technical Manual. However, these tolerances should not apply to existing finishes e.g. walls and floors that have not been upgraded or altered, or where the supporting elements will not allow for the tolerances to be met.

All thermal upgrades should be designed in accordance with the guidance given in BS5250 'Management of moisture in buildings' and BRE Report BR262 'Thermal insulation: Avoiding risk'.

All design and specification for thermal upgrades should be presented to the Warranty provider for review and should be supplemented by appropriate penetrative damp and condensation risk analysis reports undertaken by a RICS Chartered Building Surveyor or similar approved, who have experience in the conservation and refurbishment of buildings.

Reports should be based on the guidance given in the following documents:

- BRE Report BR262 'Thermal insulation: Avoiding risks'.
- BS 5250 'Management of moisture in buildings'
- BS EN ISO 13788 'Hygrothermal performance of building components and building elements — Internal surface temperature to avoid critical surface humidity and interstitial condensation - Calculation methods'.
- BS EN 15026 'Hygrothermal performance of building components and building elements - Assessment of moisture transfer by numerical simulation'.

If floors cannot be thermally upgraded due to conditions or restrictions imposed by other factors which are considered by us to prevent or restrict the achievement of the required levels of performance for Warranty, the Warranty provider will require evidence of the restrictions placed upon the building. Any alternative proposals must be agreed with the Warranty provider.



## 22.5.1 Specialist appraisal

Drainage systems shall be surveyed and their functionality and capacity assessed by an appropriate specialist.

Specialist appraisals should be carried out in accordance with the 'Conversions and Retained Elements – General Requirements' section.

Drainage systems should be replaced unless it can be demonstrated that the existing drainage system is fit for purpose and has a minimum service life as stated in, 'Appendix C - Materials, Products, and Building Systems' section of this Technical Manual.

### Below ground drainage systems

Any surveying work should be carried out by a drainage consultant and should include a thorough CCTV survey to confirm that the drainage system is fully operational and has the capacity to meet with all existing and newly created effluent.

Drainage should be removed and replaced in accordance with the relevant 'Drainage' sections of this Technical Manual where the system as existing cannot be:

- Fully surveyed due to a lack of access.
- Cannot meet with the demand created.
- Has suffered irreparable damage or the drainage systems condition cannot be improved to meet the desired level of performance required by the Warranty provider.

Drains that are no longer operational or required should be removed or filled and sealed to prevent future issues of collapse or vermin entry/habitation.

Inspection chambers and manholes should be re-built if they are structurally inadequate or are allowing ground water to enter the system due to ingress or seepage.

Covers provided to access parts of the drainage system should be replaced where they are:

- Damaged.
- Are subjected to an increased or changed loading type.

Where below ground drainage systems include interceptors, pumping equipment, septic tanks and/or cesspools, the Warranty provider will require removal and replacement.

Where existing soakaways are to be retained, they should demonstrate the performance levels expected of a new soakaway as detailed within the 'Drainage' section of the Technical Manual. Where this cannot be demonstrated, the soakaway should be replaced in accordance with the 'Drainage' section of the Technical Manual.

### Above ground drainage systems

Any reports or surveys should be carried out by a person with the relevant specialism and should confirm that the above drainage system is fully operational and has the capacity to meet with the expected performance levels.

#### Rainwater and roof drainage

The required performance levels and capacity of guttering, rainwater pipes and outlets should be determined by assessment to all relevant parts of BS EN 12056, with specific reference to Part 3 'Gravity drainage systems inside buildings - Roof drainage, layout and calculation'.

#### Sanitary pipework

The required performance levels and capacity of soil and vent pipes (SVPs), wastewater pipe work runs, connections and fittings should be determined by assessment to all relevant parts of BS EN 12056, with specific reference to Part 2 'Sanitary pipework, layout and calculation'.

## 22.5.2 Drainage system performance

All drainage systems shall be fully functional with connection to a suitable system with an approved outfall and have an appropriate capacity.

### Existing below ground drainage systems

#### Capacity

The drainage system should have the capacity to meet with all existing and newly created effluent.

#### Access and operation

The drainage system should have appropriate access to at least the levels required by a newly installed system to facilitate periodic inspection, maintenance and the clearance of blockages in-service. Where existing systems require additional access be created, they should be designed and executed in accordance with the 'Drainage - Below Ground Drainage' section of this Technical Manual.

The system and all components should be free of defects that affect their primary function and be fit for the intended purpose.

## Existing above ground drainage systems

### Capacity and sizing

The drainage system should have the required capacity, and all components should be suitably sized to meet with all existing and newly created demand.

### Operation

The system and all components should be free of defects that affect their primary function and should be fit for the intended purpose.

## New work or alteration of an existing system

Where existing drainage systems have been extended or altered, all new work should be in accordance with the 'Drainage' section.

### 22.5.3 Retained materials

All retained materials forming part of an existing drainage system shall be suitable for their intended purpose.

All materials and fittings forming part of the drainage system shall have an adequate service life as defined in 'Appendix C - Materials, Products, and Building Systems'.

Drainage systems should be replaced unless it can be demonstrated that the existing drainage system is suitable for the intended purpose and has an adequate service life as defined in 'Appendix C - Materials, Products, and Building Systems'.

Evaluation should be conducted by a competent and qualified person with relevant knowledge and experience in the materials used. For further guidance, please refer to 'Appendix C - Materials, Products, and Building Systems' section.

Where repairs are proposed to meet the desired service life, these must be specified by the drainage consultant. These must be clearly defined and agreed with the Warranty provider. Where irreparable damage has occurred or the condition cannot be improved to meet the desired level of performance required by the Warranty provider, the affected drainage should be removed and replaced in accordance with the 'Drainage' section of this Technical Manual.

The presence of certain materials historically used in the manufacture of drainage system products and fittings e.g. pitch fibre, asbestos, should be the subject of consultation with the Warranty provider. In most instances, these materials will need to be removed and replaced.

### 22.5.4 Drainage testing

Where drainage is altered, amended or added to, it shall be adequately tested at completion.

All drainage systems should be adequately tested to demonstrate a satisfactory level of performance is achieved in service to ensure that the drainage is fully functional without defects.

### 22.6.1 Specialist appraisal

Retained external wall construction shall be appraised by an Engineer in relation to structural integrity. Performance in relation to resistance to the effects of weather and moisture shall be appraised by a suitably qualified Surveyor.

Structural appraisals should be carried out in accordance with the 'Conversions and Retained Elements – General Requirements' section.

The condition of all retained external walls should be fully evaluated by competent and qualified persons with relevant knowledge and experience to determine their condition.

#### Structural appraisal

The appraisal should confirm the structural integrity of the external walls and their capacity to support the existing and any additional loads being applied.

It should be fully intrusive and assess all structural elements that interact with the external walls including foundations, floors, walls, lintels, structural roof members, support systems, etc.

The Engineer should comment on the overall performance of the entire retained building structure in relation to:

- Disproportionate collapse.
- Measure required to mitigate the risk of differential settlement where new works abut the existing structure(s).
- Any proposed connections required to attach new works to the existing structure(s).
- The potential for heave where a decrease in load will occur.
- The structural integrity of walls if found to be out of plumb.
- The potential impact of trees adjacent to the structure.
- Confirmation from the Engineer that, based on a full assessment of the structural elements proposed for retention, the building will have a residual service life of not less than 60 years once the refurbishment has concluded. The statement is intended to be a professional opinion, and a guarantee is not requested or implied.

The Engineer should also comment on the structural performance of individual building fabric components that are integral or contribute to overall performance appraisal statements, such as the condition of:

#### Loadbearing masonry

The appraisal should:

- Confirm the existing provision of lateral restraint to walls parallel to the run of floor joists or the roof structure.
- Consider the impact and extent of all structurally significant cracking.
- Consider the condition and provision of cavity wall ties.

#### No fines construction and other non-traditional methods

It is essential that any no fines construction is correctly assessed and tested to determine the durability and integrity of the structure by an Engineer to determine the structure will have a residual service life of 60 years.

#### Bonding timbers

Where walls contain bonding timbers, they should be exposed, removed and replaced with masonry. The removal and replacement works should be designed by an Engineer.

#### Moisture resistance appraisal

The appraisal should confirm the capability of the external walls in relation to resistance moisture, and their weatherproofing performance when subjected to the exposure levels related to the site and can meet the expected performance levels created by any new or changed use for the building.

All surveys that provide supplementary information in support of any determination of the performance of a retained external wall should be undertaken by either a RICS Chartered Building Surveyor, or a Certificated Surveyor in Dampness in Buildings.

Surveys should be undertaken in line with the principles contained within the Joint Position Statement (JSP2022) titled 'Investigation of moisture and its effects on traditional buildings'.

Typically, the surveys and reports required are:

#### Damp survey reports

A damp survey report should assess the current provision and functionality of all damp-proof courses to the retained elements and investigate moisture levels of the retained elements.

#### Masonry and render condition reports

Masonry condition and render condition reports should confirm that the masonry and/or render of the retained façades will have a life expectancy in accordance with the service life requirements set out in 'Appendix C'. There should also be confirmation that the retained render is adequately bonded to the substrate.

#### Timber survey reports

A timber condition survey may be required where timber components are retained as part of the external wall and should assess the effects on the external walls weather and moisture resisting performance.

## Retained curtain walling reports

The appraisal should include water penetration tests to CWCT Section 9, AAMA 501-94 or CWCT Section 10, BS EN 13051, and:

- Confirm all retained curtain walling sections and associated components have a minimum residual service life in accordance with 'Appendix C' of our Technical Manual.
- Condition of fixings and bracketry.
- Confirm the condition of the seals and gaskets are such that they can remain watertight.

## Retained cladding

The appraisal undertaken should be completed by a suitably qualified and experience façade consultant, and include a report based upon intrusive inspections to determine:

- The various wall build-ups around the site.
- Suitability of the materials within the wall build-up.
- Condition of the cladding finishes and ability to shed water away from the building.
- Condition and fixity of the cladding bracketry.
- The presence of appropriate fire stopping (depending on wall build-up).
- Confirmation that all retained cladding will have a residual service life in accordance with 'Appendix C' of the Technical Manual.
- The condition of any concrete panel cladding which is to be retained. Any determination must be supported by results gained from hammer testing.

### 22.6.2 Structural performance

Retained external walls shall be durable, be structurally capable and able to transfer loads to the foundations without excessive movement. Items to be considered are:

- Type of wall construction.
- The condition of any retained materials.

External walls are load bearing structural elements providing support to the Home. All retained external walls should achieve a service life of not less than 60 years, unless specifically agreed otherwise with the Warranty provider.

#### Arches and lintels

Existing timber lintels can be retained if they support the structural walls and it can be shown that the lintel is adequate for its purpose, i.e. there is no sign of any structural movement, loads will not be increased, and the timbers have been demonstrated to be dry and free from rot and insect infestation.

In order to ensure that any timber lintels are free from rot, all lintels should be exposed at both ends and on the inner (hidden) face of the timber embedded in the wall for openings in external walls. Where movement or decay has occurred and the timber lintel is inadequate, the lintel should be replaced with either a concrete or steel lintel.

Where cracking has occurred in masonry arches, it will be necessary to rebuild the arched construction. In cases where failure has occurred due to the low pitch of the arch, it may be necessary to incorporate a lintel.

#### Alterations to existing openings

Where existing openings are to be filled with masonry, the new work should be adequately bonded to the existing and the structural performance and weather resistance of the wall maintained.

#### Existing masonry support

Where a wall is adequately founded or supported on a beam that shows no signs of distress, it can remain providing there is no increase in load onto the wall. Any increase in load should be justified by calculation by an Engineer. New masonry supported on existing timber beams should be avoided.

In older properties, it is possible that flitch beams and bresssummers may be supporting masonry walls, and these should be examined by an Engineer to ascertain their capability to carry the load.

### 22.6.3 Structural repairs and remedial works to render and cladding systems

Where structural repairs are required, all proposed remediation works are to be clearly marked up on drawings and overseen to the satisfaction of the appointed project Engineer.

All defects and recommended remedial works required for retained render cladding and cladding systems shall be clearly detailed on elevation drawings and details provided to the Refurbishment Assessment Surveyor.

Where structural repairs are proposed to meet the desired level of performance required by the Warranty provider, all proposed remediation works are to be clearly marked up on drawings and overseen to the satisfaction of the Engineer. In addition to the above, the report must include the Engineers qualifications.

All assessment and design of remedial works must be carried out by an Engineer and upon completion they must certify that the remediated structure will have a 60 year residual service life.

### Repairs to masonry

Where repair work is required, it should:

- Be appropriate and sympathetic to the construction rationale, materials and methodology used and avoid negative performance impacts on the retained fabric e.g. strong cementitious pointing can cause or exacerbate spalling in certain masonry units.
- Have its extent clearly documented using a detailed schedule of remedial works and marked-up plans for areas requiring repair.
- Allow for all existing pointing to be raked out to a minimum of 1 and half times the depth of the bed joints, or 15mm whichever is deeper and repointed using a suitable strength mortar.
- Where required, include the removal and replacement of defective masonry units that are considered to no longer perform as required.

Where walls are more than 25mm out of plumb or bulge more than 10mm within a storey height, an Engineer should comment on the stability. The wall may need to be rebuilt or strengthening works undertaken.

Where it is intended to provide buttressing walls to support out of plumb and/or bulging walls, they should be designed by an Engineer. Once any specified remedial works are carried out the appointed Engineer should confirm that the structure has a 60 year residual service life.

In raised tie roofs (where no ceiling ties are provided at eaves level), lateral spread of the brickwork just below eaves level may have occurred because the roof has deflected. In such cases, it is necessary to prop the roof and rebuild the affected part of the wall.

### Replacement of wall ties

Where there is wall tie corrosion or inadequate ties, or where wall ties have corroded to an extent serious enough to threaten the stability of the wall or building, an Engineer should be appointed to determine the necessary remedial works and state that the structure following the remedial works has a residual service life of 60 years.

### Repairs to brick bonding at internal and external wall junctions

Where repairs are required to introduce and reinstate the bonding at internal and external wall junctions, it should be designed by an Engineer and supported by confirmation the remedial works have a residual service life of 60 years.

### Crack repairs in masonry

Minor cracking can be defined as cracking that occurs in the mortar joints and which does not extend through the masonry components. Providing that the crack is no wider than 4mm, and there has been no lateral displacement of the wall, the wall can be re-pointed.

Major cracking affects the structural integrity of the wall, and investigation should be undertaken by an Engineer to find the cause of the problem. Once any specified remedial works are carried out, the appointed Engineer should confirm that the structure has a 60 year residual service life.

### Repairs to render

All defects and recommended remedial works required for render should be clearly detailed on elevation drawings and details provided to the Refurbishment Assessment Surveyor.

Where the condition and bond of the existing render can be shown to be adequate, it can remain, subject to the following exceptions:

- If the render bridges the DPC it should be removed and redressed to a position above the line of the DPC to return functionality to the DPC.
- Above door and window openings where it is necessary to examine the type and condition of the lintels.
- Where there are signs of structural movement in the building, and further investigation is required.

If the existing render finish is to be retained, this will be subject to a condition survey from an independent RICS Chartered Building Surveyor or another recognised specialist consultant. This report must state that in their professional opinion, the render is adequately bonded to the substrate and is likely to have a residual service life in accordance with 'Appendix C'.

All new render works must be in accordance with the 'External Walls - Render' section of the Technical Manual.

### Repairs to cladding

All defects and recommended remedial works required for retained cladding system should be clearly detailed on elevation drawings and details provided to the Refurbishment Assessment Surveyor.

Existing claddings can be retained if it can be demonstrated by the appointed facade specialist that:

- The system maintains the structural and weatherproof integrity of the building.
- It is adequately fixed and the expected life span of the fixings is in accordance with the service life requirements in 'Appendix C'.
- The cladding material is free from any defects.
- Adequate provision for movement has been allowed.

If the above situations cannot be satisfied, a new external cladding or render system is required in accordance with the 'External Walls' section.

### Repairs to curtain walling

Curtain walling must be assessed by a cladding and façade specialist to determine the following:

- The structural durability of the façade.
- The adequacy of the façade in forming a suitable waterproof envelope.
- The fire performance of the façade, particularly with respect to external fire spread and ensuring cavity barriers are correctly installed in line with current Building Regulations.

## 22.6.4 Protection from moisture from the ground

Retained external walls shall have appropriate resistance to the effects of water and moisture from the ground.

All external walls at ground floor level should have a functioning DPC to resist moisture from the ground.

If it cannot be confirmed if there is a functioning DPC, or if there are signs of dampness at low level, a damp survey will be required to be undertaken by a member of the Property Care Association or a RICS Chartered Building Surveyor with relevant knowledge and experience, in line with the principles contained within the Joint Position Statement (JSP2022) titled 'Investigation of moisture and its effects on traditional buildings'.

### Repairs to protection

#### Damp proof courses in masonry

Where an existing DPC cannot be identified or is found to be defective, a remedial DPC should be provided. It should have a 10-year insurance-backed guarantee covering workmanship and materials and be installed by a member of the Property Care Association. A copy of the guarantees is required for our records upon completion of any remedial treatment carried out.

Ground levels and ventilation should be checked before any remedial DPC treatments are considered.

Where an existing DPC cannot be identified or is found to be defective, a suitable remedial DPC should be considered. However, some types of walls are not suitable for treatment by a remedial DPC system. These include:

- Walls of exceptional thickness i.e. greater than 600mm.
- Rubble-filled walls.
- Random flint/granite walls, or those of other similar impermeable materials.
- Mud walls (cob), wattle and daub.
- Rat trap bond.

Where it is not suitable to provide a remedial DPC, the wall should be assessed to demonstrate that it is not at risk from rising damp. The assessment should include the following:

- Damp Proof Survey from a member of the Property Care Association or RICS Chartered Surveyor to confirm that there is no evidence of rising damp, and a copy of the report should be provided and retained for our records.
- Suitable detail of the ground floor construction and independent internal lining system that keeps the internal environment of the dwelling dry.

Plastering work must comply with an independent third party product conformity certificate and chemical DPC's must meet the manufacturer's recommendations. Recommended plasters usually incorporate adhesives to increase resistance to the passage of hygroscopic salts from the wall into the plaster. The adhesives should not, however, act as a vapour barrier. Gypsum plaster should not be used in conjunction with chemically injected DPC. The plaster should not bridge the DPC or be in contact with the ground floor slab.

Internally drilled holes concealed by skirting boards, etc. should not be plugged. Other visible holes and external holes should be plugged.

## 22.6.5 Protection from the effects of weather

Retained external walls shall have appropriate resistance to the effects of weather and resist the passage of moisture to the inside of the building.

External walls should have appropriate resistance to the effects of weather and resist the passage of moisture to the inside of the building.

### Repairs to weather resisting performance

#### Solid masonry walls

To provide an acceptable level of protection against the ingress of rainwater, any retained solid masonry external walls should either:

- Be fully lined internally with an independent timber or metal stud wall.
- Be clad externally with a rainscreen or other protective measure.
- Comply with the requirements of BS 5628.
- Have an independent lining system where party walls between buildings project above adjacent roof coverings (thus becoming external walls).

#### Existing cavity walls

To provide an acceptable level of protection against the ingress of rainwater, any retained cavity walls should either:

- Have a clear 25mm residual cavity which is free from debris.
- Be clad externally with a rainscreen or other protective measure.
- Comply with the requirements of BS 5628.
- Have an independent lining system where party walls between buildings project above adjacent roof coverings (thus becoming external walls).

#### Pointing

Pointing can be retained providing it can be demonstrated to be free of defects, it is adequately bonded to the structure and is of suitable strength in relation to the brick/stone it serves. Where this cannot be sufficiently demonstrated, pointing may need to be replaced. The extent of repointing works should be informed by a specialist appraisal and subject to approval by the Warranty provider at the time of the Refurbishment Assessment.



**Spalling**

Spalling is an indicator of:

- Freeze/thaw cycles and a buildings inability to shed rainwater effectively.
- Salt contamination.
- Corrosion of embedded ferrous based metals.

Where there is evidence of spalling to brick or stonework, the cause must be investigated as part of a masonry condition report.

The report must confirm:

- The cause of spalling.
- The suitability of the bricks/stone used for its location.
- What remedial works are required to address the issue.

**Render**

Render should be adequately bonded to the substrate and should have an adequate residual service life in accordance with 'Appendix C' of the Technical Manual. Where the condition and bond of the existing render can be shown to be adequate, it can remain, subject to the following exceptions:

- Above door and window openings where it is necessary to examine the type and condition of the lintels.
- Where there are signs of structural movement in the building, and further investigation is required.

Where irreparable damage has occurred or the elements condition cannot be improved to meet the desired level of performance required by the Warranty provider, the external wall should be reconstructed in accordance with the 'External Walls' section of this Technical Manual.

**22.6.6 Thermally upgrading external walls**

Where thermal upgrading is required, the materials used, and the design and installation methodology shall be appropriate for the intended purpose.

Where external walls are thermally upgraded, the effects of condensation, the potential for thermal bridging and changes in the movement of moisture should be considered and appropriately resolved within designs and specification.

Where insulation is not already present in an existing wall, the retrofitting of cavity wall insulation is not acceptable as the overall condition of the cavity is not known.

If blown insulation is already present within an existing cavity, additional measures to provide continuous thermal protection to all external walls will be required. This may be in the form of an independent insulated lining internally or external wall insulation.

Execution of any new work must meet the requirements detailed within the 'Tolerances' section of the Technical Manual. However, these tolerances should not apply to existing finishes e.g. walls and floors that have not been upgraded or altered, or where the supporting elements will not allow for the tolerances to be met.

All thermal upgrades should be designed in accordance with the guidance given in BS5250 'Management of moisture in buildings' and BRE Report BR262 'Thermal insulation: Avoiding risk'.

All design and specification for thermal upgrades should be presented to the Warranty provider for review and should be supplemented by appropriate penetrative damp and condensation risk analysis reports undertaken by a RICS Chartered Building Surveyor or similar approved, who have experience in the conservation and refurbishment of buildings.

Reports should be based on the guidance given in the following documents:

- BRE Report BR262 "Thermal insulation: Avoiding risks".
- BS 5250: "Management of moisture in buildings".
- BS EN ISO 13788: "Hygrothermal performance of building components and building elements — Internal surface temperature to avoid critical surface humidity and interstitial condensation - Calculation methods".
- BS EN 15026: "Hygrothermal performance of building components and building elements - Assessment of moisture transfer by numerical simulation".

If walls cannot be thermally upgraded due to conditions or restrictions imposed by other factors which are considered by us to prevent or restrict the achievement of the required levels of performance for Warranty, the Warranty provider will require evidence of the restrictions placed upon the building. Any alternative proposals must be agreed with the Warranty provider.

## 22.6.7 Internally applied finishes

Internal surface finishes shall be suitably robust, formed from durable materials and suitable for their intended use and purpose.

### Retained plaster

Where the condition and bond of the existing plaster can be shown to be adequate, it can remain, except for the following:

- Where rising damp is present.
- Where a chemical DPC is to be installed.
- At the junction of external walls and party walls where exposure is required to determine structural bonding performance.
- Above openings to expose the make-up and condition of lintels.
- Where there is a possibility that bonding timbers may have decayed.
- Where the wall is solid, and the plaster is gypsum-based.

### Independent metal or timber framed systems

Independent framed systems that are provided to facilitate installation of lining materials should be specified and detailed to prevent moisture penetration reaching the internal environment.

These should:

- Incorporate an appropriately specified AVCL layer to the warm side of the lining system.
- Be appropriate for the intended use and conditions of the respective internal environment.
- Be independently fixed to avoid contact with the walls surface – typically fixed at the 'head and base' to avoid direct contact.
- Be appropriately ventilated to avoid a build-up of condensation between the masonry and the inner lining system. An air gap of minimum 15mm should be maintained between the lining system and the masonry walls.

All existing external and party walls in all areas including common areas are required to have an independent insulated lining system installed.

The lining system and insulation must be returned into any opening reveals, heads and sills to mitigate areas prone to cold bridging.

Any existing gypsum-based plaster coatings must be removed prior to the installation of the lining system.

Minimum life expectancy for elements not performing a structural function, should be in accordance with 'Appendix C'.

All materials specified must have appropriate testing to prove and demonstrate performance.

Where solid masonry walls are present, or the condition of cavity wall construction is unknown, dot and dab application of plasterboard is not acceptable.

### Restrictions to new lining systems

Where there are restrictions placed upon the scheme due to listed status/planning restrictions that prevent the installation of an independent lining system, it is a requirement of Warranty that a condensation and penetration risk analysis to all retained masonry is carried out by a Building Surveyor or similar approved, who have experience in the conservation and refurbishment of historic buildings.

The report should be based on the guidance given in the following documents:

- BS 5628-3: "Code of practice for the use of masonry".
- BRE Report BR262 "Thermal insulation: Avoiding risks".
- BS 5250 "Management of moisture in buildings".
- BS EN ISO 13788 "Hygrothermal performance of building components and building elements — Internal surface temperature to avoid critical surface humidity and interstitial condensation - Calculation methods".
- BS EN 15026 "Hygrothermal performance of building components and building elements - Assessment of moisture transfer by numerical simulation".

An independent surveyor should undertake a detailed condensation risk analysis, water penetration risk analysis and a dampness survey for the external walls, including any opening reveals and solid masonry mullions or transoms, confirming that the existing walls are sufficient to give adequate performance for residential use, i.e. adequate resistance to moisture ingress, no risk of cold bridging and no risk of condensation issues.



## 22.7.1 Specialist appraisal

Retained structural frame construction shall be appraised by an Engineer in relation to durability and structural integrity.

Structural appraisals should be carried out in accordance with the 'Conversions and Retained Elements – General Requirements' section.

The condition of all elements of a structural frame should be fully evaluated by competent and qualified persons with relevant knowledge and experience to determine their condition.

### Structural appraisal

The appraisal should confirm the structural integrity of the structural frame and its capacity to support the existing and any additional loads being applied.

It should be fully intrusive and assess all structural elements of the structural frame including foundations, floors, walls, lintels, structural roof members, support systems and connective elements, etc. In all forms of external wall construction.

An appraisal of the structural frame should be carried out by an Engineer, considering the proposals for the change of use. This should include:

- Condition of the structural frame, including joints.
- Proposals to increase loadings on the structure and foundations.
- Alterations to existing load paths.
- Alterations to stability systems.
- Changes in environmental exposure.
- Recommendations to cover additional reports and testing by specialists.

The Engineer should also comment on the structural capability and performance of the frame material within any structural appraisal as this is considered integral to overall performance.

### Timber

Timber framed elements must be structurally durable and free from rot.

The timber frame must be assessed as part of any timber survey in accordance with the 'Conversions and Retained Elements – General Requirements' section. Particular attention should be given to sole plates and timber framed elements that are close to the ground.

### Concrete

Where the building is of concrete construction, the survey and report should be based on the recommendations made by 'TR54 - Diagnosis of determination of concrete structure - The Concrete Society' and 'IStructE guide for assessing concrete structures. It is recommended that the Engineer completes the following:

- An overall loading assessment.
- An assessment of existing foundations.
- An assessment of the structural impact of any cutting out of cladding to form balconies.
- A full wind load assessment with the alterations and proposed cladding.
- Tolerance and movement reports for the existing structure.
- Assessment of the increased floor load in respect of new glazing systems and internal lining systems and how this will be accommodated in relation to deflection/movement.
- Concrete testing - The Engineer is to provide us with an outline testing proposal for our review regarding:
  - Carbonation.
  - Chlorination.
  - Concrete cover.

### Steel

Any appraisal should cover the relevant points below:

- Condition of the structural frame, including joints.
- Identification, scale, and impact of any corrosion.
- Identify all unprotected steel (in relation to corrosion and fire).
- Proposals to increase loadings on the structure and foundations.
- Alterations to existing load path.
- Alterations to stability systems.
- Full wind load assessment with the alterations and proposed cladding.
- Consideration of the increased floor load in respect of new glazing systems and internal lining systems and how this will accommodate deflection/movement.
- Changes in environmental exposure.
- Recommendations to cover additional reports and testing by specialists.

Where corrosion is present, accurate measurements can be made using an ultrasonic gauge. Data collected can be used to compare the thickness of steel sections against the original steelwork drawings, British Standards, and the Historical Structural Steelwork Handbook to ascertain if the structural frame is adequate for the proposed loads. Steelwork in direct contact with or embedded in the outer leaf of a building is prone to corrosion, particularly in older properties. A sign indicating that this has happened is the displacement of the external masonry due to the expansion of the steelwork caused by corrosion. During the conversion process, the appropriate repairs/replacement should be carried out.

### Cast iron, wrought iron and mild steel structures

Many older buildings that are converted into dwellings or other uses, e.g. warehouses, cotton mills, etc. were built using cast iron, wrought iron or mild steel.

When the intention is to keep the existing structural elements, an appraisal of the existing building is necessary. In addition to this, the Engineer should comment on the following:

- The age of the building and the materials used.
- The buildings condition inclusive of any specifics relating to any elements being considered for retention.
- 'Any loading affecting the structural element(s), supplemented with calculations as justification.
- Any areas where additional testing and/or opening up is necessary.

If the proposed loads remain unchanged or are reduced, as will probably be the case, and it can be shown that the existing structure has not suffered any deterioration due to corrosion or deflection of structural members, etc. the building may only require localised structural alterations.

## 22.7.2 Structural performance

Retained framed structure shall be durable, be structurally capable and able to transfer loads to the foundations without excessive movement. Items to be considered are:

- Type of structural frame construction.
- The condition any retained materials.

Structural frames are load bearing structural elements providing support to the Home and should achieve a service life of not less than 60 years, unless specifically agreed otherwise with the Warranty provider.

## 22.7.3 Structural repair and alteration

Where structural repairs and/or alterations are required, all proposed works are to be clearly marked up on drawings and overseen to the satisfaction of the appointed project Engineer.

Where the intention is to increase loads, and there is a requirement to carry out structural alterations, an Engineer should comment on this and provide calculations to justify the proposals.

### Steelwork

Exterior steelwork should be inspected; where corrosion is visible, the steel can be grit blasted, cleaned and re-coated.

Perimeter steelwork in direct contact with the outer leaf of the building can be prone to corrosion, particularly in older properties. Appropriate repairs/replacement should be carried out in accordance with the Engineers design and specification.

For interior steelwork, the risk corrosion of unprotected steelwork within the interior of a building is low, with only superficial rusting. Providing that a visual inspection confirms this, and the environment intends to remain dry, no further treatment of the steel will be required. Where the proposals involve the steelwork in a 'humid or wet' environment, such as kitchens and bathrooms, it should be adequately protected.

### Bimetallic corrosion

This should be considered in the existing and proposed structure.

Where there is a possibility of this occurring, or if it has already occurred, advice should be taken from a specialist on how to deal with it.

## 22.8.1 Specialist appraisal

Retained internal wall construction shall be appraised by an Engineer in relation to their structural integrity.

Structural appraisals should be carried out in accordance with the 'Conversions and Retained Elements – General Requirements' section. Their condition should be fully evaluated by competent and qualified persons with relevant knowledge and experience to determine their condition.

### Structural appraisal

The appraisal should confirm the structural integrity of the internal walls and their capacity to support the existing and any additional loads being applied.

#### Loadbearing masonry

The appraisal should:

- Be appropriately bonded at junctions with external walls and other internal walls.
- Confirm the existing provision of lateral restraint to walls parallel to the run of floor joists or the roof structure.
- Consider the impact and extent of all structurally significant cracking.

#### Bonding timbers

Walls contain bonding timbers, should be exposed, removed and replaced with masonry. The removal and replacement works should be designed by an Engineer.

#### Existing timber studwork

If a timber studwork is load bearing, providing it is adequate, the loads are not being increased and the timber is free from rot and insect infestation, it can remain. Where there are defects e.g. the floor sags on the line of the partition and/or there is distortion of door heads, then additional strengthening works should be undertaken to an appropriate design by an Engineer.

#### Trussed timber studwork

These walls are load bearing and continue up through the building and carry floor and roof loads onto the foundations. Alterations e.g. new door openings to an existing trussed partition should be overseen by an Engineer, as this can adversely affect the structural performance of the truss.

### Moisture resistance appraisal

The appraisal should confirm the capability of the internal walls in relation to resistance moisture and confirm the expected performance levels created by any new or changed use for the building can be met.

All surveys that provide supplementary information in support of any determination of the performance of a retained external wall should be undertaken by either a RICS Chartered Building Surveyor, or a Certificated Surveyor in Dampness in Buildings.

Surveys should be undertaken in line with the principles contained within the Joint Position Statement (JSP2022) titled 'Investigation of moisture and its effects on traditional buildings'.

Typically, the surveys and reports required are:

#### Damp survey reports

A damp survey report should assess the current provision and functionality of all damp-proof courses and investigate moisture levels of the retained elements. Consideration needs to be given to the risk of moisture transfer from the external wall to the internal wall where adjoining.

#### Masonry condition reports

Masonry condition and render condition reports should confirm that the internal wall is structurally capable and meets with the appropriate life expectancy for the role it performs with the structure.

#### Timber survey reports

A timber condition survey is required where internal walls are constructed for framed timber and linings, or any timber components are retained as part of the internal wall e.g. timber lintels.

## 22.8.2 Structural performance

Retained internal walls shall be durable, be structurally capable and able to transfer loads to the foundations without excessive movement. Items to be considered are:

- Type of wall construction.
- The condition any retained materials.

Internal walls that are load bearing structural elements providing support to the Home, should achieve a service life of not less than 60 years, unless specifically agreed otherwise with the Warranty provider. Any other internal wall should have an appropriate service life relevant to its required function.

## 22.8.3 Structural repairs

Where structural repairs are required, all proposed remediation works are to be clearly marked up on drawings and overseen to the satisfaction of the appointed project Engineer.

Where structural repairs are required, reference should be made to relevant guidance in 'Conversions and Retained Elements – Retained External Walls' section. All proposed remediation works are to be clearly marked up on drawings and overseen to the satisfaction of the appointed project Engineer.

## 22.8.4 Protection from moisture

Retained internal walls shall have appropriate resistance to the effects of water and moisture from the ground, and from any interfacing construction.

All internal walls at ground floor level should have a functioning DPC to resist moisture from the ground.

Where an existing DPC cannot be identified or is found to be defective, a suitable remedial DPC should be considered.

Internal walls should also be free from penetrative damp at any junctions with external walls. Where moisture transfer is identified, a suitable remedial plan should be provided by the designer to the satisfaction of the Warranty provider.

Where repairs or damp proofing remedial works are required, reference should be made to relevant guidance in 'Conversions and Retained Elements – Retained External Walls' section.

## 22.8.5 Internally applied finishes

Internal surface finishes shall be suitably robust, formed from durable materials and suitable for their intended use and purpose.

For guidance on internally applied finishes, reference should be made to relevant guidance in 'Conversions and Retained Elements – Retained External Walls' section.

## 22.8.6 Regulatory compliance

Where internal walls also serve as Party Walls or separating compartment walls, confirmation of their performance shall be provided in relation to relevant Building Regulations, particularly in meeting the relevant sound insulation and fire separation requirements.

The separating wall between the new and existing building must meet the requirements of the relevant Building Regulations.

Confirmation should be provided where the existing wall is to be upgraded to meet current relevant Building Regulations, particularly in meeting the sound insulation and fire separation requirements. The structural integrity of the existing wall and its resistance to ground moisture should also meet current standards.

### Sound testing

Party walls should be sound tested in accordance with the Building Regulations to determine compliance.

'Test and Declare' is not permitted unless the building is classed as a 'historic building' as defined by the Building Regulations and dispensations are placed on the requirements of the regulations by the Local Authority.

Please note, the Robust Details scheme is only applicable to new build units and cannot be accepted on conversion projects.

## 22.9.1 Specialist appraisal

Retained intermediate floor construction shall be appraised by an Engineer in relation to structural integrity.

Structural appraisals should be carried out in accordance with the 'Conversions and Retained Elements – General Requirements' section. Their condition should be fully evaluated by competent and qualified persons with relevant knowledge and experience to determine their condition.

### Structural appraisal

The appraisal should confirm the structural integrity of all intermediate floors and their capacity to support the existing and any additional loads being applied.

All load bearing structural elements providing support to the Home regardless of whether it is a new or existing element, will have a service life of not less than 60 years, unless specifically agreed otherwise with the Warranty provider.

An Engineer will need to explicitly confirm this in a written report. All existing intermediate floors to be retained should be subject to a survey(s) to assess if they are suitable to be retained. Any remedial works conducted will have to ensure that the floors meet the required service life of the building.

All surveys that provide supplementary information in support of any determination of the performance of a retained intermediate floor should be undertaken by either a RICS Chartered Building Surveyor, or a Certificated Surveyor in Dampness in Buildings.

### Timber survey reports

A timber survey is required for all retained timber joists (and timber components that provide support or are integral to the intermediate floors structural performance) in accordance with the 'Conversions and Retained Elements – General Requirements' section.

### Concrete structure condition reports

Concrete structure condition reports should be required where intermediate floors are constructed from concrete, including any beams or supportive elements, structural screeds, etc. An Engineer should confirm that the intermediate floor is structurally capable and meets with the required life expectancy.

### Filler joist floors

Intermediate floors constructed of clinker concrete supported by embedded iron or steel joists should be subjected to specialist investigation to determine their condition and whether any significant corrosion has taken place particularly where the floors have been subjected to damp conditions.

## 22.9.2 Structural performance

Retained intermediate floors shall be durable, be structurally capable and suitable for their intended purpose. Items to be considered are:

- Type of construction.
- Existing and new loadings.
- The condition any retained materials.

An intermediate floor is considered a load bearing structural element providing support to the Home regardless of whether it is a new or existing element. It should have a service life of not less than 60 years, unless specifically agreed otherwise. An Engineer will need to explicitly confirm this in a written report.

### Timber intermediate floors

Existing timber floor joists can be retained within the building, providing they are adequate for their purpose. The following points should be considered:

- Joists are of sufficient size for the span.
- Load on the floor is not being increased.
- Joists have not been weakened by excessive notching and/or drilling.
- All timbers are subject to an intrusive survey, confirming the ends of joists are free from rot.
- All timbers to be treated for insect infestation and wood rot.
- No masonry walls are built off timber joists.
- Appropriate strutting is provided.

### Filler joist floors

Rooms containing areas of high humidity use or potential areas where water spillage can occur, e.g. wet rooms, bathrooms, en-suite bath or shower rooms, kitchens, utility rooms should not be constructed over filler joist floors. Particular attention should also be paid to ensuring that the floor remains dry during the conversion, and this could include providing a temporary covering if removal of the existing roof is necessary.

## 22.9.3 Structural repairs

Where structural repairs are required, all proposed remediation works are to be clearly marked up on drawings and overseen to the satisfaction of the appointed project Engineer.

Where structural repairs are proposed to meet the desired level of performance required by the Warranty provider, all proposed remediation works are to be clearly marked up on drawings and overseen to the satisfaction of the Engineer. In addition to the above, the report must include the Engineers qualifications.

All assessment and design of remedial works must be carried out by an Engineer and upon completion they must certify that the remediated structure will have a 60-year residual service life.

## 22.9.4 Regulatory compliance

Confirmation shall be provided where the existing floors are to be upgraded to meet current relevant Building Regulations, particularly in meeting the relevant sound insulation and fire separation requirements.

Confirmation should be provided where the existing floors are to be upgraded to meet current relevant Building Regulations, particularly in meeting the relevant sound insulation and fire separation requirements.

### Sound testing

Party floors should be sound tested in accordance with the Building Regulations to determine compliance. 'Test and Declare' is not permitted unless the building is classed as a 'historic building' as defined by the Building Regulations and dispensations are placed on the requirements of the regulations by the Local Authority. Please note, the Robust Details scheme is only applicable to new build units and cannot be accepted on conversion projects.

## 22.10.1 Specialist appraisal

Where external windows and/or doors are retained, their condition shall be appraised by an independent, qualified Surveyor or specialist to confirm the service life requirements of 'Appendix C' are satisfied.

In general, all windows and doors considered to be over the age of 15 years old will be required to be replaced. Typical exceptions may include existing windows that are subject to planning and conservation restrictions.

If windows are to be retained, a condition survey and report will be required by an independent, qualified Surveyor or specialist to confirm a residual service life in accordance with 'Appendix C'. Consideration must be given to improving the thermal characteristics.

All retained windows must be fully inspected by a Building Surveyor or similar approved consultant, who have experience in the conservation and refurbishment of historic buildings. The assessment should include the following:

- Confirmation of the condition of the windows and their functionality.
- Mark areas of decay and defects on elevation drawings.
- Propose an appropriate remedial schedule with a full specification of materials and methods.
- Confirm the windows and doors have a residual service life in accordance with 'Appendix C'.

The appointed consultant must be invited to inspect and approve the refurbishment of the first window to benchmark the acceptable standard of workmanship agreed by all parties, and again once all windows have been completed. Any deviation from the agreed benchmark may result in works being redone.

The Developer should acknowledge the risk of cold bridging around window reveals and ensure this is considered and insulation is returned around reveals. Further reading on repairing timber windows is available from the BRE Good Repair Guide 10 Parts 1 and 2.

Once all remedial works are complete, on-site testing must be carried out on all retained window and door units in accordance with the guidance provided in CWCT Technical Note No. 41.

## 22.10.2 Functionality and performance

Where external windows and/or doors are retained, they shall be durable, fully functional to the required performance level and have a residual service life in accordance with 'Appendix C'.

Any retained windows and doors must:

- Be in good condition and free from any damage, rot, or decay.
- Be able to perform as part of the waterproof envelope.
- Provide adequate ventilation where the building ventilation system relies on purge ventilation.
- Have window mechanisms and catches operate correctly.

Where timber windows and doors are retained, care should be taken in ensuring that they are able to perform as required in maintaining the integrity of the waterproof envelope. Please note the following is not an exhaustive list of issues but forms the basis of an initial assessment:

- Failing and weak framing joints.
- Failure of butted and pinned joints.
- Provision of projecting profiles for opening casements.
- Lack of drainage to insulated glazing units.
- Failing glazing beads.
- Failing draft seals.
- Distortions and twists in opening elements.

Where windows and doors are replaced, this should be in accordance with the 'External Windows and Doors' section of this Technical Manual. The Warranty provider reserves the right to accept or reject the retention of existing windows as part of their Refurbishment Assessment.

## 22.11.1 Specialist appraisal

Retained roofs shall be appraised by an Engineer in relation to structural integrity. Performance in relation to resistance to the effects of weather and moisture shall be appraised by suitably qualified Surveyor.

Structural appraisals should be carried out in accordance with the 'Conversions and Retained Elements – General Requirements' section.

The roofs condition should be fully evaluated by a competent and qualified Engineer with relevant knowledge and experience to determine their condition and structural integrity.

All surveys that provide supplementary information in support of any determination of the performance and condition of a roof should be undertaken by either a RICS Chartered Building Surveyor, or a Certificated Surveyor in Dampness in Buildings.

### Timber survey reports

A timber survey is required for all retained roof timbers in accordance with the 'Conversions and Retained Elements – General Requirements' section. The timber survey report should be supplemented by a report detailing any necessary treatment to be carried out.

Particular attention should be given to rafter feet, wall plates and valley timbers, as these often show signs of rot. Common problems encountered include:

- Excessive spans of rafters, purlins, binder and ceiling joists.
- Inadequate ties between rafters and ceiling ties.
- Insufficient number of collar ties at purlin level.
- Decay of rafter feet and valley beams.
- Settlement of purlin supports.
- Lateral spread of raised-tie roofs.

### Concrete structure condition reports

Concrete structure condition reports should be required where flat roofs are constructed from concrete, including any beams or supportive elements, structural screeds, etc. An Engineer should confirm that the roof is structurally capable and meets with the required performance levels and life expectancy.

### Moisture resistance appraisal

The appraisal should confirm the capability of the roof in relation to resistance moisture, and its weatherproofing performance when subjected to the exposure levels related to the site and can meet the expected performance levels created by any new or changed use for the building.

## 22.11.2 Structural performance

Retained roof structure shall be durable, be structurally capable and able to transfer loads to supporting structure without excessive movement.

All load bearing structural elements providing support to the Home regardless of whether it is a new or existing element, will have a service life of not less than 60 years, unless specifically agreed otherwise with the Warranty provider.

The structural integrity of the roof and supporting structure should be considered prior to any new roof covering or additional loading created. The roof structure should have adequate strength, stiffness and dimensional accuracy appropriate for the existing and new loadings. All strengthening work should be designed by an Engineer to prove that after the work has been completed, the roof structure will have a residual service life of 60 years.

Where roofs are to be re-covered, it is required that existing gable walls be appropriately supported during the construction works and lateral restraint straps are fitted to any gable walls.

All new roofs and/or installation of new building fabric supplementing the roof structure should be in accordance with the 'Roofs' section of this Technical Manual.

## 22.11.3 Structural repairs

Where structural repairs are required, all proposed remediation works are to be clearly marked up on drawings and overseen to the satisfaction of the appointed project Engineer.

Where structural repairs are proposed to meet the desired level of performance required by the Warranty provider, all proposed remediation works are to be clearly marked up on drawings and overseen to the satisfaction of the Engineer. In addition to the above, the report must include the Engineers qualifications.

All assessment and design of remedial works must be carried out by an Engineer and upon completion they must certify that the remediated structure will have a 60-year residual service life.



**22.11.4 Protection from the effects of weather**

Roofs shall have appropriate resistance to the effects of weather and resist the passage of moisture to the inside of the building.

All existing roof coverings should be either be replaced or demonstrated to be able to provide an acceptable level of protection against the ingress of rainwater and provide a weathertight envelope.

**Existing pitched roof coverings**

Roofs should be re-covered in accordance with the 'Roofs' section of the Technical Manual.

There may be exceptional circumstances where an existing tiled roof covering can be retained subject to the approval of the Warranty provider; however, the following requirements would apply:

- A report should be provided on the condition of the existing roof covering has a residual service life in accordance with 'Appendix C'. The report should be provided by a suitably qualified expert.
- Fibre cement tiles/slates are not acceptable for retention.
- Adequate provision for ventilation to the roof voids should be considered in accordance with BS 5250 and the guidance provided within the 'Roofs' section.
- The requirements for resisting fire spread in the relevant Building Regulations must be considered e.g. how will fire stopping at heads of compartment and party walls etc. is to be achieved.
- Mortar bedded hips and ridges must be demonstrated to be adequately fixed, or if found to be poorly bedded then they should be stripped and mechanically fixed (or if subject to planning and conservation restrictions, they should be re-bedded in accordance with BS 5534).
- All parapet capping/copings should be removed, new DPCs provided and re-fixed with mechanical fixings.

**Reclaimed or reused tiles/slates**

Recovered materials may be reused where prior approval has been granted (independent certification of suitability may be required).

Existing clay tiles that are to be reused are required to be assessed against the same criteria as new tiles. The existing tiles are required to be tested in accordance with the following British Standards:

- BS EN 1304. Defines the minimum requirements for a product which if satisfactory at the time of delivery will ensure that the product is able to perform its function in relation to the performance levels declared for it, whilst subjected to the changes that occur in such materials during normal conditions of use.
- BS EN 538. Defines the testing procedure to determine the flexural strength of the tiles.
- BS EN 549. Defines the test method for the determination of frost resistance of clay roofing tiles and fittings.
- All tests should be carried out by an UKAS accredited laboratory.

**Existing flat roof coverings**

Existing flat roof coverings are to be replaced. New membranes are to be installed in accordance with the 'Roofs' and 'Roof Terraces and Balconies' sections of the Technical Manual.

If an existing cold deck roof is retained, it is important to ensure that the ventilation requirement is achieved, whether or not the level of insulation is to be increased. For Warranty purposes, flat cold deck roofs over 3m<sup>2</sup> in area are not acceptable.

It is also not feasible to introduce vapour control and insulation below an existing structural deck of concrete, e.g. if during refurbishment, a cold deck roof is converted to a warm deck roof by placing insulation above the deck and closing off the ventilation. It is necessary to provide at least as much thermal resistance above the deck as was previously provided below the deck. A condensation risk calculation should always be carried out in such circumstances to ensure that the deck is above dew point during service.

## 22.12.1 Specialist appraisal

Retained chimneys and flues shall be appraised by an Engineer in relation to structural integrity.

Performance of the flue shall be appraised by a suitably qualified Surveyor.

Structural appraisals should be carried out in accordance with the 'Conversions and Retained Elements – General Requirements' section.

Where a chimney rebuild is required, the 'Chimneys and Flues' section should be satisfied.

## 22.12.2 Protection from the effects of weather

Unless conservation restrictions apply, it is expected that sufficient works are undertaken to ensure the continuity of the weatherproof envelope of the building is maintained.

Unless conservation restrictions apply, it is expected that sufficient works are undertaken to ensure the continuity of the weatherproof envelope of the building is maintained around any chimney stack and any junctions formed with the roof structure and/or walls by the removal and replacement of the following items where applicable:

1. Render.
2. Pointing to be raked out a minimum of 1.5 times the joint width and repointed with a suitable mortar.
3. Damaged masonry.
4. Leadwork.
5. Flashing.

## 22.12.3 Chimneys being reused for heating purposes

Any retained chimney shall be appropriately tested to demonstrate an appropriate level of functionality and ventilation is achieved for its intended purpose.

If chimneys are to be reused for heating purposes, they shall be smoke tested by a qualified Gas Safe/HETAS engineer and relined as necessary. If chimneys are to be retained but not used for heating purposes, they shall be capped and adequately through vented.



# A.

## Appendix A

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### Contents

|     |          |     |
|-----|----------|-----|
| A.1 | Finishes | 548 |
|-----|----------|-----|

## Introduction

This section provides guidance on meeting the performance requirements for finishes in new homes.

### A.1.1 Compliance

Finishes identified within this section shall satisfy the performance requirements of this section.

### A.1.2 Plastered finishes

Plastered finishes shall be specified and applied to receive a suitable finish in accordance with the design and shall be durable enough to prevent surface cracking.

Supporting evidence will be required, where the plastered finish is intended to perform additional functions (e.g. fire resistance or acoustic performance).

## Substrate and background

Plasterwork should be applied to suitable substrates. The substrate may also require additional sealing or bonding agents, in accordance with the requirements set out in BS 8481.

Plaster proposed to be applied to backgrounds that are susceptible to thermal movement, such as lightweight concrete or aerated blockwork, may not be suitable and an independent dry lining or board on dabs system be adopted. Guidance on applications of plaster should be in accordance with the block manufacturer's instructions.

Where the background has a mix of varying materials, e.g. blockwork and brickwork, expanded metal should be provided to prevent differential movement in the plaster finish.

## Plaster mixes

Plaster mix ratios should be in accordance with manufacturer's recommendations and be appropriate for the intended use.

## Minimum plaster thickness

The thickness of plaster will vary depending on the evenness of the substrate. The finished element must meet the tolerances identified in the 'Tolerances' section, and be of a suitable quality so that a decorative finish can be applied. Minimum thickness should be in accordance with the following table.

| Element                | Minimum number of coats | Typical thickness                                        |
|------------------------|-------------------------|----------------------------------------------------------|
| Walls - metal lath     | 3                       | 13mm (nominal)                                           |
| Blockwork              | 2                       | 13mm (nominal)                                           |
| Brickwork              | 2                       | 13mm (nominal)                                           |
| Walls - plasterboard   | 1                       | Skim to provide suitable and durable finish              |
| Walls - concrete       | 1                       | Minimum thickness to provide suitable and durable finish |
| Ceiling - plasterboard | 1                       | Skim to provide suitable and durable finish              |
| Ceiling - concrete     | 2                       | 10mm maximum                                             |

## Tape and jointing

Where plasterboards are to be taped and jointed, they should provide an adequate surface to receive the intended finish as required by the design. Supporting evidence will be required where the wall lining is intended to perform additional functions (e.g. racking resistance, fire resistance or acoustic performance).

Where plasterboards are to be taped and jointed, all materials shall be in accordance with the manufacturer's recommendations.

Where plasterboards to internal walls and ceilings are to be taped and jointed, and not plastered they must:

- Be durable enough to prevent surface cracking.
- Meet the required levels of fire and sound insulation in accordance with current Building Regulations (i.e. proven to achieve the standards without a plaster skim coat).
- Have all materials (such as tape, jointing compound etc.) that are specified, to be a part of the board manufacturer's system or approved by the board manufacturer for use with their board.

Please note, tapered edge boards must be used for directly applied finishes where plasterboards are not to be plastered.

## A.1.3 Painting and decorating

Where building elements require painting or decorating, it shall:

- Be compatible with the building element.
- Be suitable for the intended purpose.
- Be suitable for the exposure conditions.
- Be applied to satisfy the Warranty tolerance requirements.

For further information on painting and decorating, please refer to the 'Tolerances' section.

### Timber

Painting or staining of external timber is required to provide protection and stability, even if the timber is preservative treated. Timber with moisture content greater than 18% is not suitable for painting or staining.

The paint and stain systems specified should be compatible with any timber preservatives and timber species used.

Where windows and doors are to be stained, proprietary sealants and beads should be used in glazing rebates in accordance with the manufacturer's instructions as an alternative to linseed oil putty.

### Staining

Timber should be stained in accordance with the manufacturer's recommendations.

### Painting

Painting of timber should consist of at least one primer coat, one undercoat and one finish coat, or alternatively in accordance with the manufacturer's instructions.

### Masonry and rendering

External brickwork and render should be dry before paint is applied, and paint systems for external brickwork or render should be applied in accordance with the manufacturer's instructions.

### Metal

Internal and external structural steel should be protected with at least two coats of zinc phosphate primer. A decorative paint finish may then be applied.

Internal and external steel that has been galvanised to a rate of at least 450g/m<sup>2</sup> is acceptable without further protection. Steel galvanised to a rate of less than 450g/m<sup>2</sup> should be protected with at least two coats of zinc phosphate primer and a suitable decorative finish, where required. This may need to be increased where a development is within a coastal location - see 'Appendix B - Coastal Locations'.

Intumescent paint coverings must be applied in accordance with the manufacturer's instructions.

### Plaster and plasterboard

Plaster and plasterboard surfaces should be prepared and made ready for decorating in accordance with the manufacturer's instructions.

## A.1.4 External finishes in coastal locations

External finishes shall also satisfy the requirements in 'Appendix B' for developments within a coastal location.

## A.1.5 Ceramic wall tiling

Tiles shall be fit for purpose, have a suitable finish and be of an appropriate size and thickness.

The installation of the tiling should follow the guidance contained in BS 5385 – 3.

### Background surfaces

Background surfaces should be adequate to support ceramic tiles, and as a minimum should:

- Be even, to adequately support the whole tile.
- Be strong and durable enough to support the tile.
- Have sufficient absorbency to ensure that adhesives will stick effectively or a suitable bonding agent applied.
- Be of the same construction type; where two construction types are present, e.g. blockwork and timber stud, light reinforcing should be provided over the junction between the two types.

In addition, where forming part of a framed wall to a shower enclosure, walk in shower or wet room:

- A moisture resisting plasterboard (or a water resistant backed board with a third party product conformity certificate) should be used for the area of the 'shower enclosure' wall that is to be tiled (up to a height of 1800mm above the floor level).
- The enclosure walls are required to be waterproof for a height of 150mm above the floor junction.

### A.1.6 Walk in showers and wet rooms floors

Where walk in showers and wet rooms are specified, they shall be suitably waterproofed and drained.

The floor areas to a walk in shower or wet room (where the floor area is part of the shower floor) is required to be waterproof and drained, a timber floor deck substrate should not be used. The floor deck must be a water stable component with a third party product conformity certificate confirming its use for this situation.

The fall to the wet room area floor must prevent ponding and should be between 1:80 to 1:100 to a drainage point.

The floor drainage point must be maintainable and adequate in size to take the intended water flow from the shower head without flooding occurring.

Due to the need for a fall in the finished surface to an outfall a suitable threshold may be necessary at the wet room door opening (which gives access to the rest of the accommodation).

### A.1.7 Anhydrite screeds/calcium sulphate screeds

Anhydrite screeds/calcium sulphate screeds shall be dried in accordance with the manufacturer's recommendations prior to any finishes being installed.

Anhydrite screeds/calcium sulphate screeds need to be left to dry to allow for hydration to take place to gain its strength. Finishes should not be installed until the screed has gone below 75% relative humidity.

The drying times should be in accordance with the manufacturer's guidance, testing will be required to confirm the screed has been suitably cured before any surface applied finishes are laid. If an OPC based adhesive or ceramic tile adhesive is to be used, then an acrylic or water dispersible epoxy penetrating sealer should be applied to seal the screed in 1 to 2 coats in accordance to the sealant manufactures instructions.

### A.1.8 Cold weather working for finishes including rendering, plastering and screeds

Rendering, plastering and screeding shall only be completed if the outside temperature is at least 2°C; there shall be no frost within the construction that is to be rendered, plastered or screeded and, where possible, rendering shall not take place where freezing weather conditions are anticipated prior to adequate curing.

No plastering or screeding should take place unless the building is free from frost. It is acceptable to use internal heating to warm the building effectively; however, it is important to ensure that heaters do not emit excessive vapour into the building. Adequate ventilation should be provided to allow moist air to escape. The building should be appropriately pre-heated before plastering, and continue to be heated whilst the plaster dries.

# B.

## Appendix B

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### Contents

|     |                   |     |
|-----|-------------------|-----|
| B.1 | Coastal Locations | 552 |
|-----|-------------------|-----|



## Introduction

This section provides guidance on meeting the performance requirements for developments located in a coastal location. For the purposes of Warranty, the design of, and material selection of the building construction must take account of the coastal environmental conditions and risks as identified within this section.

### Coastal location definition

For the purposes of Warranty, we are considering any building works on:

- The shoreline and sites within 500m of the shoreline.
- Sites located in 'tidal' estuarine areas where they are within 500m of the general UK coastal shoreline.

For the purposes of Warranty, Shoreline means:

- The foreshore.
- Land adjacent to the foreshore including in particular any cliff, bank, barrier, dune beach or flat which is adjacent to the foreshore.

### B.1.1 Compliance

The design team shall provide specifications and detailing to demonstrate the durability, suitability and weather tightness of the construction for its location, with particular attention to:

- The externally exposed structural frame.
- Window and door openings.
- Exposed lintels.
- Claddings and roof fixings.
- Balcony/roof abutments (particularly at balcony window openings).

The choice of materials and coatings must be appropriate for the aggressive environment.

### B.1.2 Key risks to construction in coastal locations

The designer shall consider the following risks in relation to the specification of exposed materials and their durability:

- Wind speed.
- Aggressive environment.
- UV.
- Rain penetration.
- Maintenance.

A high number of failures of the building envelope in coastal environments are directly related to the incorrect specification of materials i.e. using materials that are not suited to the environment leading to premature failure or corrosion. This can include:

- Lack of adequate preparation and protective finishes to external window frames whether they be timber or metal. The coatings may have a shorter durability due to the high UV or saline environment.
- Exposed metal surfaces not provided with the correct protection or grade..
- A defect due to the incorrect specification for the environment will manifest itself sooner and to a greater extent in a coastal location than one not in such a location.

Coastal locations are at risk from a combination of one or more of the following:

#### Wind speed

Coastal regions particularly in the South West, West and North Western areas of the UK are at greater risk of exposure to higher wind speeds than inland areas. Gust wind speeds in combination with rain from offshore can create particular design issues for buildings sited in shoreline locations, particularly for cladding and roof coverings and their associated fixtures and fittings.

#### Aggressive environment

Materials and fixings need to be protected from the saline rich environment particular in wind driven rain. This can effect and reduce the durability (and life expectancy) of materials and finishes compared to those located inland and non coastal locations.

#### UV

Higher levels of UV are to be expected in coastal locations which have an impact on durability and longevity of finishes. This has the effect of reducing the durability of a material or finish and requiring maintenance at more frequent periods than would otherwise be expected inland.

#### Rain penetration

Walls, claddings, external openings including windows and doors, construction junctions and roofs exposed to the prevailing wind driven rain are vulnerable to rain penetration unless correctly designed and constructed for the conditions of the site and orientation of the elevations. The level of exposure to rain penetration in coastal locations should be determined by using the calculation method in BS 8104. This determines the wind blown rain category for a specific site.

It should be noted that not all coastal locations are classified in BS 8104 as severe or very severe. Nonetheless, a coastal and shoreline location is at much greater risk of exposure to higher wind speeds and driving rain than inland areas.

BS 8104 and the wind driven rain maps found in BR 262 must not be used as a means to solely identify exposure to all the environmental factors associated with a coastal location.

There are numerous publications providing good practice guidance on methods of preventing rain penetration to internal surfaces of buildings in very severe exposure locations e.g. BRE publication: Thermal insulation: avoiding risks.

## Maintenance

It is the designer's responsibility to ensure that exposed components forming part of the structure or waterproof envelope must perform to meet the Functional Requirements within this Technical Manual.

Certain materials and particularly the finishes may, due to the environment, require an on-going planned maintenance requirement in order to keep a satisfactory finish. In these circumstances it will be the building owner's responsibility to ensure that regular maintenance of exposed components and finishes is undertaken to ensure they perform correctly. Maintenance plans will need to be in place during the lifetime of the building to ensure premature failure of coatings or components is avoided. Typically dark coloured finishes will fade much sooner.

Debris build up, e.g. wind-blown sand, must be managed, particularly to balconies. These can lead to leaks and overflowing of blocked outlets which in turn cause damage to other parts of the structure and concentrate the potential for water ingress. Bi fold and patio type doors are known for the seals, mechanisms and drainage holes being affected by wind-blown sand if not regularly maintained.

### B.1.3 External masonry walls

External masonry walls shall be designed and specified to suit the degree of exposure.

In addition, the requirements in the 'External Walls' section, the following should also be satisfied.

- The guidance in BS EN 771 for masonry walls of bricks and/or blocks incorporating damp-proof courses and flashings may be adopted.
- Masonry walls of natural stone or cast stone blocks should be constructed in accordance with the relevant recommendations of BS EN 771 and to suit the degree of exposure.
- External masonry walls also located in severe and very severe categories of exposure will benefit from having additional protective features to avoid excessive wetting of the masonry. Features such as deep overhanging eaves, verges and projecting sills should be incorporated into the design.
- The following architectural detailing should be avoided:
  - Flush sills.
  - Inadequate or non existent overhangs at verges.
  - Large expanses of glazing or impermeable cladding with no effective means to shed run off water, clear of the masonry below.
  - Areas of rendering abutting masonry with no effective seal at the junction to prevent water penetration to the rear of the render.

### B.1.4 Insulated concrete formwork (ICF) structures

ICF structures shall incorporate a suitable external cladding system which is suitable for the degree of exposure.

ICF structures rely on a suitable external cladding to provide the waterproof envelope. The external cladding, if masonry, should be constructed as described within the 'MMC Systems' section. Direct render applications are not acceptable for Warranty purposes.

### B.1.5 Rendering

External rendering and the background substrate shall be suitable for the degree of exposure.

External rendering to external masonry walls should conform to the relevant recommendations of BS EN 13914-1:2005, and follow the guidance in the 'External Walls - Render' of this Technical Manual. However, the following points should be adopted when constructing a render cladding finish in a coastal location.

- Render angle beads should be appropriate for the environment when installed. Non corrosive render beading e.g. PVC or marine grade stainless steel should be specified. Any other products used must have a current third party product conformity certificate stating they are suitable for the environmental conditions proposed.
- Fixings to render angle beads must be suitable to prevent corrosion occurring.
- The durability of the rendering will also be dependent upon the type of background, the type of rendering, mix proportions and the method of application.
- The 'background' or substrate which is to support the render must be suitable for bonding the render and be dry in condition. Materials of differing densities should be avoided in the substrate, if this latter point cannot be avoided, the render manufacturer must provide a specification for the render application over these areas to avoid future cracking.
- The choice of render and render carrier boards (if used) must be correctly specified for the location proposed.
- Wherever possible, whatever the conditions of exposure, advantage should be taken of architectural features which protect the rendering. Such protective features become more important as conditions become more severe, adequate overhangs and drips will reduce the risk of frost damage.

- Whilst traditional renders are applied in several layers and normally are 20 to 25mm thick to provide a cladding in a severe location, a detailed specification of a factory made render system from the render manufacturer will be required to justify it is suitable for the proposed conditions and the overall thickness.
- Polymer modified, ready to use factory produced renders contain high quality raw materials and a range of admixtures (notably water repellents) which reinforce the waterproofing properties of the renders. The thickness of these renders may vary depending upon the particular application and guidance should be sought from the render manufacturer.

Note: adding additional water repellent which is not within the render manufacturer's specification into the mix on the worksite should not be carried out, it may even be harmful to pre-prepared render systems as it can lead to faults in the finish.

For more guidance for the suitability of Render construction, please see the guidance in the 'External Walls - Render' section of this Technical Manual.

### B.1.6 External cladding systems including rain screens

The materials used within any cladding system shall be capable of withstanding weathering, atmospheric pollution and potential chemical attack for the intended service life.

The cladding system shall have a current third party product conformity certificate confirming the specification is suitable for a coastal environment.

The supplier and designer should provide evidence to satisfy the following:

- Evidence of the minimum service life of the enclosure as a whole for the particular environment location (with maintenance considered to allow for components that may have a lesser design life but are expected to be periodically replaced).
- Confirmation of what routine maintenance, repair and replacement is likely during the design life and who will be responsible for this.
- Details to confirm that the potential for electrolytic corrosion will be avoided within the system.
- The surfaces of the cladding system should be capable of resisting the action of chemicals with which it is likely to come into contact during its design life.

Components should have a service life as stipulated in the Functional Requirements, see the service life table in 'Appendix C - Materials, Products, and Building Systems' for further information.

- |                                                |                             |                                  |
|------------------------------------------------|-----------------------------|----------------------------------|
| ▪ Secondary framing and its fixings.           | ▪ Window sub frames.        | ▪ Window and door equipment.     |
| ▪ Panels and their fixings.                    | ▪ Door frames.              | ▪ Glazing.                       |
| ▪ Thermal-insulating components and materials. | ▪ Fixed window frames.      | ▪ Gaskets and compression seals. |
| ▪ Vapour barriers.                             | ▪ Opening windows.          | ▪ Sills and closure pieces.      |
| ▪ Flashings.                                   | ▪ Doors.                    | ▪ Inlet and extract grilles.     |
|                                                | ▪ External shading devices. |                                  |

Components which are likely to have a shorter service life of only a few years and will need to be periodically replaced as part of a planned maintenance programme are:

- Gun and knife-applied sealants.
- Site-applied external finishes.

The cavity behind a rain screen is deemed to be a moist zone and materials selected must not corrode, deteriorate or affect the performance of the cavity barrier during its service life.

### B.1.7 Corrosion protection

All external metals (included embedded fixings/wall ties etc, in external wall claddings) shall have suitable corrosion protection for the intended environment.

Further guidance can be found in 'Appendix C - Materials, Products, and Building Systems'.

## B.1.8 External windows and doors

External windows and doors (both factory made and bespoke) shall have adequate: air permeability, watertightness and wind resistant in accordance with BS EN 14351-1.

For low-rise housing, BS 6375-1 may be used to determine the weathertightness performance classifications for the site exposure conditions.

All ironmongery shall have suitable corrosion protection for the intended environment.

The choice of windows and doors must be supported by the manufacturer's certification to confirm they meet the design weather conditions and be classified and tested in accordance with the following weather performance standards:

- BS 6375-1 Weather tightness.
- Air permeability - BS EN 12207 - Classification & BS EN 1026 - Test method.
- Water resistance - BS EN 12208 - Classification & BS EN 1027 - Test method.
- Wind resistance - BS EN 12210 - Classification & BS EN 12211 - Test method.

Site testing for water penetration of the joints to windows and doors in accordance with the CWCT test methods is recommended to check the site workmanship of the building envelope as constructed. See CWCT Technical Note No. 41 for guidance on site hose testing.

In addition to the above, workmanship should follow the recommendations of BS 1186-2. The design and construction of factory assembled windows must meet BS 644. Non factory assembled units and 'bespoke' units are also expected to meet the same standard.

Window and door furniture and fittings must be resistant to the effects of the saline environment.

Where back ground ventilators (trickle vents) are installed, they must be correctly specified for the location and should be installed so as not cause potential damage to render finishes or restrict the ability to open the window/door.

All ironmongery should have suitable corrosion protection for the intended environment. Refer to 'Appendix C' for further information.

## B.1.9 Balconies

The balcony construction and their fixtures and fixings shall be suitable for the degree of exposure.

The following guidance is to be read in addition to the guidance found in the "Roof Terraces and Balconies" section.

### Balcony construction

The materials used in balcony construction must comply with the relevant Building Regulations.

An adequate step or raised threshold must be provided to avoid the risk of penetrating moisture created by the high wind driven rain. A minimum of 75mm upstand between the highest point of the balcony roof waterproof surface and the underside of the door sill should be provided, 150mm in all other situations.

In all locations:

- A flush fitting balcony floor finish abutting any door unit in the external wall of the dwelling must not occur as this could lead to a concentration of water against the window frame. A minimum gap of at least 10mm will be required which should be maintainable to ensure build up of any silt or other debris is avoided.
- Where a decorative walking surface deck is installed above; the balcony roof waterproof covering must be designed to fall away from any external doors opening into the building to prevent water pooling against the door units due to lack of fall.
- Drainage outlets must be easily accessible and maintainable even if decking/balcony floor finishes are applied.
- Fixings used in balcony decking or guarding must be appropriately specified to prevent adverse reaction with certain timbers.
- Regular maintenance of balcony floors will be required to avoid wind blown sand clogging up drainage outlets and balcony door seals and tracks.
- Balcony steelwork must be adequately protected against the potential for corrosion ('Appendix C - Materials, Products, and Building Systems').

## B.1.10 Exposed above ground drainage

Exposed above ground drainage and their ancillary components (such as fixings and brackets) shall be suitable for the degree of exposure.

Where developments fall under the coastal location definition the following additional requirements should be met for sanitary and surface water drainage.

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**Corrosion**

The materials should be suitably protected against corrosion, see 'Appendix C - Materials, Products, and Building Systems' for further information.

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**Fixings**

External fixings that are exposed to weathering, moisture and corrosive environments or applications where concentrations of corrosive agents may accumulate should be made from high grade austenitic stainless steel (e.g. A4) or a protective coating suitable for the corrosion category described in the table 'the classification of environmental corrosion conditions' in 'Appendix C - Materials, Products, and Building Systems'.

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**Durability**

External soil and waste pipes must be suitable for the environmental conditions. Please refer to the manufacturer's specifications to confirm durability. Discolouration of dark plastic goods may be unavoidable in coastal locations.

Due to the environment, certain materials and particularly the finishes may require on-going maintenance in order to keep a satisfactory finish e.g. external SVP. In these circumstances it will be the building owner's responsibility to ensure that regular maintenance of exposed components and finishes is undertaken to ensure they perform correctly. Maintenance plans will need to be in place during the lifetime of the building to ensure premature failure of coatings or components is avoided.

# C.

## Appendix C

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### Contents

|     |                                           |     |
|-----|-------------------------------------------|-----|
| C.1 | Materials, Products, and Building Systems | 558 |
|-----|-------------------------------------------|-----|

## Introduction

This section provides guidance on meeting the performance requirements for materials, products and building systems and should be read in conjunction with the performance requirements from other relevant sections.

### C.1.1 Compliance

The specification, installation and storage of materials, products and building systems shall meet the performance requirements of this section.

### C.1.2 Suitability of materials, components, products and building systems

Materials, components, products and building systems (building systems such as rainscreen cladding systems, brick slip SIP lintels for example) shall be suitable for their intended purpose, evidence of which shall be provided upon request.

Materials, components, products and building systems shall be used within the scope of any third party product conformity certificate and/or test certificates.

## Modern methods of construction (MMC) covered by this section

For products and components which incorporate MMC and which are beyond the scope of the 'MMC Systems' section, they should satisfy the requirements of this section.

## Suitability of all materials, components, products and building systems

Materials, components, products and building systems should be suitable for their intended purpose. Factors that should be taken into account include:

1. Durability; including:
  - a. Compatibility of materials (interactions between components, structural or otherwise).
  - b. Longevity of materials (identifying it achieves a 60 year service life where used in the structure or lesser period where identified in the 'Service life requirements' table contained within this section of the Technical Manual).
  - c. Maintenance requirements.
2. Structural integrity, including serviceability of product (where applicable).
3. Health & Environment including:
  - a. Vapour permeability and moisture resistance.
  - b. Water/weather tightness.
  - c. Release of dangerous substances.
4. Demonstrable evidence of quality control in production.
5. Proof and demonstration of product suitability through supporting statements on scope, use and installation. This may be provided by the manufacturer or an independent approval body.
6. The use of approved of installers where specified by the manufacturer, Warranty provider or third party product conformity certificates.

Materials, components, products and building systems can be proven to satisfy the above requirements by<sup>1</sup>:

- Providing a valid full third party product conformity certificate from an independent approval body which is accepted by us. This could either be a UKAS, European equivalent product conformity accredited organisation or other body accepted by us, which looks at the product/system as a whole and reports on its suitability and scope of accepted use. Such third party approval can assist in demonstrating compliance with our Warranty, but the applicable Functional and Performance Requirements in the Technical Manual must also be complied with. There are also certain systems and products which whilst they may hold a third party product conformity certificate, represent an enhanced Warranty risk and are not acceptable to us. If in doubt please contact our Technical team for further clarification <sup>2</sup>, **and/or**
- Providing evidence products meet the requirements of relevant British Standards, Codes of Practice or equivalent European Standards current at the time of application <sup>3</sup>, **and/or**
- Providing evidence of CE/UKCA marking where a corresponding European standard exists. This shall be supported by evidence of testing carried out on the product and a Declaration of Performance Certificate being provided <sup>3</sup>.

### Note 1

- A combination of these methods may need to be provided to prove products satisfy our Functional Requirements.

### Note 2

- The third party product conformity certificate must be valid and current.
- We will require to assess the third party product conformity certificate to determine if it provides sufficient information to confirm the product or system meets the requirements of this Technical Manual and that it is being used within the scope of that approval.
- Some of the above Warranty requirements are not always included in the third party product conformity certificate or do not take account of specific risk areas that our Warranty requires to be addressed.
- Materials, components, products and building systems may not have been tested for the particular application on site. To avoid doubt, developers and Builders should seek clarification from the Warranty provider that the third party product conformity certificate for the product/system will be acceptable.
- Certain systems and products which hold third party certification may not be acceptable as they are considered an enhanced risk for Warranty cover purposes. Please refer to our Technical team for further clarification.

## Note 3

- Evidence materials, components, products and building systems meets a relevant British Standard, code of practice or equivalent European standard, or has evidence of CE/UKCA marking but not fully satisfy all of our 6 Warranty requirements as highlighted above and further information may be required.

Where no British or European standard exists for materials, components, products and building systems, it must have a valid full third party product conformity certificate from an independent approval body which is accepted by us. The third party product conformity certificate must satisfy all of the above requirements.

## Product selection and Building Regulations

The designer should demonstrate the materials, components, products and building systems meets the requirements of the Building Regulations. This may include, but is not limited to:

- Structure and movement characteristics.
- Safety in case of fire.
- Sound insulation.
- Water resistance.
- Thermal performance.
- Air tightness.

The Warranty surveyor, at their discretion may ask for evidence of the above in support of Warranty Provision.

## European Technical Assessment (ETA)

Materials, components, products and building systems with an ETA certificate will need to be reviewed by our Technical Team as these do not always potentially cover all the factors that a full third party product conformity approval certificate may provide and aspects such as durability or the quality management systems that are in place may not be included.

In addition where bearing a CE marking/UKCA marking in accordance with the Construction Products Directive, this shall be supported by evidence of the testing carried out on the product.

Construction products that do not meet the Warranty requirements may not be acceptable for Warranty approval. It is advised that the design team must approach the Warranty provider early in the design stage to discuss the viability of the use of such a material, and determine what further independent third party testing may be required in advance of the final design proposal.

Products that hold a full third party product conformity certificate will still need to be structurally accepted on a site-by-site basis depending on the layout and loading of the component. Thermal properties and measures to prevent condensation will also require specific assessment depending on exposure, orientation etc.

## CE / UKCA marking

All construction products in circulation in the England, Wales and Scotland markets must either have UKCA or CE marking where a corresponding European standard exists.

There are separate requirements for the Northern Ireland market.

## UK approved bodies

From 1st January 2021, UK notified bodies operating under the EU Construction Products Regulation and based in the UK were granted new UK 'approved body' status and listed in a new UK database.

Approved bodies are able to undertake conformity assessment activity for UK 'designated standards'. Where an approved body has undertaken the assessment, the manufacturer (or their authorised representative) must affix the UK marking. Rules around affixing the new UK marking will be equivalent to current CE marking.

For the Northern Ireland market, UK 'approved bodies' will be designated by the United Kingdom Accreditation Service (UKAS) and be allowed to assess the performance of construction products to EU harmonised standards. This will enable economic operators to use the CE marking with the UK (NI) indication and place their product on the Northern Ireland market.

These bodies are be listed on the UK Market Conformity Assessment Body ('UKMCAB') database.

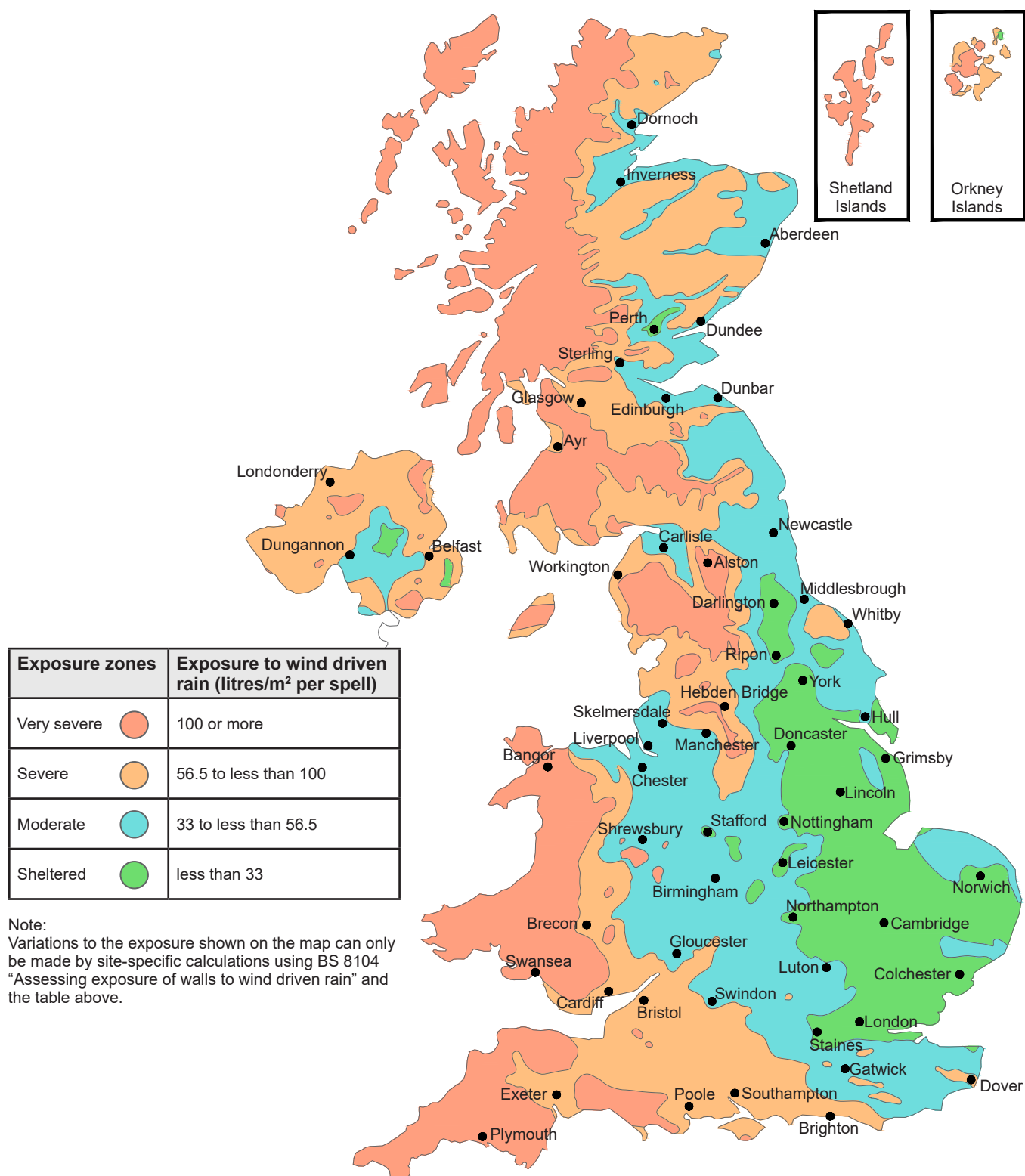
## Proprietary products and systems in place of a traditional construction method

Where a proprietary product or system is proposed in place of a traditional construction method, the product or system must still meet the requirements of the relevant British Standard or have a full third party product conformity certificate.



**Wind driven rain exposure for materials, components, products and building systems**

All materials, components, products and building systems which form part of the external weatherproof envelope should take account of the site specific wind driven rain exposure.



For further information on determining the exposure for the site location please see BS 8104 and BR 262 for further guidance.

## C.1.3 Service life requirements

All materials, components, products and building systems shall have a service life for which is suitable for their intended purpose.

The following table provides an indication of the service life requirements expected. The list is not exhaustive and other elements not mentioned will need to be agreed with us prior to works starting on site.

For the purposes of Warranty, the following service life requirements are in relation to the function of the building components only (not in relation to discolouration for example).

|                                                                        | Building element <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Service life required |
|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>Load bearing structural elements providing support <sup>2</sup></b> | Foundations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>60 years</b>       |
|                                                                        | Substructure load bearing walls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                       |
|                                                                        | Basement structural retaining walls                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                       |
|                                                                        | Basement slabs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                       |
|                                                                        | Podium and transfer decks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                       |
|                                                                        | Ground floors (all construction types e.g. timber, steel, concrete etc.)                                                                                                                                                                                                                                                                                                                                                                                                                                         |                       |
|                                                                        | Superstructure frame, i.e. RC columns and beams                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                       |
|                                                                        | External loadbearing wall elements including: <ul style="list-style-type: none"> <li>Both leaves of cavity masonry wall</li> <li>Timber frame panels (e.g. traditional stud, I-beam etc.)</li> <li>Light gauge steel frame</li> <li>External masonry leaf to framed structure</li> <li>Solid masonry walls</li> <li>MMC offsite manufactured wall panels (timber, steel, concrete etc.)</li> <li>Lintels, posts and beams</li> <li>Soleplates</li> <li>Heavy gauge steel frame</li> <li>Infill panels</li> </ul> |                       |
|                                                                        | Internal walls (load bearing)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                       |
|                                                                        | Intermediate floors (all construction types e.g. timber, steel, concrete)                                                                                                                                                                                                                                                                                                                                                                                                                                        |                       |
|                                                                        | Masonry chimneys                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |
|                                                                        | Roof structural members (timber, steel, concrete etc.) including: <ul style="list-style-type: none"> <li>Ceiling joists</li> <li>Rafters</li> <li>Trusses</li> <li>Purlins</li> <li>Roof cassettes</li> <li>Flat roof joists/planks/RC units etc.</li> <li>Wall plates</li> <li>Tiling battens</li> <li>Flat roofing decking</li> </ul>                                                                                                                                                                          |                       |
|                                                                        | Exposed beams and posts providing a structural support e.g. porch posts, gallows brackets etc.                                                                                                                                                                                                                                                                                                                                                                                                                   |                       |
|                                                                        | Balcony/terrace structural members (steel, timber or composite where above 600mm from ground level)                                                                                                                                                                                                                                                                                                                                                                                                              |                       |
| <b>Non-load bearing elements</b>                                       | Guarding (to balcony, terrace edges, stairs etc.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>25 years</b>       |
|                                                                        | Fascia, soffits, gutters and downpipes                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>15 years</b>       |
|                                                                        | Thermal Insulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>25 years</b>       |

|                                                                                                                         | Building element <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Service life required                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Cladding systems</b>                                                                                                 | <ul style="list-style-type: none"> <li>▪ Curtain walling</li> <li>▪ Proprietary rainscreen claddings systems</li> <li>▪ Metal cladding systems</li> <li>▪ Brick slip cladding systems</li> <li>▪ External wall insulation systems</li> <li>▪ Vertical hung tiles and slates on masonry cavity walls or framed structures</li> <li>▪ Coated <sup>6</sup> and uncoated timber <sup>7</sup> cladding boards on masonry cavity walls or framed structures <sup>4</sup></li> </ul> | <p>Primary components (i.e. those not easily replaced) - <b>60 years</b></p> <p>Secondary components i.e. those that are easily replaced / accessible and do not require substantial dismantling of the system. (Repairs can be easily undertaken as part of planned maintenance program in place during the service life of the cladding) - <b>25 years</b></p> |
| <b>Factory made insulated chimneys</b>                                                                                  | Solid fuel or oil                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>30 years operation life</b>                                                                                                                                                                                                                                                                                                                                   |
| <b>External building elements not forming a structural function but part of the waterproof envelope <sup>3, 4</sup></b> | Roof tiles and metal roof cladding                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>25 years</b>                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                         | Flat roof coverings                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>25 years</b>                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                         | Offsite manufactures MMC elements such as false glass fibre chimney stacks, coping stones, window cills                                                                                                                                                                                                                                                                                                                                                                       | <b>25 years</b>                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                         | Breather membranes in vertical framed external walls and pitched roofs                                                                                                                                                                                                                                                                                                                                                                                                        | <b>25 years</b>                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                         | Coated timber window/doors including frames                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>15 years</b>                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                         | PVCU and metal window/doors including frames                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>15 years</b>                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                         | Render finishes including render boards                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>25 years</b>                                                                                                                                                                                                                                                                                                                                                  |
| <b>Horizontal Timber decking boards (structural walking surface, not supporting structure/joists) <sup>4, 5</sup></b>   | Up to 600mm above the ground                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>15 years</b>                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                         | Between 600mm and 2400mm above the ground                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>30 years</b>                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                         | Greater than 2400mm above the ground level                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>60 years</b>                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                         | All structural elements of a balcony                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>60 years</b>                                                                                                                                                                                                                                                                                                                                                  |

**Notes**

<sup>1</sup> The list of elements in this column have been put together to help identify the service life requirements for typical components. It is not exhaustive and other elements not listed – please discuss with your Warranty surveyor.

<sup>2</sup> Fixings for load bearing structural elements require a service life to match the building element as specified in the above table.

<sup>3</sup> Fixings for non-structural building elements (building elements only for waterproof envelope functions), should have a service life which matches non-structural building element.

<sup>4</sup> Will need planned maintenance, repair or replacement during this reduced period.

<sup>5</sup> Does not take account of other legislative requirements e.g. fire resistance.

<sup>6</sup> Coated timber cladding boards should have a use class of 3.1 in accordance with BS EN 335-1 and be preservative treated in accordance with BS 8417 or have a durability class of 3 in accordance with BS EN 350.

<sup>7</sup> Uncoated timber cladding boards should have a use class of 3.2 in accordance with BS EN 335-1 and be preservative treated in accordance with BS 8417 or have a durability class of 2 in accordance with BS EN 350.

**C.1.4 Timber**

All timber shall:

- Be of the appropriate strength classification in order to meet its design intention.
- Be either have adequate natural durability (as defined in BS EN 350 or be preservative treated against fungal decay and insect attack with the preservative treatment in accordance with BS 8417.
- Have preservative treatment which is compatible with any metal fixings.
- Be stored correctly to ensure the timber does not deteriorate.
- Be handled, transported and lifted to avoid damage to the timber component.

**Timber grading**

Timber that is to be used for structural purposes e.g. floor joists, rafters and ceiling joists, the minimum strength classification shall be C16.

BS EN 338 should be used by the designer to determine the suitable strength class for all structural timber components.

All structural timber should be:

- Machine graded to BS EN 14081 or, visually graded to BS 4978 for softwoods or BS 5756 for hardwoods.
- Dry graded.
- Marked in accordance with BS EN 14081.

**Timber durability and preservative treatment**

BS 8417 provides information to establish the appropriate type of treatment according to the particular element and conditions of use. Tables 1 to 3 of BS 8417 must be referred too to identify 'Use classes', 'Service Factor code' and durability class of wood for the desired service life.

It is important that any pre-treated timber be re-treated if it is cut to expose untreated end grain. The treatment should be coloured so it can be proven that the end grain has been treated.

## Preservative treatment

Preservative treatment of roof timbers is normally unnecessary, except where specifically required under relevant standards and Codes of Practice, and in the following circumstances:

Roof timbers should be preservative treated where the insulation and ceiling line follow the roof pitch.

Trussed rafter construction which is cut back at eaves or where the rafter 'feet' are trimmed to sit into the external walls. Preservative treatment will be required to the cut ends.

The Approved Document of Regulation 7 of the Building Regulations for England requires that in certain geographical areas, all softwood roof timbers should be treated against attack by the House Longhorn Beetle.

The areas at risk are:

- The District of Bracknell Forest.
- The Borough of Elmbridge.
- The Borough of Guildford (other than the area of the former Borough of Guildford).
- The District of Hart (other than the area of the former Urban District of Fleet).
- The District of Runnymede.
- The Borough of Spelthorne.
- The Borough of Surrey Heath.
- In the Borough of Rushmoor, the area of the former district of Farnborough.
- The District of Waverley (other than the parishes of Godalming and Haslemere).
- In the Royal Borough of Windsor and Maidenhead, the parishes of Old Windsor, Sunningdale and Sunninghill.
- The Borough of Woking.

The timber should be impregnated with a preservative suitable for use in 'Use Class 1' in pitched roofs (Class 2 if in pitched roofs with high condensation risk) and 'Use Class 2 flat roofs', in accordance with BS 8417, for a 60 year anticipated service life. Cut ends must be liberally brushed or dipped with an end-grain preservative.

It is strongly recommended that, where punched metal fasteners are proposed to roof trusses, only micro-emulsion or organic solvent preservatives should be used for timber treatment, to limit the possibility of corrosion of the fasteners and so as not to adversely affect glued joints.

## Natural durability recommendations for timber components (based on natural durability against fungi given in BS EN 350-2)

| Component                                                                                         | Use Class (table 1 BS 8417) | Minimum durability class of wood for which heartwood can be used without preservative treatment | Examples of service situations                                                                                                                            |
|---------------------------------------------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Internal joinery                                                                                  | 1                           | 5                                                                                               | Internal joinery and timbers in upper/intermediate floors not built into solid walls. Examples include: Architraves, skirting boards, internal doors, etc |
| Roof timbers (dry)                                                                                | 1                           | 5                                                                                               | Wood in pitched roofs except tiling battens and valley gutter members                                                                                     |
| Roof timbers (dry)(Longhorn beetle area)                                                          | 1                           | 3                                                                                               | As above                                                                                                                                                  |
| Roof timbers (risk of wetting)                                                                    | 2                           | 2                                                                                               | Tiling battens, wood in pitched roofs with high condensation risk, flat roof timbers, ground floor joists                                                 |
| Timber frame external walls (protected by a weatherproof cladding)                                | 2                           | 2                                                                                               | Frame timbers in timber frame houses (including engineered I-studs and metal web studs), walls forming dormer windows                                     |
| Intermediate floors joists not built into solid external walls, floor boards                      | 1                           | 5                                                                                               |                                                                                                                                                           |
| Ground floor joists                                                                               | 2                           | 2                                                                                               |                                                                                                                                                           |
| Sole plates above DPC                                                                             | 2                           | 2                                                                                               |                                                                                                                                                           |
| External joinery (non-load-bearing coated) and cladding (coated) – not in contact with the ground | 3.1 coated                  | 3                                                                                               | Coated cladding, soffits, fascia's, windows and doors, valley gutter timbers                                                                              |
| Uncoated cladding boards                                                                          | 3.2 uncoated                | 2                                                                                               |                                                                                                                                                           |

| Component                                                                             | Use Class (table 1 BS 8417) | Minimum durability class of wood for which heartwood can be used without preservative treatment                                  | Examples of service situations |
|---------------------------------------------------------------------------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Balcony decking boards <sup>1</sup>                                                   | 3                           | 1, 2 or 3 dependent on desired service life. See the 'Service life requirements' table within this section for more information. |                                |
| Deck posts                                                                            | 4                           | 1                                                                                                                                |                                |
| Poles                                                                                 | 4                           | 1                                                                                                                                |                                |
| Sleepers                                                                              | 4                           | 1                                                                                                                                |                                |
| <sup>1</sup> Further guidance available from Timber Decking and Cladding Association. |                             |                                                                                                                                  |                                |

## Oak

### Green oak

For the purposes of Warranty, green oak is recently felled oak with a moisture content typically between 60%-80%.

Green oak is **not acceptable** for inclusion as a structural element/component, either internally or externally of the property to be constructed, regardless of whether it forms part of the waterproof envelope or not.

Green oak is also not acceptable for inclusion in the external wall construction, frame, window/door construction, internal wall, or roof constructions, regardless of whether it forms part of the waterproof envelope or not, and will **not be acceptable** for Warranty cover.

### Air dried (seasoned) oak

For the purposes of Warranty, air dried (seasoned) oak is naturally stored oak with a natural seasoning process moisture content up to 30%.

Air dried (seasoned) oak is **not acceptable** for inclusion as a structural element/component, either internally or externally of the property to be constructed, regardless of whether it forms part of the waterproof envelope or not.

Air dried (seasoned) oak is also not acceptable for inclusion in the external wall construction, frame, window/door construction, internal wall, or roof constructions, regardless of whether it forms part of the waterproof envelope or not, and **will not be acceptable** for Warranty cover, except where described below.

Air dried (seasoned) oak **may be acceptable** in the following location:

- As an external cladding finish material, subject to the moisture content at the time of installation (max. 16%) and a suitable second line of weatherproof envelope defence behind the cladding to protect the structural substrate and internal linings.

### Certified kiln dried oak

For the purposes of Warranty, certified kiln dried oak is processed seasoned timber with a moisture content of 12% or less.

Certified kiln dried oak is **not acceptable** for inclusion as a structural element/component, regardless of whether it forms part of the waterproof envelope or not.

Certified kiln dried oak with a certified maximum moisture content of 12% **may be acceptable** for:

- Parts of the internal structure where any movement of the oak will not affect the waterproof envelope e.g. floor beams, floor joists, roof trusses and purlins; providing the Engineer proves that any shrinkage/twisting in the oak will be catered for and be isolated from the waterproof envelope.
- Windows and doors. See the guidance in the 'External Windows and Doors - Additional Requirements for External Timber Window and Door Frames' section for manufacturing criteria/testing.

### Independent cladding/decorative cladding

Independent cladding/decorative cladding (i.e. mock Tudor cladding) which is not built into the wall should have a certified moisture content of 16% +/- 2%.

### 'Green' timber species used instead of oak

Where 'green' timber species are proposed, they should be specified based on the required service life as specified within this section.

### Metal fixings and treated timber

Some preservative treatments to timber (e.g. Copper-containing treatments) can have an adverse effect on metal components. Where moisture is expected, metal components should be austenitic stainless steel (likely wetting) or galvanised (occasional dampness) where they are to be fixed or used adjacent to treated timber.

Preservative treated timber should be re-dried to a moisture content of 22% or less before being in contact with metal fittings.

## Timber storage

It shall be kept dry and covered in cold conditions to prevent surface freezing, and should be kept off the ground and spaced to allow air to move around freely. Timber should be kept flat to prevent warping or twisting.

## Handling, transportation and lifting

Handling, transportation and lifting of timber components (including roof trusses and engineered joists) should be carried out in a manner which does not damage the timber components and for engineered products should be in accordance with the manufacturer's recommendations.

## Standards referred to

- BS EN 1912 Structural timber-strength classes - Assignment of visual grade and species.
- BS EN 1995-1-1 Eurocode Design of timber structures.
- BS 8417 Preservative of wood - Code of Practice.
- BS EN 335 Durability of wood and wood based products.

### C.1.5 Concrete

- Concrete shall be of an adequate strength and durability. Concrete and any reinforcement shall be suitable for the intended purpose.
- Concrete mixes shall be suitable for the intended use.
- Concrete should be adequately cured before loads are applied.
- Admixtures shall only be used to enhance the performance and durability of concrete and shall only be used if stipulated as part of the original design specification.
- Where concrete testing is required, it shall be in accordance with BS EN 12390 by UKAS approved laboratories. Proof of testing, reports and certificates shall be made available upon request.
- The minimum working temperature for concrete shall not fall below 2°C.

## Concrete specification

Concrete of the appropriate durability and strength should be used in all circumstances. The Table below gives details of the correct concrete for varying applications.

Please note: Non-cement based concrete products need prior approval by us.

| Application                                                                                                                                                 | Ready mixed concrete        | Site mixed concrete | Consistence class           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|---------------------|-----------------------------|
| Substructure<br>Blinding (unreinforced)<br>Backfilling                                                                                                      | GEN1                        | N/A                 | S3                          |
| Substructure (unreinforced)<br>Structural blinding<br>Strip, trench, and mass filled foundations<br>Concreting of cavity walls to ground level              | GEN1                        | N/A                 | S3/S4 <sup>1</sup>          |
| Floor (unreinforced and unsuspended) with<br>screed added or other floor finish                                                                             | GEN1                        | N/A                 | S2                          |
| Floor slab as finish (e.g. power float)                                                                                                                     | GEN2                        | N/A                 | S2                          |
| Garage floors (unreinforced and unsuspended)                                                                                                                | GEN3                        | N/A                 | S2                          |
| Reinforced slabs (buildings and garages<br>suspended or unsuspended)                                                                                        | RC35                        | N/A                 | S2                          |
| Superstructure                                                                                                                                              | As specified by an Engineer | N/A                 | As specified by an Engineer |
| External works:<br>Pathways                                                                                                                                 | PAV1                        | ST5                 | S2                          |
| Bedding for paving slabs                                                                                                                                    | GEN1                        | ST1                 | S1                          |
| <sup>1</sup> Consistence class S3 should be used for strip foundation concrete and consistence class S4 should be used for trench fill foundation concrete. |                             |                     |                             |

## Reinforcement

Reinforcing bars and mesh should be clean and free from loose rust and any other contaminants that may cause deterioration of the reinforcing material or the durability of the concrete.

Reinforcing bars and mesh should be placed in accordance with structural drawings; bars that are to be bent should be done so using the correct tools for the job.

Reinforcing should be located near the bottom of the slab. Where reinforcing bars are specified, the main reinforcing bars placed first and the secondary bars on top.

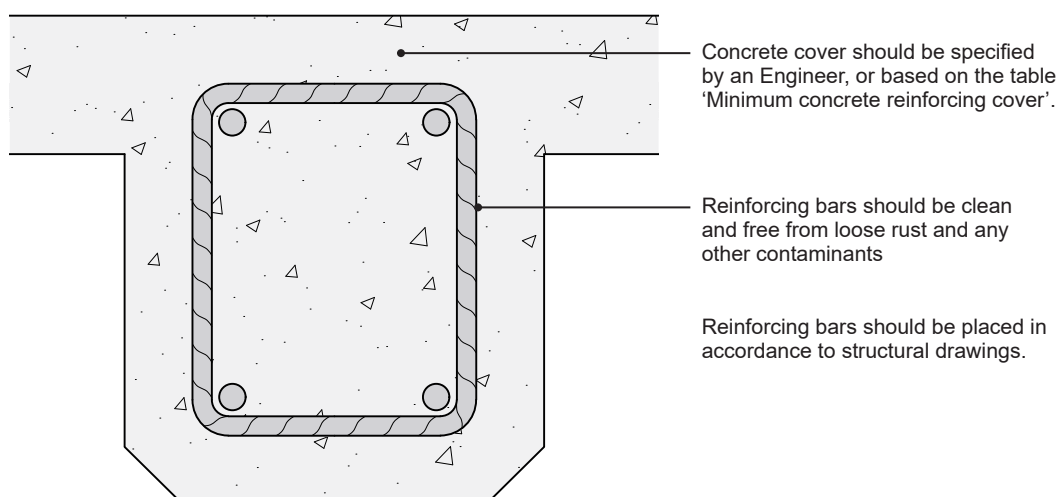
Reinforcing bars or mesh should be lapped according to type and size as indicated by the designer to ensure that loads are fully transferred across the lap. Any additional laps require the designer's approval.

### Minimum concrete reinforcing cover

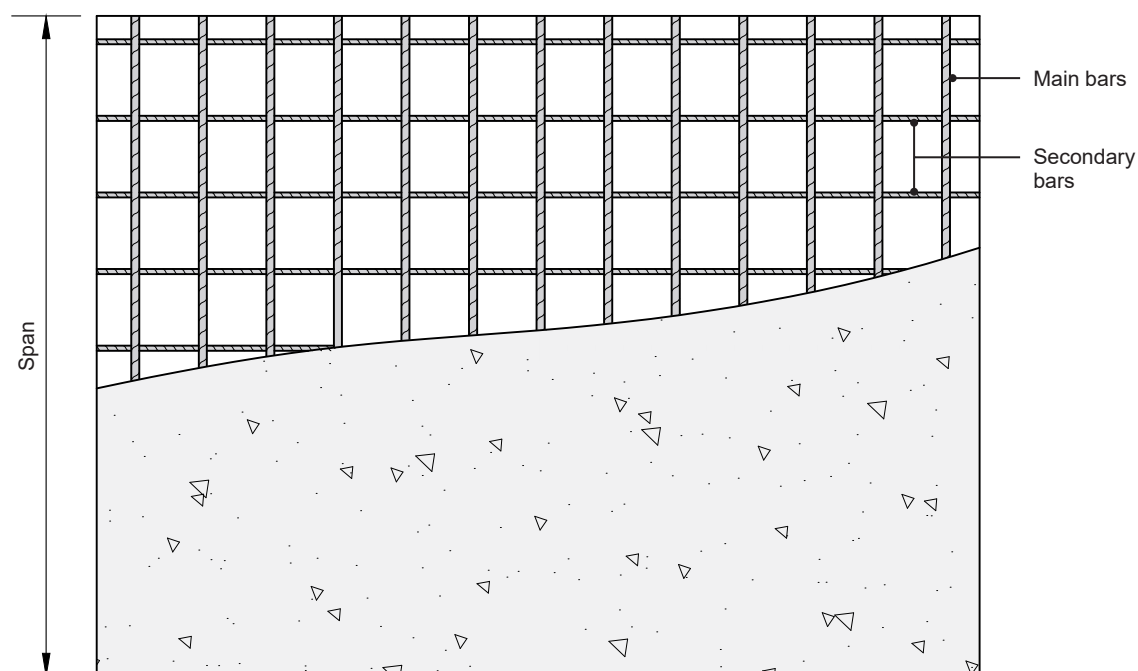
An appropriate level of concrete cover should be provided to the reinforcement; the cover thickness will depend on the exposure of the concrete and its application. Concrete cover should be specified by an Engineer, or alternatively by using the following table.

| Application (concrete position)                                           | Minimum cover (mm) |
|---------------------------------------------------------------------------|--------------------|
| Concrete in direct contact with the ground                                | 75                 |
| All external applications e.g. shuttered walling                          | 50                 |
| Floor slabs and other applications where concrete is cast onto a membrane | 40                 |
| Concrete over blinding concrete                                           | 40                 |
| Internal conditions                                                       | 25                 |

### Reinforcing bars in concrete beams



### Position of bars on reinforced concrete slab

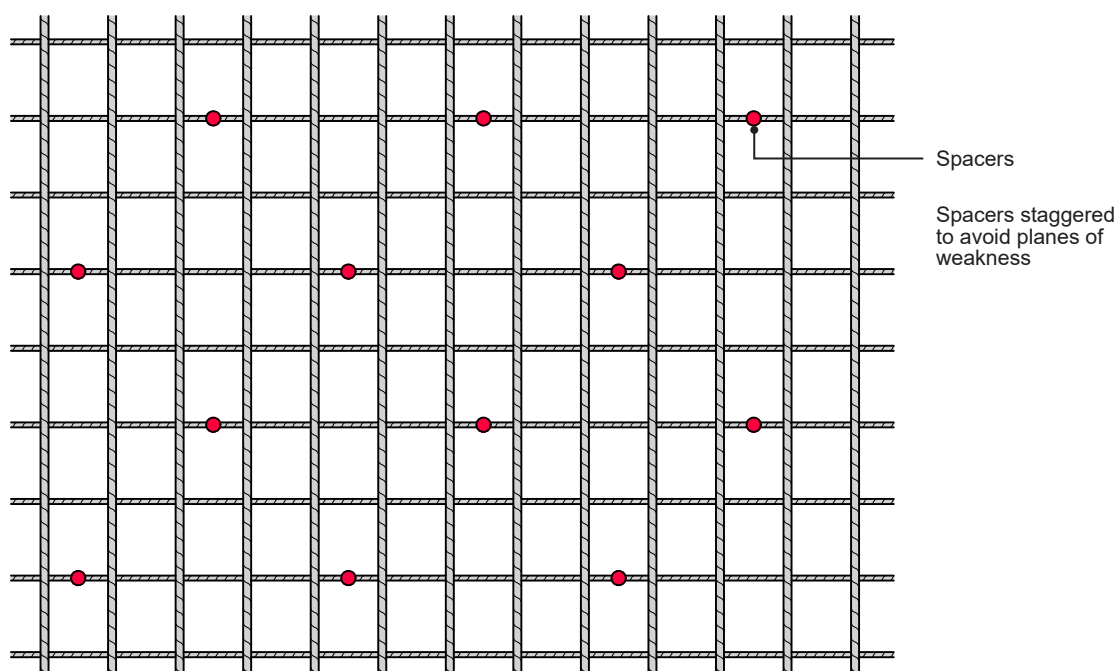


Reinforcing bars should be correctly positioned, ensuring there is appropriate concrete cover, and reinforcing mesh placed in the right direction (main bars parallel to span).



## Position of spacers

Reinforcing should be supported by proprietary chairs or spacers, and can be made of concrete, plastic or steel. The thickness and depth of a concrete spacer should not exceed 50mm x 50mm. Spacers should be placed at a maximum of 1m centres, and when supporting mesh should be staggered.



## Concrete mixes

### Site mixed concrete

Site mixed concrete should generally be avoided unless it is for non-structural applications e.g. backfilling or bedding of paving slabs etc. There may be exceptional circumstances where site mixing is unavoidable. Where this is the case, extra caution must be taken to ensure that the correct mix proportion is used; delivery notes should be provided if necessary, and a provision for testing may be required.

### Ready mixed concrete

Ready mixed concrete should be specified in accordance with BS 8500 and BS EN 206.

Concrete must be mixed using the correct proportions of cement, sand, aggregate and water. Ready mixed concrete should be delivered as close as possible to the site works and should be poured immediately to prevent settlement or separation of the mix. Ideally, ready mixed concrete should be poured within two hours of the initial mixing at the concrete plant.

Ready mixed concrete should only be sourced from a supplier who has a quality control system in place to ensure the correct standard of concrete is delivered. The quality control scheme should be either QSRMC (Quality Scheme for Ready Mixed Concrete) or a relevant British Standard Kite mark scheme.

It is important to pass all design specifications of the concrete to the ready mixed supplier to ensure that the delivered concrete meets the design intention.

Delivery notes should be kept and made available for inspection if required.

Additional water should not be added to the concrete on-site, nor should the ready mixed concrete be poured into water-filled trenches unless the concrete has been specifically designed for this purpose.

### Exposure classes related to environmental factors

Concrete mixes should be specified in relation to the expected conditions of the geographical location of the site and location of the concrete element in the structure. The environmental actions are classified by exposure classes, see table 1 of BS EN 206 for further information.

Higher grade concrete has greater resistance to chemical and mechanical damage and should be specified in accordance BS EN 206 and BS 8500.

Where buried concrete is specified in aggressive ground conditions, they should be specified in accordance with the below standards and the alkali content of the concrete should not exceed 3kg/m<sup>3</sup>:

- BS EN 206
- BS 8500
- BS EN 934-2
- BS EN 1008
- BS EN 12620
- BRE special digest 1
- BRE Digest 357
- BRE Digest 330



## Admixtures

Admixtures should only be used if stipulated as part of the original design specification. If an admixture is to be proposed where it was not intended as part of the design, an Engineer must confirm that the admixture is appropriate and required.

It is important that the appropriate amount of admixture is applied to any mix. Any overdosing may cause concrete deterioration or poor workability.

Admixtures should be specified in accordance with BS EN 934-2 and BS EN 206.

### Common admixtures

- Plasticisers - improve the workability of concrete, especially when pumped; they can also improve concrete adhesion, which is particularly enhanced when concrete is reinforced.
- Air entraining agents - increase the air void volume of concrete, which in turn produces a surface more resilient to cold weather, and is therefore ideally suited to outdoor conditions where cold weather exposure is high, such as pathways or roads.
- Accelerators - provide an improved curing time, but caution should be taken to allow for reasonable time to 'finish' the concrete.

### Admixtures in cold weather

Admixtures may be used in cold weather, but usually will not assist in preventing concrete from freezing; therefore, they should not be relied upon to compensate for freezing conditions. The guidance for cold weather working should be followed in these circumstances.

### Admixtures and reinforcing

Admixtures containing chloride will cause corrosion to occur, meaning they should not be used in concrete containing reinforcing.

## Expansion/movement joints in concrete

A larger number of expansion joints should be provided to concrete where weak spots may occur. This could include a narrowing width of floor slab for example.

## Vibration and compaction of concrete

Reinforced concrete shall be compacted using a vibrating poker, but care must be taken to ensure the concrete is not over-compacted and the concrete mix separated.

## Curing of concrete

Concrete should be adequately cured before loads are applied. It is acceptable that masonry walls may be built up to damp proof course (DPC) on a foundation that is not fully cured; however, care must be taken to prevent any damage to the foundation. The concrete should be at least durable enough to carry the masonry.

The speed at which concrete mixes cure depends on the mix ratio and whether there are any additives within the concrete. Where curing time is critical, such as cast in-situ upper floors, curing times should be indicated as part of the design and formwork struck, as advised by an Engineer.

To prevent concrete curing too rapidly after initial drying, exposed concrete should be covered with hessian, polythene or sand. This prevents the surface drying too quickly and protects the concrete. This level of protection is particularly critical in hot or adverse weather conditions.

Standards referred to:

- BS 8110 Structural use of concrete.
- BS EN 1992-1-1 Design of concrete structures, general rules and rules for buildings (incorporating UK National Annex to Eurocode).
- BS 8500 Concrete - Complementary British Standard to BS EN 206-1.
- BS EN 206-1 Concrete. Specification, performance, production and conformity.
- BS EN 12620 Aggregates for concrete.
- BS EN 197 Cement. Conformity evaluation.

## Concrete testing

All materials and work execution must be strictly in accordance with the Engineer's design and specification, and supplemented by a quality control plan which should incorporate concrete testing.

Additional testing may be required by the Warranty provider. Where this is the case, there should be prior agreement on the Warranty provider's testing requirements.

In all situations, testing should be in accordance with BS EN 12390 by UKAS fully approved laboratories.

Proof of testing, reports and certificates shall be made available upon request.

## Cold weather working and concrete

To meet the Functional Requirements, the minimum working temperature should not fall below 2°C. It is important that during cold weather periods, regular temperature readings should be taken. Thermometers should be placed away from direct sunlight, preferably in a shaded area. When assessing the temperature, it is also important to consider wind chill and weather exposure, and make the necessary allowances for sites that have a higher level of exposure.

## Ready mixed concrete

It is a requirement of BS 8500 and BS EN 206-1 that the temperature of fresh concrete shall not be below 5°C at the time of delivery. Measures should also be put in place to ensure immature concrete is prevented from freezing before sufficient strength has been achieved.

## Site mixed concrete

Site mixing is acceptable at low temperatures, provided:

- The minimum temperature is no less than 2°C.
- The concrete is appropriately protected during curing.
- Ground conditions are not frozen.

## Concreting of foundations and oversite

Concrete should not be poured if the ground is frozen as frozen ground can change in stability and volume during thawing, and therefore may cause damage to the recently poured concrete.

During cold weather, it may be appropriate to cover the ground to prevent freezing and, in some extreme cases, heating of the ground may be required.

## Other concreting

Concrete reinforcing and formwork should not be frozen and be free from snow and ice.

## Curing of concrete

Concrete may take longer to cure in cold conditions, and an additional six days may be required in extreme cases. Concrete may be covered with a rigid insulation to prevent freezing during curing periods. This is particularly useful for oversized slabs. Concrete should not be poured if the ground is frozen, or if the temperature is less than 2°C.

### C.1.6 Masonry units

Masonry units shall be of an appropriate durability to meet the design intention.

The minimum working temperature for masonry shall not fall below 2°C.

Covers shall be provided to protect masonry stored on site, new walls or other masonry construction from frost, snow and ice, particularly bricks, blocks, sand and cement.

## Masonry unit durability

Masonry units should be of an appropriate durability to meet the design intention. The type of masonry unit to be used will affect the specification of the mortar.

Masonry units with greater durability should be used where there is a higher potential for saturation or severe exposure to wind-driven rain. Refer to the masonry unit manufacturer when making this selection.

The designer/specifier should use the following standards when specifying the use of masonry units:

- BS EN 771
- BS EN 1996-2
- BS EN 1996-1-1
- PD 6697

Refer to the masonry unit manufacturer for further information on the selection of the correct masonry units.

Due to difficulties in testing the durability of the exact batch proposed to be used, reclaimed bricks should not be used for Warranty purposes.

Please note: Non-cement based concrete products need prior approval by us.

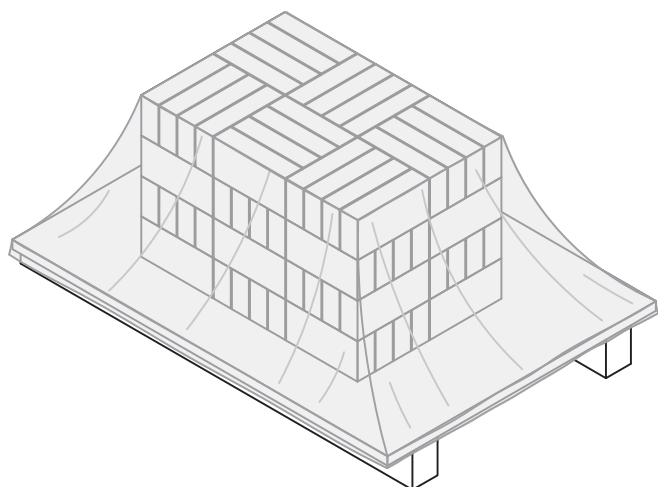
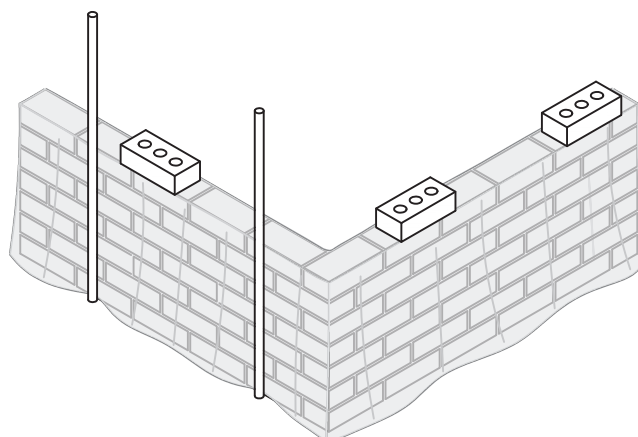
## Cold weather working for masonry

To meet the Functional Requirements of this Technical Manual, the minimum working temperatures should not fall below 2°C when working with masonry. It is important that during cold weather periods, regular temperature readings should be taken. Frozen materials should never be used under any circumstances.

Thermometers should be placed away from direct sunlight, preferably in a shaded area. When assessing the temperature, it is also important to consider wind chill and weather exposure, and make necessary allowances for sites that have a higher level of exposure.

## Protection of masonry

Any new walls or other masonry construction will require protection against frost where temperatures are expected to drop below 2°C. Ideally, all masonry should be protected with polythene or hessian. If temperatures are expected to fall to an extremely low level, insulation boards may be required, and heating may even be considered.

**Protection of blockwork****Protection of masonry walls****C.1.7 Mortar**

Mortar in masonry shall:

- Be suitable for the intended purpose.
- Be sufficiently durable to resist the relevant micro exposure conditions for the intended life of the building.
- The minimum working temperature for mortar shall not fall below 2°C.
- Not contain constituents which can have a detrimental effect on the properties or durability of the mortar or abutting materials.

**General requirements**

Acceptable masonry unit specifications and mortar can be selected from PD 6697:2019. It is strongly recommended that you check with the manufacturers for suitability in specific applications when making your selection.

Mortar should be designed to take account of any requirement for bed joint reinforcement.

Factory made mortars and pre-batched mortars shall be used:

- In accordance with the manufacturer's instructions, including mixing time and type of mixer.
- Before the expiry of the workable life stated by the manufacturer.
- Taking account of weather conditions.

Site made mortar shall be:

- Ready for use when it is discharged from the mixer, and no subsequent additions of binders, aggregates, admixtures or water should be made.
- Used before its working life has expired.
- Be mixed so as to have a sufficient workability for it to fill the space into which it is placed, without segregation.
- Used taking account of weather conditions.

For guidance on render, please refer to the 'External Walls – Render' section.

**Specification of mortars for masonry**

Mortar for masonry can be:

- General purpose or thin layer or lightweight.
- Designed (performance concept) or prescribed (recipe concept).
- Factory made (pre-batched or pre-mixed) or semi-finished factory made (both to BSEN998-2) or site made (to BSEN1996-2).

Designed masonry mortar has a composition and method of manufacture chosen by the producer in order to achieve specified properties.

Prescribed masonry mortar is made in predetermined proportions whose properties are assumed from the stated proportion of constituents.

Historically mortars were generally specified in terms of a prescription or recipe as, for example, in BS 5628. The updated British Standard for masonry mortar, BS EN 998-2, is a performance based standard.

Mortar should be specified, manufactured and installed in accordance with:

- BS EN 1996: Design of masonry structures.
- PD 6697: Recommendations for the design of masonry structures to BSEN1996-1-1 and BSEN1996-2.
- BS EN 998-2: Specification for mortar for masonry.
- PD 6678: Guide to the specification of masonry mortar.

## Specification of factory-made or semi-finished factory-made to BS EN 998-2

For prescribed mortars:

- The prescribed mortar specification should be drafted so that the quality is controlled by stated compositional requirements.
- The compressive strength shall be declared using publicly available references establishing the relationship between same mix proportions of the same constituents and compressive strength. The proportion of the prescribed constituents required to provide the stated "M" values for prescribed masonry mortars are given in table NA.2 of the National Annex to BS EN 1996-1-1.
- The mix proportions by volume or by weight of all the constituents shall be declared by the manufacturer. The manufacturer shall verify the conformity of the mortar to the specification by referring to any production records and delivery documentation. CE marking/UKCA marking of prescribed factory made mortar signifies that the product conforms to the European Commission's Construction Products Directive. Conformity is demonstrated by initial type testing and factory production control to BS EN 998-2.

For designed mortars:

- The compressive strength of masonry mortar shall be declared by the manufacturer. The manufacturer may declare the compressive strength class with the compressive strength designated by a 'M' followed by the compressive strength class in N/mm<sup>2</sup>, which it exceeds.
- CE marking/UKCA marking of a designed factory made mortar signifies that the product conforms to the essential requirements of the European Commission's Construction Products Directive (CPD). Producing designed factory made mortar in accordance with BS EN 998-2 ensures that the mortar conforms to the CPD and can therefore be CE marked/UKCA marked.
- BS EN 998-2, Annex ZA specifies that if designed mortar carries the CE mark/UKCA mark, the factory production control system will have been certified by a notified body (third party certification body).

## Specification of site-made mortar to BS EN 1996-2

Prescribed and designed mortars:

- The design specification should state the required product performance characteristics and the means of their verification including the requirements for sampling and frequency of testing.
- Where the designer is satisfied that a prescriptive specification will provide the required performance, a detailed specification of the constituent materials, their proportions and the method of mixing may be given either on the basis of tests carried out on trial mixes and/or on the basis of authoritative publicly available references acceptable in the place of use.
- When the mix prescription is not given in the design specification, the detailed specification of constituent materials, their proportions and the method of mixing should be selected on the basis of tests carried out on trial mixes and/or on the basis of authoritative publicly available references acceptable in the place of use. When tests are required, they should be carried out in accordance with the design specification and BS EN 1015. When test results indicate that the mix prescription is not giving the required performance characteristics, the mix prescription should be amended and if it is part of the design specification any amendments should be agreed with the designer.
- Where designed mortars are manufactured on site, and not within a factory control system, the mortar specification should state how conformity is to be assessed. This can range from infrequent but regular testing of samples to visual inspection and random testing of samples with statistical analysis of results. The specification should describe the supervision, inspection and testing that is required in order to confirm that the mortar conforms to the specifiers chosen BS EN 998-2 requirements.

## Testing and conformity evaluation

Conformity evaluation methods for both factory and site made masonry mortar can range from examination of production records to testing and comparison of the results with tabulated values for known compositions.

Standards referred to

- |                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>▪ BS 6399 Loadings for buildings.</li> <li>▪ BS 8103 Structural design of low rise buildings.</li> <li>▪ BS 187 Specification for calcium silicate (sand lime and flint lime) bricks.</li> <li>▪ BS 3921.</li> </ul> | <ul style="list-style-type: none"> <li>▪ BS 5628 Parts 1, 2 and 3 Code of Practice for use of masonry.</li> <li>▪ BS EN 771-1.</li> <li>▪ BS EN 998 Specification for mortar for masonry.</li> <li>▪ BS EN 1996-1 Design of masonry structures.</li> <li>▪ PD 6697:2019.</li> </ul> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### C.1.8 Cavity trays and DPC's

Cavity trays and DPC's shall be suitable for their intended purpose with evidence provided upon request.

The following table provides the minimum required supporting information for cavity trays and DPC's within different positions of a building. For circumstances not covered in the following table, early engagement with the Warranty surveyor is advised.

| Minimum required supporting information         |                                   |                                        |                                |                        |                          |
|-------------------------------------------------|-----------------------------------|----------------------------------------|--------------------------------|------------------------|--------------------------|
| Position                                        | Installation type                 | BS EN 14909 Declaration of Performance | UKAS Third Party Accreditation | Manufacturers guidance | Engineer's specification |
| Base of a wall                                  | Horizontal linear DPC             | ✓                                      |                                | ✓                      |                          |
| Window reveal                                   | Vertical linear DPC               | ✓                                      |                                | ✓                      |                          |
| Accommodation of movement e.g. stone heads      | Slip plane provision              | ✓                                      |                                |                        | ✓                        |
| Retaining structures                            | Horizontal linear DPC             | ✓                                      | ✓                              | ✓                      | ✓                        |
| Parapet walls                                   | Horizontal linear DPC             | ✓                                      | ✓                              | ✓                      | ✓                        |
| Under coping stones                             | Horizontal linear DPC             | ✓                                      | ✓                              | ✓                      | ✓                        |
| Base of a wall                                  | Cavity tray                       | ✓                                      | ✓                              | ✓                      |                          |
| Under a jointed stone sill                      | Cavity tray                       | ✓                                      | ✓                              | ✓                      |                          |
| Over an obstruction in the cavity or an opening | Cavity tray                       | ✓                                      | ✓                              | ✓                      |                          |
| Over a horizontal cavity fire barrier           | Cavity tray                       | ✓                                      | ✓                              | ✓                      |                          |
| Over a brickwork support angle                  | Cavity tray                       | ✓                                      | ✓                              | ✓                      | ✓                        |
| Roof abutments – flat and pitched               | Cavity tray – horizontal/stepping | ✓                                      | ✓                              | ✓                      |                          |
| Parapet walls                                   | Cavity tray                       | ✓                                      | ✓                              | ✓                      | ✓                        |

#### Flexible DPC materials (e.g. polyethylene)

Where flexible DPC materials are to be used as a cavity tray, they should:

- Have supporting evidence in the form of a Declaration of Performance to BS EN 14909:2012.
- Have a third party product conformity certificate confirming their suitability for use as a cavity tray.
- Be supplemented by clear manufacturer's guidance in relation to installation.
- Where required, be subject to the assessment of an Engineer e.g. where used in parapet walls, retaining structures, etc.

The Declaration of Performance information should include reference to BS EN 14909:2012 and include one of the 'Product Designation Codes' given within that standard to enable clear determination of the material being used on site.

### C.1.9 Corrosion protection and protective coatings

Materials and components shall have appropriate corrosion protection and protective coatings which are suitable for the site specific conditions and material.

#### Corrosion protection to steelwork (including lintels)

All materials on buildings are subject to wear during use, this is caused by mechanical, chemical, electrochemical, thermal, microbiological and radiation related impacts. Mechanical reactions lead to wear, chemical and electrochemical reactions cause corrosion.

Corrosion is defined as the physical interaction between a metal and its environment which results in changes to the metals properties, and which may lead to significant functional impairment of the metal, the environment, or the technical system of which they form part of (BS EN ISO 8044).

Corrosion resistance is the ability of a metal to maintain its operational capability in a given corrosion system. When selecting suitable construction materials which are protected to resist corrosion during its service life, it is important to consider the building, its location, the surrounding environment, the atmosphere and climatic conditions.

There are several types of corrosion that must be considered to ensure that the material(s) selected will not corrode and lead to functional impairment:

- Uniform surface corrosion.
- Electrolytic corrosion.
- Crevice corrosion.
- Pitting corrosion.
- Stress corrosion.
- Contact corrosion.

## Steel lintels in coastal locations

Steel lintels in coastal locations, used in both leaves of an external wall openings on projects within 500m of the shoreline, should be austenitic stainless steel and, in addition protected by a separate damp proof system/ cavity tray.

For sites between 500m and 5km of the shoreline, the lintel manufacturer should confirm their product is suitable for use in this environment– if not made from austenitic stainless steel and confirm will remain durable for 60 years. The durability of this element should not be reliant on maintenance.

## Protective coatings and finishes to metals

All metals must have a suitable protective coating to minimise or prevent corrosion during its life and be selected to comply with the appropriate standards and with the corrosion category described in the following table.

The classification of environmental corrosion conditions has been taken from BS EN ISO 9223 Table 4 and BS EN ISO 12944-4 Table 1. This provides a verbal description of the corrosion categories. Note: to determine the corrosion rates for aluminium, copper, steel and zinc, please refer to the standards listed.

**Table 1: Hotrolled steelwork environment and protection categories**

| Area              | Condition                                                                                                | Description                                                         | Environment Categories               |
|-------------------|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|--------------------------------------|
| External          | Outside                                                                                                  | All steelwork                                                       | C4 or C5 – <b>Note 1</b>             |
| Building Envelope | Facade                                                                                                   | All steelwork                                                       | C4 or C5 – <b>Note 1</b>             |
| Building Envelope | Cavity zone: Very high corrosion risk - Coastal locations and areas within (500m) from the shoreline     | All steelwork located within the cavity zone should be galvanised   | C4 or C5 – <b>Note 1</b>             |
| Building Envelope | Cavity zone: High corrosion risk - Coastal locations and areas located (1km to 0.5km) from the shoreline | All steelwork located within the cavity zone should be galvanised   | C4 or C5 – <b>Note 1</b>             |
| Building Envelope | Cavity zone: Reduced corrosion risk - Coastal locations and areas over (5km) from the shoreline          | Steelwork protection category will depend on location within cavity | <b>Note 2</b> and <b>Note 3</b>      |
| Building Envelope | Basement and steelwork below ground level                                                                | Full or partial basement situation                                  | C5 - <b>Note 1</b> and <b>Note 4</b> |
| Internal          | Sub-floor void                                                                                           | Steelwork not in contact with the ground                            | C3                                   |
| Internal          | Internal swimming pool                                                                                   | Steelwork located in areas that can be effected by chemicals        | C4 - <b>Note 1</b>                   |
| Internal          | Kitchen                                                                                                  | Protected against condensation                                      | C2                                   |
| Internal          | Bathrooms                                                                                                | Protected against condensation                                      | C2                                   |
| Internal          | Roof voids                                                                                               | Unheated                                                            | C2                                   |

Please note, additional paint coatings over galvanised steel, such as Intumescent paint, need to be correctly specified and applied to suit environment and fire rating.

### Notes

1. Material specification and corrosion protection plan should be provided by the Principal Designer to ensure that the steelwork has a 60 year life to first maintenance.
2. Under normal conditions, where wall cavities remain dry, either by use of an impermeable outer skin or where there is (40mm or greater) physical separation of the steelwork from the brick outer skin – a corrosion environment category C2 or C3 may be used (depending on the external severity of the environment category and corrosivity rating in Tables 1 and 2 respectively).
3. Steelwork located within the cavity (less than 40mm from the brick outer skin) will normally require a corrosion category C4 or C5 protection.
4. Alternative steelwork protection methods including concrete encasement should be agreed prior to steelwork fabrication. Note: Post applied paint systems are NOT accepted as an alternative to Hot Dipped Galvanising.



## Standards

- ISO 8044 - Corrosion of metals and alloys - Basic terms and definitions.
- ISO 9223 - Corrosion of metals and alloys - Corrosively of atmospheres - Classification.
- ISO 9224 - Corrosion of metals and alloys - Corrosively of atmospheres - Guiding values for the corrosively categories.
- ISO 12944-2: Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 2: Classification of environments.
- BRE Digest 301 - Corrosion of metals by wood.
- PD 6484 - Commentary on corrosion at bi-metallic contacts and its alleviation.

Note: The CWCT Technical Note 24 provides guidance on corrosion and corrosion protection to cladding.

**Table 2: Steelwork corrosion rating and protection categories**

| Corrosivity rating                                                                                                                                                                                                                                | Corrosion protection                                                            | Protection thickness           | Number of coats                | Comments                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------|--------------------------------|---------------------------------------------------------------------------------------|
| <b>C1</b><br>Interior Dry                                                                                                                                                                                                                         | High build zinc phosphate epoxy primer                                          | 80 µm                          | 1 or 2                         |                                                                                       |
| <b>C2</b><br>Interior Rural Occasional Condensation                                                                                                                                                                                               | High build zinc phosphate epoxy prime                                           | 80 µm                          | 1 or 2                         |                                                                                       |
| <b>C3</b><br>Interior Urban<br>Inland some air pollution located over (5km) from the shoreline.                                                                                                                                                   | High build zinc phosphate epoxy primer (80 µm) + high build epoxy (MIO, 120 µm) | 200 µm                         | 1 or 2                         | Steelwork protection category will depend on location within cavity                   |
| <b>C4</b><br>Coastal locations and areas between (5km to 1km) from the shoreline.                                                                                                                                                                 | Hot Dip Galvanise to BS EN ISO 1461                                             | 85 µm                          | 1                              | All steelwork located within the cavity zone should be galvanised                     |
| <b>C5</b><br>High Humidity or Coastal with High Salinity within (500m) from the shoreline.                                                                                                                                                        | Hot Dip Galvanise to BS EN ISO 1461                                             | 140 µm                         | 1                              | All steelwork located within the cavity zone should be galvanised                     |
| <b>CX or C5+</b><br>Coastal<br>Splash Zones                                                                                                                                                                                                       | Specialist design including a site specific assessment required                 | As per Engineers specification | As per Engineers specification | Additional risks to consider in splash zones: Accelerated Low Water Corrosion. (ALWC) |
| <b>Notes</b><br>Surface Preparation for all corrosion protection applications:<br>Thoroughly clean surfaces prior to abrasive blast cleaning in accordance with BS EN ISO 8501.                                                                   |                                                                                 |                                |                                |                                                                                       |
| <b>Application:</b><br>All protection coatings to be factory applied to manufacturers recommendations.                                                                                                                                            |                                                                                 |                                |                                |                                                                                       |
| <b>Treating damaged areas of protective coating:</b><br>Make good to appropriate Corrosivity Rating in accordance to manufacturers recommendations.                                                                                               |                                                                                 |                                |                                |                                                                                       |
| <b>Connections:</b><br>All connections and fittings to the hotrolled steelwork will need to achieve 60 year life to first maintenance.                                                                                                            |                                                                                 |                                |                                |                                                                                       |
| <b>Additional guidance:</b><br>Additional guidance on corrosivity categories (C1 to C5) and associated protective coatings can be found on the following website:<br><a href="http://www.steelconstruction.info">www.steelconstruction.info</a> . |                                                                                 |                                |                                |                                                                                       |
| Galvanising protection recommendations can be found within The Galvanizers Association Handbook which includes UK map showing atmospheric corrosion rates of Hot Dip Galvanising.                                                                 |                                                                                 |                                |                                |                                                                                       |

## Steelwork protection

For Warranty purposes:

- Exposed steel frame construction used on sites with an atmospheric corrosivity of C4 or C5 to BS EN ISO 12944, including sites within 500m from a coastal shoreline, should be galvanised to a rate of 710 g/m<sup>2</sup>.
- Decorative finishes must be compatible with the protective coat specification. Refer to BS EN 12944 'paints and varnishes: corrosion protection of steel structures by protective paint systems' and the manufacturers recommendations.
- Any section of previously galvanised or other protected steel which is then cut or drilled must be provided with appropriate remediation to the exposed parts of steel to ensure adequate corrosion protection is maintained.
- The designer should specify the protective coating system where any steelwork is to be welded.
- Surface preparation should be to BS EN 12944-4.
- The use of Intumescent paint for achieving fire protection should be compatible with any corrosion protective coating applied and the manufacturer's guidance should be followed.

## Fixings

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Fixings that are exposed to weathering, moisture and corrosive environments or applications where concentrations of corrosive agents may accumulate should be made from high grade austenitic stainless steel (e.g. A4) or a protective coating suitable for the corrosion category described in the table above.

### Durability of fixings

ISO 12944 also classifies three different durability ranges 'low, medium & high' for protective paint systems. Therefore, in severe and very severe environments, external paints and varnishes, and other protective coatings must be chosen to have a 'high' durability rating.

Whilst the durability range is not a 'guarantee time', consideration has to be made to the Functional Requirements of this Technical Manual (see the 'Service life requirements' table in this section).

Due to the environment, certain materials and particularly the finishes may require on-going maintenance in order to keep a satisfactory finish e.g. balcony timber decking. In these circumstances it will be the building owner's responsibility to ensure that regular maintenance of exposed components and finishes is undertaken to ensure they perform correctly. Maintenance plans will need to be in place during the lifetime of the building to ensure premature failure of coatings or components is avoided.

## Roof fixings

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In addition to the guidance found in the 'Roofs' section, the following is applicable:

For clay, concrete and slate roofing a full roof fixing specification from the slate or tile manufacture must be provided and the exposure and orientation of the site taken into account.

All fixings must be durable for the environment location.

For metal cladding:

1. The designer must establish the environment's corrosivity when specifying metal cladding for roofs in coastal locations as well as the potential for wind uplift and movement in a cladding system during severe wind conditions, particularly over party wall positions.
2. The designer should ensure capillary action at the overlapped joints is prevented which with high saline water could also cause pitting corrosion to take place, leading to the failure of the roof panels.





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