Chapter

7.1

Flat roofs, terraces and balconies

This chapter gives guidance on meeting the Technical Requirements for flat roofs, terraces and balconies.

Figure reference table

Figure Reference Table 7.1			
Fig No	**Title/Description**	**Clause**	**Page**
Figure 1	Individual reinforced concrete (RC) elements	7.1.3	7
Figure 2	Warm roof	7.1.3	7
Figure 3	Cold roof	7.1.3	7
Figure 4	Inverted warm roof	7.1.3	7
Figure 5	Uninsulated Roof Deck Construction	7.1.3	7
Figure 6	Roof toppings	7.1.3	8
Figure 7	Paving	7.1.3	8
Figure 8	Uninsulated decks	7.1.3	8
Figure 9	Warm roof construction	7.1.3	8
Figure 10	Inverted warm roof construction	7.1.3	8
Figure 11	Cold roof construction	7.1.3	9
Figure 12	Blue Roof make-up	7.1.3	9
Figure 13	Firrings used to form deck fall gradient	7.1.4.2	10
Figure 14	Joist hanger	7.1.6.2	13
Figure 15	Joist strap	7.1.6.2	13
Figure 16	Softwood tongued and grooved boarding	7.1.6.3	14
Figure 17	Profiled metal deck features	7.1.8.3	17
Figure 18	Warm roof construction — with metal deck	7.1.8.3	17
Figure 19	Inverted warm roof construction	7.1.8.3	17
Figure 20	Twin skin build-up	7.1.9	18
Figure 21	Standing seam roof (secret fixings)	7.1.9	18
Figure 22	Example of edge seal with composite roof panels	7.1.9	19
Figure 23	Composite insulated timber deck	7.1.10.2	20
Figure 24	Ventilated cold roof design	7.1.11.2	25
Figure 25	Ventilated warm roof design	7.1.11.2	25
Figure 26	Intensive Green Roof on warm roof deck	7.1.12	27
Figure 27	Extensive Green Roof on warm roof deck	7.1.12	27
Figure 28	Intensive Green Roof on inverted warm roof deck	7.1.12	27
Figure 29	Extensive Green Roof on inverted warm roof deck	7.1.12	27
Figure 30	Raised podium	7.1.14	29
Figure 31	Buried podium	7.1.14	29
Figure 32	Upstands	7.1.15	30
Figure 33	Skirting to rooflights or ventilator kerb	7.1.15	30
Figure 34	Twin-kerb expansion joint	7.1.15	30
Figure 35	Mansard edge	7.1.15	31
Figure 36	Pitched roof abutment	7.1.15	31
Figure 37	Independent skirting detail	7.1.15	31
Figure 38	Verge detail	7.1.15	31
Figure 39	Welted drip to external gutter	7.1.15	31
Figure 40	Pipe passing through roof	7.1.15	31
Figure 41	Upstand to ventilator or rooflight kerb	7.1.15	32
Figure 42	Rainwater outlet	7.1.15	32
Figure 43	Inverted warm roof drainage outlet	7.1.15	32
Figure 44	Uninsulated balcony deck	7.1.16	33
Figure 45	Insulated terrace deck	7.1.16	34
Figure 46	Accessible threshold	7.1.16	34
Figure 47	Parapet wall waterproofing details at roof upstand and head coping	7.1.18.3	36

Definitions for this chapter

For the purposes of this chapter, the following definitions apply:

Air and vapour control layer (AVCL)	Continuous layer of impermeable material to prevent the movement of air and water vapour.
Balcony	Accessible external amenity platform over an open space above ground level, with direct access from a building Balconies may take the form of: • **access balcony** — providing pedestrian access to two or more dwellings (sometimes referred to as a 'walkway' or 'access deck') • **enclosed** — protected from rain by a roof or balcony above and walls or weather screens to the sides (sometimes referred to as a 'winter garden') • **freestanding** — fully, or partially, supported independent of the building structure • **inset** — recessed inwards from the external wall line of a building • **open** — has guarding but no other form of vertical enclosure • **projecting** — cantilevered from the external wall line of a building.
Biodiverse (brown) roof	Surface often of rubble or site-excavated soil, sometimes with the inclusion of logs and rocks, etc to replicate the ecology of the local area, and seeded or left to self-seed.
Blue roof	Roof installation designed for temporary attenuation of rainwater to delay entry into the urban drainage system and prevent flooding (Blue Roofs are not for water storage use).
Cold roof	Insulation below the deck with a ventilated void between the deck and breather membrane, supported on the insulation.
Deck	The structural substrate, including timber boarding or sheeting, profiled metal sheeting on joists/purlins, or the upper surface of in-situ or precast concrete and any applied screed.
Design fall	The fall that a roof should be designed at to accommodate initial and long-term deflection and achieve at least the required 'finished fall' in use (the design fall is normally taken as twice the finished fall).
Finished fall	The minimum fall that should be achieved on the waterproofing layer once the roof has been installed and fully loaded.
Firring	A tapered batten which creates a fall to a timber deck.
Flat roof	A roof with a maximum slope of 10 degrees from the horizontal.
Flat roof build-up	The roof components above the deck, including as applicable, AVCL, insulation, waterproofing layer and surface finish/topping.
Fully supported hard metal roofing	Flat hard metal sheeting forming the weather skin and fully supported on a deck.
Fully supported soft metal roofing	Soft metal sheeting (lead) forming the weather skin and fully supported on a deck.
Green Roof — extensive	Roof topping of a shallow growing medium supporting plants such as sedums, grasses, wildflower species, etc; generally low maintenance and access for maintenance only.
Green Roof — intensive	Roof topping of a growing medium to support trees, shrubs, lawns, etc; may include hard landscaping and be used as an amenity space (sometimes referred to as a 'roof garden').
Interstitial condensation	Condensation that occurs within or between layers of construction.
Inverted warm roof	A roof with insulation placed directly above the waterproofing layer.
Paving/decking	A protection layer on which people walk, above the waterproofing layer, on a balcony or terrace.
Profiled self-supporting metal deck	Profiled metal deck, spanning between structural supports, eg purlins and supporting the flat roof build-up.
Profiled self-supporting metal roofing	Profiled metal sheeting forming the weather skin and spanning between structural supports, eg purlins.
Terrace	External surface for amenity use, above an internal space, above ground level and with direct access from a building (treated as a flat roof for waterproofing and thermal purposes). Terraces may take the form of: • **access terrace** — providing pedestrian access to two or more dwellings (sometimes referred to as a 'walkway' or 'access deck') • **buried podium** — a roof structure at, or below, ground level with hard and/or soft landscaping and sometimes vehicular access for emergency vehicles or parking; waterproofing to the podium is linked to the tanking of the basement structure below, as described in Chapter 5.4 Waterproofing of basements and other below ground structures • **private terrace** — for the use of a single dwelling • **raised podium** — a terrace, other than an access terrace, above ground level, over a non-habitable area(s) such as a car park or plant room(s); the podium itself may provide hard and/or soft landscaped amenity areas.

Upstand	Perimeter waterproofing to provide continuity between a flat roof or deck and adjoining vertical wall construction (the minimum upstand height is normally 150mm unless serving an accessible threshold where this height may be reduced to 75mm).
Warm roof	A roof with insulation placed directly below the waterproofing layer.
Water flow reducing layer (WFRL)	A vapour permeable loose laid layer, resistant to water, UV and rot, used to reduce the flow of water and fines into the insulation layer in an inverted warm roof system.
Waterproofing layer	Layer of impermeable flexible material forming the primary barrier to water ingress.
Zero fall roof	A roof with a finished slope which lies between 0 and 1:80 and which achieves a finished drained surface that has no back falls or ponding this definition remains relevant to flat roof design and is currently recognised by the flat roofing industry.

7.1.1 Compliance

Also see: Chapter 2.1

Flat roofs, terraces and balconies shall comply with the Technical Requirements.

Flat roofs, terraces and balconies which comply with the guidance in this chapter will generally be acceptable to NHBC.

Other sources of information include:

- BS 6229 Flat roofs with continuously supported flexible waterproof coverings. Code of practice
- BS 8579 Guide to the design of balconies and terraces
- BS 8217 Reinforced bitumen membranes for roofing. Code of practice
- BS 8218 Code of practice for mastic asphalt roofing
- BS 8747 Reinforced bitumen membranes for roofing
- BS 5250 Code of practice for control of condensation in buildings
- BS 5427 Code of practice for the use of profiled sheet for roof and wall cladding on buildings
- BS 6915 Design and construction of fully supported lead sheet roof and wall coverings. Code of practice
- BS EN 507 Roofing products from metal sheet — Specification for fully supported roofing products of aluminium sheet
- BS EN 1090-4 Execution of steel structures and aluminium structures. Technical Requirements for cold-formed structural steel elements and cold-formed structures for roof, ceiling, floor and wall applications
- BS EN 12056 Gravity Drainage Systems inside buildings. Part 3 Roof drainage, layout and calculation
- BS 8490 Guide to siphonic roof drainage systems
- BS 8204 Screeds, bases and in situ floorings
- CIRIA C753 SuDS Manual 2015
- National Federation of Roofing Contractors (NFRC) — eg NFRC Technical Guidance Note for Construction and Design of Blue Roofs. Roofs and podiums with controlled temporary water attenuation
- Mastic Asphalt Council (MAC) Mastic asphalt — The technical guide
- Single Ply Roofing Association (SPRA) Single Ply: Design Guide
- Federation of Traditional Metal Roofing Contractors (FTMRC) 'UK Guide to Good Practice — 3rd edition'
- Lead Contractors Association 'Lead Sheet in Roofing. The Ultimate Guide to Best Practice'
- Lead Sheet Training Academy 'The complete manual'
- The GRO Green Roof code of practice for the UK
- The Green Roof Organisation GRO fire risk guidance document
- Liquid Roofing and Waterproofing Association (LRWA) Code of Practice Specification and Use of Liquid Applied Waterproofing systems for Roofs, Balconies and Walkways
- Siphonic Roof Drainage Association (SRDA) A guide to Siphonic Roof Drainage
- Metal Cladding and Roofing Manufacturers Association (MCRMA).

Where a flat roof or terrace is above another home, it should provide satisfactory acoustic performance in accordance with relevant Building Regulations.

Where applicable, flat roofs, balconies and terraces should meet the relevant fire protection requirements in accordance with relevant Building Regulations.

7.1.2 Provision of information

Designs and specifications shall be produced in a clear understandable format, include all relevant information and be distributed to all appropriate personnel.

Design and specification information should be issued to NHBC, site supervisors, relevant specialist subcontractors and suppliers, and include the following information.

- design and details for balcony construction, including the decking and drainage system
- extent and direction of falls, and position of outlets to provide effective drainage with no back falls (a roof deflection analysis should be provided for medium to large roofs and those with complex roof layouts)
- sections through the construction, including how falls are formed
- method of ventilating voids where ventilation is required
- size, specification and position of the components, including treatment for durability, and position and extent of the AVCL, insulation and waterproofing layers
- details at critical junctions
- details of fixings, their frequency and fixing method, including those for insulation and surfacing
- specification for intensive and extensive Green Roofs, biodiverse roofs or Blue Roofs
- details and fixing methods of balcony support and guarding components
- survey requirements and preparation treatment of deck before application of waterproofing
- method of testing the integrity of the waterproofing layer.

7.1.3 Flat roof, terrace and balcony general design

The flat roof, terrace and balcony construction should suit the design and intended use.

The design of the flat roof, terrace (including podium or balcony) should adopt one or more of the following forms of construction.

Note
The suitability of any combination of deck, insulation, Blue Roof attenuation and roof toppings will depend on the structural loadings and the capability of the deck and insulation to safely support those loads in accordance with the structural engineer's design.

Figure 1: Individual reinforced concrete (RC) elements

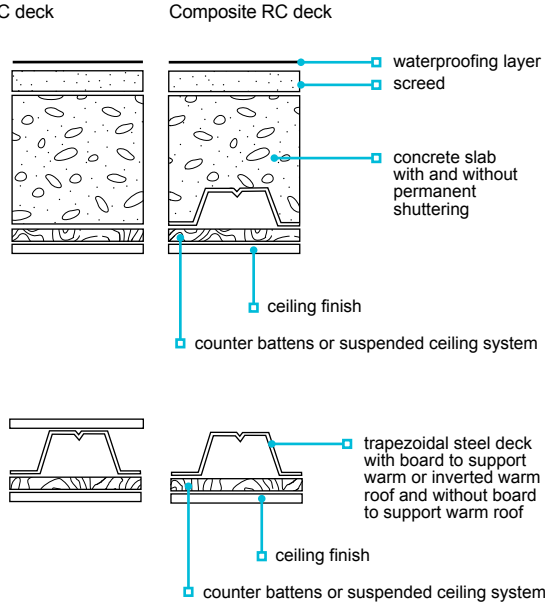


Figure 2: Warm roof

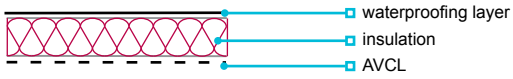


Figure 3: Cold roof

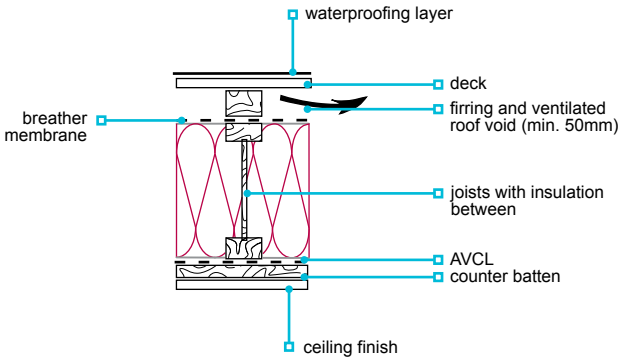


Figure 4: Inverted warm roof

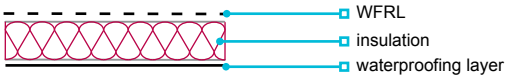


Figure 5: Uninsulated roof deck construction

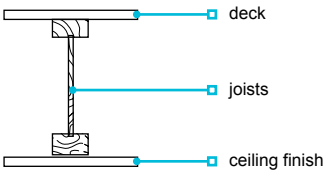
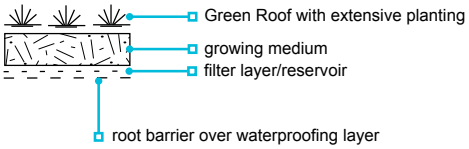


Figure 6: Roof toppings

Green Roof



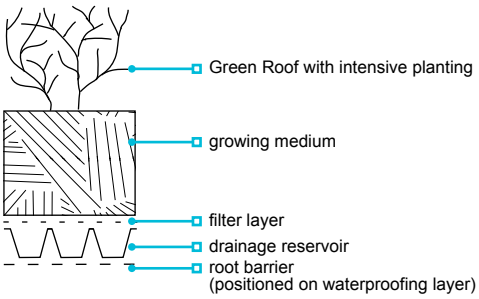
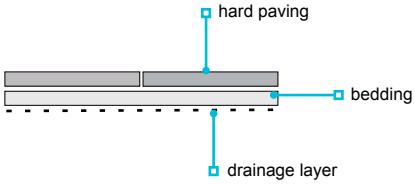
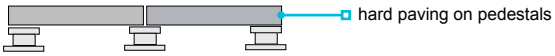


Figure 7: Paving





Roof, terrace and balcony constructions using the individual elements

Figure 8: Uninsulated decks

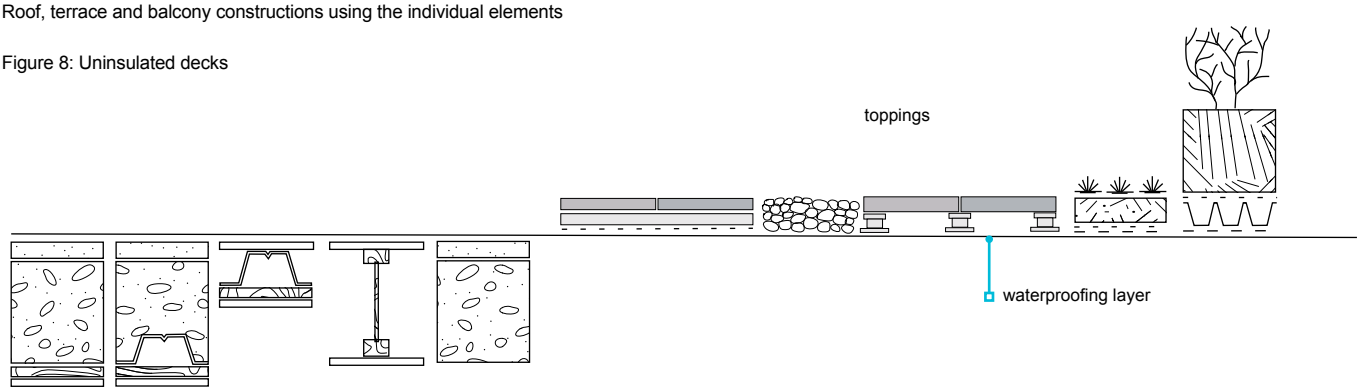


Figure 9: Warm roof construction

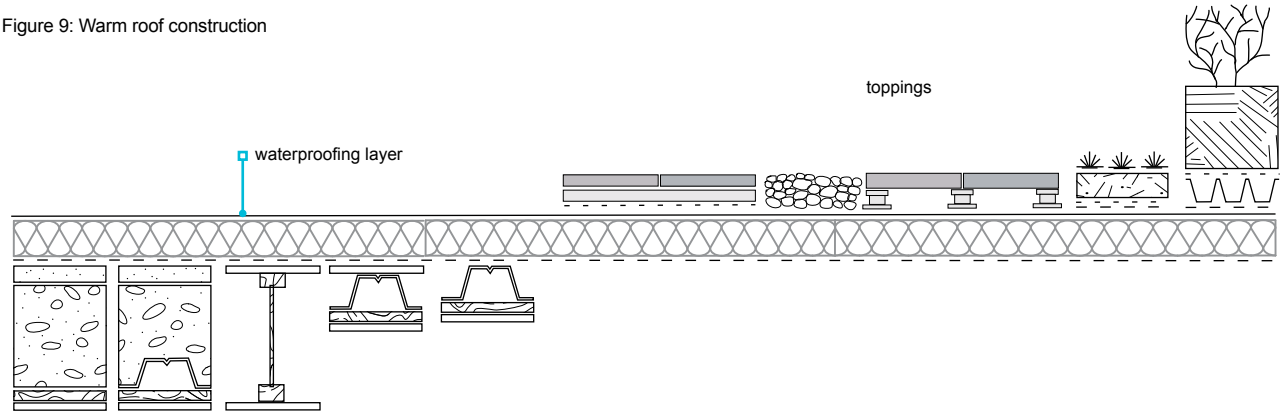


Figure 10: Inverted warm roof construction

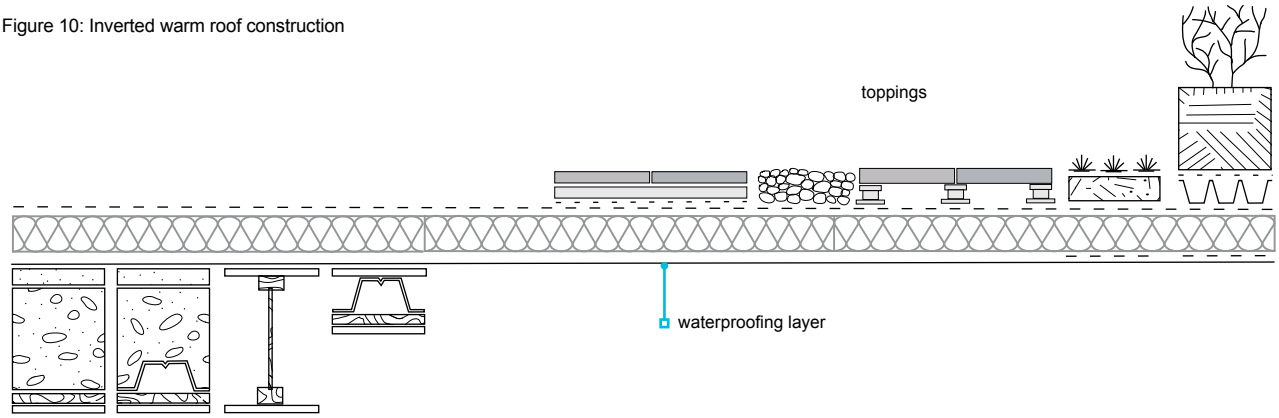


Figure 11: Cold roof construction

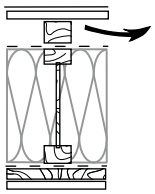
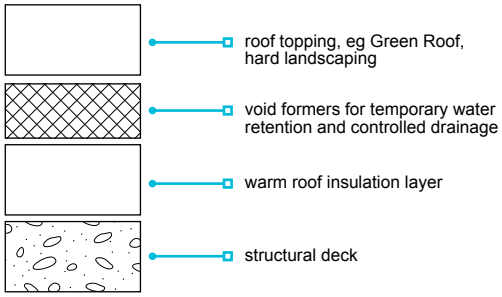


Figure 12: Blue Roof make-up



7.1.4 Drainage

Flat roofs, balconies and terraces shall have adequate and effective rainwater drainage to a suitable outfall. Design issues to be considered include:

1) **drainage system**
2) **falls**
3) **zero fall roofs**
4) **deck survey.**

7.1.4.1 Drainage system

The rainwater drainage system may be based on conventional piped drainage or an edge drained design. In all cases, the downpipes, overflows and edge drainage outlets should be positioned in the construction to provide effective drainage that will not cause water to flow directly down onto the walls and fascia surfaces below, or barrier edges of balconies installed in any stacked multi-storey arrangement.

A drainage system of outlets and downpipes should be:

- provided to all flat roof, balcony and terrace areas
- of sufficient size to accommodate normal rainfall and sized to cope with concentrated flows, including the accumulative effect of one roof draining onto another
- fixed in accordance with the design
- supported and jointed in accordance with the manufacturer's recommendations
- installed ensuring any gutters, including box gutters, are provided with stop ends where applicable, and with sufficient falls to provide effective drainage to outlets/downpipes
- provided with overflow(s) to avoid flooding in the event of one or more drainage outlets becoming blocked
- designed with a projecting profile that prevents rainwater from either tracking back into any soffit or running straight down onto vertical surfaces below
- designed with a downpipe shoe fitted where any downpipe outlet discharges above finished ground level, including above a drainage gulley.

Designs for drainage of balconies and terraces should follow BS 8579 guidance for the provision of discharge outlets with effective clearance, capacity and profile shape to throw rainwater clear of the edge and prevent residual dripping onto other parts of the building beneath.

A design approach for free draining balconies can be accepted if rainwater will always be routed away from the building to drain via a suitably formed soffit drainage tray that directs water to run outwards over a continuous formed perimeter edge. But where this drainage design is installed for stacked balconies on multi-storey elevations, the rainwater will tend to cascade down from these edge drainage slots as water runs off each balcony.

Under typical wind-driven rainstorm conditions, the water runoff volumes from these balcony catchment surfaces will progressively increase in a downward direction until the full volume of water reaches ground level. This can adversely affect locations such as main entrances to apartment buildings, as well as any access doorways and private gardens of individual homes at ground level. Therefore, in addition to the free draining balcony design, there is a requirement for design of ground level drainage to effectively prevent ponding or flooding of water. This drainage design is required along all building perimeter locations where thresholds, access locations and other places of regular use will exist.

Rainwater outlets should:

- be of the size and number required to deal with the expected rainfall intensity in accordance with BS EN 12056-3
- be positioned to provide effective drainage to all areas of the roof
- be recessed to facilitate the free flow of water without forming ponding at the junction with the waterproofing layer
- be accessible for maintenance
- be insulated to avoid surface condensation on the outlet and downpipe if passing through habitable areas.

Where a flat roof, balcony or terrace has an upstand on all sides, drainage should consist of a minimum of two outlets connected to separate downpipes, or be one outlet plus an overflow.

The overflow should be:

- provided through parapet walls or perimeter upstands
- sized for effective flow-rate and positioned to prevent water from entering the building, particularly in relation to door thresholds and low windowsills
- of higher capacity than the combined capacity of the other outlet(s)
- positioned to discharge safely away from the building
- always visible when in operation.

7.1.4.2 Falls

The finished roof, balcony or terrace should have effective drainage to the outlet(s) without creating back falls or ponding on the waterproofing layer and WFRL where fitted.

For large, medium and complex roof layouts a detailed analysis should be undertaken to establish both overall and localised deflections under predicted loading conditions, including long-term creep. This analysis should be co-ordinated with design for effective falls to roof drainage outlets. Allowances should be included for workmanship and construction tolerances, particularly with steel frame erection tolerances. The effects of localised loadings from features such as planters, service equipment, etc should be included in the design.

The design should show how ponding will be avoided, eg by placing outlets at points of maximum deflection, by use of a screed or tapered insulation, or firings, to take out the deflection and form falls to outlets.

Where falls are formed by use of screeds, follow the guidance in Clause 7.1.7.

Where tapered insulation is used:

- drainage should be designed by the insulation manufacturer, with design falls of no less than 1:60
- installation should comply with the design and manufacturer's recommendations
- the sequence of installation should ensure that boards are waterproofed and the roof sealed at the end of each day, or before the arrival of inclement weather
- it should be installed directly onto the AVCL, with the primary waterproofing layer above
- changes in the direction of falls should be formed with mitred joints
- successive roof layers should be installed with a minimum of delay, to avoid trapping water during construction.

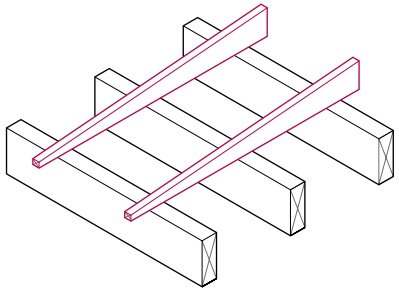
Firring pieces should be:

- used to form falls, unless the design specifies a sloping joist or ceiling
- of the size given in Table 1 where installed across the joists
- adequately fixed to the joists in accordance with the design.

Table 1: Size of firring pieces used to form falls

Joist centres (mm)	Minimum width (mm)	Minimum depth (mm)
400 or 450	38	38
600	38	50

Figure 13: Firrings used to form deck fall gradient



Where a detailed analysis is not undertaken, the roof should be designed with a design fall that caters for initial and long-term deflection to ensure the finished fall provides effective drainage without back falls or ponding.

Table 2: Suggested design falls for various roof types

Type of roof	Design fall	Minimum finished fall
Membrane and liquid applied waterproofing	1:40[3]	1:80
Profiled metal roof system (self-supporting)	5.5° (1:10)[1]	4° (1:14)[2]
Profiled metal roof (fully supported)	6.5° (1:9)	5° (1:12)[4]
Standing seam roof system (self-supporting)	2.5° (1:23)[1]	1° (1:60)[4]
Flat sheet hard metal roof (fully supported)	1:40[3]	5° (1:12)[4]
Lead roof (fully supported)	1:40[3]	1:80
Green/biodiverse roof	1:40[3]	1:80 (at drainage level)
Blue Roof	1:40[3]	1:80 (Also see Clause 7.1.13)
Tapered insulation	1:60[3]	1:80

Notes
1. The supporting structure should be designed at a pitch of 1.5° more than the minimum pitch for the sheeting, or the designed roof slope, to allow for tolerances and on-site variations, unless justified by a detailed structural analysis of the main frame and secondary steelwork to account for deflection/settlement.
2. Based on through fixings. For lesser pitches, including the apex of any curved roof which approaches flat, proprietary secret fixed types of profiled sheeting should be used in accordance with the system manufacturer's instructions.
3. Design fall to take account of deflection and construction tolerance for the supporting deck to ensure at least minimum finished fall on completed roof. Design fall is usually taken as twice the finished fall unless a detailed deflection/settlement of the deck is carried out.
4. Check with manufacturer for alternative pitch recommendations.

7.1.4.3 Zero fall roofs

Zero falls are not accepted for roofs with exposed waterproofing layers; such roofs should be designed to the falls shown in Table 2.

7.1.4.4 Deck survey

Prior to laying the waterproofing layer(s), a site survey of the deck should be carried out by the deck erector, and any backfalls should be rectified. Depending on the deck construction material, this may be achieved by applying localised screed, to remove depressions and maintain falls to outlets, these remediated areas should be resurveyed to ensure no backfalls remain. Additional rainwater outlets may be required at any remaining point(s) of maximum deflection. A formal handover procedure should be undertaken between the deck erector and a specialist waterproofing contractor.

7.1.5 Flat roof, terrace and balcony structural design

Flat roofs, terraces and balconies shall support and transmit loads safely to the structure.

The structure of the flat roof, terrace or balcony should:

- be produced by an engineer in accordance with Technical Requirement R5, and BS EN 1991-1-1, BS EN 1991-1-3, BS EN 1991-1-4 and BS 8579: 2020 for balconies
- be designed to address both short-term and long-term deflection to provide an effective drainage strategy with no back falls or ponding
- resist wind uplift by self-weight or by being anchored to the main structure — where required, holding-down straps should be provided at maximum 2m centres at the perimeters
- have adequate provision for additional loads where a flat roof is to act as a terrace, roof garden, for support of permanent service equipment, and for additional loads during construction
- have adequate provision for movement in larger roofs, particularly where the span of the roof deck changes (in L-shaped buildings; joints should be continuous through the vertical upstands, walls and edges of the building)
- include support steelwork and joists which are square, true and free from twists or sagging
- have adequate crack control/dimensional stability to avoid damage to directly applied AVCL and waterproofing layers, particularly for liquid applied waterproofing.

Where joists and concrete roof elements are used to provide lateral restraint, they should:

- have a minimum bearing of 90mm, or
- have restraint straps at 2m centres (maximum) where joists or concrete beams are parallel to walls.

7.1.6 Timber structure and deck

Timber flat roofs, balconies and terraces shall be of adequate strength and durability and be installed to form a satisfactory substrate for the waterproofing system. Issues to be considered include:

1) **structure and durability**
2) **joist hangers, straps and strutting**
3) **installing timber decks.**

7.1.6.1 Structure and durability

Structural elements of balconies should have a service life of at least 60 years.

Timber in balconies should be limited to elements which are supported by materials other than timber. Timber should not be used for:

- gallows brackets supporting a balcony
- posts or columns supporting a balcony
- guardrails, including their support
- infill joists
- cantilevered joists or decks.

Decking boards should be specified and fixed in accordance with:

- guidance from the Timber Decking and Cladding Association (TDCA), or
- an engineer's design, in accordance with Technical Requirement R5.

The use of timber in balcony and terrace constructions may also be restricted by fire protection requirements set out in the Building Regulations.

Timber, including solid and engineered joists, should be:

- checked for conformity with the design upon delivery
- rejected where excessively wet, damaged or not of a suitable quality or shape
- stored under cover to prevent wetting but avoid sweating
- preservative treated or naturally durable, in accordance with Chapter 3.3 Timber preservation (natural solid timber)
- re-treated along the cut edges with a coloured preservative, where preservative treated timber has been cut
- be temporarily covered to prevent wetting, unless the waterproofing is to be installed immediately.

Timber structure should:

- be in accordance BS EN 1995-1-1 or appropriate load/span table published by TRADA in support of Building Regulations
- be from regularised timber, dry graded to BS 4978 and marked 'DRY' or 'KD' where softwood is used internally
- have I-joists or metal web joists specified in accordance with the manufacturer's recommendations and not used where any part of the joists is exposed to external conditions
- have joists which are sized and spaced in accordance with the design and at maximum 600mm centres
- be level and, where necessary, using hard packing such as tiles or slates bedded in mortar to adjust joists (loose or soft packing, including timber, should not be used).

Timber decks should be formed from one of the materials listed in Tables 3, 4 and 5.

Table 3: Materials used for deck to flexible membrane roof coverings

Material	Minimum thickness of deck (mm) [1]	
	450mm joist centres	600mm joist centres
Plywood board to BS EN 636, Use Class 3.2, 'S'[2]	15[4]	18[4]
Oriented strand board, to BS EN 300 type OSB3	15	18
Pre-treated timber planking, tongue and grooved (close boarded timber; maximum plank width 100mm[3])	19	19

Notes
1. Deck may need to be thicker to resist pull-out forces on fixings.
2. All square board edges to be supported.
3. Moisture content between 16-20% at time of fixing.
4. For curved roofs, two layers of thinner boards to achieve minimum thickness.

Table 4: Decking materials for fully supported traditional hard metal roof coverings

Material	Minimum thickness of deck (mm)
Plywood board to BS EN 636, Class 3.2, 'S'[1] square edged with 2-3mm gaps between boards[3]	18[2]
Pre-treated timber square edged sarking boards, width 100-125mm with 3-5mm gaps between[4]	18

Notes
1. Avoid yellow and maritime pine or low-quality softwoods.
2. For curved roofs, two layers of thinner boards to achieve minimum 18mm thickness.
3. All board edges to be supported.
4. Moisture content between 16-20% at time of fixing.

Table 5: Decking materials for lead roof coverings

Material	Minimum thickness of deck (mm)
Plywood board to BS EN 636, Class 3.2 'S'[1] square edged with 3-5mm gaps between boards[3]	18[2]
Pre-treated softwood timber square edged sarking boards, width 100-125mm with 2-3mm gaps between[4]	18

Notes
1. Avoid oak, Douglas fir and Western red cedar.
2. For curved roofs, two layers of thinner boards to achieve minimum 18mm thickness.
3. All board edges to be supported.
4. Moisture content between 16-20% at time of fixing.

7.1.6.2 Joists hangers, straps and strutting

Masonry carrying joist hangers should be level and at the correct height.

Mild steel straps and fixings should be protected against corrosion in accordance with BS EN 845-1.

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.

Where holding-down straps are required to prevent the roof from lifting from the supporting structural, they should be:

- spaced at a maximum of 2m centres at the perimeters
- fixed with minimum of four hardened nails 4mm in diameter x 75mm long, or No. 12 wood screws x 50mm long, into plugs (where fixed to masonry)
- fixed with the lowest fixing secured within 150mm of the bottom of the vertical strap
- 30mm x 2.5mm and 1m long
- predrilled for fixings.

Figure 14: Joist hanger

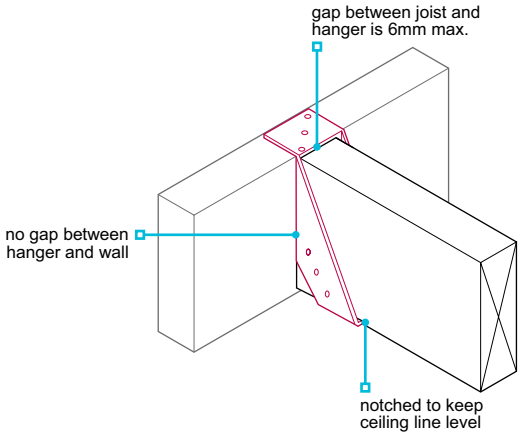
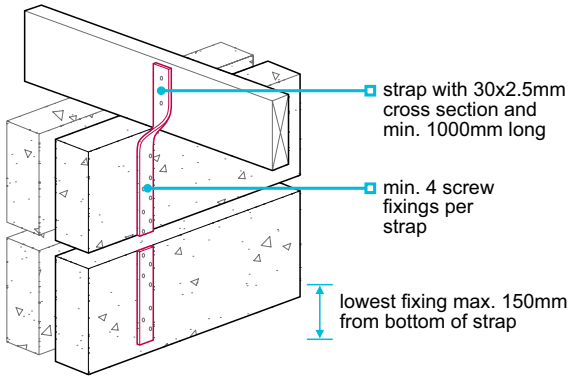


Figure 15: Joist strap



Strutting should be provided to prevent excessive movement, and:

- be either herringbone type (timber 38mm x 38mm), solid blocking (38mm thick timber x 0.75 depth of joist) or proprietary steel strutting or I-joist sections
- not prevent cross ventilation in cold roofs
- be spaced in accordance with Table 6.

Table 6: Spacing for strutting

Joist span (m)	Rows of strutting
Up to 2.5	None needed
2.5 – 4.5	One (at centre of span)
Over 4.5	Equally spaced along the span at maximum 2.5m centres

7.1.6.3 Installing timber decks

When installing timber decks:

- conditions should be dry, and materials protected from wetting until the roof is complete
- the area of deck installed should be of a size which can be quickly covered in the event of rain
- materials that have been damaged or adversely affected by moisture should be discarded
- tops of boards should be laid flush, with no deviation greater than 2mm
- boards should be laid in a staggered pattern
- cut edges should be treated to prevent moisture ingress
- boards should have a minimum 'good one side'
- boards should have all nails and screws punched or countersunk below the surface of the board
- boards should be free of sharp arises on external angles.

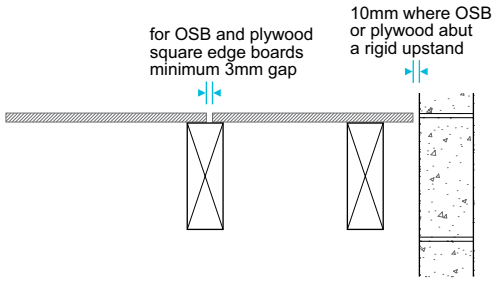
Plywood and oriented strand board (OSB) should:

- have tongued and grooved boards installed with the long edges at right angles to the supporting firrings or joists, and short edges supported on a joist or nogging (always use square edge boards for support of hard metal and lead roofs)
- have edges of square edged boards supported on joists or noggings with movement gaps of 3-5mm between boards
- have a minimum movement gap of 10mm (or 2mm per metre of boarding, whichever is the greater) where boards abut a rigid upstand
- be supported on noggings where the edges of boards situated along the roof perimeter do not coincide with joists, and where square edged boards within the roof area do not coincide with a joist
- be fixed at a maximum of 100mm centres (unless the design specifies closer)
- be fixed with flat-headed ring shank nails (minimum of 50mm long x 3mm for plywood, or for OSB, a 3mm gauge nail size of minimum length 2.5 x board thickness. For woodscrew fixings, the same minimum lengths will apply.

OSB should be:

- installed over supports in the direction indicated on the boards, with the stronger axis installed at right angles to the supporting joists
- fixed a minimum of 8mm from the edge of the board.

Figure 16: Softwood tongued and grooved boarding



Softwood tongued and grooved boarding should be:

- closely clamped together with end joints staggered
- fixed with two ring shank nails to each joist or firring, with nail heads punched below the timber surface.

Cross Laminated Timber (CLT)

Due to the semi-impervious nature of CLT panels and the risk of trapping moisture in the panels during the construction period, they are not accepted for flat roof construction.

Structural insulated panels systems (SIPS) (used as self-supported deck)

Due to the difficulty in achieving effective continuity of an AVCL across the warm side of a SIPS deck construction, and the risk of trapping moisture in these panel assemblies during the construction period, SIPS elements are not accepted for warm flat roof construction.

7.1.7 Concrete decks

Concrete flat roofs and balconies shall form a satisfactory substrate for the waterproofing systems. Issues to be considered include:

1) structure and durability
2) screeds to falls
3) drying.

7.1.7.1 Structure and durability

Concrete flat roofs should be constructed to ensure they achieve the required design, strength and durability, and be in accordance with BS EN 1992-1-1 and Chapter 3.1 Concrete and its reinforcement.

In-situ reinforced concrete decks should:

- be formed using a mix which has low shrinkage characteristics
- have accurately constructed and suitably supported formwork
- have an even surface to receive the selected waterproofing layer (with adhesive bonded membranes; the surface should be slightly roughened, wooden floated or lightly brushed, in accordance with the manufacturer's recommendations)
- be protected until adequately cured and dried
- not contain additives that could affect the adhesion of any adhesive bonded waterproofing membranes.

Note
Liquid applied surface treatment onto the concrete to assist curing can adversely affect the bonding of the waterproofing layer. The compatibility of such liquids should be checked with the waterproofing layer manufacturer before use.

Precast concrete decks should:

- have a minimum 90mm bearing (unless the design specifies a smaller dimension)
- have allowance for continuity or anti-crack reinforcement to avoid differential movement between units and stress in the waterproofing layer
- have allowance for movement approximately every 15m and at abutments
- be installed to provide an even surface with no back falls
- be grouted, as specified in the design.

7.1.7.2 Screeds to falls

Where falls have not been formed in the concrete deck, they may be formed by the application of a screed. Sand/cement screeds used to form falls to concrete roofs should be:

- free from ridges and indentations
- laid on a concrete deck that has been suitably prepared to receive a screed
- finished with a wooden float to provide a smooth, even surface for the AVCL and waterproofing finish
- to a minimum thickness in Table 7 where a cement/sand screed 1:4 (cement:sand) is used
- suitably dry and primed to receive the waterproofing system in accordance with the membrane manufacturer's recommendations.

Lightweight screed should only be installed by specialist contractors and have a topping of 1:6 (cement:sand) 15mm thick.

Table 7: Minimum screed thicknesses

Location of screed	Nominal thickness (mm)
Bonded monolithically in-situ or separately bonded to precast concrete(1)	40 (25 minimum)
Unbonded on separating layer	70 (50 minimum)
Proprietary polymer modified screeds	In accordance with manufacturer's recommendations

Notes
1. Precast units should be sufficiently rigid and properly grouted to avoid movement between units leading to cracking in the bonded screed. Movement joints/details may be required over ends of precast units and at perimeters or abutments. The waterproofing layer detailing should take account of any movement joints.
2. Where a cast in-situ concrete deck, designed and laid to falls, is found to have areas of ponding or back falls, preparation work should be carried out to provide effective drainage prior to the application of the waterproofing layer. Polymer modified screeds may be used to make up any depressions in the concrete roof to avoid any ponding or correct any back falls. The adjusted areas should be resurveyed to ensure no ponding or back falls remain. The compatibility of the levelling screed with the waterproofing layer should be confirmed by the waterproofing manufacturer.

7.1.7.3 Drying

A permanent waterproofing layer should not be installed until the deck has cured and dried sufficiently to avoid trapping potentially damaging moisture and to allow the application of the waterproofing in accordance with the membrane manufacturer's recommendations. A check should be carried out on the moisture content of the slab to meet the membrane manufacturer's recommendations. Where an adhesively bonded waterproofing layer is to be applied, a bond test should be undertaken to check whether the concrete is sufficiently dry to achieve effective bonding adhesion. This is usually around 28 days for fully bonded waterproofing, or to the manufacturer's recommendations.

Note
Permanent metal shuttering will significantly prolong the period needed to achieve an acceptable moisture content of the concrete before applying any waterproofing layer. Perforated shuttering can assist drying out; any perforation should be factory made. A mechanical extraction/dehumidifier can also assist in the drying process.

7.1.8 Profiled self-supporting metal roof decks

Profiled self-supporting metal decks shall form a satisfactory substrate for the flat roof build-up. Issues to be taken into account include:

1) **structural performance**
2) **material and profile**
3) **roof build-up.**

7.1.8.1 Structural performance

Profiled self-supporting metal flat roofs should:

- be constructed to ensure they achieve the required strength and durability, and be checked for conformity with the design upon delivery
- comply with the manufacturer's load and span tables including relevant applied safety factors
- conform to BS EN 1090-4 (steel) and BS EN 10905 (aluminium)
- resist loads in accordance with BS EN 1991-1-4
- be fixed in accordance with the manufacturer's instructions with side laps stitched to ensure performance as a continuous structural plane (unless a manufacturer and design specialist recommends otherwise)
- be adequately protected from construction loads
- be suitably stored to prevent damage.

7.1.8.2 Material and profile

Profiled self-supporting metal flat roof sheeting should:

- be galvanised steel to BS EN 10346 (typical gauge range 0.7-1.2mm) or aluminium to BS EN 485-2 (minimum gauge 0.9mm) and used in accordance with BS EN 1993-1-3 and BS EN 1999-1-4 respectively
- for bonded systems — have a crown which at least 45% of the profile width, not including the crown stiffener grooves
- for mechanically fixed systems — have a crown which at least 40% of the profile width, not including the crown stiffener grooves
- be of suitable quality and finish before the waterproofing layer and insulation system is installed
- be fixed using suitably specified fixings which avoid bimetallic corrosion in accordance with the manufacturer's recommendations.

7.1.8.3 Roof build-up

The roof build-up should:

- be a warm or inverted-warm roof design
- have drainage falls formed by installing the profiled metal sheeting fitted at a slope or by use of tapered insulation
- use an insulation board product with a compressive strength capable of spanning across the troughs of the profiled sheeting without crushing, or be laid over support boards fixed across the profiles
- in warm roof build-ups where unsupported across the troughs, use a reinforced AVCL, or AVCL recommended by the waterproofing manufacturer
- for inverted warm roof designs, these should incorporate support boarding fixed across profiles to fully support the waterproofing layer.

Figure 17: Profiled metal deck features

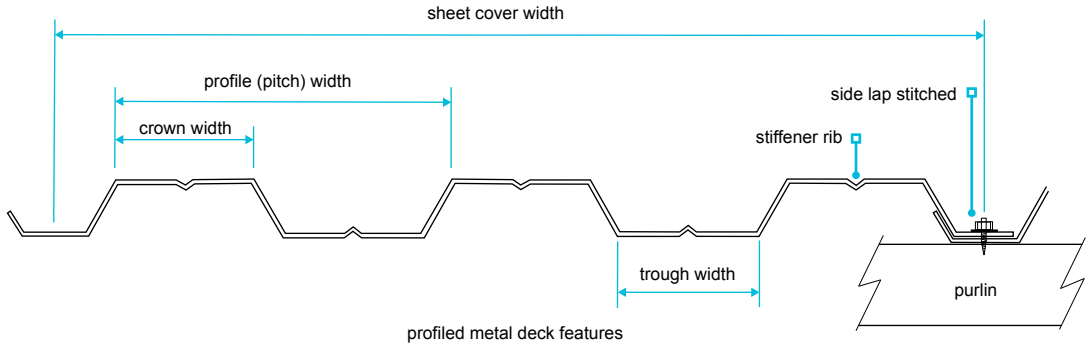


Figure 18: Warm roof construction — with metal deck

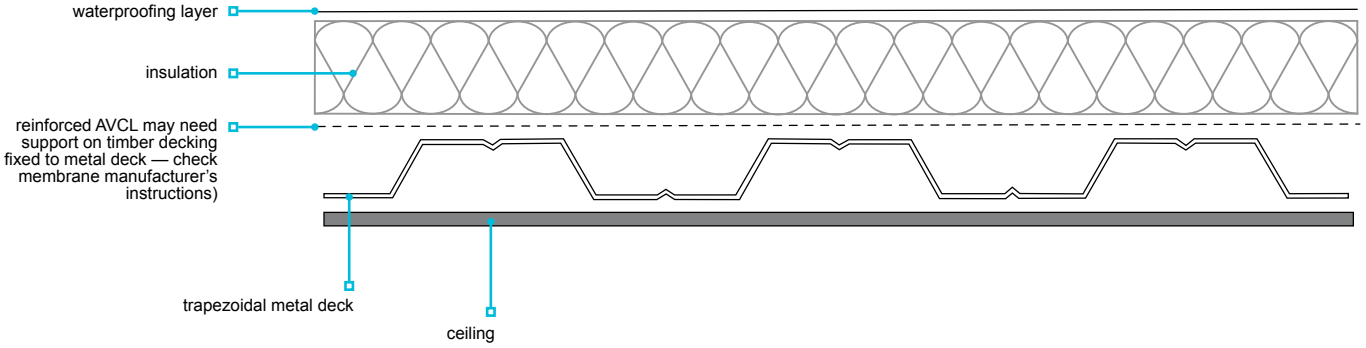
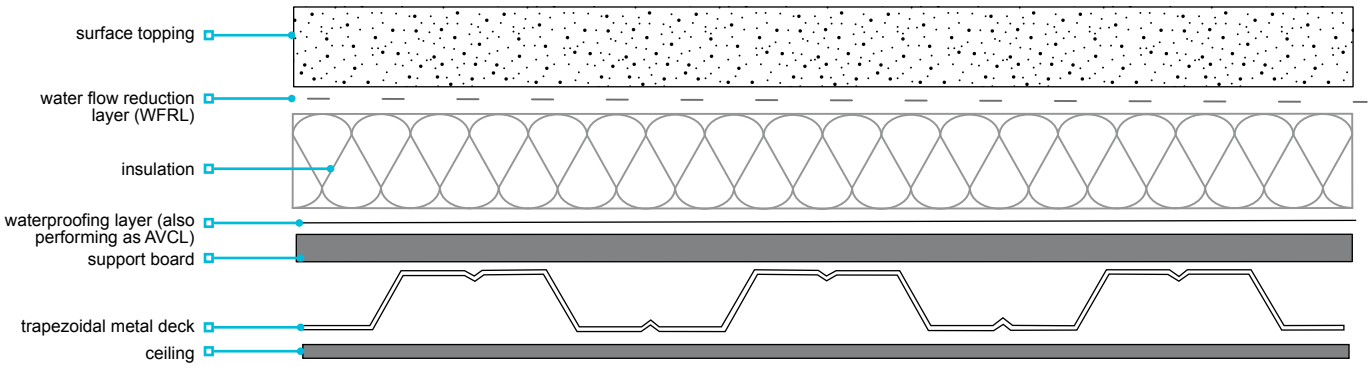


Figure 19: Inverted warm roof construction



7.1.9 Profiled self-supporting metal roofing

Profiled self-supporting metal roofing shall be of adequate strength and durability, resist the passage of water to the inside of the building, and provide an adequate level of thermal and sound insulation.

Profiled self-supporting metal sheet roofs should be designed and constructed 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.

Profile sheet roofing can be:

- a site assembled system including self-supporting metal liner and outer metal profile. To be held apart by a site-installed structural support system, with insulation between the liner and profile layers
- factory insulated panels system ie, sandwich panels or composite panels with metal inner and outer skins factory bonded onto a thermal core insulation layer to form a composite self-supporting assembly.

An AVCL must be provided on the warm side of the insulation.

Note
Subject to the profile manufacturer's recommendations, the AVCL can be formed by sealing the side and end laps of the metal liner or by the provision of a separate AVCL membrane directly above the inner liner. The AVCL must be fully sealed around all penetrations and at the roof perimeter, and have a vapour resistance of at least 5,000MNs/g. If high-density polythene is used, it must be reinforced 1,000 gauge or more and of virgin material.

Insulation should contact both the inner and outer metal layers. Any voids formed by the profile of the outer sheet metal roof covering should be ventilated. Ventilation can be achieved by leaving open the profile at both ends of the sheeting above the insulation. If profile fillers are fitted, they should leave a free area of not less than 5% of the cross-sectional area of the void. Where the insulation is likely to be affected by local condensation, a breather membrane should be provided on top of the insulation to discharge condensate externally in accordance with the profile manufacturer's recommendations.

The profiled panels should be fixed using suitable fixings which avoid bimetallic corrosion in accordance with the manufacturer's recommendations.

Figure 20: Twin skin build-up

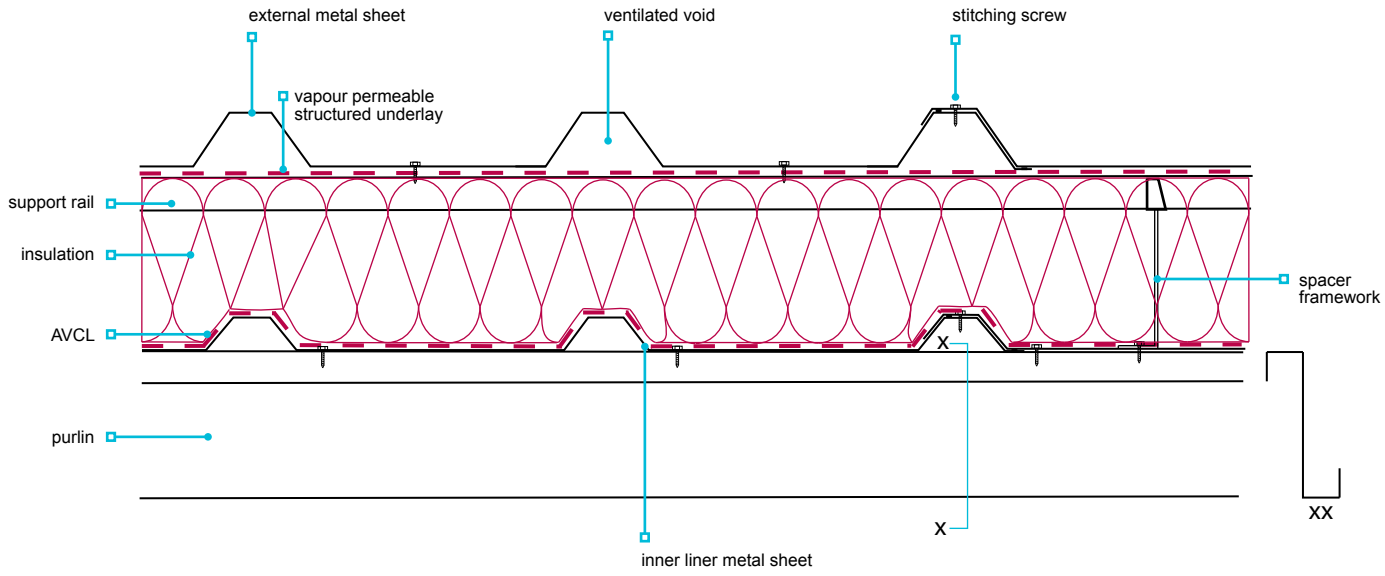


Figure 21: Standing seam roof (secret fixings)

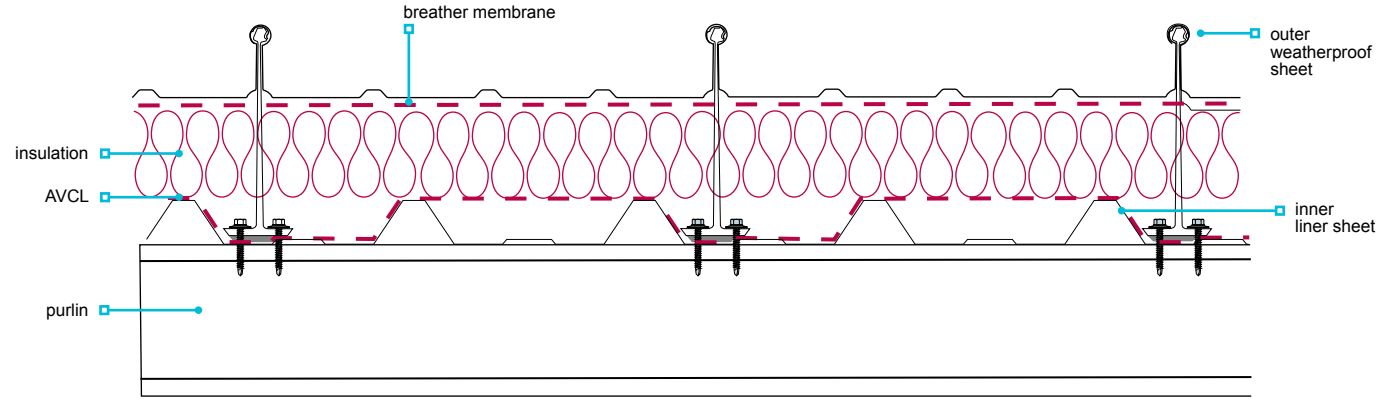
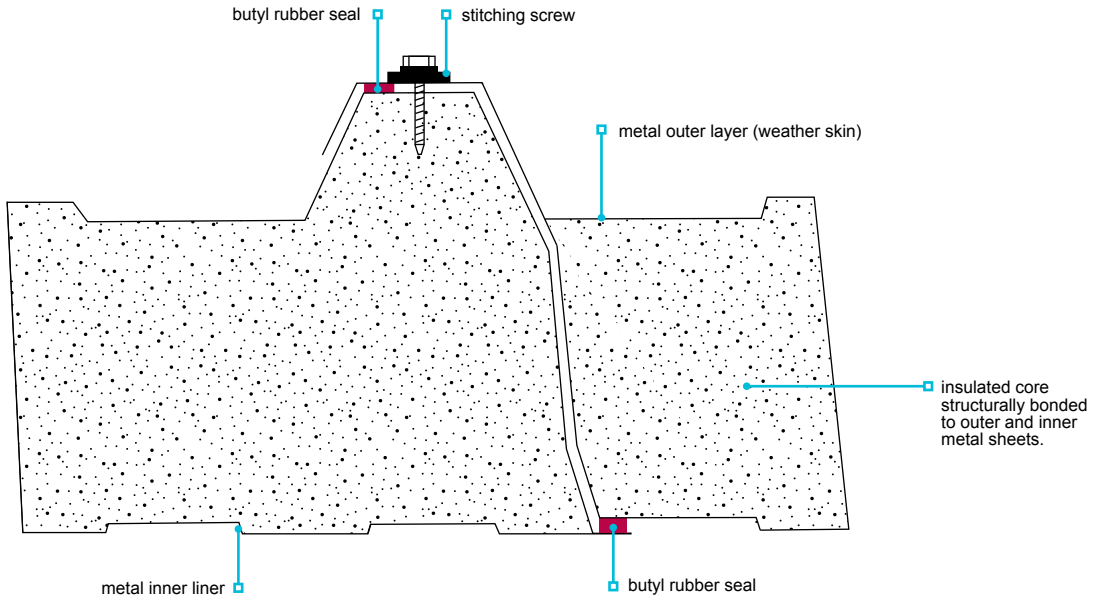


Figure 22: Example of edge seal with composite roof panels



The panel side laps and end laps should be sealed to provide an air barrier as part of the overall air leakage and vapour control requirement of the building, in accordance with the panel manufacturer's instructions.

7.1.10 Thermal insulation and vapour control

Also see: BRE Report Thermal insulation: avoiding risks and BS 5250

Thermal insulation, vapour control and ventilation shall ensure satisfactory performance, and prevent the formation of condensation which could adversely affect the construction. Issues to be considered include:

1) **thermal characteristics of roof types**
2) **types of insulation**
3) **control of water vapour.**

7.1.10.1 Thermal characteristics of roof types

Uninsulated roof — the temperature of the deck is at or close to that of the interior or exterior of the building, whichever is the lesser.

Cold roof — the temperature of the deck is at or close to that of the external climate. Cold roof designs should be limited to roofs where it can be shown that effective cross-ventilation can be provided to reduce the risk of interstitial condensation.

Warm roof — the temperature of the deck is at or close to that of the building interior.

Inverted warm roof — the temperature of the deck is at or close to that of the building interior. The WFRL should be designed and installed to collect and drain most of the rainwater to reduce water entering and cooling the insulation layer.

Condensation analysis should be calculated as given in the relevant clause of BS 6229 for Control of Condensation, in accordance with BS 5250 and BS EN ISO 13788.

7.1.10.2 Types of insulation

Types of insulation and their use should be in accordance with Table 8.

Table 8: Insulation materials — types and product standards

Insulation material	Abbreviation	BS EN Standard	Applications	
			Warm roof	Inverted warm roof [1]
Expanded polystyrene board	EPS	13163	yes[2]	no[3]
Extruded polystyrene board	XPS	13164	yes[2]	yes
Rigid polyurethane foam board	PUR, or PU	13165	yes	no
Phenolic foam board	PF	13166	yes	no
Polyisocyanurate board	PIR	13165	yes	no
Cellular glass board	CG	13167	yes	no[3]
Expanded perlite board	EPB	13169	yes	no
Cork board	ICB	13170	yes	no
Fibreboard, bitumen-impregnated (used in conjunction with EPS with hot applied waterproofing)			yes	no
Composite boards or decks (eg PIR insulation bonded to plywood)			yes	no
Resin bonded mineral wool rigid board	MW	13162	yes	no
Mineral wool quilts[4]	MW	13162	no	no
Vacuum insulation panels[5]	VIP		yes	yes

Notes
1. Thermal insulation used in inverted roofs should be designed in accordance with ETAG 031 Inverted Roof Insulation Kits Guideline for European Technical Approval.
2. Suitably protected when using hot applied waterproofing.
3. Unless the product has an independent third-party assessment for use in inverted warm roofs.
4. Not suitable for warm or inverted warm roofs and only used in cold roofs.
5. Suitably assessed in accordance with Technical Requirement R3.

Insulation for warm roofs should be:

- either:
  - bonded or mechanically fixed to resist wind uplift in accordance with the manufacturer's recommendations; where mechanically fixed, it should be installed using fixings of sufficient length to ensure adequate penetration into the supporting structure, or
  - part of a loose laid roof system which is ballasted to resist wind uplift
- kept dry and installed in quantities which can be quickly covered if it rains (to aid bonding and to avoid trapping moisture)
- dimensionally stable at working temperatures (eg 100°C under metal roofs)
- lightly butted to avoid gaps.

Insulation for inverted roofs should be:

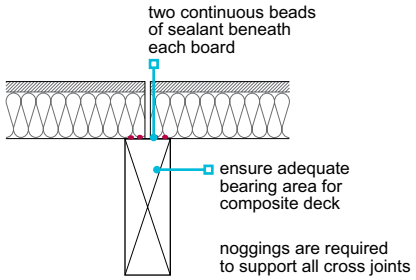
- extruded polystyrene (XPS), or expanded polystyrene (EPS) should be suitably assessed in accordance with Technical Requirement R3
- suitable for external use
- ballasted to avoid floatation and wind uplift
- suitable for the weight of the ballast and able to withstand anticipated traffic and design loads
- protected by a breathable water flow reducing layer WFRL to reduce the cooling effect of cold water flowing into and under the thermal insulation and across the waterproofing layer
- calculated to take account of the cooling effect of rainwater seeping through the insulation board joints in accordance with BS 6229 and ETAG 031-1 and the dry calculated thickness increased to allow for this cooling effect.

Note
A WFRL should be designed and installed to drain most of the water from the roof. It should be installed at right angles to the designed slope of the roof, starting at the bottom of the slope. All side and end laps should be a minimum of 300mm. The WFRL should be star cut around pipes and wrapped with an additional membrane section, turned up at upstands and penetrations, and turned down at drainage locations/outlets.

Composite insulated timber decks should:

- have two beads of sealant along each board joint at the foil under face (to maintain the integrity of the VCL) in accordance with the board manufacturer's recommendations.

Figure 23: Composite insulated timber deck



7.1.10.3 Control of water vapour

The movement of water vapour within the roof construction must be controlled to avoid the risk of interstitial condensation. This can be achieved by providing an AVCL on the warm side of the insulation.

In a cold roof, the addition of ventilation to the void(s) between the insulation and decking can also assist by removing water vapour from within the construction.

Warm roofs do not incorporate ventilation and rely entirely on the AVCL to avoid interstitial condensation. It is therefore essential that a good quality AVCL is used and that all laps, joints or penetrations are fully sealed. All AVCLs should be fully checked for any damage just prior to being covered over. Any damage should be repaired using a full width section of membrane. Penetrations should be kept to a minimum and fully sealed to the AVCL.

In an inverted warm roof, the waterproofing layer also acts as the AVCL. Control of interstitial condensation relies on the thermal insulation above the waterproofing layer being kept free from running or ponding water between the insulation and waterproofing layer, and within joints between the insulation boards. This should be controlled by the correct installation of the WFRL laid over the insulation.

AVCLs can be formed with one of the materials listed in Table 9.

Table 9: Materials for use as an AVCL

Material	Specification
Reinforced bitumen membranes	BS 8747 BS EN 13970
Self-adhesive polythene/metal foil/bitumen membranes for cold self-adhesion	BS EN 13970 BS EN 13984
High-density polyethylene sheet with metal foil core	BS EN 13984
High-density polyethylene sheet	BS EN 13984
Plastic and rubber sheets	BS EN 13984
12mm one coat mastic asphalt on glass fibre tissue	BS 6925

Note
Metal-cored flexible reinforced bitumen membranes are also suitable to form an AVCL.

AVCLs to warm roofs should:

- include at least one layer of reinforced bitumen roofing membrane (S2P3) below the insulation, fully or partially bonded to the structural deck as appropriate, or a suitable self-adhesive or torch-on membrane
- be self-sealing (eg self-adhesive aluminium foil-backed modified bitumen membrane) if penetrated by mechanical fixings, eg those securing the insulation boards to the deck
- be sealed and lapped to the waterproofing layer (where compatible) at the perimeters and at each penetration, eg at outlets and pipes, rooflights, etc or extended up a minimum 50mm above the insulation and sealed to the wall, rooflights, etc
- be fixed to resist the calculated wind uplift forces.

AVCLs for warm roof constructions supporting traditional hard metal roofs should have a minimum vapour resistance of 4000MNs/g and be fully supported.

Any fixings that penetrate the AVCL, eg those securing insulation boards to the deck, should be carefully installed to avoid creating open perforations that would allow water vapour to pass through.

Cold flat roofs are difficult to detail correctly but, where used, they should be in accordance with BS 6229 and BS 5250 and have:

- an effective AVCL at ceiling level
- an unobstructed minimum 50mm ventilation space above the insulation
- adequate cross ventilation (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.

Note
All ventilation gaps should have protective mesh or grilles (nominal 4mm openings) to avoid entry of large insects and birds.

7.1.11 Waterproofing layer and surface treatments

Flat roofs, and balconies forming roofs, shall adequately resist the passage of water to the inside of the building. Issues to be considered include:

1) installation of waterproofing layer
2) waterproofing systems
3) surface treatments
4) fire protection.

7.1.11.1 Installation of waterproofing layer

Prior to the waterproofing layer being installed:

- the surface should be even and dry, and any nails should be punched, or screws countersunk, below the surface
- any penetrations for drainage, services, rooflights, etc should be formed before the waterproofing layer is applied
- the manufacturer's recommendations for the preparation, including priming upstands, roof outlets, etc should be followed to achieve a satisfactory bond with the waterproofing layer
- the manufacturer's recommendations for conditioning, and unrolling membranes in advance of laying, should be followed.

Environmental conditions should be suitable for installing the waterproofing layer. Issues to be considered include the following:

- membranes should not be installed or handled when the product temperature and the air temperature is 5°C or less, unless otherwise agreed with the manufacturer
- self-adhesive bitumen membranes should not be installed or handled below 5°C, unless otherwise permitted by the manufacturer
- membranes should not be installed on damp or frosted surfaces, or when any rain, sleet or snow is falling.

Waterproofing layer should be:

- secured in a manner that resists the wind uplift
- secured in a manner that allows expansion of metal decks
- installed in accordance with the design and the manufacturer's recommendations
- installed by a specialist roofing contractor approved by the manufacturer, where a proprietary system is used
- installed by the same contractor who installs the AVCL, insulation and surface finish
- checked by the contractor to ensure that the deck and insulation boards are waterproofed at the end of each day with 'night joints' and before inclement weather
- installed so that membrane laps near outlets do not impede drainage ie, outlets should be recessed to avoid forming a raised lip with the waterproofing layer
- installed so that successive layers do not trap water.

Inverted roofs should:

- not be used for slopes greater than 10 degrees
- be laid on a deck with no back falls or ponding
- be designed to support the loads, particularly from ballast needed to retain insulation
- be ballasted to the depth specified in the design to resist wind uplift, flotation and provide fire protection, using minimum 40mm paving slabs or 20-40mm diameter rounded shingle ballast minimum 50mm deep, subject to any other requirements to meet fire protection measures
- installed with a separating layer between the waterproofing layer and inverted warm roof insulation where required by the membrane manufacturer.

Note
The depth of ballast required to resist flotation may exceed the minimum depths needed to meet the fire protection.

7.1.11.2 Waterproofing systems

Table 10: Waterproofing layer materials

Material	Standard	Code of practice	Other guidance
Reinforced bitumen membrane (RBM)	BS 8747 BS EN 13707	BS 8217 BS 6229	
APP and SBS modified bitumen roofing systems	BS EN 13707 evaluation of conformity	BS 8217 BS 6229	Standards as listed in BS EN 13707 Normative references
Mastic asphalt	BS 6925	BS 8218	Mastic Asphalt Roofing TECHNICAL GUIDE Mastic Asphalt Council (MAC)
Plastic and rubber sheets	BS EN 13956		SPRA S01-2020 SINGLE PLY ROOFING DESIGN GUIDE 2020 Single Ply Roofing Association
Liquid applied waterproofing (hot or cold applied)			LRWA DESIGN GUIDE issue 1 Liquid Applied Waterproofing Systems for Roofs and Balconies 2020 ETAG 005 Liquid applied roof waterproofing kits Part 1: General GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL Rev. March 2004

Reinforced bitumen membranes (RBM) and modified bitumen roofing systems

Bitumen membranes should be high performance to BS EN 13707 Flexible sheets for waterproofing. Reinforced bitumen sheets for roof waterproofing. Definitions and characteristics and reinforced with polyester reinforcement. SBS (elastomeric) modified bitumen membranes offer increased extensibility and flexibility, especially at low temperatures. APP (plastomeric) modified bitumen membrane products offer resistance to UV degradation, have high softening points and provide a longer service life than traditional RBMs.

Built-up bitumen membrane roofs should be complete systems provided by the membrane manufacturer and installed in accordance with BS 8217 Reinforced bitumen membranes for roofing. Code of practice and the membrane manufacturer's instructions.

The installation methods should consider the safe use and application of any hot applied materials including such guidance as the NFRC's Safe2Torch guidance.

Table 11: Modified bitumen membranes used in warm roof construction

Deck	Preparation	AVCL RBM minimum (S2P3) or modified bitumen membranes	Insulation	First/preparatory layer (S2P3)	Final layer/cap sheet[2] with integral surface protection[3]
Concrete or screed	Smooth surface, and prime	Applied in accordance with the membrane manufacturer's instructions	See note under Table 12	Applied in accordance with the membrane manufacturer's instructions	Applied in accordance with the membrane manufacturer's instructions
Plywood or OSB	Prime deck				
Profiled metal eg steel, aluminium	Stitch side laps, prime crowns (or timber decking where provided)				

Table 12: Modified bitumen membranes used in an inverted warm roof construction

Deck	Preparation	First/preparatory layer (S2P3)	Final layer/cap sheet[2]
Concrete or screed	Smooth surface and prime	Applied in accordance with the membrane manufacturer's instructions	Applied in accordance with the membrane manufacturer's instructions

Notes to Tables 11 and 12

1. Insulation to be mechanical or adhesive fixed to deck in accordance with the design of the roof build-up. Torching on to insulation boards and timber deck is not acceptable, apart from suitable insulation boards, eg rock fibre, perlite or foam insulation boards with a torch receivable facing.
2. Classification by performance should be in accordance with BS 8747, eg a minimum value of S2P3 for ballasted roofs with access for light maintenance only and minimum S5P4 for accessible roofs with paving slabs on supports. S = tensile strength and elongation, P = resistance to puncture ie, both static and dynamic. The higher the number, the better the performance.
3. The use of stone chippings is not recommended unless required to enhance fire protection. Solar reflective paint, if used, should not be used as the sole protective finish to the membrane.

Mastic asphalt

Mastic asphalt should be:

- to BS 6925, type 988 T25, 20mm thick on the flat and installed on black sheathing felt
- 3 x 10mm layers on horizontal surfaces and 3 layers with a total thickness of 20mm on vertical surfaces, for upstands to walls on Green Roofs.

Polymer modified asphalt should be assessed in accordance with Technical Requirement R3.

Single-ply membrane

Single-ply membranes, including materials such as PVC, EPDM, and TPO (thermoplastic polyolefin) should be:

- either bonded to the insulation, mechanically fixed to the deck or loose laid, and sealed and ballasted (fixing methods should be in accordance with the manufacturer's recommendations)
- welded at laps using either hot air or a specific solvent with or without taped seams
- designed and installed in accordance with SPRA Design Guide
- assessed in accordance with Technical Requirement R3.

Liquid applied membranes

Liquid applied membranes, including hot and cold applied systems, should be:

- selected and applied in accordance with the LRWA DESIGN GUIDE issue 1 Liquid Applied Waterproofing Systems for Roofs and Balconies 2020
- applied in accordance with the manufacturer's recommendations
- assessed in accordance with Technical Requirement R3.

Fully supported flat sheet hard metal roof

Fully supported flat sheet hard metal roof coverings should be designed and constructed:

- to the material Standards as shown in Table 13 and assessed in accordance with Technical Requirement R3
- in accordance with BS EN 14783 Fully supported metal sheet and strip roofing, external cladding and internal lining. Product specification and requirements
- in accordance with the relevant codes of practice and technical guidance documents published by the Metal Cladding & Roofing Manufacturers Association (MCRMA)
- to avoid damage from condensation
- to follow the supply manufacturer's recommendations (including design for thermal movement and wind uplift)
- for roofs with maintenance access only.

Table 13: Fully supported flat sheet hard metal roof coverings

Metal type	British Standard
Aluminium (Al)	BS EN 485-1
Copper (Cu)	BS EN 1172
Galvanised steel (Gst)	BS EN 10346
Stainless steel (Sst)	BS EN ISO 9445 Parts 1 and 2
Titanium zinc (Zn)	BS EN 988

Direct contact between dissimilar metal roof coverings and metal fixings can cause corrosion; similarly, rainwater from dissimilar metal roofs should not discharge on to one another. Acid run-off from timber cladding, contact with fresh cement mortar, and acidic cleaners can also affect metal roofing, particularly Zinc, and in marine environments, metal roofing can suffer unsightly salt deposits. Various coatings have been developed to protect against corrosive environments and unsightly deposits. Advice on the above aspects should be sought from the metal roofing manufacturer when considering the roof design.

It is essential that interstitial condensation does not build up on the underside surface of metal roof coverings. This trapped moisture will increase the risk of corrosion developing in key parts of the construction containing metals such as Zinc, Aluminium and galvanised steel. Prevention of interstitial condensation should be achieved by a ventilated design for either of the cold or warm roof types — with each having a ventilated void beneath the deck supporting the metal covering.

Ventilation needs to be effective in accordance with BS 5250 and BS 6229, with minimum 50mm ventilated void with continuous 25mm edge ventilation gaps and a maximum 5m between ventilation points in the direction of the joists. With verge to verge cross-ventilation, and ventilation in the direction of the joists and 5-10m between ventilation points, a ventilation gap of minimum 100mm and continuous edge ventilation gaps of 60mm is recommended. Intermediate mushroom ventilators are ineffective in reducing these ventilation distances.

Note
Ventilation gaps should have mesh or grilles (nominal 4mm openings) to stop the entry of large insects and birds.

Ventilation also helps form a protective patina to the underside of aluminium, galvanised steel and zinc. Timber sarking boards with 3-5mm gaps between are the preferred deck option; if plywood is used, it should have 3-5mm gaps between boards. The metal should be laid on a structural underlay ie, a breathable underlay with outer layer of bonded polypropylene mesh, which assists air and moisture movement, all in accordance with the metal roof manufacturer recommendations.

Figure 24: Ventilated cold roof design

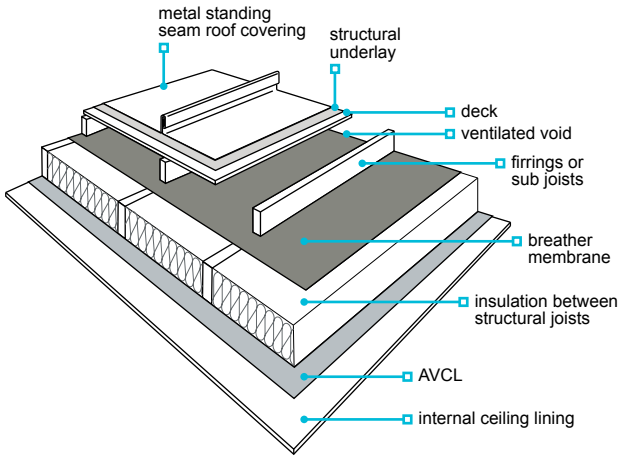
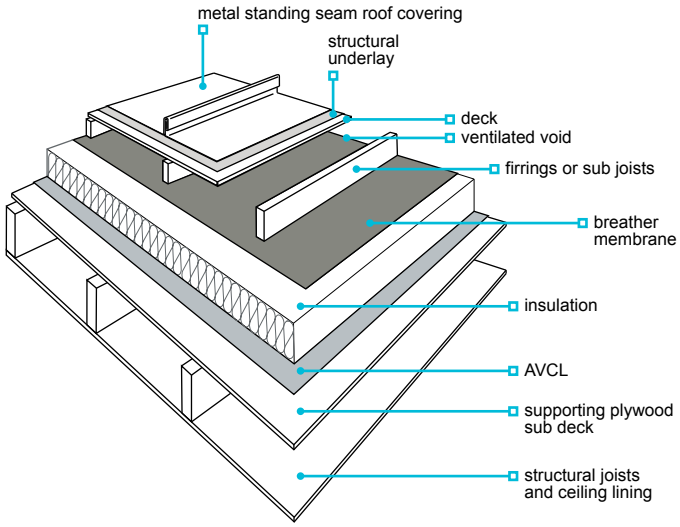


Figure 25: Ventilated warm roof design



7.1

Fully supported lead roof

Fully supported lead roofing should be:

- laid loose on building paper to BS 1521 Class A for plywood deck or smooth concrete/screed deck, or polyester geotextile felt for timber boards (fitted with penny width air gaps)
- installed as a ventilated cold or ventilated warm roof system
- installed in accordance with BS 6915, The ultimate guide to best practice as published by the Lead Contractors Association or other manufacturers recommendations
- installed to include allowance for thermal movement and uplift
- treated with patination oil directly after installation where rainwater run-off may cause staining to adjoining surfaces.

Table 14: Lead materials for roofing

Metal type	British Standard	Code of practice
Lead (rolled)	BS EN 12588	BS 6915
Lead (machine cast)	BS EN 14783	

Integrity testing of waterproofing layer

The waterproofing layer should be inspected for defects after installation. Any defects are to be repaired and retested and left in a satisfactory condition.

Waterproofing layers on flat roofs, terraces and balconies greater than 50m², or roofs which are difficult to access (such as on buildings over three storeys), should be subject to visual inspection and an appropriate integrity test, undertaken by a suitably qualified surveyor.

Waterproofing layers under 50m² or those unsuitable for electronic testing, eg EPDM or foil-faced bitumen membranes, may be checked by visual inspection which should include inspection of any seams with suitable probes.

Guidance on electronic test methods and their application can be found on the Roofing And Waterproofing Test Association website.

A test report containing the test results and photographic record of the roof should be made available to NHBC.

7.1.11.3 Surface treatments

Surface treatments should be in accordance with Table 15.

Table 15: Surface treatments for flat roofs

Material	Access for maintenance only	Access roof, walkway or terrace
Reinforced bitumen membranes	• mineral surfaced cap sheets (eg type S5P5) • reflective stone chippings(1), bedded in a bitumen-based compound • a minimum thickness of 50mm washed, rounded 20-40mm shingle ballast laid loose	• precast semi-porous concrete tiles bedded in bitumen or approved adhesive • precast concrete proprietary paving slabs on supports, or sand/cement blinding(2) • proprietary decking systems(3)
Single-ply membranes	• supplementary solar reflective coatings or other finishes not required • where laid loose, membranes can be ballasted with a 50mm minimum thickness of washed, rounded 20-40mm shingle ballast installed on a non-woven polymeric protection layer	• proprietary flexible, non-slip walkway sheets or tiles, compatible with the membrane product • precast concrete proprietary paving slabs on adjustable supports or suitable non-woven polymeric protection layer • proprietary decking systems(3) with bearers set on an additional membrane or suitable non-woven polymeric protection layer(3)
Cold applied liquid roofing membranes	• products generally do not require supplementary solar reflective coatings or other finishes	• proprietary surface treatments compatible with the membrane product • proprietary non-slip walkway tiles compatible with the membrane product • precast concrete proprietary paving slabs on supports on a suitable non-woven polymeric protection layer • proprietary decking systems(3) with bearers set on additional pads on suitable non-woven polymeric protection layer/filter layer(3)
Hot melt rubberised bitumen systems	• use in inverted/buried membrane applications or in roof garden/Green Roofs • must be protected with a substantial reinforced bitumen membrane protection sheet or protection board • all upstands/details where the membrane becomes exposed need a protective membrane to be applied to prevent UV degradation	
Mastic asphalt	• reflective stone chippings(1), bedded in a bitumen-based compound • solar reflective paint in accordance with BS 8218	• precast semi-porous concrete tiles bedded in bitumen or approved adhesive • precast concrete proprietary paving slabs on supports or sand/cement blinding(2)

Notes
1. Loose surface finishes should be prevented from being removed by weather and discharged into gutters and drainpipes. Chippings should be a minimum of 12.5mm limestone or white spar, not pea gravel.
2. Cement/sand blinding should be installed on two layers of 1000 gauge polyethylene separating membrane.
3. Decking systems must meet the fire protection requirements for the overall roof construction and should be securely fastened to a loadbearing support structure.

7.1.11.4 Fire protection

The surface protection provided to the waterproofing layer must satisfy the fire protection requirements as set out in the Building Regulations.

Account must be taken of the waterproofing detail at abutments with a building and the extent that the waterproofing can be dressed up the wall of the building, and the jointing detail between the roof waterproofing and the cavity trays/DPC. This may include the use of non-combustible trays in the external wall of the building.

Extensive Green Roof systems should include non-combustible perimeter abutment strips to buildings, roof lights, etc and at regular intervals across the roof. Sustainable roof types, including Green Roofs and Brown Roofs, should be designed for resistance to fire spread in accordance with guidance in The Green Roof Organisation — GRO fire risk guidance document and in full compliance with Building Regulations.

7.1.12 Green and biodiverse roofs - including roof gardens

Green and biodiverse roofs shall be suitable for their intended use.

Green and biodiverse roofs should:

- be designed with a finished fall at the waterproofing layer of 1:60 (1°) minimum
- be designed in accordance with the GRO Green Roof Code of Best Practice 2021 and CIRIA C753 SuDS Manual 2015
- have a certified waterproofing system that is endorsed by the manufacturer as fully suitable to be specified for a green sustainable roof design
- be designed to take account of wind uplift and flotation
- have supporting data to demonstrate compliance with relevant material standards and codes of practice
- include a waterproofing layer suitable for use in the specified roof system
- have rainwater outlets that are accessible and have a visible inspection hatch.

Green and biodiverse roof systems that do not comply with the principles of this chapter should be assessed in accordance with Technical Requirement R3.

Both the green/biodiverse roof system and the waterproofing layer should be installed by a contractor trained and approved by the system supplier.

The waterproofing layer should be either:

- reinforced bitumen membrane
- mastic asphalt
- single-ply membrane, or
- a liquid applied system (cold or hot melt).

The system should be installed in accordance with the design and the waterproofing layer manufacturer's recommendations and integrity tested prior to covering (see Clause 7.1.11, integrity testing of the waterproofing layer).

Other issues that should be considered when installing Green Roofs include the:

- provision of a root barrier or use of a waterproofing layer that is resistant to root penetration in accordance with BS EN 13948
- height of upstands in relation to soil height and flashings
- protection, reservoir and filter layers
- moisture control of the soil.

Figure 26: Intensive Green Roof on warm roof deck

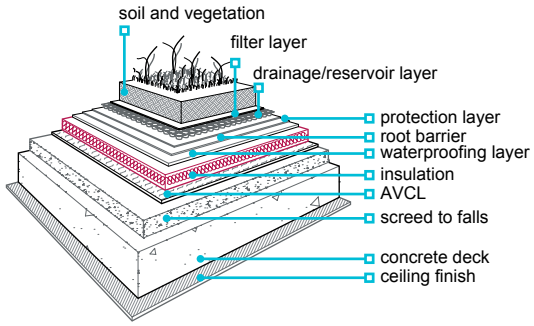


Figure 27: Extensive Green Roof on warm roof deck

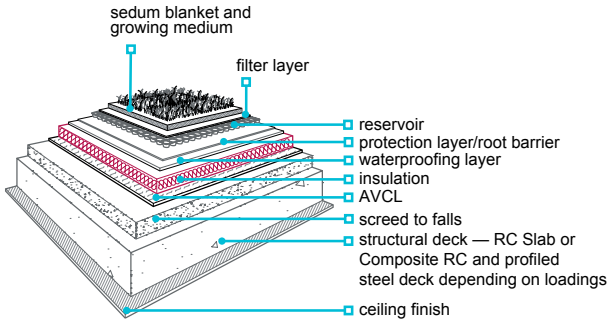


Figure 28: Intensive Green Roof on inverted warm roof deck

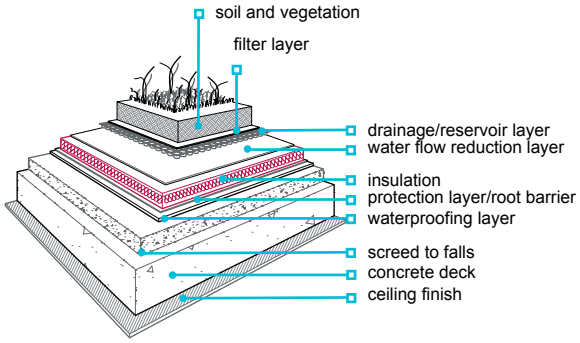


Figure 29: Extensive Green Roof on inverted warm roof deck

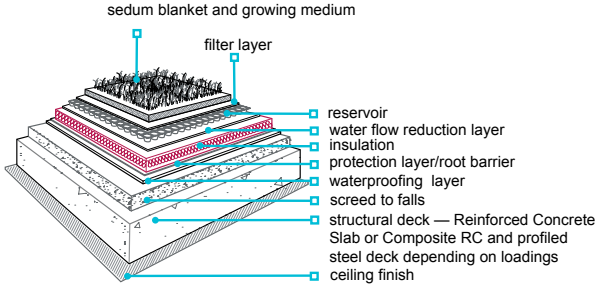


Table 16: Principles for Green Roofs

	Intensive	Extensive
Features	• provides a normal garden environment • uses natural topsoil at least 150mm deep and 'normal' plants such as grass, bushes, shrubs and trees • requires regular 'intensive' maintenance ie, like a normal garden • requires protection of the waterproofing membrane from possible damage during maintenance of the garden, eg from weeding/planting	• requires minimal maintenance, ie, annual attention • types of planting includes sedum in a blanket or modular trays, wildflower blanket, non-blanket solutions using plug plants or hydroseeding
Structure	• 10° maximum roof pitch unless anti-shear measures are taken, accounting for full weight of wet soil (generally supported by a concrete deck)	• 45° maximum roof pitch deck (profiled metal deck or concrete deck depending on load)
Drainage falls	• finished fall of 1:60 at drainage level	
Moisture control	• irrigation system may be required • can be designed to retain some water in order to maintain the vegetation and to reduce run-off	
AVCL	• fully bonded polyester — reinforced RBM (S2P3), a suitable self-adhesive membrane or a torch-on membrane	
Insulation	• insulation material should have adequate compressive strength to withstand likely applied loads	
Roots	• a root-resistant element is required above the waterproofing layer; alternatively, an approved root-resistant waterproofing layer can be used (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)	
Protection and filter layers	• a protection layer (or board) should be placed above the waterproofing layer • a filter layer should be placed above the reservoir layer	• in accordance with the manufacturer's recommendations

7.1.13 Blue Roofs

Blue Roofs shall be suitable for their intended use.

Blue Roofs should:

- be designed in accordance with relevant parts of BS 6229 and the NFRC Technical Guidance Note for the construction and design of Blue Roofs. Roofs and podiums with controlled temporary water attenuation
- have a certified waterproofing system that is endorsed by the manufacturer as fully suitable to be specified for a Blue sustainable roof design
- have supporting data to demonstrate compliance with relevant material standards and codes of practice
- include waterproofing layer suitable for use in the Blue Roof system and subject to independent third-party assessment
- have specific flow restrictor outlets to meet the required water discharge rate and which are accessible for inspection and maintenance
- fully drain over the designed retention period (permanent retention of water is not accepted on the roof waterproofing layer)
- include overflows independent of the rainwater drainage system, to avoid water ingress into the building should the water attenuation level be exceeded (operation of an overflow should be visible to warn of a potential blockage in the drainage system)
- have minimal penetrations of the waterproofing layer other than rainwater outlets and overflows
- be designed as a warm roof or inverted warm roof.

If designed as an inverted warm roof, the design should take into account the additional thickness of insulation, over and above the dry state 'U' value calculation, that is required to compensate for the cooling effect of water penetrating the insulation and reaching the waterproofing layer, in accordance with the guidance in BS 6229.

The design should also include sufficient topping of ballast, paving or Green Roof to avoid flotation of the insulation, flotation forces can be quite significant and occur before the attenuation system reaches full capacity.

Care should also be taken in the design and installation of the WFRL so that it performs as the principal drainage layer and reduces water penetration to the insulation layer below.

The WFRL should be:

- lapped and sealed to avoid/minimise rainwater getting below the insulation layer
- lapped and taped onto the lip of the water attenuation chamber
- finished a minimum of 50mm above the top of the Blue Roof attenuation level at parapets/upstands
- taken up all protrusions/penetrations and sealed (this includes between the top of the insulation layer and the bottom of the recessed lip of the water attenuation chamber, and behind parapet chambers).

7.1.14 Raised and buried podiums

Podiums shall be protected by adequate weatherproofing and drainage.

Podium roofs

Podiums shall be protected by a fully co-ordinated waterproofing and drainage system as part of the design. Products used for waterproofing and damp proof courses should have accredited third-party certification, with proof of performance from relevant testing. For particular specified conditions of use in construction, wherever applicable, this testing should include membrane resistance to root penetration and durability performance for waterproofing of concrete surfaces trafficable by vehicles. Also, where relevant for compliance, refer to Chapter 5.4 Waterproofing of basements and other below ground structures, BS EN 13967:2012 and Property Care Association guidance document — Podium Decks and Buried Roofs.

A raised podium is a deck or terrace, usually situated over a non-habitable space where thermal insulation is generally not required.

Waterproofing system combinations should be designed and installed to fully protect the envelope and provide continuity of a water-resistant barrier, along all interfaces between the raised podium ie, bridging across to the superstructure and/or the basement substructure. Chapter 5.4 Waterproofing of basements and other below ground structures provides further details of the design and construction of podium at or below ground level (buried podiums).

The make-up of the waterproofing layer and topping should follow the guidance given for the individual waterproofing layers and toppings quoted within this chapter and to suit the type of deck that has been used to form the podium.

Consideration must be given to emergency vehicular traffic at the planning stage and, where necessary, waterproofing and structural designs must be capable of accommodating foreseeable loading. Also see Chapter 5.4 with reference to the figures below.

Figure 30: Raised podium

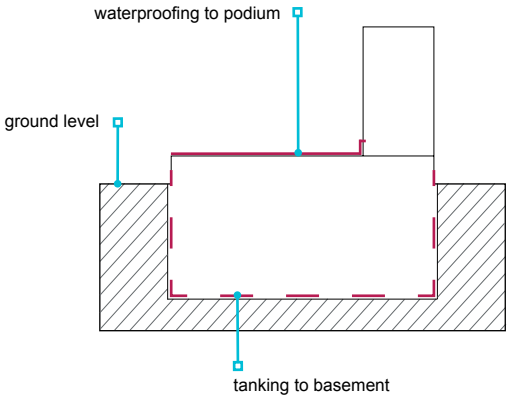
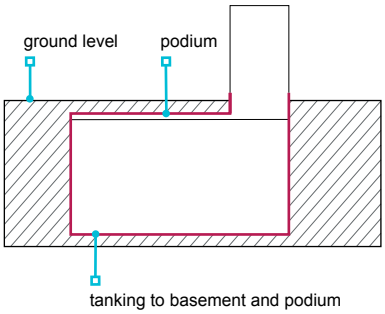


Figure 31: Buried podium



7.1.15 Detailing of flat roofs

Flat roofs shall be detailed to ensure satisfactory performance.

Table 17: Materials for flashings

Flashing material	Guidance
Rolled lead sheet	Minimum Code 4. BS EN 12588
Aluminium and aluminium alloys	BS EN 485 and BS EN 573, 0.6-0.9mm thick and protected from contact with mortar by a coating of bituminous paint
Zinc alloys	BS EN 988 and 0.7mm thick
Copper	BS EN 1172, 0.6mm thick and fully annealed
Stainless steel	BS EN ISO 9445 Parts 1 and 2
Galvanised steel	BS EN 10142/3
Proprietary flashing, including plastic and composite	Assessed in accordance with Technical Requirement R3

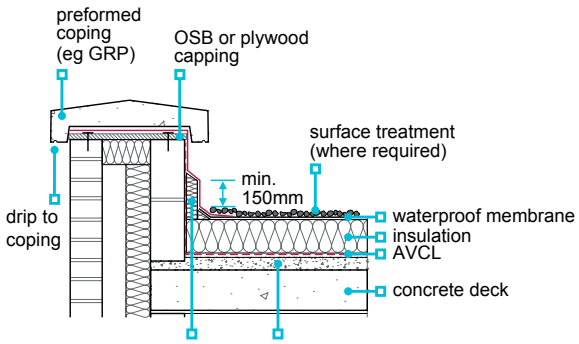
Note
Where two metals are to be joined, they should be compatible and not cause bimetallic corrosion in that environment. Alternatively, they should be isolated from each other.

The following figures are intended as a guide to demonstrate the general principles of the flat roof, detailing commonly used on flat roofs, terraces and balconies. Where indicated, the principles are applicable to other types of roof construction. Further information on specific waterproofing systems may be obtained from BS 6229 and BS 8217.

Concrete decks

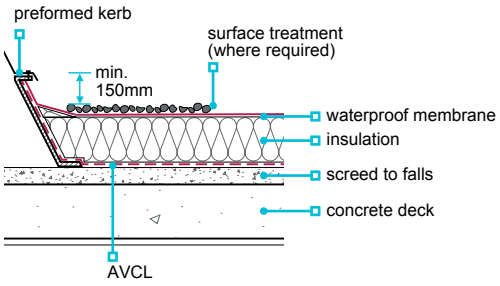
Upstands may be fixed to the wall and should be a minimum of 150mm high. Similar details apply to inverted roofs with concrete decks.

Figure 32: Upstands



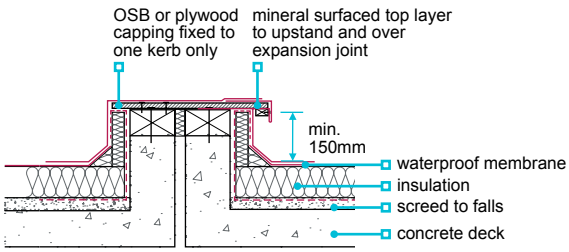
Similar details apply to inverted roofs. Allow for thickness of ballast to achieve a minimum 150mm upstand.

Figure 33: Skirting to rooflights or ventilator kerb



Similar details apply to inverted roofs.

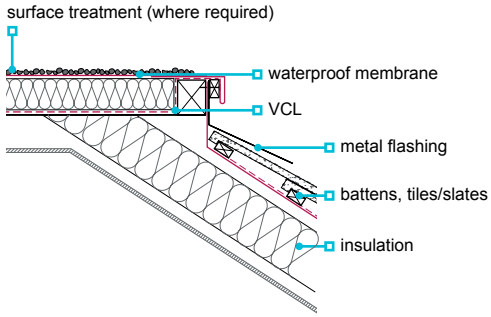
Figure 34: Twin-kerb expansion joint



Timber decks

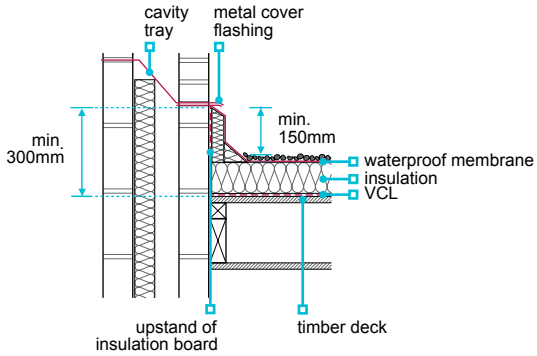
Elements should be firmly fixed to prevent peelback in high winds.

Figure 35: Mansard edge



The upstand should be a minimum of 150mm high above surface finish. Upstands should be kept separate from wall, and allow for movement. Similar details apply to cold deck timber roofs.

Figure 37: Independent skirting detail



Inverted timber decks should be detailed to avoid insulation being lifted by wind suction, and an alternative detail used.

Figure 39: Welted drip to external gutter

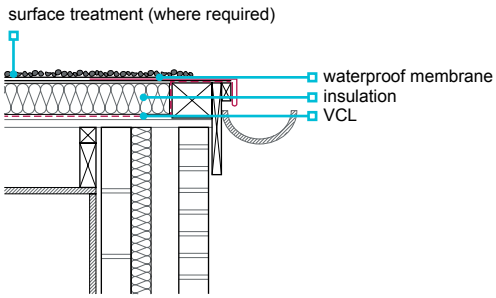
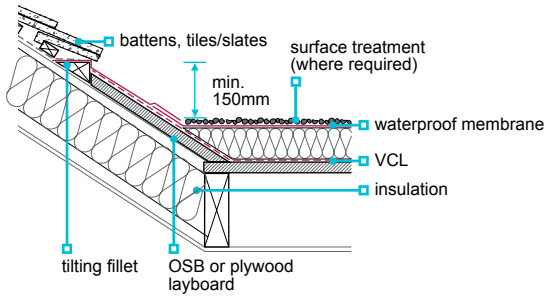
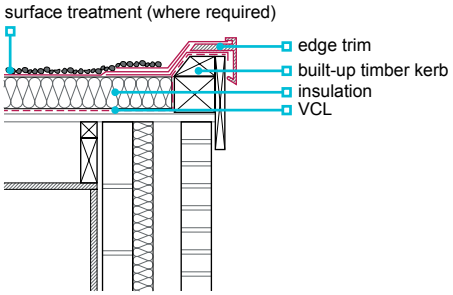


Figure 36: Pitched roof abutment



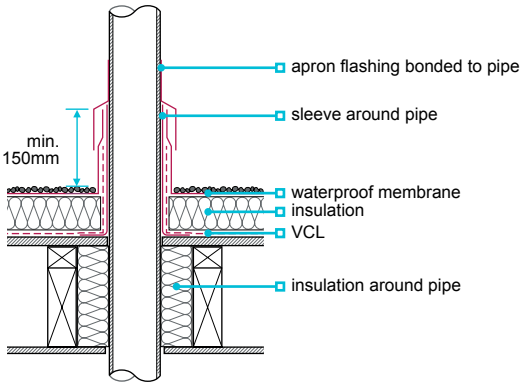
Similar details apply to inverted decks.

Figure 38: Verge detail



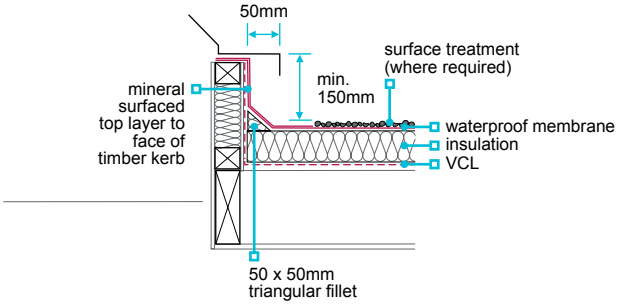
A VCL should be bonded to the waterproofing. Detailing of upstand and flashing is similar for all roofs.

Figure 40: Pipe passing through roof



Similar details apply to cold and inverted roofs. Allow for the thickness of ballast in inverted roofs, to achieve upstand dimensions.

Figure 41: Upstand to ventilator or rooflight kerb



Outlet should be at the lowest point in the roof.
The opening should be properly trimmed.
Ensure that the outlet is fixed securely to decking to prevent displacement by thermal expansion of the rainwater pipe.
Similar details apply to concrete roofs.

Figure 42: Rainwater outlet

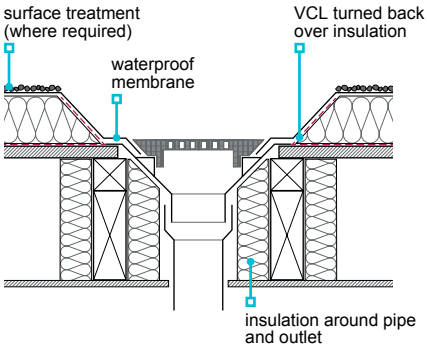
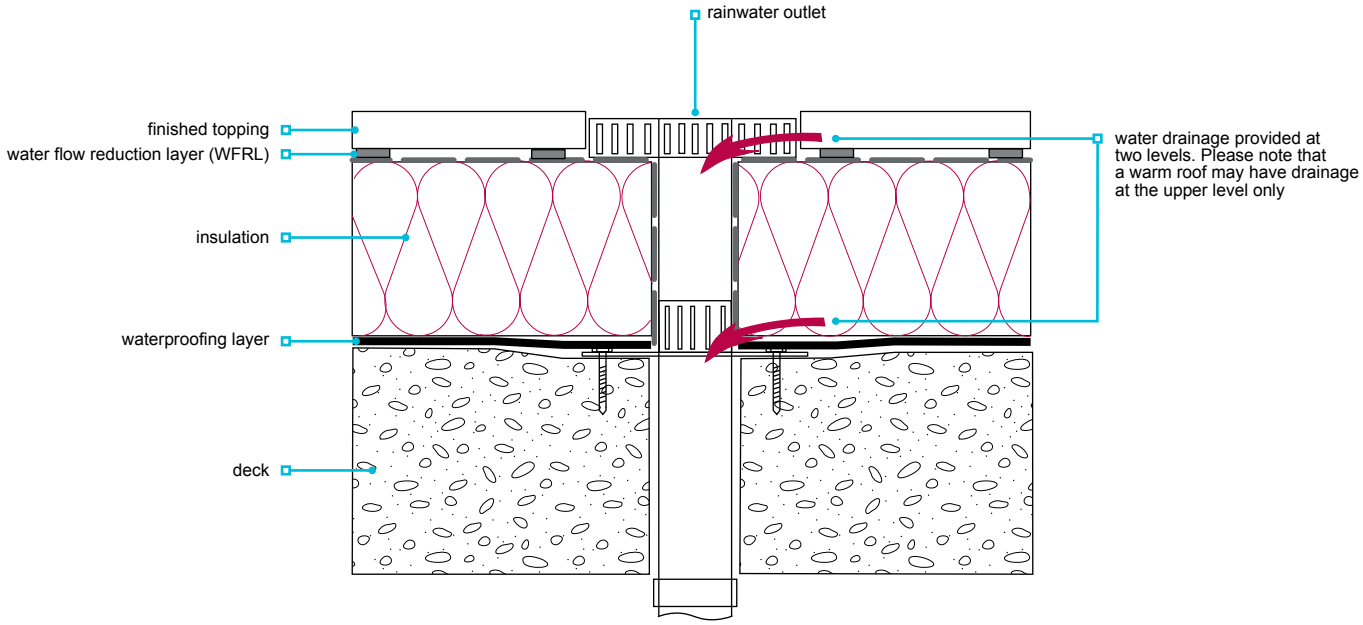


Figure 43: Inverted warm roof drainage outlet



7.1.16 Accessible thresholds and upstands

Accessible thresholds shall be protected by adequate weatherproofing and drainage.

Generally, where a flat roof or terrace abuts a wall, the waterproofing layer should extend up the wall to form a minimum 150mm upstand measured from the balcony/terrace drainage layer of the roof/terrace. The waterproofing material forming an upstand should link directly under a cavity tray to ensure the cavity fully drains outwards. Weepholes should be provided in masonry walls at 1m maximum spacings to assist drainage.

Where any door threshold or window sill is located less than 150mmm above the balcony/terrace drainage layer the upstand and accessible threshold design requirements, as shown in the figures below, should apply. This should include doors with level access and fenestration designs involving windows adjacent to the internal floor level and the external paving/decking level.

Designs which continue the waterproofing layer horizontally through/under the outer leaf of a cavity wall and form an upstand against the inner leaf within the cavity are not acceptable because:

- materials used for the waterproofing layer are generally unsuitable to perform as a DPC supporting masonry loads
- the cavity must fully drain to avoid water retention problems arising from prolonged saturation of the wall material with risks from frost action damage and stagnant retained water
- water draining from the waterproofing layer must not be directed into a cavity wall
- future inspection, repair and maintenance of hidden upstands cannot be carried out without significant disruption to the construction.

Accessible thresholds should:

- be in accordance with the design — specific fire, thermal, waterproofing and acoustic precautions may be required
- have a maximum 15mm upstand at the threshold (measured at the door position); additional sloping transition elements, such as a small internal ramp and external sill, may be provided either side of the upstand; the maximum slope on the ramps and sills should be 15 degrees
- have a minimum 45mm projecting sill to shed rainwater away from the interface with the waterproofing layer, with a drip feature a minimum 30mm away from the face of the upstand
- have a 75mm minimum balcony upstand below the underside of the projecting sill, measured from the balcony/terrace drainage layer.

Figure 44: Uninsulated balcony deck

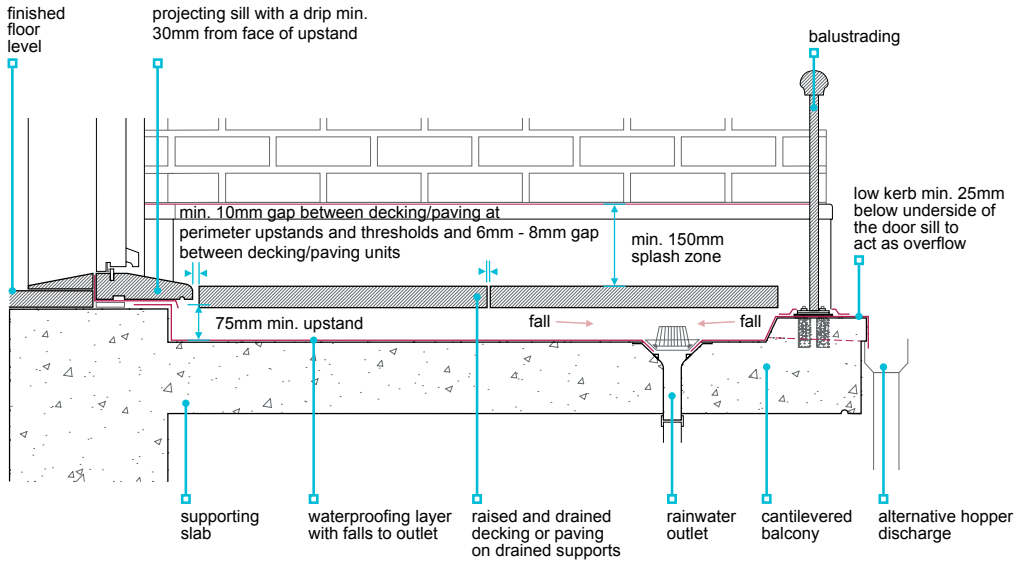


Figure 45: Insulated terrace deck

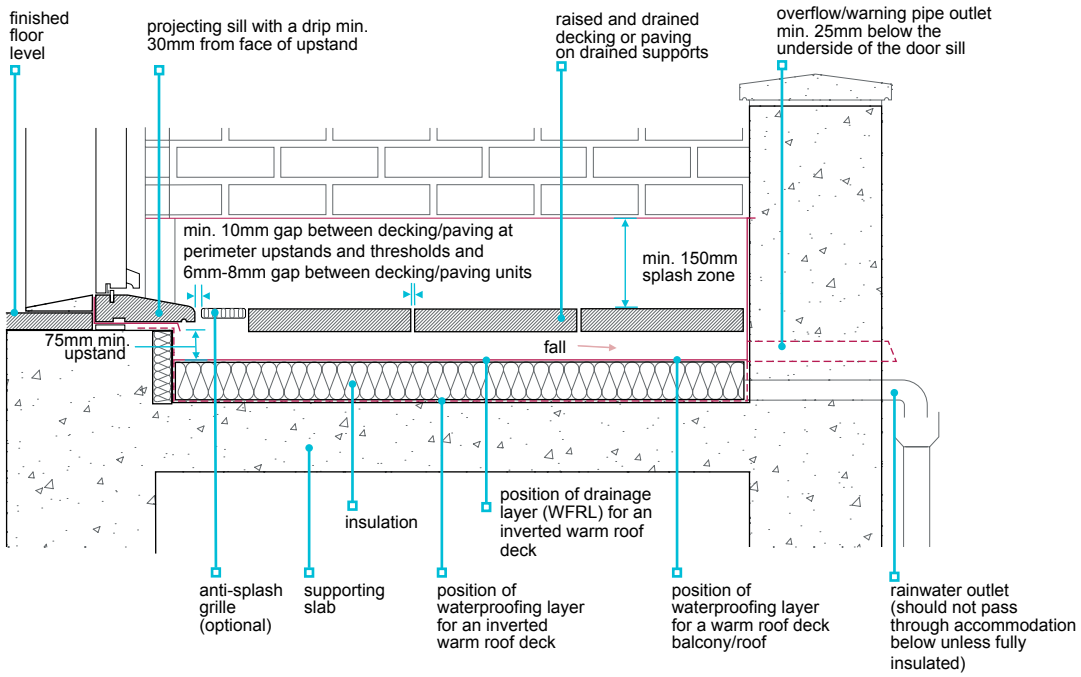
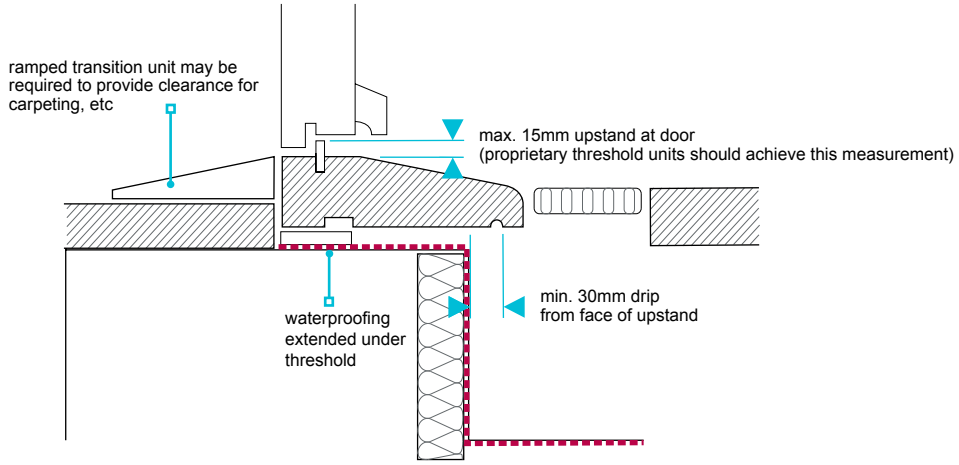


Figure 46: Accessible threshold



Waterproofing layers should:

- be laid without forming ponding and associated stagnant water
- have a finished fall of a minimum of 1:80 to rainwater outlet(s)
- be subject to specific third-party assessment where falls are zero degrees with no back falls or ponding
- be designed to ensure that where falls are towards or parallel to the building, blockage of the outlet(s) cannot cause flooding to the building
- be fully protected from direct trafficking
- be capable of withstanding point loads from supports to decking or paving
- be UV resistant or fully protected from daylight.

Drainage arrangements should be effective and have a suitable overflow. The building should not flood where an outlet or downpipe is blocked. This can be achieved by using:

- at least one outlet and an overflow with at least the capacity of the outlet
- at least one outlet chute and hopper (chute should be sized to serve at least twice the discharge capacities to allow for partial blockage without causing flooding into the building)
- two outlets connected to independent downpipes such that if one downpipe becomes blocked, the other outlet(s) can still cope with the discharge, or
- setting the balcony kerb a minimum 25mm below the door threshold to discharge safely without causing any adverse effect to the construction below.

Outlets beneath decking or paving should be clearly identified and accessible for maintenance.
To ensure adequate drainage:

- As-built gaps of 10mm-12mm should be provided between decking/paving units along perimeter upstands/thresholds
- As-built gaps of 6mm-8mm should be provided between individual units of decking or paving
- spacers and supports which raise the decking or paving should not obstruct the flow of rainwater to outlet(s).

A splash barrier around the perimeters should be provided:

- to ensure water does not reach any part of the wall that could be adversely affected by the presence of moisture
- to a minimum of 150mm above the decking or paving
- using an impervious wall finish or cladding or by extending the waterproofing layer to form an upstand with cover flashing and cavity tray (impervious masonry units with porous bed joints are unsuitable within this zone).

7.1.17 Metal balcony decking systems

Metal balcony framework structures and metal balcony decking systems should be designed and constructed as recommended in BS 8579 guidance for the design of balconies and terraces and their component parts.

7.1.18 Parapets and guarding to terraces and balconies

Terraces and balconies to which persons have regular access, other than for maintenance, shall be adequately guarded to minimise the risk of falling. Issues to be considered include:

1) **guarding**
2) **stability of guarding**
3) **strength, movement and weatherproofing of masonry balcony walls**
4) **durability and fixing of balustrading and guard rails**
5) **access for maintenance.**

7.1.18.1 Guarding

Guarding should:

- not be easily climbed by young children
- be to an adequate height
- be toughened glass, laminated glass (subject to meeting fire regulations) or glass blocks (suitably reinforced) where glazed balustrading is used
- not inhibit the flow of drainage on the waterproofing layers or overflows in the event of a blocked outlet.

7.1.18.2 Stability of guarding

Guarding, including parapet walls and balustrading used as guarding, should be designed in accordance with BS EN 1991-1-1 to resist horizontal loading and as required by Building Regulations. Care is needed when the design incorporates balustrading fixed to parapet walls to ensure stability and prevent overturning. End fixings into walls or returns may be needed to ensure stability.

The structural stability should be checked for balcony walls, especially long balconies. Cavity walls and DPCs in the wall can create a slip plane that can seriously limit the ability of the wall to resist horizontal forces. In such cases, it may be necessary to incorporate a ring beam or other support to ensure stability.

7.1.18.3 Strength, movement and weatherproofing of masonry balcony walls

Masonry balcony walls should be built in accordance with Chapter 6.1 External masonry walls. In particular:

- walls should incorporate strengthening as required by the design
- movement joints should be provided in accordance with the design
- tops of walls should be weatherproofed with a coping, or by the deck waterproofing layer taken up and over the masonry wall
- copings should be firmly fixed
- copings should project a minimum 45mm beyond the faces of the wall below and incorporate a drip feature that discharges water at least 30mm away from the face of the wall and stops water running back under the coping
- preformed edge trims that are sealed to and form a finished edge to the waterproofing layer and which extend down over the wall/fascia, may have a lesser drip projection provided the waterproofing layer drains away from the trim
- copings should incorporate DPCs and cavity trays linked to the waterproofing layer upstands
- cavity trays should be installed to discharge towards the external face of the wall and incorporate weepholes at maximum 1000mm centres.

Figure 47: Parapet wall waterproofing details at roof upstand and head coping

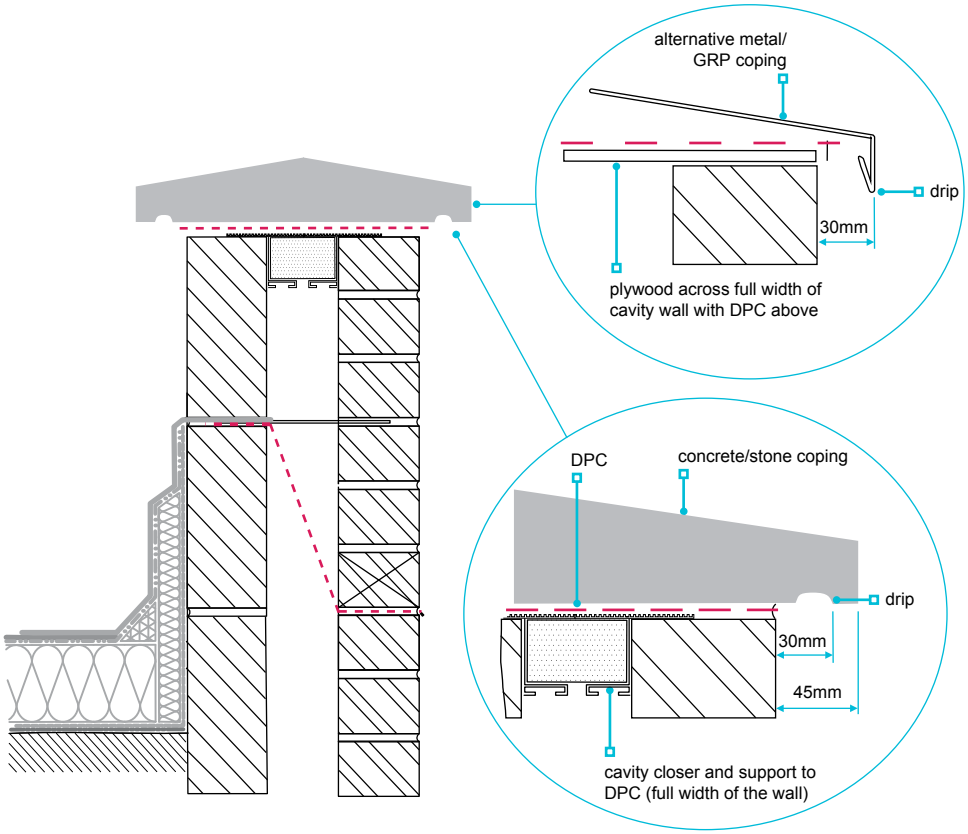
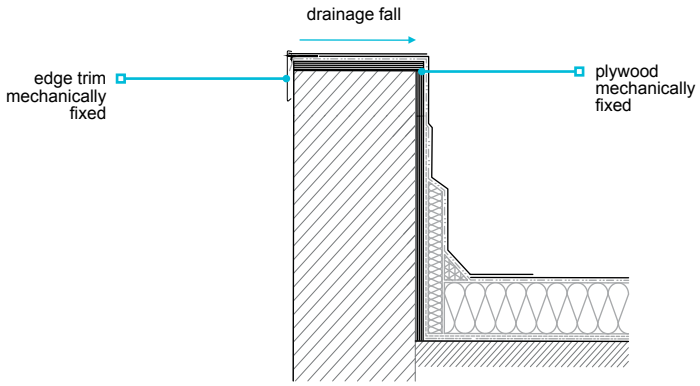


Figure 48: Parapet detail with waterproofing taken over top of wall and finished with edge trim



7.1.18.4 Durability and fixing of balustrading and guard rails

Balustrading and guard rails should be of adequate durability and fixed securely. The structure to which the balustrading and guard rails are fixed should be adequate to safely resist the potential forces acting on the guarding.

Balustrading should not be:

- fixed through a coping or capping due to the difficulties in achieving a waterproof junction with the coping or capping and maintaining an imperforate DPC beneath the coping or capping
- fixed through the waterproofing layer unless suitable precautions are taken to provide a waterproof junction, eg locating baseplates on a raised waterproofed kerb or surrounding the baseplates in a pitch pocket detail.

These issues should be avoided by fixing the balustrading to the face of the wall below the coping or capping.

Figure 49: Pitch pocket sealing detail around post fixed to deck

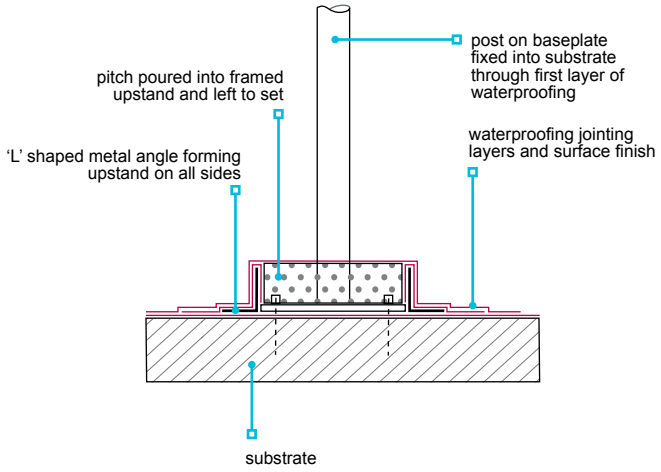


Figure 50: Handrail fixing on upstand formed in concrete roofs

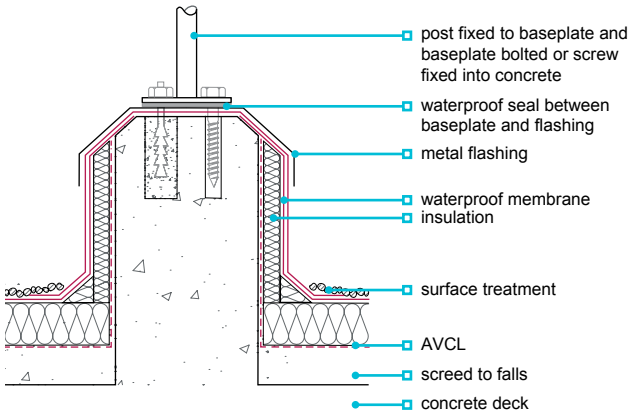


Figure 51: Base of balustrade post raised above drainage level

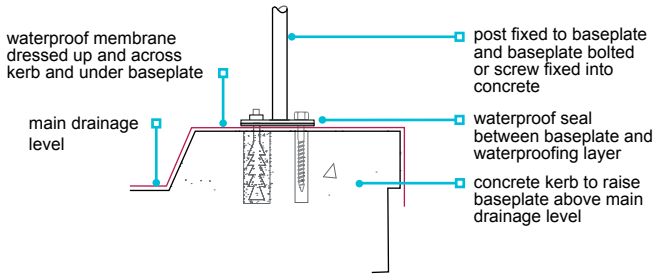
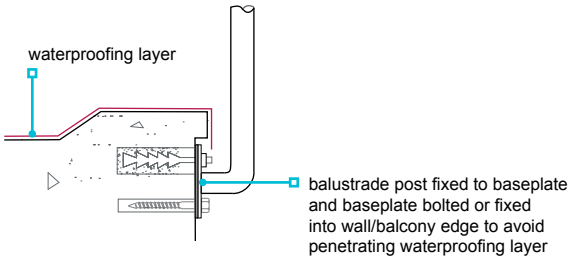


Figure 52: Balustrade post fixed to wall below coping/kerb



Particular attention should be given to use of materials or finishes that resist corrosion or unsightly surface staining in aggressive environments such as coastal zones.

Note
Ferritic stainless steel can suffer surface rusting/staining in coastal zones.

7.1.18.5 Access for maintenance

Provision should be made for safe future access to flat roofs for the purposes of maintenance.

7.1.19 Further information

- *BS EN 13162 Thermal insulation products for buildings — Factory made Mineral Wool (MW) products. Specification*
- *BS EN 13163 Thermal insulation products for buildings — Factory made expanded polystyrene (EPS) products. Specification*
- *BS EN 13164 Thermal insulation products for buildings — Factory made Extruded Polystyrene foam (XPS) products Specification*
- *BS EN 13165 Thermal insulation products for buildings — Factory made rigid Polyurethane foam (PU) products. Specification*
- *BS EN 13166 Thermal insulation products for buildings — Factory made Phenolic Foam (PF) products — Specification*
- *BS EN 13167 Thermal insulation products for buildings — Factory made Cellular Glass (CG) products — Specification*
- *BS EN 13168 Thermal insulation products for buildings — Factory made wood wool (WW) products. Specification*
- *BS EN 13169 Thermal insulation products for buildings — Factory made expanded perlite board (EPB) products. Specification*
- *BS EN 13170 Thermal insulation products for buildings — Factory made products of expanded cork (ICB) — Specification*
- *BS EN 14783 Fully Supported Metal Sheet and Strip for Roofing External Cladding & internal lining — product specification & requirements*