Chapter

7.2

Pitched roofs

This chapter gives guidance on meeting the Technical Requirements for pitched roofs, including:

- **coverings**
- **fixings**
- **ventilation**
- **vertical tiling**
- **weatherproofing.**

For figure reference tables in this chapter, please go to the end of the chapter

Definitions for this chapter

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

Air impermeable weatherproof covering	A roof covering where the airflow through it is not greater than 17.4 A_r (in m^3/h)
Air permeable weatherproof covering	A roof covering where the airflow through it is greater than 17.4 A_r (in m^3/h)
Air and vapour control layer	A continuous layer to restrict the movement of air and water vapour
Cavity barrier	Cavity barriers are a construction within a cavity, other than a smoke curtain, to either close a cavity to stop smoke or flame entering, or restrict the movement of smoke or flame within a cavity
Coastal locations	A site within a distance of 500m from the general coastline of the United Kingdom
Cold pitched roof	A roof where the insulation is laid horizontally at ceiling level and the space above is unconditioned
Complex roof	Large span roofs of over 12m, or roofs with complex geometry and/or features
Conditioned space	Occupied space in which the temperature and humidity are controlled
Fire-stopping	Fire-stopping is a seal provided to close an imperfection of fit or design tolerance between elements or components, to restrict the spread of fire and smoke
Hybrid roof	A roof where the insulation is positioned partly on a horizontal ceiling, vertical members and partly at the rafter line
Normal ceiling	A ceiling with a typical air permeability of 300 mm^2/m^2 (0.3%)
Perimeter roofing element	The single roofing element (eg tile, slate, shingle) at any discontinuity in the plane of the roof, including, roof windows, dormers, valleys, roof edges etc
Pitched roof	Part of the external envelope of a building that is at an angle between 10° and 70°
Sarking board	Softwood timber boards, fixed over the rafters of a pitched roof, used for the purposes of roof bracing. Boards may be tongue and grooved or open jointed
Sarking sheet	Tightly jointed sheet boards, fixed over the rafters of a pitched roof, used for the purposes of roof bracing (eg OSB, exterior grade plywood, etc.)
Solar roof panel	Solar roof panels could be either solar photovoltaic or thermal roof panels, and either be 'on-roof' type or integrated into the roof covering
Type HR underlay	A membrane with a high water vapour resistance, s_d, greater than 0.05 m (0.25 MN·s/g)
Type LR underlay	A membrane with a low water vapour resistance, s_d, not exceeding 0.05 m (0.25 MN·s/g)
Unconditioned space	Unoccupied space in which the temperature and humidity are not controlled
Warm pitched roof	A roof where the insulation follows the rafter line
Well-sealed ceiling	A ceiling with a typical air permeability of not more than 30 mm^2/m^2 (≤0.03%)

7.2.1 Compliance

Also see: Chapter 2.1

Pitched roof structures and coverings shall comply with the Technical Requirements.

Pitched roofs that comply with the guidance in this chapter will generally be acceptable.

Roofs with a tile or slate covering should be in accordance with BS 5534.

7.2.2 Provision of information

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

Designs and specifications for traditional cut roofs and roof trusses should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include the following information:

- the layout of cut roofs, trusses and associated items
- details of mono-pitch, lean-to roofs and roof intersections (ie, hips and valleys)
- details of girder trusses, multiple trusses and diminishing trusses, including how they are to be fixed together and supported on truss shoes, layboards or similar
- details of bracing requirements
- details of supports for equipment in the roof space
- the type and position of air and vapour control layers
- details of restraint/holding-down strapping, including coatings and fixings
- the types, position and thickness of insulation
- the means of providing ventilation
- details of fire-stopping at separating wall and boxed eaves
- details of coverings and fixings, including number and type
- details of flashing details at abutments, chimneys, etc
- details of trimming around chimneys, access hatches, etc
- details of loose rafter and floor joist trimming arrangements around staircases, dormer roofs etc where attic trusses are utilised.

For trusses, the design should be provided to the manufacturer in accordance with PD 6693-1, which includes:

- usage, height and location of building, referencing any unusual wind conditions
- rafter profile, referencing camber where required
- spacing, span and pitches
- method of support and position of supports
- type and weight of coverings, including sarking, insulation and ceiling materials
- eaves overhang and other eaves details
- size and approximate position of water tanks or other equipment to be supported
- positions and dimensions of hatches, chimneys and other openings
- type of preservative treatment, where required
- special timber sizes, where required to match existing construction.

7.2.3 Design of pitched roofs

Also see: BM TRADA Eurocode 5 span tables (4th edition) and BS 8103-3

The sizing and spacing of members shall ensure structural stability and provide restraint to the structure without undue movement or distortion. Issues to be taken into account include:

a) trussed rafter roofs

b) traditional cut roofs.

The design of pitched roofs should:

- have dead, imposed and wind loads calculated in accordance with BS EN 1991-1-1, BS EN 1991-1-3 and BS EN 1991-1-4
- be in accordance with PD 6693-1, and Technical Requirement R5, where appropriate
- be appropriate for the location, accounting for exposure and wind uplift
- ensure that the structure is coherent and that all forces are resolved
- ensure the deflection of floors formed by the bottom chords of attic trusses are in accordance with the requirements of Clause 6.4.9 ‘Timber joists’
- ensure that where raised collar trusses are used, as part of the room-in-roof construction, the horizontal deflection of the trusses at the supports should be no more than +/- 6mm
- ensure stability with the complete structure, including the connections and compatibility with the supporting structure and adjacent elements
- where trussed rafters and a cut roof are combined, the designer should provide details of the complete roof (particular care is needed in such circumstances).

Roofs should be designed by an engineer in accordance with Technical Requirement R5 where:

- the roof is not a basic pitched roof
- hips, valleys or other special features are included in a trussed rafter roof
- the spans, sizes, spacing or strength classes of the timber are outside the scope of authoritative tables
- trussed rafters support traditional cut roof members, or
- it is a proprietary system (designs supplied by manufacturers will generally be acceptable).

Structural timber components should be of a suitable strength class as specified by the designer to BS EN 338. Solid structural timber should be:

- machine graded to BS EN 14081, or visually graded to BS 4978 for softwoods or BS 5756 for hardwoods
- assigned a strength class based on BS EN 1912 when visually graded
- dry graded
- marked in accordance with BS EN 14081.

Further guidance on strength classes for certain timber species can be found in PD 6693-1.

Engineered wood products such as I-section or metal-web studs, joists and rafters should be assessed in accordance with Technical Requirement R3.

Trussed rafter roofs

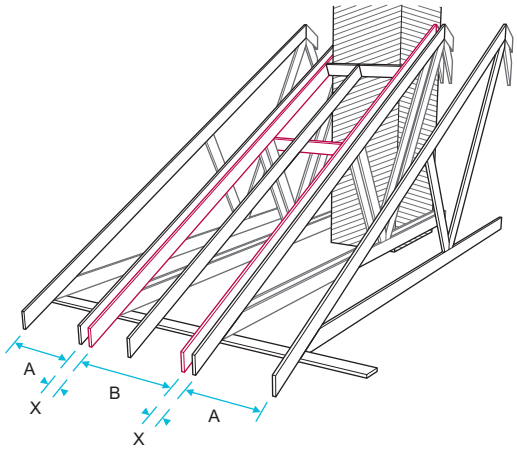
Trussed rafters should be:

- installed in accordance with the design, and the structure or spacing should not be altered without prior consent from the designer
- fixed to the wall in accordance with the design (eg using double skew nailing or truss clips)
- vertical and suitably located (where necessary, temporary bracing should be used to maintain spacing and to keep trusses vertical)
- evenly spaced at maximum 600mm centres.

Where the maximum 600mm spacing cannot be achieved, eg to accommodate hatch openings or chimneys, spacing may be increased to a maximum of twice the nominal spacing, provided that the spacing X is less than, or equal to, 2A-B where:

- X = distance between centres of trussed trimmed rafters and the adjacent trussed rafter
- A = design spacing of trussed rafters
- B = nominal width of opening.

Figure 1: Trussed trimmed rafters



Where multiple and reinforcing timbers to simple or multiple trussed rafters are used, they should be:

- designed to be permanently fastened together
- either fixed together during manufacture, or fully detailed drawings and specifications showing the fixing method should be supplied.

Hipped roofs constructed with trussed rafters typically require a series of diminishing mono-pitched trusses supported by a girder truss.

The bearing of mono-pitched trusses into shoes should be in accordance with Table 1, unless designed by an engineer in accordance with Technical Requirement R5.

Table 1: Bearing length of mono-pitched trusses into shoes

Span	Minimum bearing length	Minimum thickness of trussed rafter
Less than 4m	50mm	35mm
4m or more	75mm	35mm

Ceiling finishes should be fixed according to the spacing of the support members and the thickness of the sheet. Plasterboard should be fixed as follows:

- 9.5mm plasterboard should be fixed at a maximum support spacing of 450mm
- 12.5-15mm plasterboard should be fixed at a maximum support spacing of 600mm
- additional members will generally be required to support coverings and finishes where trusses are spaced further apart.

Where the width of a gable ladder exceeds that of the trussed rafter centres, noggings should be used to reduce the span of the roofing tile battens.

Traditional cut roofs

For traditional cut roofs:

- the design should specify the details of each structural member and the method of fixing or jointing
- the roof should be in accordance with the design and members accurately located
- members should be fully supported and tied together where necessary, particularly where the roof is not a simple triangle
- temporary support to long span members should be used until framing is complete
- purlins and binders should be built in where necessary
- framing should be completed before coverings are installed.

Table 2: Basic timber members

Member	Notes
Valley rafter	Provides support for loads from both sections of the roof and should: ● be larger than ordinary rafters to take the additional load ● provide full bearing for the splay cut of jack rafters ● be provided with intermediate support where required
Hip rafter	Provides spacing and fixing for jack rafters and should: ● have a deeper section than the other rafters to take the top cut of the jack rafters Purlins should be mitred at hips and lip cut to accept the bottom of the hip rafter
Ceiling joist or ties	Provides support for the rafters and should: ● stop the walls and roof spreading outwards ● provide support to the ceiling finish and walkways, etc
Ridge	Provides fixings and spacing for the tops of the rafters
Purlin	Provides support to long span rafters to prevent deflection and increase stiffness
Struts	Provides support to purlins to prevent deflection and to transfer roof loads to the load-bearing structure below
Collar	Ties the roof together at purlin level
Ceiling binders and hangers	Provides support to long span ceiling joists
Pole plates	Similar to purlins, but used where ceiling joists are above wall plate level

Figure 2: Traditional roof members

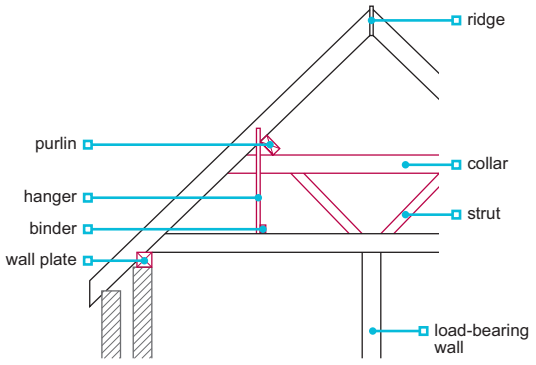
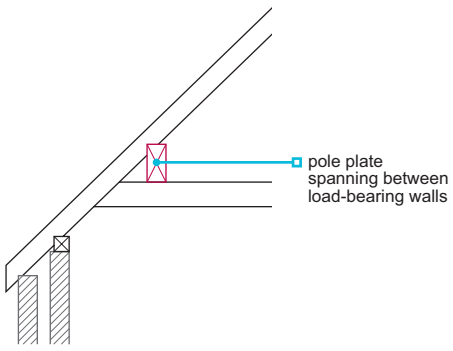


Figure 3: Pole plate

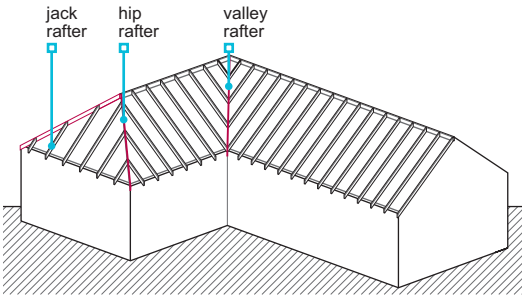


Generally sizes should be as Table 3, unless designed by an engineer in accordance with Technical Requirement R5.

Table 3: Typical sizes for timber members

Member	Minimum size
Struts	100mm x 50mm
Valley rafter	32mm thick
Ridges and hips	Rafter cut + 25mm

Figure 4: Types of rafter



7.2.4 Protection of trusses

Also see: Trussed Rafter Association Technical Handbook

Trusses shall be protected from damage.

To avoid distortion and to prevent damage, trusses should be:

- protected against weather to prevent the corrosion of truss plates and the deterioration of the timber
- adequately ventilated during storage
- stored clear of the ground
- stored vertically and propped
- stored with level bearers under the joints
- carried upright (fasteners can loosen when carried flat).

Trussed rafters should not be cut, modified or repaired, except in accordance with written or drawn instructions issued and approved by the trussed rafter designer.

7.2.5 Durability

Also see: Chapter 3.3

Timber shall be of suitable durability.

The following timber members should be preservative treated or have adequate natural durability in accordance with Chapter 3.3 'Timber Preservation (natural solid timber)':

Table 4: Durability options for the following components

	Preservative treatment			Naturally durable species
	Treatment required	Use Class	Desired service life (years)	Select timber from a minimum Natural Durability Class(1) (heartwood only)
Porch posts	✓	3.1/3.2	60	2/1
Tiling battens	✓	2	60	2
Soffits	✓	3.1/3.2	30	3/2
Barge boards	✓	3.1/3.2	30	3/2
Fascias	✓	3.1/3.2	30	3/2

Notes

1 Where natural durability is used in lieu of preservative treatment, timber must be specified and selected as being heartwood only. Natural durability classes for the heartwood of commonly used timbers are available in BS EN 350 and Table 2 in Chapter 3.3.

Where the pitched roof is to include a fully supported weatherproofing membrane (ie, impervious coverings such as single ply membranes, bituminous membranes, etc) or continuous metal coverings, the risk of condensation is increased. The timber components listed in Table 5 should be preservative treated or have adequate natural durability.

Table 5: Durability options where fully supported weatherproofing membranes and continuous metal coverings are used

	Preservative treatment			Naturally durable species
	Treatment required	Use Class	Desired service life (years)	Select timber from a minimum Natural Durability Class(1) (heartwood only)
Rafters / trussed rafters	✓	2	60	2
Purlins	✓	2	60	
Ceiling joists	✓	2	60	
Bracings	✓	2	60	
Wall Plates	✓	2	60	
Battens	✓	2	60	

Note

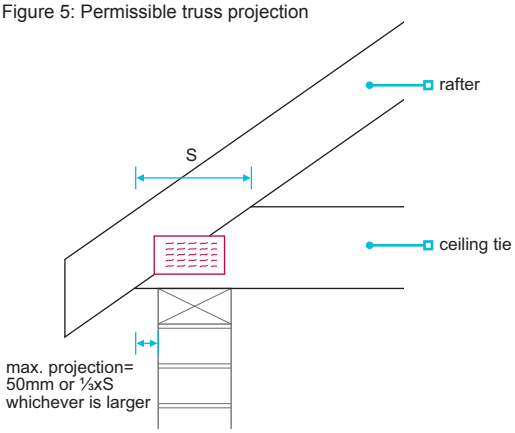
1 Where natural durability is used in lieu of preservative treatment, timber must be specified and selected as being heartwood only. Natural durability classes for the heartwood of commonly used timbers are available in BS EN 350 and Table 2 in Chapter 3.3.

7.2.6 Wall plates

Wall plates and the roof structure shall be bedded and fixed to distribute and transmit loads, and to prevent uplift.

Trussed rafter roofs and traditional cut roofs should be supported on timber wall plates. Trussed rafters should only be supported at the junction between the ceiling tie and rafter, unless specifically designed otherwise, eg as a cantilever.

Figure 5: Permissible truss projection



Wall plates should be:

- bedded to line and level
- fixed using nails or straps
- a minimum of 3m or extend over at least three joists, rafters or trusses
- joined using half-lapped joints, including at corners
- 38 x 100mm or in accordance with local practice.

Fixings used to connect the roof structure to the wall plate should be specified according to the roof construction and exposure of the site.

Where trussed rafter roofs are not subject to uplift, a minimum of two 4.5mm x 100mm galvanized round wire nails, skew nailed, one on each side of the trussed rafter, or truss clips (fixed in accordance with the manufacturer's instructions) are acceptable.

Where the roof is required to resist uplift, skew nailing is unlikely to provide sufficient strength, and appropriate metal straps should be used. Holding-down straps should be:

- provided according to the geographical location and construction type
- provided where the self-weight of the roof is insufficient against uplift
- provided in accordance with the design
- a minimum of 1m long with a cross section of 30mm x 2.5mm and spaced at a maximum of 2m centres (galvanised steel straps are generally acceptable) or proprietary straps and fixings
- fixed to the wall, or turned into a bed joint.

Fixings for straps should be:

- in accordance with the design
- of a material or finish which is compatible with the straps
- where into masonry, a minimum of four number, 50mm long No 12 wood screws (into suitable plugs)
- provided so that the lowest fixing is within 150mm from the bottom of the strap.

Proprietary straps should be:

- in accordance with Technical Requirement R3
- installed in accordance with manufacturer's recommendations.

7.2.7 Joints and connections

Joints and connections shall be designed to ensure structural stability without undue movement or distortion.

Members should:

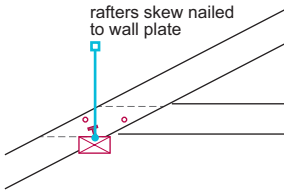
- be accurately cut to fit tightly
- not be damaged or split.

The following joints should be used at the main connections of traditional cut roof members:

Rafters to ceiling joists using a nailed lapped joint

The rafter should be birdsmouthed and skew nailed to the wall plate.

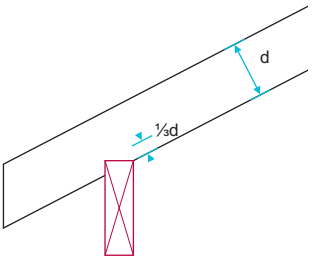
Figure 6: Rafter to ceiling joist connection



Rafter to purlin

A birdsmouth joint should be used, generally the purlin is fixed vertically.

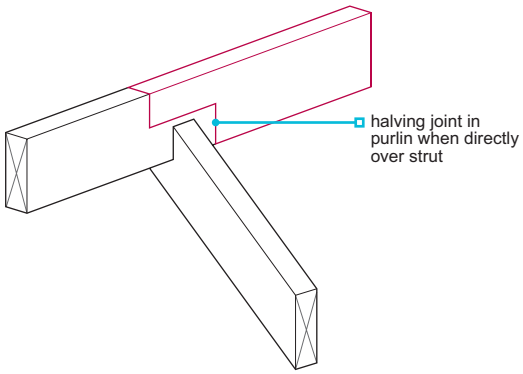
Figure 7: Rafter to purlin connection



Purlin connections

Support should be provided directly under the joint or a scarf joint used. Scarf joints should be made near to a strut so that the joint supports the longer span.

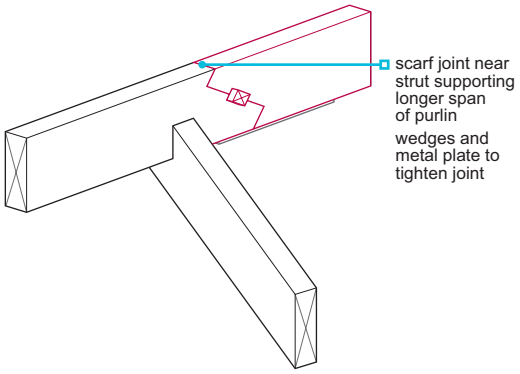
Figure 8: Purlin connection



Scarf joint

Used to support the long span of the purlin.

Figure 9: Scarf joint



Hipped roof joints

Angle ties should be used at the corners of hipped roofs to prevent the wall plates from spreading.

Where hip rafters are heavily loaded, eg carrying purlins, they should be jointed using dragon ties, or similar, to prevent the hip rafter spreading.

Figure 10: Angle tie

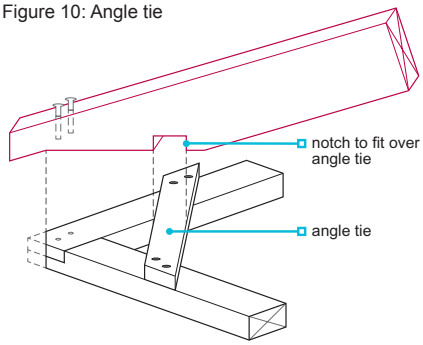


Figure 11: Dragon tie

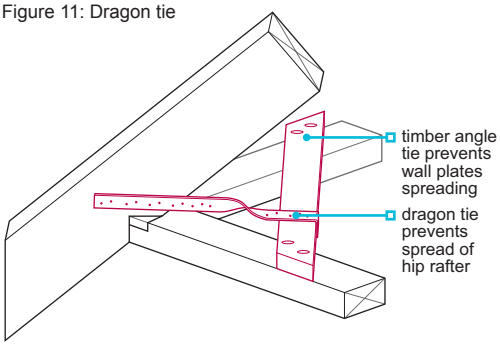
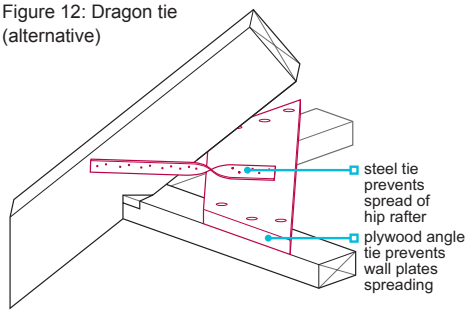


Figure 12: Dragon tie (alternative)



Diminishing truss support

Diminishing trusses should be adequately supported by one of the following:

- by having a splayed bottom chord to ensure correct seating on the rafter or
- by sitting on a continuous binder which is splayed to receive the diminishing truss (Figure 13) or
- by sitting on 25mm x 38mm x 300mm long battens which are splayed to receive the diminishing truss (Figure 14) or
- proprietary diminishing support brackets assessed in accordance with Technical Requirement R3.

Figure 13: Diminishing truss supported by continuous binders

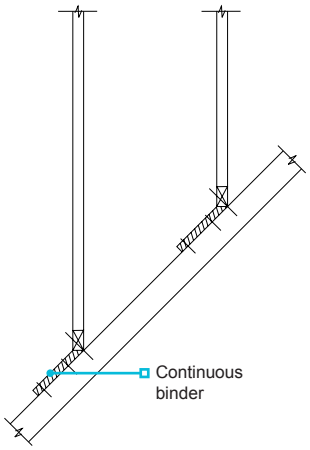
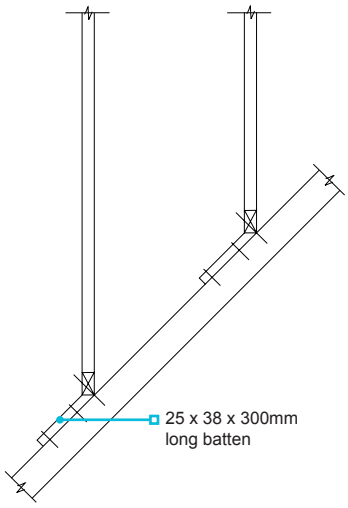


Figure 14: Diminishing truss supported on long battens



7.2.8 Restraint

Also see: Chapter 6.1

Adequate restraint shall be provided to support the structure, distribute roof loads and prevent wind uplift. Strapping shall be of adequate strength and durability, and fixed using appropriate fixings.

Restraint straps, or a restraining form of gable ladder, should be used where required to provide stability to walls, and be installed in accordance with the design.

Lateral restraint straps should be located:

- for homes up to and including three storeys (two storeys in Scotland), at a maximum spacing of 2m
- for homes four storeys (three storeys in Scotland) or over, fixed at a maximum spacing of 1.25m.

Lateral restraint straps should be fixed to the roof structure by either:

- fixing to solid noggings using a minimum of four 50mm x 4mm steel screws or four 75mm x 4mm (8SWG) round nails, with one fixing in the third rafter (Figure 15), or
- fixing to longitudinal bracing members using eight 25mm x 4mm steel screws evenly distributed along the length of the strap (Figure 16). Alternatively, 100mm x 25mm timber members, fixed over four trusses and nailed in accordance with Clause 7.2.9 can be used where the position of the strap does not coincide with a longitudinal binder.

Figure 15: Lateral restraint strap secured to timber blocking

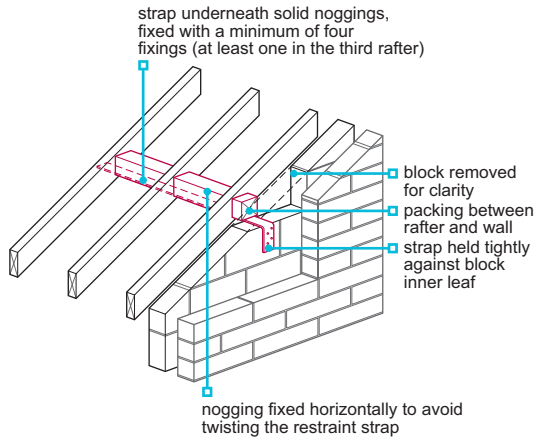
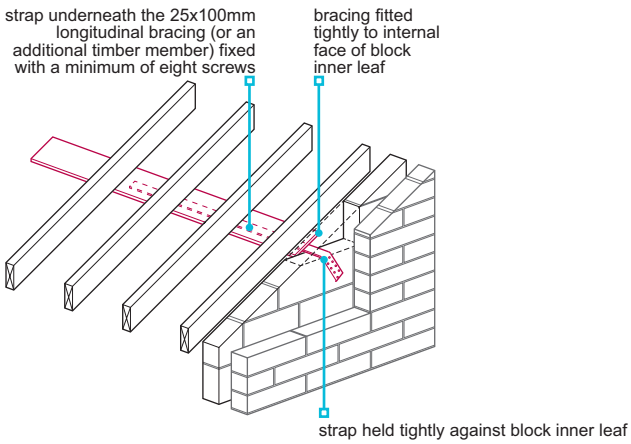


Figure 16: Lateral restraint strap secured to longitudinal bracing



Lateral restraint straps should be:

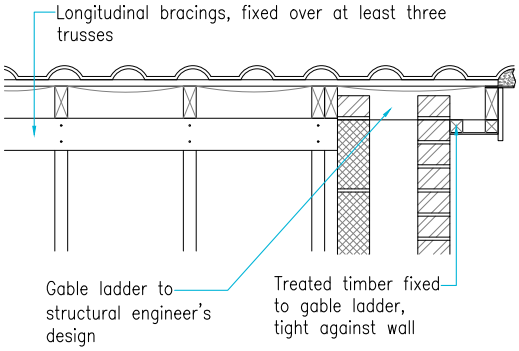
- ordered and supplied according to the design, ie, the correct length and number of bends and twists
- provided at rafter level on gable walls, where the home is of masonry construction (larger or separating walls may require restraint at ceiling level)
- protected against corrosion in accordance with BS EN 845-1 Clause 6.1.11 Table 4 (sherardised straps or fixings are not acceptable in Northern Ireland and the Isle of Man)
- of sufficient length to be fixed to a minimum of three trusses
- a minimum size of 30mm x 5mm and have a minimum anchorage downturn to 100mm (or proprietary straps)
- fixed with the downturn on a substantial piece of blockwork, preferably fitted over the centre of an uncut block
- in accordance with BS EN 1995-1-1, where the home is of timber frame construction.

In framed roofs, as an alternative, purlins and pole plates can be used to provide restraint where the timber abuts a gable construction. Where purlins are used to provide restraint, the maximum permissible spacing is 2m unless the design shows otherwise.

Gable ladders can also be used to provide restraint to the external wall where:

- forming part of the structural design
- there is blocking between the last trussed rafter and the inner leaf (maximum 2m spacing) or the longitudinal bracing is in contact with the inner leaf (maximum 2m spacing). Additional intermediate boards may need to be provided, where bracings are more than 2m apart and where homes are four storeys (three storeys in Scotland) or over
- the soffit board is cut carefully and then fixed securely to restrain the outer leaf.

Figure 17: Restraint by gable ladder – masonry



Proprietary straps should be:

- in accordance with Technical Requirement R3
- installed in accordance with manufacturer's recommendations.

7.2.9 Bracing for trussed rafter roofs

Also see: BS EN 1995-1 and PD 6693-1

Trussed rafters shall be suitably braced to support applied loads and self-weight without undue movement. Issues to be taken into account include:

a) general requirements
b) duo-pitched roofs
c) mono-pitched roofs
d) attic roofs.

For the purposes of this chapter, the guidance and use of standard trussed rafter bracing applies to all homes designed within the parameters set out below. For large houses with truss spans of over 12m, homes with complex roofs or roofs near exposed sites, the bracing should be designed by an engineer in accordance with Technical Requirement R5.

Standard trussed rafter bracing, in accordance with Table 6, is generally acceptable, where the home:

- has a rectangular roof (including hip ends) and is either a duo-pitched or a mono-pitch structure
- is not taller than 8.4m (to the underside of the ceiling tie)
- is braced in accordance with this chapter
- is braced according to the conditions of the site and in accordance with the design
- does not have trusses which span more than 12m
- has trusses which are only supported at each end
- does not have unsupported masonry spanning more than 9m (between buttressing walls, piers or chimneys)
- has a ceiling of plasterboard directly under each truss (where there is no plasterboard, ie, garages, additional diagonal ceiling bracing and longitudinal binder bracing at each ceiling node point is required).

Table 6: Location, height and span for standard bracing conditions for buildings at site altitudes ≤150m

	Roof type		Duo-pitch						Mono-pitch								
	Max pitch		35°			30°			35°			30°			25°		
	Storeys		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Maximum span (m)	England[1] and Wales[1]	Wind zone A[2]	11.3	9.3	8.9	12	11.6	10.5	5.7	3.0	4.5	6.9	5.9	5.3	8.5	7.2	6.6
	Scotland[1] upto Glasgow and Aberdeen	Wind zone B[2]	9.4	8.1	7.6	11.6	10.2	9.1	5.0	4.0	3.8	5.9	5.2	4.5	7.2	6.4	5.7
	Scotland[1] upto Oban and Inverness	Wind zone C[2]	8.7	6.9	6.4	10.3	8.9	7.8	4.4	3.7	3.2	5.2	4.5	3.9	6.5	5.7	5.0
	Scotland[1] areas north of Isle of Mull and Broro	Wind zone D[2]	7.7	6.4	5.4	9.1	7.8	6.7	3.8	3.2	2.7	4.5	3.9	3.3	5.8	5.0	4.0
	Northern Ireland[1] and the Isle of Man	Wind zone B[2]	9.4	8.1	7.6	11.6	10.2	9.1	5.0	4.0	3.8	5.9	5.2	4.5	7.2	6.4	5.7
	Northern Ireland[1] areas north west of Ballymena	Wind zone C[2]	8.7	6.9	6.4	10.3	8.9	7.8	4.4	3.7	3.2	5.2	4.5	3.9	6.5	5.7	5.0

Notes
1 For details of area specific wind zoning please refer to PD6693-1.
2 Wind zones in accordance with PD6693-1.

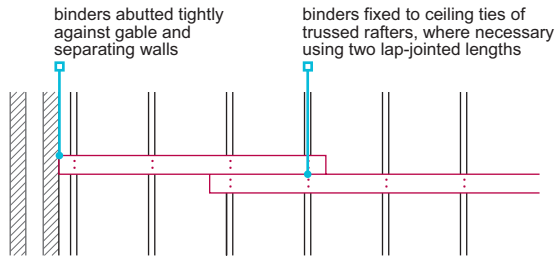
Where trussed rafter designs are outside the parameters above, the guidance in PD6693-1 should be followed.

General bracing requirements

Roof bracing should be:

- in accordance with this chapter or PD6693-1
- in accordance with the design and not altered without prior approval from the designer
- appropriate for the site (for large houses with truss spans of over 12m, homes with complex roofs or roofs near exposed sites, the bracing should be designed by an engineer in accordance with Technical Requirement R5)
- completed before the roof covering is laid
- provided using a minimum timber size of 100mm x 25mm (3mm tolerance)
- nailed twice to each rafter it crosses; fixings should be 3.35mm x 65mm (10 gauge) galvanized round wire nails or minimum 3.1mm x 75mm mechanically driven gun nails
- where braces and binders are not continuous, they should be lap jointed and nailed to a minimum of two trusses.

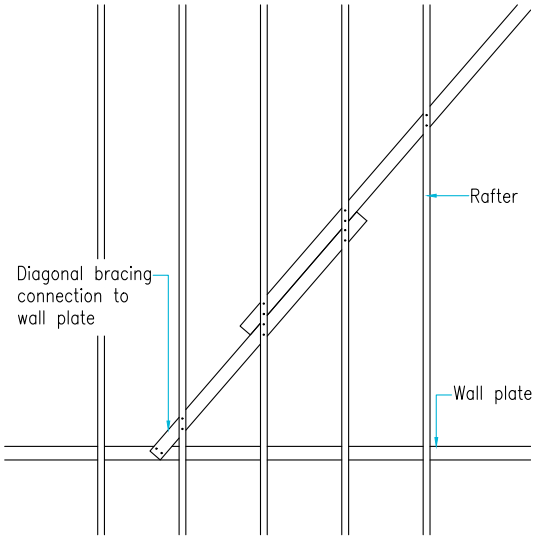
Figure 18: Roof bracing – lap joint



When bracing pitched roofs:

- diagonal and longitudinal bracing should be provided at rafter level (this may be omitted where sarking sheets or boards are used, eg chipboard, plywood or OSB, which are fixed to each trussed rafter with 3mm x 50mm galvanised round wire nails at 200mm spacing)
- diagonal and chevron bracing should pass across each rafter in the roof, however, small gaps, such as two trussed rafters between sets of bracing, or one trussed rafter adjacent to gable or separating walls, is permitted in the middle of an otherwise fully braced roof
- longitudinal bracing members should extend the full length of the roof, tightly abut gable and party walls and permit diagonal bracing to pass (they may be lap-jointed providing the overlap is nailed to a minimum of two trussed rafters)
- there should be a minimum of four diagonal rafter braces in each roof; in narrow fronted roofs (Figure 22) and mono-pitched roofs, where the braces cross, the intersection detail (Figure 23) should be used
- the diagonal bracing should extend over and be directly fixed to the wall plate, fixings should be 3.35mm x 65mm (10 gauge) galvanized round wire nails or minimum 3.1mm x 75mm mechanically driven gun nails, see Figure 19. Where the bracing cannot be directly fixed to the wall plate the bracing should be terminated as detailed in PD6693-1:2019, Figure E.9.

Figure 19: Roof bracing – wall plate connection



Duo-pitched roofs

Diagonal bracing for duo-pitch trusses

Applicable to all trussed rafter roofs unless sarking sheets or boards, are used.

Diagonal bracing should also be provided in-between hipped ends, where the length of roof between the hip ends exceeds 1.8m.

Diagonal rafter bracing should be approximately 45° to the rafters on plan.

Figure 20: Diagonal rafter bracing – square roofs

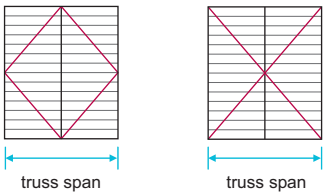


Figure 21: Diagonal rafter bracing – larger roofs

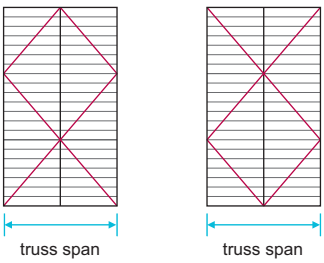
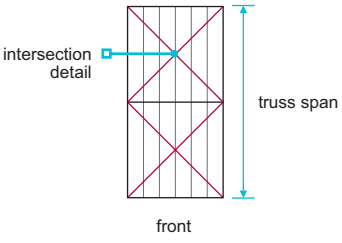


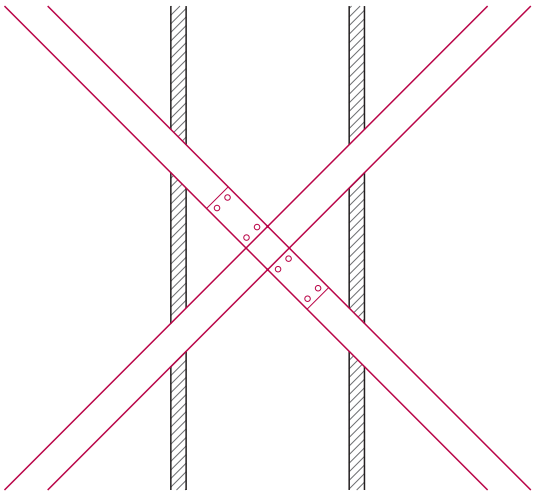
Figure 22: Diagonal rafter bracing – narrow fronted roofs



Intersection details should be formed by:

- 22mm x 97mm x 600mm timber splice plate
- nailing, using a minimum of four 3.35mm x 65mm galvanised round wire nails or minimum 3.1mm x 75mm mechanically driven gun nails to each side of the intersection, with nails driven through bracing and clenched over.

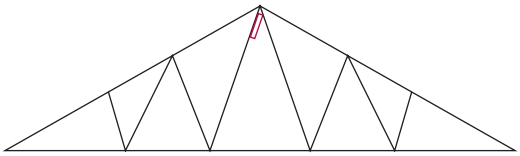
Figure 23: Intersection detail



Longitudinal bracing member at ridge node point

Applicable to all trussed rafter roofs. Not necessary where sarking sheets or boards are used.

Figure 24: Longitudinal bracing – ridge node

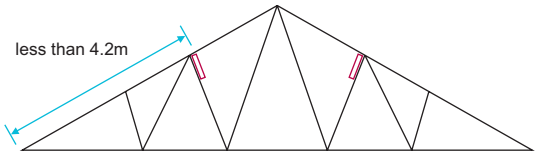


Longitudinal bracing member at rafter node point

Applicable to all rafter node points. Not necessary where:

- spacing between braced nodes is less than 4.2m, or
- sarking sheets or boards are used.

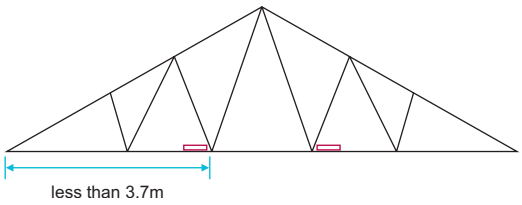
Figure 25: Longitudinal bracing – rafter node



Longitudinal binders at ceiling node points

Applicable to all ceiling node points. Not necessary where the spacing between braced nodes is less than 3.7m.

Figure 26: Longitudinal binders – ceiling node

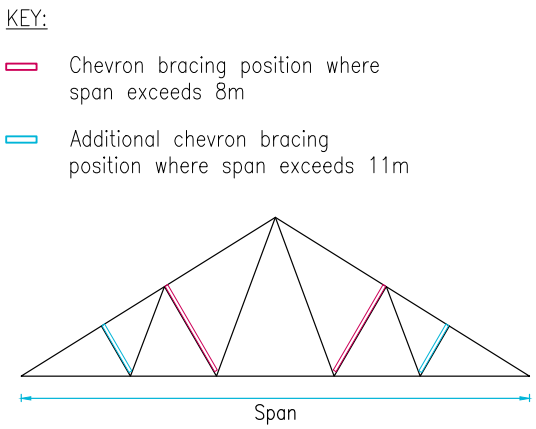


Chevron bracing between webs

Chevron bracing should be:

- provided where the span exceeds 8m
- at approximately 45°
- nailed to at least three trusses.

Figure 27: Chevron bracing – duo pitched roof



For duo-pitch roofs over 11m span, chevron bracing should be designed by an engineer in accordance with Technical Requirement R5.

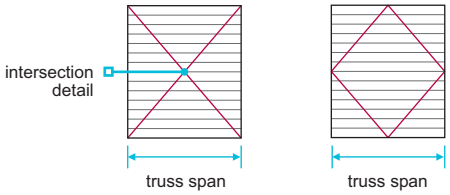
Mono-pitched roofs

Diagonal bracing for mono-pitch trusses

Applicable to all mono-pitched trussed rafter roofs unless sarking sheets or boards are used.

Diagonal rafter bracing should be approximately 45° to the rafters on plan.

Figure 28: Mono-pitch truss - diagonal rafter bracing

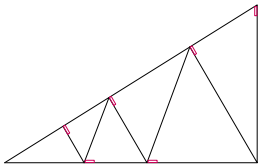


Longitudinal bracing to mono-pitch trusses

Longitudinal bracings should be located at the apex and either:

- all other node points (excluding support points); or
- where intermediate longitudinal bracing members are omitted, the resultant spacing between longitudinal braced node points does not exceed 4.2 m measured along each rafter and 3.7 m measured along each ceiling tie.

Figure 30: Mono-pitch truss – longitudinal bracing

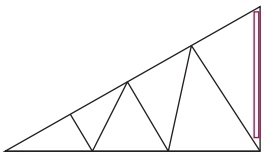


Diagonal bracing to end vertical member of mono-pitch trusses

Applicable where the truss is not restrained by:

- a masonry wall, or
- cladding, ie, plywood.

Figure 29: Mono-pitch truss - diagonal bracing to end vertical member

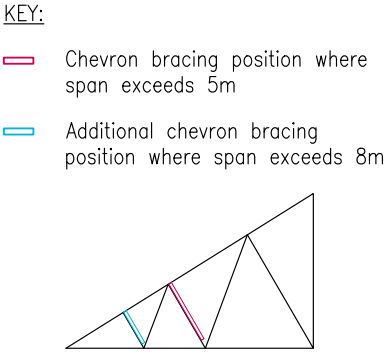


Chevron bracing between webs

Chevron bracing should be:

- provided where the span exceeds 5m
- at approximately 45°
- nailed to at least three trusses.

Figure 31: Mono-pitch truss - chevron bracing



For mono-pitch roofs over 8m span, chevron bracing should be designed by an engineer in accordance with Technical Requirement R5.

Attic trusses

Attic trusses should be braced in accordance with the design.

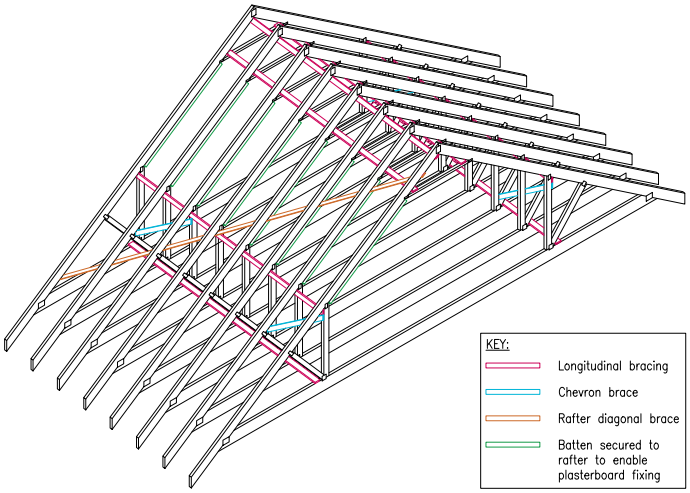
Diagonal bracing

Applicable to all attic trussed rafter roofs unless sarking sheets or boards are used.

Diagonal bracing is required:

- at each gable end at approximately 45° on plan
- at intervals along the roof to ensure each truss is braced
- to be fixed to the underside of the rafters (where diagonal bracing passes through the room space, ceiling boards can be fixed over the diagonal bracing onto battens fixed to the rafters on each side of the bracing).

Figure 32: Attic truss - diagonal bracing



Diaphragm bracing

Where the diagonal bracing passes through the room space and needs to be interrupted to allow boarding to be fixed without battening out the rafters the following options may be used:

- continuous internal 9mm plywood or OSB sheathing (see Table 9) minimum 900mm width, as shown in Figure 33, face fixed to underside of rafters for the full length of the roof, or
- diaphragm bracing closely fitted between the rafters as shown in Figure 34 and Figure 35. The bracing should be 9mm plywood or OSB sheathing (see Table 9), at least 1200mm long fixed to a 50mm x 50mm timber framework.

Figure 33: Attic truss – diaphragm bracing

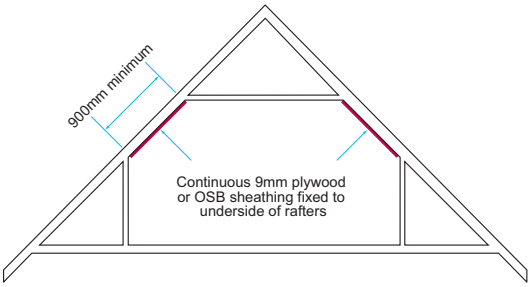


Figure 34: Attic truss – diaphragm bracing

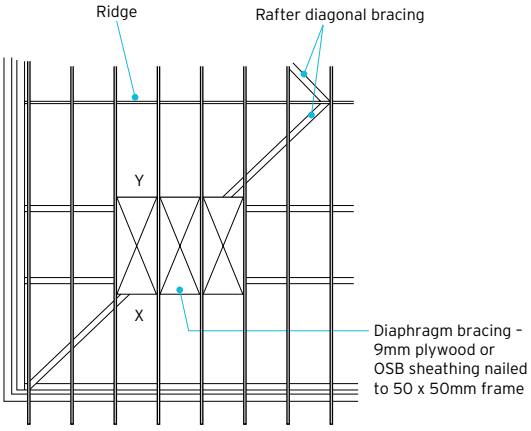
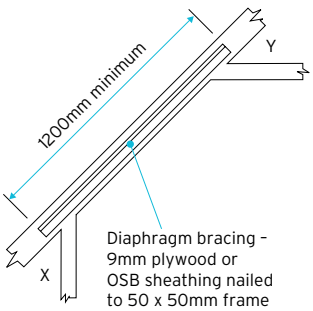


Figure 35: Attic truss – diaphragm bracing

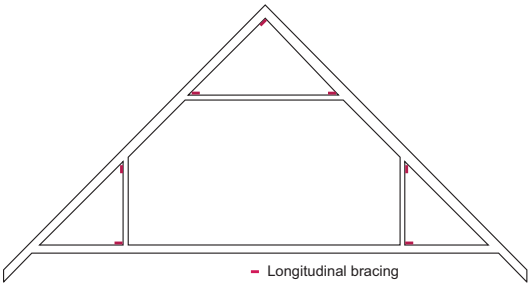


Longitudinal bracing

Longitudinal bracing is required:

- at node points (excluding support points).

Figure 36: Attic truss – longitudinal bracing



Also see: Chapter 6.4

7.2.10 Strutting for site formed attic trusses and cut roofs that form a floor

Strutting to site formed attic trusses shall be provided to support the applied loads and self-weight without undue movement or distortion.

Strutting should be provided:

- in accordance with the design
- where the span between the node points which form the width of the floor of the attic truss exceeds 2.5m
- where the span between the supports to a floor within a cut roof exceeds 2.5m
- using herringbone (38mm x 38mm timber) or solid strutting (a minimum of 0.75x the depth of the floor and a minimum of 38mm thick).

Table 7: Provision of strutting

Span of floor	Rows of strutting
Under 2.5m	None required
2.5m-4.5m	One (at centre of span)
Over 4.5m	Two (at equal spacing)

7.2.11 Support for equipment

Permanent equipment in roof voids shall be adequately supported.

Where equipment (eg water tanks and MVHR fan units) is located in the roof void, the structure should be designed in accordance with PD 6693-1 and the truss manufacturer's recommendations, to support the additional load. Platforms supporting permanent equipment, should be positioned with a minimum clearance of 50 mm between the top of the insulation and the underside of the platform, to ensure a clear ventilation space.

7.2.12 Access

Also see: Clause 7.2.15

Roof voids shall be provided with suitable access.

Access to roof voids should be provided to allow for periodic inspection, maintenance and removal of permanent equipment.

Access should:

- be provided to the main roof space and to voids which contain permanent equipment (eg heating, water storage, energy producing and ventilation equipment, etc), service connection boxes or connection points for TV aerials, etc
- permit the removal of permanent equipment located in the roof space
- have a minimum opening width of 520mm in each direction
- not be located directly over stairs or in other hazardous locations
- include securely fixed boarded walkways between the opening and the permanent equipment and at each piece of permanent equipment, a minimum 1m^2 platform should be provided to facilitate maintenance
- boarded walkways and working platforms should be securely fixed with a minimum clearance of 50 mm between the top of the insulation and the underside of the walkway to ensure a clear ventilation space.

Access may not be required where a void does not contain any permanent equipment, service connection boxes or connection points for TV aerials, etc where:

- the main roof consists of only a small void below the ridge where the raised collar is less than 2m in length
- roof cassette systems are used in forming room-in-roof and the length of the raised collar is over 2m and the floor to ceiling dimension below the ceiling is over 2.4m
- small voids are present in the eaves (including those which contain water pipes only).

Access hatches should be in accordance with Clause 7.2.15. Where an access hatch is required to provide fire resistance, the fire-resistance period should be supported by test evidence.

7.2.13 Dormer construction

Also see: Chapter 3.3

Dormers shall be adequately constructed. Issues to be taken into account include:

a) structure
b) ventilation
c) insulation
d) control of condensation
e) proprietary dormers.

Structure

Figure 37: Dormer – rafter supported

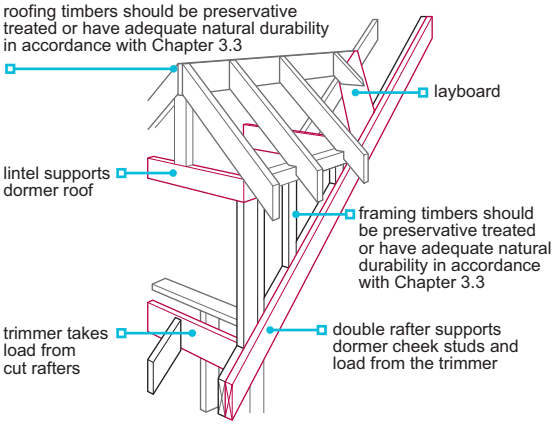
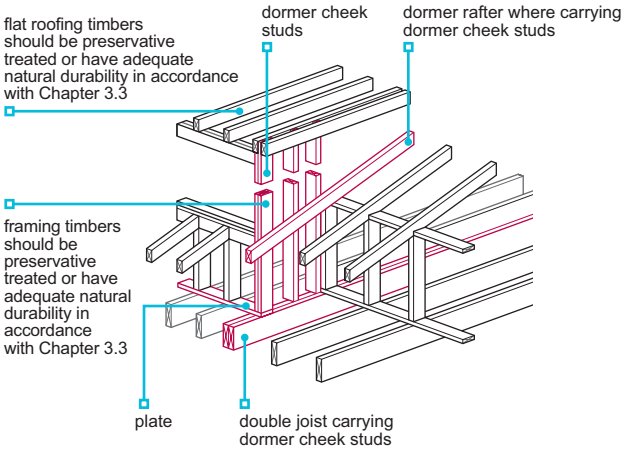


Figure 38: Dormer – floor supported



Site formed dormer roofs:

- should be constructed in accordance with the design
- cheek studs should be supported by either a double rafter or a double floor joist
- trimming members should be large enough to support additional loads from the main roof members, dormer framing and cladding
- which are unusually large or of bespoke design should have an appropriate support designed by a suitable qualified person or a structural engineer in accordance with Technical Requirement R5
- should have a suitable lintel provided over the opening
- lintels should be structurally independent from the window frame
- timbers should be preservative treated or have adequate natural durability in accordance with Table 1 of Chapter 3.3 ‘Timber preservation (natural solid timber)’
- should have roofs braced in accordance with this chapter, where roof trusses are used
- should have roof coverings in accordance with this chapter or Chapter 7.1 ‘ Flat roofs, terraces and balconies’.

The external walls of a site formed dormer:

- should be sheathed and protected by a suitable breather membrane
- have a drained and ventilated cavity behind claddings, in accordance with Clause 6.2.10.

Lead, used to clad dormer cheeks, should be detailed in accordance with the Lead Sheet Training Academy ‘The complete manual’ and be:

- a minimum Code 4 (blue) or 5 (red) in a sheltered to moderate exposure zone or
- code 5 (red) or 6 (black) in a severe exposure zone.

Ventilation

Pitched roofs shall be adequately ventilated to limit the risk of interstitial condensation. For cold roofs, ventilation should be provided from eaves to eaves or at ridge level, in accordance with Table 8.

Figure 39: Ventilation to dormer pitched roofs

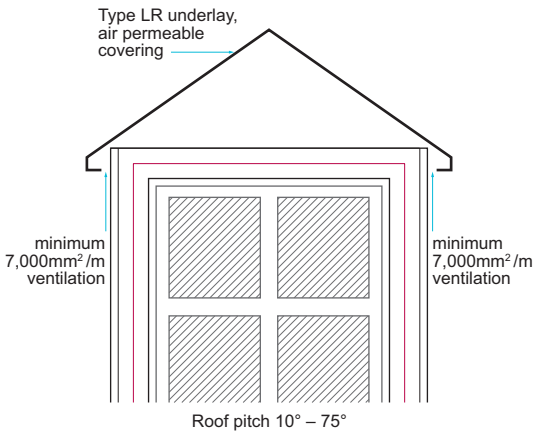


Figure 40: Room in roof (flat cold roof dormer)

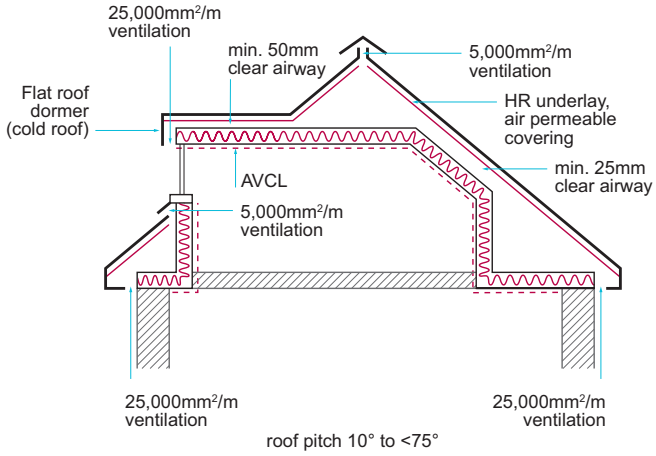


Table 8: Dormer pitched roof ventilation requirements

Cold roof with air permeable outer weatherproof covering			
Roof pitch	**Underlay type**	**Ceiling type**	**Minimum eaves ventilation**
10° to 15°	Type HR	Any	25 000mm²/m
>15° and <75°	Type HR(1)	Any	10 000 mm²/m
10° to 75°	Type LR	Normal(2)	7000 mm²/m
		Well-sealed(2)	3000 mm²/m(3)

Notes:
1. High level vent 5000 mm²/m based on the longest horizontal dimension should be provided where the roof pitch exceeds 35°.
2. A normal ceiling typically has an air permeability of 300 mm²/m² (0.3%). A well-sealed ceiling conforms to Clause 12.4.2 of BS 5250 and BS 9250, and typically has an air permeability of not more than 30 mm²/m² (<0.03%).
3. Alternatively, a high-level vent 5 000 mm²/m based on the longest horizontal dimension of roof can be provided.

Where air impermeable outer weatherproof coverings are used, please refer to Clause 7.2.15 for guidance on roof ventilation strategies.

Flat roof dormers should:

- have falls to the front or sides
- be either of warm deck or cold deck construction (in accordance with BS 5250)
- be ventilated where of cold deck construction in accordance with Clause 7.1.11
- be constructed in accordance with Chapter 7.1 ‘Flat roofs, terraces and balconies’.

Insulation

Dormer roofs and cheeks should be insulated to meet the requirements of the Building Regulations.

Control of condensation

To limit interstitial condensation, site formed dormers should incorporate an air and vapour control layer to the walls.

Air and vapour control layers should also be provided to flat roofs, in accordance with Chapter 7.1 and are recommended to be applied to the warm side of the insulation within pitched roofs.

Further guidance on air and vapour control layers can be found in Clause 7.2.15.

Proprietary dormers

Propriety dormers (eg glass reinforced plastic - GRP) should hold a satisfactory assessment by an appropriate independent technical approval’s authority acceptable to NHBC.

Proprietary dormers should meet the Technical Requirements and:

- be suitably durable
- limit the risk of interstitial condensation occurring to the walls and roof
- be installed in accordance with certification requirements.

Walls and roofs of proprietary dormers should typically incorporate an air and vapour control layer. The air and vapour control layer specification should be in accordance with manufacturers requirements.

7.2.14 Underlay, sarking boards and sheets

Underlay and sarking shall be provided to resist the passage of moisture.

Underlay and sarking should:

- be in accordance with the manufacturer's recommendations
- take account of the type and fixing of the roof covering
- be used in accordance with relevant assessments.

In areas of severe exposure, a rigid sarking sheet or board with underlay is recommended.

Table 9: Acceptable materials for use as underlay and sarking

Material	Standard / requirement	Minimum material specification (where applicable)	Minimum material thickness (where applicable)
Solid timber tongue and grooved or square edged board	BS 1297		16 mm
Plywood	BS EN 636	BS EN 636 - 2S(2)	9 mm(1)
Chipboard	BS EN 312	Type P5	12 mm(1)
OSB	BS EN 300	OSB/3	9mm(1)
Type HR (>0.25MNs/g) and Type LR (<0.25MNs/g) underlay	BS EN 13859-1	Class W1	
	BS 8747	1F/5U	
Type LR - Low water vapour resistance (<0.25MNs/g) and air permeable underlay (min. air permeability of 34m³/m².h at 50 Pa)	Technical Requirements R3(3)	Class W1	
Proprietary products	Technical Requirements R3(3)		

Notes:

1. Minimum thickness suitable only where roof coverings (eg slates and tiles) are independently supported on battens, secured to counter battens. Minimum thicknesses quoted, actual design requirements may differ.
2. S- Structural.
3. Propriety products should hold a satisfactory assessment by an appropriate independent technical approval's authority acceptable to NHBC.

Underlay should:

- be provided to all tiled and slated roofs
- not be left exposed to sunlight for longer than recommended by the manufacturer
- where fully supported on a sarking sheet which offers a high resistance to the passage of air or water vapour, such as plywood, OSB, chipboard, or tongue and grooved sarking boards, be treated as a type HR underlay for roof ventilation purposes
- be supported by a continuous fillet or proprietary eaves support tray, laid to inclined falls (see Figure 41), to prevent sagging (which can form a water trap)
- be securely fixed in accordance with manufacturers requirements
- at vertical laps, be fixed only over rafters, and at horizontal laps be held in place by battens. Where no batten is provided over a horizontal lap, the underlay manufacturers guidance should be sought
- be cut neatly to fit tightly around surface penetrations and not be torn, ie, where pipes project through the underlay
- be dressed into the gutter where exposed at eaves level, be UV resistant or of type 5U felt or a proprietary eaves guard used
- where traditional mortar pointing is used to bed ridge tiles, extend over the ridge, in accordance with Clause 7.2.19
- be detailed in accordance with manufacturer's requirements where proprietary ventilating ridge tiles or dry ridge systems are used
- continue over hips to form a 150mm minimum lap parallel with the hip rafter
- at abutments, be supported and turned up by a minimum of 100mm
- be draped to allow water to drain behind the tiling battens.

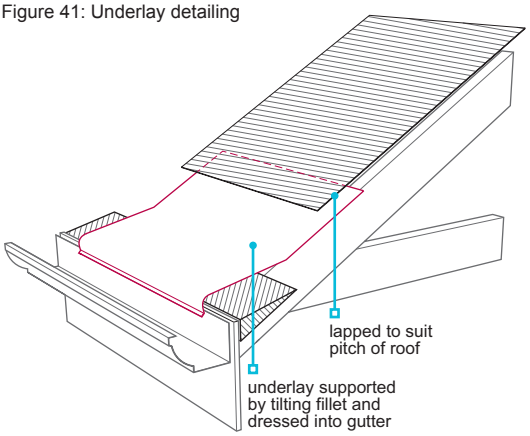
Table 10: Horizontal laps for unsupported and supported underlays

Pitch	Minimum horizontal laps	
	Unsupported underlay	Supported underlay
Less than 15°	225mm	150mm
15° and above	150mm	100mm

At valleys:

- the main roof underlay should be cut to the valley batten line
- a strip of underlay should be laid under the main roof underlay and held down by the valley battens (where used).

Figure 41: Underlay detailing



7.2.15 Ventilation, vapour control and insulation

Also see: Part 8.0, BS 5250

Roofs shall have adequate precautions against condensation and cold. Issues to be taken into account include:

a) ventilation
b) vapour control
c) insulation
d) pipework.

Ventilation

This guidance on ventilation should be read in conjunction with the definitions table at the beginning of Chapter 7.2 'Pitched roofs'.

Pitched roofs should be adequately ventilated to limit the risk of interstitial condensation. Roof ventilation should be in accordance with BS 5250:2021.

The roof ventilation guidance in this clause is taken from BS 5250:2021 'Management of moisture in Buildings – Code of practice'. New-build homes can be at risk of a significant additional moisture load from the construction process and therefore roof-space condensation may occur during the first heating season. The builder may consider additional precautions than those stated below, to help reduce the potential for condensation during this period eg by providing 5000mm^2/m high level ventilation in cold roof construction, where high level ventilation is not be required in the British Standard.

The roof ventilation strategy should be selected dependent upon:

- the roof covering ie, air permeable or air impermeable
- the underlay type ie, Type LR or Type HR
- the roof type ie, cold or warm roof
- the pitch of the roof
- ceiling type ie, normal or well-sealed (where applicable).

Roofing underlay

Roofing underlays, Type HR or Type LR, should be selected with consideration for the roof type, the outer weatherproof covering and the design of the property, in order to ensure that the required ventilation provision can be met.

Where a Type LR underlay is fully supported on sarking sheets or boards which offer a high resistance to the passage of air or water vapour, such as plywood, oriented strand board (OSB), chipboard, or tongue and grooved sarking boards, the Type LR underlay and sarking should be treated as a Type HR underlay, for roof ventilation purposes.

Where Type LR underlays are laid on open jointed square-edged sarking boards, typically 150 mm wide with a minimum 2 mm gap between each board, these may be treated as Type LR underlays, for roof ventilation purposes.

Air permeability of roof coverings

Manufacturers information should be checked to confirm the air permeability of the roof covering. BS 5534 'Slating and tiling for pitched roofs and vertical cladding' (Annex L) provides information on testing the air permeability of tiles or slates.

Where the permeability of the roof covering is unknown, the roof covering should be treated as air impermeable.

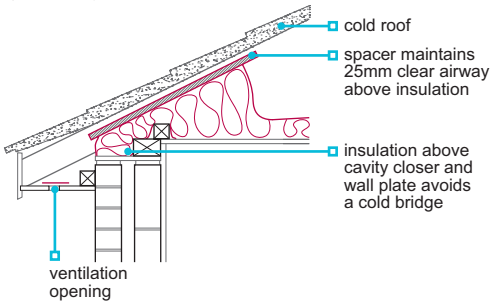
Where arrays of integrated solar roof panels are installed forming the roof covering, then the whole roof covering should be treated as air impermeable, unless the panel manufacturer is able to demonstrate their system is air permeable. Intergrated solar roof panel manufacturers may also require a larger air space beneath the panel, than stated in this Clause, to increase ventilation and cooling of the panel.

Roof ventilation strategies

Roof ventilation should:

- prevent the entry of birds, etc (fabrications with 3mm-10mm openings are acceptable)
- ensure that ventilation pathways remain clear, ie, not blocked by insulation or the structure
- have a spacer in the eaves to allow insulation to be installed over and beyond the wall plate to minimise the thermal bridge without blocking the ventilation path (the spacer should be of sufficient length to maintain ventilation throughout the thickness of the insulation)
- incorporate correctly sized, proprietary eaves ventilators, which are fixed in accordance with the manufacturer's instructions.

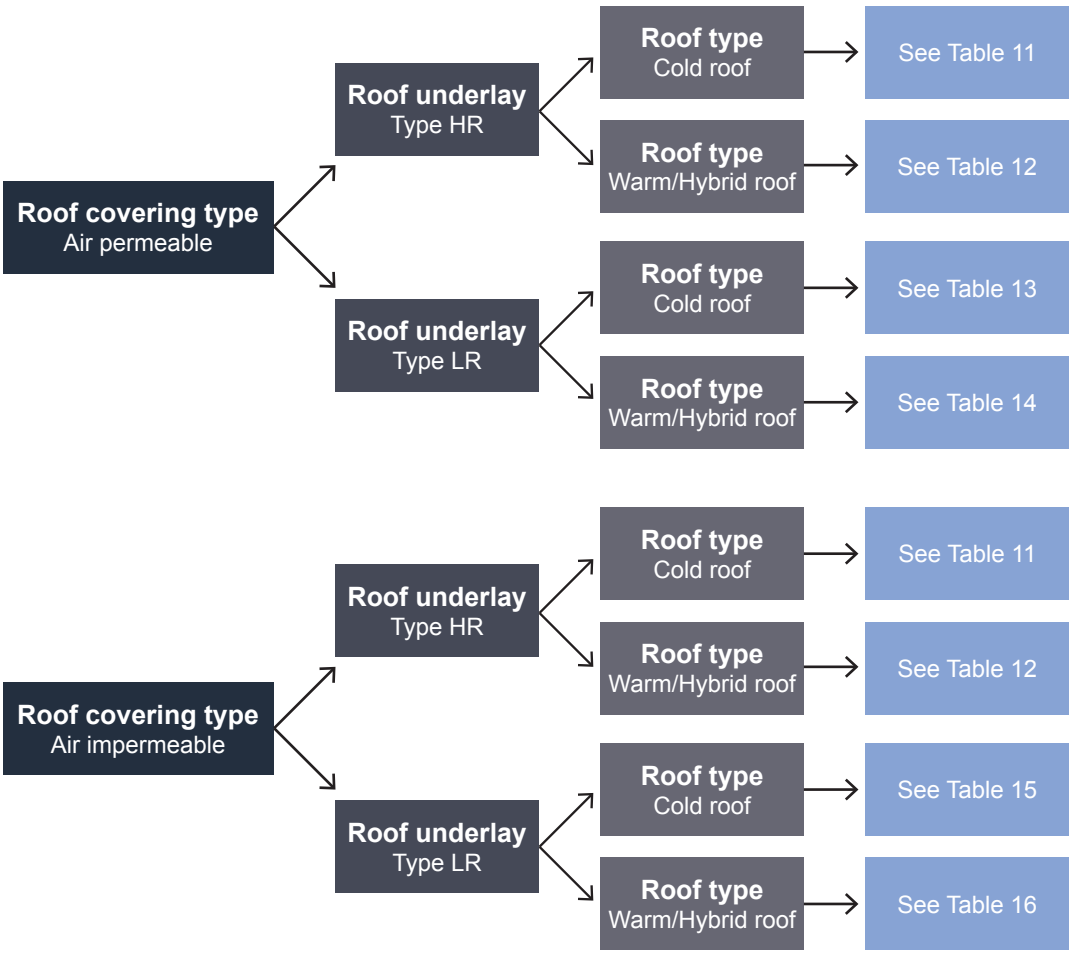
Figure 42: Typical eaves ventilation



For the purposes of health and safety it may not be necessary to provide ventilation to small roof areas (3m^2 or less) over porches or bay windows. Where no roof ventilation is proposed, a condensation risk analysis should be undertaken to ensure the risk of interstitial condensation is mitigated. Alternative designs for small roofs maybe more appropriate, for example:

- warm roof designs or
- the use of air and vapour permeable underlays.

To avoid condensation in larger roofs, pitched roofs which incorporate insulation, should be designed to limit the risk of interstitial condensation. Guidance on roof ventilation strategies can be found using the flow chart below:



Air permeable outer weatherproof coverings

This section provides guidance on the roof ventilation strategy where an air permeable outer weatherproof covering is used.

Outer weatherproof coverings of concrete and clay tiles are typically classed as air permeable, manufacturers information should be consulted.

Table 11: Cold roof ventilation (Type HR underlay and air permeable outer roof covering)

Roof pitch	Minimum eaves/ low level ventilation (underneath underlay)	Additional requirements
10° to 15°	25 000mm²/m	Additional 5000 mm²/m ridge or high level ventilation (underneath underlay), based on the longest horizontal dimension, should be provided where the roof pitch exceeds 35° or the roof span exceeds 10m, or the roof is a lean-to or mono pitch
>15° and <75°	10 000mm²/m	

Figure 43: Roof pitch 10° to 15°

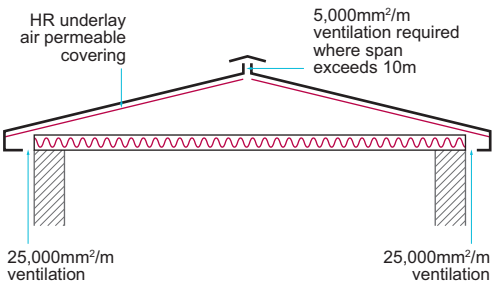


Figure 44: Roof pitch >15° and <75°

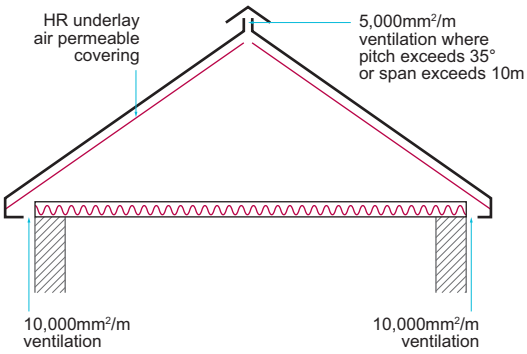


Figure 45: Mono-pitched roof

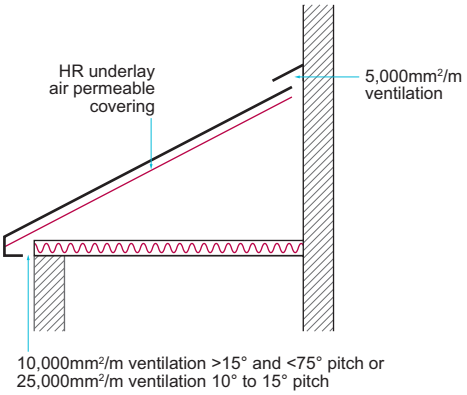
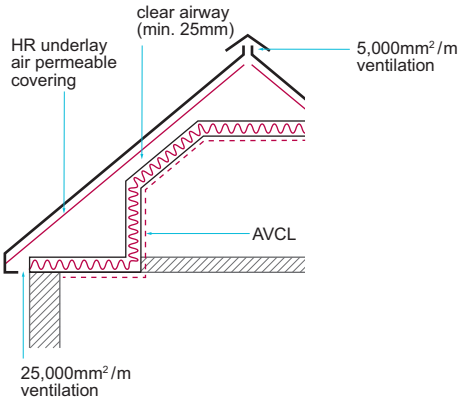


Table 12: Warm or hybrid roof ventilation (Type HR underlay and air permeable outer roof covering)

Roof pitch	Minimum eaves/ low level ventilation (underneath underlay)	Minimum ridge/ high level ventilation (underneath underlay)	Additional requirements
10° to <75°	25 000mm²/m	5000mm²/m	AVCL required Minimum 25mm clear ventilation pathway required(1)

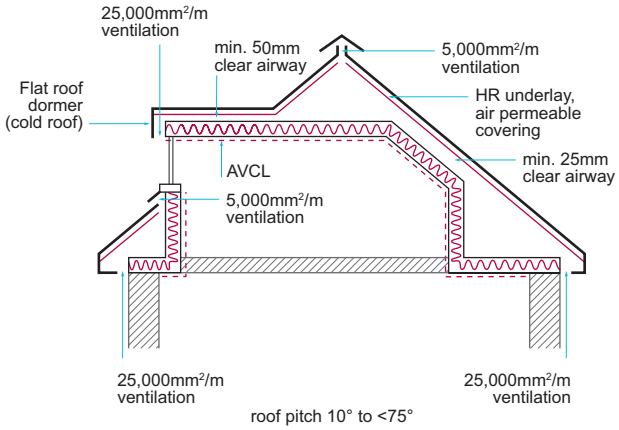
Note:
1. Minimum 25mm clear ventilation pathway is measured from the lowest point of the underlay drape or underside of sarking.

Figure 46: Hybrid roof - Room-in-roof



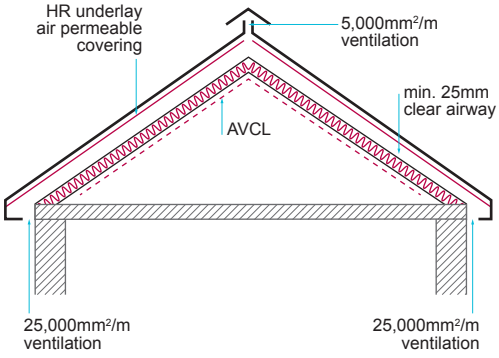
Roof pitch 10° – <75°

Figure 47: Hybrid roof - Room in roof (flat roof dormer)



roof pitch 10° to <75°

Figure 48: Warm roof



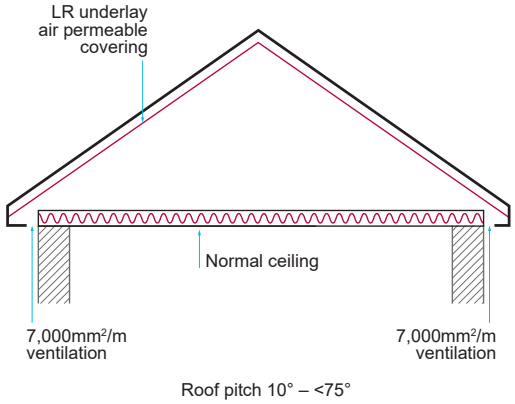
Roof pitch 10° – <75°

Table 13: Cold roof ventilation (Type LR underlay and air permeable outer roof covering)

Roof pitch	Ceiling type	Minimum eaves/low level ventilation (underneath underlay)
10° to <75°	Normal(1)	7000mm²/m
10° to <75°	Well-sealed(1)	3000mm²/m(2)

Notes:
1. A normal ceiling typically has an air permeability of 300 mm²/m² (0.3%).
   A well-sealed ceiling conforms to BS 9250 and typically has an air permeability of not more than 30 mm²/m²(≤0.03%).
2. Alternatively, a high-level vent 5000 mm²/m based on the longest horizontal dimension of roof can be provided.

Figure 49: Cold roof – LR underlay with air permeable covering



Where no ventilation is proposed to the cold roof void with air permeable outer roof coverings, the roofing underlay (Type LR) must be a low water vapour resistance and air permeable underlay and hold current certification for use in a non-ventilated application, from an appropriate independent technical approvals body, acceptable to NHBC. Such membranes should have a water vapour resistance, sd, not exceeding 0.05 m (0.25 MN·s/g) and a minimum air permeability of 34m³/m².h at 50 Pa, or more.

Table 14: Warm or hybrid roof ventilation (Type LR underlay and air permeable outer roof covering)

Roof pitch	Roof type	Minimum eaves/ low level ventilation (underneath underlay)	Minimum ridge/ high level ventilation (underneath underlay)	Additional requirements
10° to <75°	Warm roof	None	None	AVCL required(1) Underlay drape should be maintained
10° to <75°	Hybrid roof	7000mm²/m	5000mm²/m	AVCL required A minimum 25mm clear ventilation pathway is required(2)

Notes:

1. Where a continuous air and vapour control layer is impractical to install, an additional 25 000mm²/m eaves or low level ventilation and 5000mm²/m ridge or high level ventilation should be provided below the underlay. A minimum 25mm clear ventilation pathway is required below the underlay.
2. Minimum 25mm clear ventilation pathway is measured from the lowest point of the underlay drape or underside of sarking.

Figure 50: Warm roof - LR underlay with air permeable covering

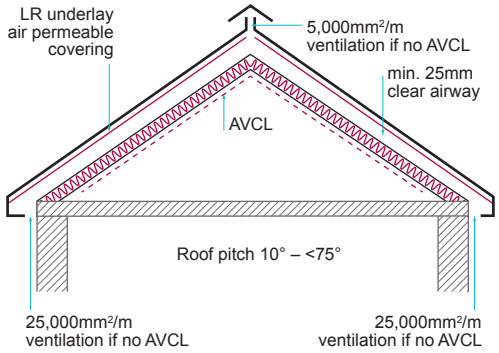
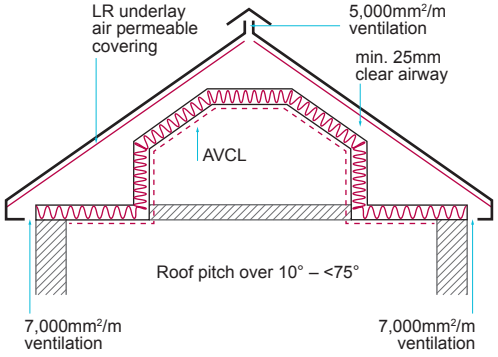


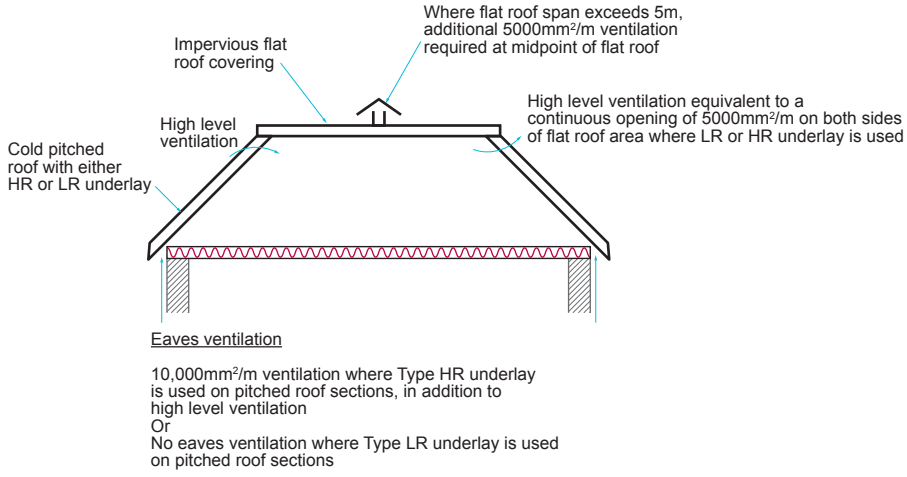
Figure 51: Hybrid roof - LR underlay with air permeable covering



Cold Roof with flat roof apex

Where a cold pitched roof meets a cold flat roof, there is a risk of condensation occurring on the underside of the flat roof deck. Ventilation beneath the underlay, should therefore be provided in accordance with Figure 52 below.

Figure 52: Cold pitched roof with flat roof apex



Air impermeable outer weatherproof covering

This section provides guidance on the roof ventilation strategy where an air impermeable outer weatherproof covering is used.

Outer weatherproof coverings of fibre cement slates, sheet metal, continuous bitumen or plastic membranes, are typically considered to be air impermeable, manufacturers information should be consulted.

Roofs with a Type HR underlay and air impermeable outer roof covering, should be ventilated in accordance with the following guidance:

- cold roof - Table 11
- warm or hybrid roof - Table 12

Roofs with a Type LR underlay and air impermeable outer roof covering, should be ventilated in accordance with:

- cold roof - Table 15
- warm or hybrid roof - Table 16

Table 15: Cold roof ventilation (Type LR underlay and air impermeable outer roof covering)

Roof pitch	Ceiling type	Minimum eaves/low level ventilation (underneath underlay)	Minimum batten space ventilation using min. 25mm deep counterbattens (above underlay)(1)
10° to <75°	Normal(2)	7000mm²/m	25 000 mm²/m at eaves/low level and 5000 mm²/m at ridge/high level
10° to <75°	Well-sealed(2)	3000mm²/m (or 5000 mm²/m ridge or high level ventilation based on the longest horizontal dimension of roof)	25 000 mm²/m at eaves/low level and 5000 mm²/m at ridge/high level

Notes:

1. If no batten space ventilation is provided then the LR underlay should be treated as an HR underlay and ventilation provided in accordance with Table 11 above.
2. A normal ceiling typically has an air permeability of 300 mm²/m² (0.3%). A well-sealed ceiling conforms to BS 9250 and typically has an air permeability of not more than 30mm²/m² (≤0.03%).

Figure 53: Cold roof – Type LR underlay with air impermeable covering

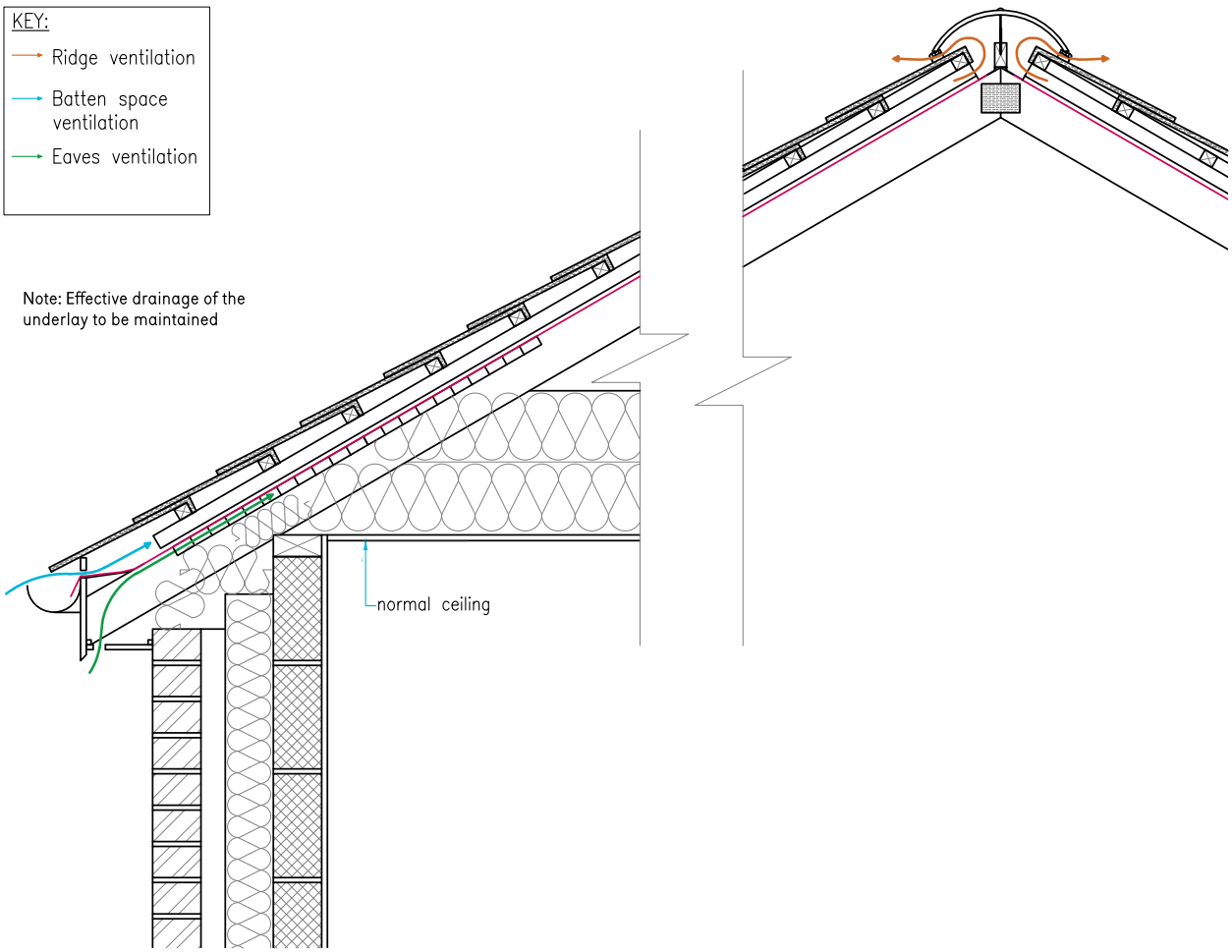


Table 16: Warm or hybrid roof ventilation (Type LR underlay and air impermeable outer roof covering)

Roof pitch and type	Minimum eaves/low level ventilation (underneath underlay)	Minimum ridge/high level ventilation (underneath underlay)	Minimum batten space ventilation using min. 25mm deep counterbattens (above underlay)	Minimum ridge/high level ventilation (above underlay)	Additional requirements
10° to <75° Warm roof	None	None	25 000mm²/m at eaves or low level	5000mm²/m	AVCL required Underlay drape should be maintained
10° to <75° Hybrid roof	7000mm²/m	5000mm²/m	25 000mm²/m at eaves or low level	5000mm²/m	AVCL required A minimum 25mm clear ventilation pathway(1)

Note:
1. Minimum 25mm clear ventilation pathway is measured from the lowest point of the underlay drape or underside of sarking.

Figure 54: Warm roof – LR underlay with air impermeable covering

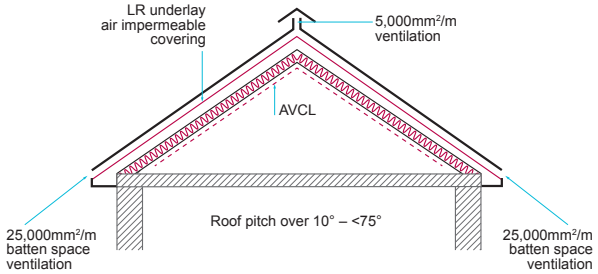
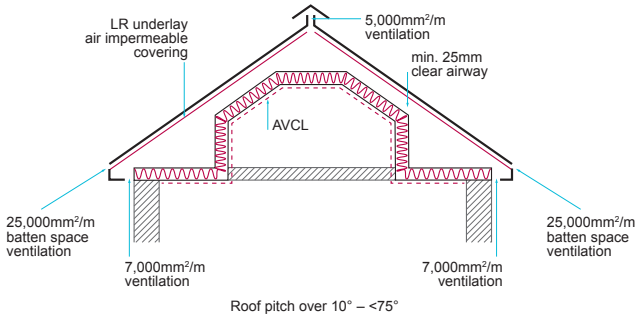


Figure 55: Hybrid roof - LR underlay with air impermeable covering



Pitched roofs with no ventilation provision and air impermeable outer weatherproof covering

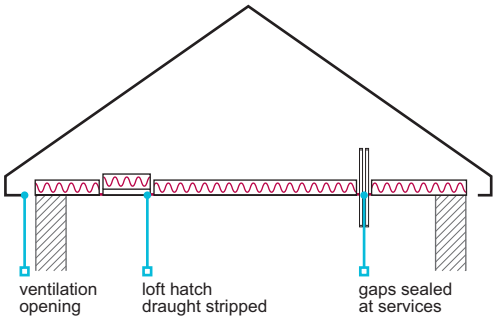
Pitched roofs with no ventilation provision and air impermeable outer weatherproof covering will not be acceptable to NHBC.

Vapour control

Air and vapour control layers (AVCL) should be provided in accordance with the design, and be:

- placed on the warm side of insulation
- used in warm and hybrid roof construction.

Figure 56: Ceiling penetrations



Air and vapour control layers should be:

- installed once framing timbers have a moisture content of less than 20%
- installed once the building is weathertight
- selected in accordance with the design eg a minimum 500 gauge (125 micron) polyethylene sheet, vapour control plasterboard or a product assessed in accordance with Technical Requirement R3
- fixed at 250mm centres to framing members including laps and around openings, boards should be fitted in accordance with Chapter 9.2 ‘Wall and ceiling finishes’
- lapped into openings ie, roof windows, dormers, etc
- sealed around service penetrations, where used downlighters should be specified and sealed to limit air leakage
- made good where damage has occurred.

Joints in the air and vapour control layers:

- should have 100mm minimum laps
- should be located on rafters
- may be sealed with adhesive tape for enhanced air tightness (but joints should still occur over rafters).

Where vapour control plasterboard is used, joints should be:

- positioned on rafters
- cut with care to avoid displacing the vapour control material
- filled, taped and finished, in accordance with the design and manufacturers recommendations.

Where the ceiling below a cold pitched roof includes an air and vapour control layer, the design should ensure adequate ventilation is provided to the habitable areas to prevent condensation problems in the home.

Access hatches to cold roof voids should have:

- an air leakage rate not more than 1m^3/h at a pressure of 2 Pa when tested to BS EN 13141-1, or
- a push-up cover with a minimum weight of 5.5 kg and compress a closed cell seal or ‘o-ring’ between the cover and frame (clamps may also be required to ensure that the cover compresses the seal).

Proprietary hatches should be fitted and sealed to the surrounding construction in accordance with the manufacturer’s instructions.

Insulation

Insulation should be of sufficient thickness to meet the requirements of Building Regulations and laid over the whole loft and wall plate.

The thermal performance of any access hatch should contribute to the overall thermal performance of the ceiling or wall in which the hatch is located and avoid cold bridging.

Table 17: Suitable materials for roof insulation

Material	Standard
Mineral wool	BS EN 13162
Blown mineral fibre	BS 5803-2
Blown cellulose fibre	BS 5803-3
Rigid polyurethane foam	BS EN 13165
Proprietary products	Technical Requirement R3(1)

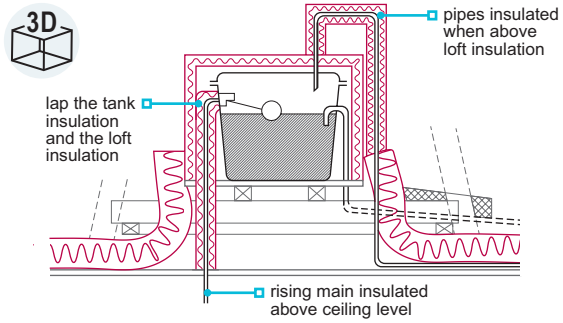
Note:
1. Propriety products should hold a satisfactory assessment by an appropriate independent technical approval's authority acceptable to NHBC.

Pipework

To reduce the risk of freezing or condensation forming on pipework in roof voids, the following precautions should be taken:

- where possible, water pipes should be below the main roof insulation
- water pipes should be insulated in accordance with with Part 8 'Internal services and low or zero carbon technologies'
- roof insulation should be placed above and around water tanks, but not below them
- 'cold rising' pipework above ceiling level should be insulated, even where it is below the main roof insulation.

Figure 57: Storage tank insulation



7.2.16 Fire-stopping and cavity barriers

Also see: Chapter 6.8

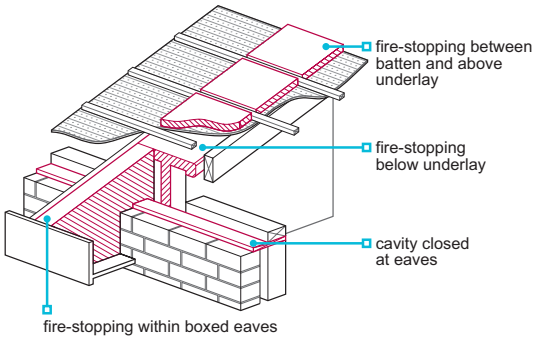
Pitched roofs shall be constructed to provide adequate fire resistance and separation.

Fire-stopping should be provided in accordance with the Building Regulations, including, at the junction between a compartment wall and roof and be extended into any eaves.

When providing fire-stopping:

- gaps between compartments should be fire-stopped, using materials which achieve the same level of fire resistance as the compartment wall
- compartment walls should stop approximately 25mm below the top of adjacent roof framing, and a soft fire-stopping material, should be used to allow for movement in roof timbers and prevent 'hogging' of the tiles.

Figure 58: Fire precautions



Cavity barriers should be provided in accordance with the Building Regulations, including, at the edges and junctions of cavities.

When providing cavity barriers, they should be:

- sized appropriately for the cavity
- tightly fitted to a rigid construction
- mechanically fixed in position.

Combustible material, such as roof timbers and sarking felt, should be kept away from heat sources.

7.2.17 Battens

Also see: Chapter 3.3 and Part 8.0

Battens and counter battens shall be adequately sized, spaced and fixed to support the roof covering.

Battens and counter battens should be:

- in accordance with BS 5534, accompanied by a delivery note and indeliby marked with the supplier, origin, grade and size
- preservative treated and not re-sawn, ripped or planed after treatment (battens can be cut to length)
- where cut ends are located in wet or dry verges, treated with preservative
- cut square, butt jointed over rafters and nailed to each rafter they span
- fixed by skew driven nails on each side of a joint.

Counter battens should be fixed to the rafters and not only to sarking sheets or boards. The dimensions of counter battens should be sufficient to provide a ventilation gap (where required) and permit a drainage pathway beneath the battens.

Battens should be:

- a minimum of 1.2m long and span a minimum of three rafters
- set out in straight lines parallel to the ridge and to the gauge required for the tile or slate (the lap should not be decreased as this would reduce weathertightness)
- set out so that the tiles project a minimum of 50mm over the gutter
- fixed through counter battens to rafters
- where on sarking sheets or boards, be supported on counter battens
- at verges, tile battens should finish 25mm-50mm from the face of the protecting undercloak
- sized in accordance with the roof covering/solar roof panel manufacturer's recommendations, but not less than shown in Table 18.

Table 18: Minimum batten sizes

		450mm span		600mm span	
		Depth	Width	Depth	Width
Double lap slates	Natural: sized or random	25mm	50mm	25mm	50mm
	Fibre cement or concrete	25mm	38mm	25mm	50mm
Clay/concrete tiles	Double lap	25mm	38mm	25mm	38mm
	Single lap	25mm	38mm	25mm	50mm

Notes

1 Tolerances on the basic sizes of timber battens should be: width ±3 mm, depth −0 +3 mm.
2 Batten sizes may need to be increased, where solar roof panels are installed, to ensure full fixing depth penetration is achieved.

Battens should be set out to avoid joints occurring over the same rafter. Where batten spacing is:

- more than 200mm, no more than one batten in any group of four should be joined over any one truss or rafter, see Figure 60
- 200mm or less, no more than three joints should be made over any twelve consecutive battens, see Figure 61.

Figure 59: Incorrect batten jointing

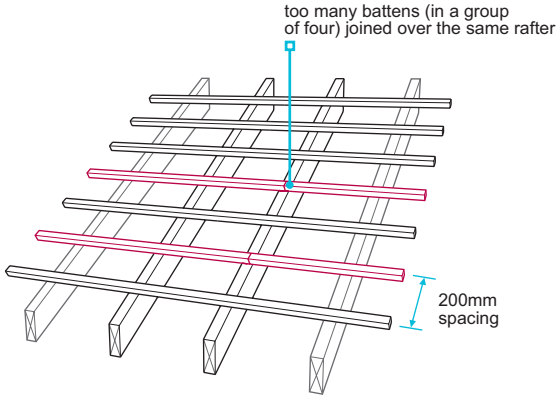


Figure 60: Correct batten jointing – batten gauge >200mm

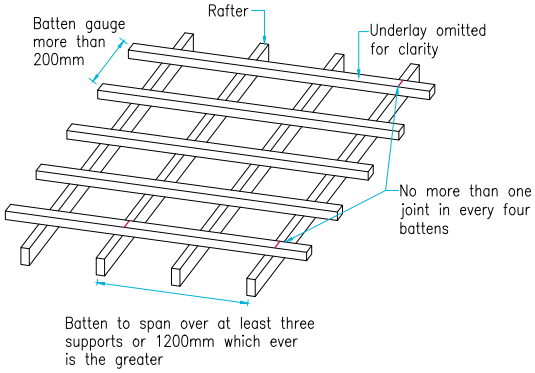
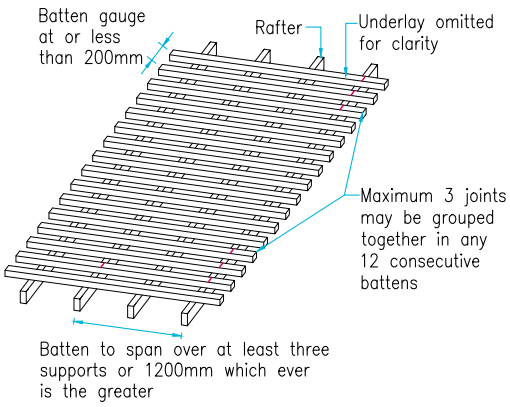


Figure 61: Correct batten jointing – batten gauge ≤200mm



Batten fixings should be capable of resisting wind forces in accordance with BS 5534 (Annex H.7 'Batten fixing penetration'). The length, type and material specification of the fixing to be used, should be determined according to the site exposure and location.

Nails for fixing battens and counterbattens, should meet the following minimum requirements:

- be a driven nail of a minimum of 3.35mm diameter with 40mm minimum penetration into the supporting structure
- a mechanical gun nail with a shank diameter not less than 3.1mm
- round plain shank, indented, spiral roll or annular ring shank nails maybe selected (ring shank nails are recommended in Scotland and Northern Ireland)
- zinc-coated in accordance with BS EN 10230-1
- hot dip galvanised steel or aluminium when situated in a coastal location.

Nails should not be driven below the top of the batten, this reduces the thickness of timber between the nail head and the underside of the batten, which reduces the pull-off resistance and may damage the batten.

7.2.18 Roof coverings

Also see: Part 8.0

Roof coverings shall be of a suitable quality and durability to protect the building from weather.

When covering a pitched roof:

- coverings should be in accordance with the design and established building practices
- recovered materials may be used where prior approval by NHBC has been granted (independent certification of suitability may be required).

Table 19: Standards relevant to roof coverings

Material	Standard	Code of Practice	Other guidance
Clay tiles and fittings	BS EN 1304		
Concrete tiles and fittings	BS EN 490 and BS EN 491		
Dry fixed systems	BS 8612		
Natural slates	BS EN 12326		
Fibre cement slates and fittings	BS EN 492		
Fully supported lead sheet roofing		BS 6915	Technical requirement R3
Rolled lead sheet for building purposes	BS EN 12588		
Zinc and zinc alloys	BS EN 988	CP 143-5	Technical requirement R3
Copper	BS EN 1172	CP 143-12	Technical requirement R3
Stainless steel	BS EN 508-3		Technical requirement R3
Aluminium	BS EN 508-2	CP 143-15	Technical requirement R3
Roof windows	BS EN 14351-1		Technical requirement R3
Natural stone slates			Established practices
Thatch			Standards set by the Thatching Advisory Services or other appropriate authority, in accordance with Technical Requirement R3
Shingles should be of western red cedar			Grade 1 to the Canadian Standards Association
Proprietary roof coverings and products ie, Flashings, soakers, GRP and composite products (dormers, chimneys, copings, cappings, bay window canopies, etc)			Proprietary products should hold a satisfactory assessment by an appropriate independent technical approval's authority acceptable to NHBC.

Natural slates used for roofing should meet the requirements of Table 20.

Table 20: Acceptable characteristics for natural slates

Characteristics	Grade to BS EN 12326:2014[1]
Water absorption less than 0.6%	W1
Thermal cycle	T1
Carbonate content less than 20%	S1

Note
1 A copy of the slate manufacturers Accompanying Commercial Document (ACD), in accordance with BS EN 12326:2014, should be provided to NHBC when requested.

7.2.19 Fixing tiles and slates

Also see: BS 5534

Coverings shall be suitably fixed to protect the building from weather. Issues to be taken into account include:

a) eaves, ridge and hip tiles
b) verges
c) mortar
d) mansard roofs and dormers.

Careful setting out will improve the finished appearance of the roof, help avoid problems such as unequal overhangs, and reduce excessive tile cutting at abutments, chimneys and similar obstructions.

When installing coverings:

- clay tiles that do not meet the dimensional and geometric requirements given in BS EN 1304 should not be laid at pitches less than 40°
- joints between tiles and slates should be slightly open, which provides some flexibility in setting out and should help to avoid tile cutting (single lap interlocking tiles have a tolerance of approximately 3mm at the joint)
- double tiles, tile-and-a-half or half tiles can be used, when available from the manufacturer (to avoid the use of small sections of cut tiles). Alternatively, where the tile manufacturer provides guidance, small sections of single lap tile can be bonded to full tiles
- the bottom edges of double-lapped slate and plain tile roofs should be finished with an under-eaves course.

Table 21: Pitch, gauge and lap

Type or tile	Gauge	Minimum headlap	Minimum permissible pitch (°)
Plain (double lap)	Maximum 1/3 length lap	65mm generally for clay tiles 75mm in severe exposure conditions	35 (clay) 35 (plain concrete)
Concrete (single lap interlocking)	Comply with the manufacturer's recommendations	75mm or to the manufacturer's recommendations	30[2]
Slates (double lap)	Maximum 1/3 length lap	54mm[1] minimum, increased with lower pitch and severe exposure conditions	20 subject to headlap

Notes
1 For pitches greater than 45° and less than 75° in sheltered and moderate exposure zones only.
2 For pitches below 30°, evidence shall be provided as to suitable performance.

When fixing coverings to a pitched roof:

- the fixing schedule should be produced by the tile manufacturer; fixings for single and double lap tiles should be in accordance with BS 5534 and BS EN 1994-1-4 (evidence of calculations in compliance with Technical Requirements R3 and R5 may be required)
- coverings should be fixed in accordance with the design and the manufacturer's recommendations
- perimeter (see definitions) roof tiles or slates should be mechanically fixed using a minimum of two fixings (subject to meeting the wind loading recommendations), one of which can be a tile clip, adhesive (following manufacturers recommendations) or dry verge capping system where designed to resist uplift
- slates and tiles should generally be fixed using clout or slate nails, these should be either silicon bronze, phosphor bronze, aluminium to BS 1202-3 or copper to BS 1202-2, additionally tiles can also be fixed using stainless steel clout nails
- galvanized steel nails should not be used for slates and tiles
- fixings should be a minimum of 38mm long, and penetrate a minimum of 15mm into battens
- tile clips should be made of aluminium alloy or other alloy types, stainless steel, non-ferrous metals or polymer based materials and be of adequate durability and strength in accordance with BS 5534
- slates should be be fixed in accordance with BS 5534, fully nailed over the whole roof, and nailed twice where centre nailed. Alternatively slate hooks maybe used where they can be shown to resist wind uplift.

Where slate hooks are used they should:

- meet the requirements of BS 5534
- have a minimum shank diameter of 2.7mm
- be stainless steel grade 316 to BS EN 10088-3
- be 'nail-in' type slate hooks and not 'hook-over' batten type
- have a crimped shank when used on roof pitches less than 30 degrees. Slate hooks should not be used on roof pitches below 25 degrees.

Where the hooked fixing method is used, slates at the perimeters of a roof eg eaves, valleys, verges, ridges, hips, abutments and penetrations, should be nailed (or nailed and hooked) to resist uplift and lateral drift.

Eaves, ridge and hip tiles

At eaves:

- tiles should project a minimum of 50mm across the gutter
- when using natural or fibre cement slates or plain tiles, an under-eaves course should be used
- the height of the facia should maintain the tile pitch, in accordance with the tile manufacturer's recommendations.

Where ridge tiles are mortar bedded:

- on duo-pitched roofs the underlay should be lapped over the ridge in accordance with Table 10
- on mono-pitched roofs the underlay should extend over the mono ridge by a minimum 100mm
- small openings above the top batten are permitted at ridges where required for ventilation of the roof void.

At hips:

- underlay should continue to form a 150mm minimum lap parallel with the hip rafter
- where wet bedded tiles are used, they should be supported at the base by a galvanized hip iron and project to the centre line of the gutter.

Ridge and hip tiles should be mechanically fixed with self-sealing non-ferrous fixings into timber battens, and have a nominal joint thickness of 10mm where wet bedded.

Figure 62: Eaves detailing

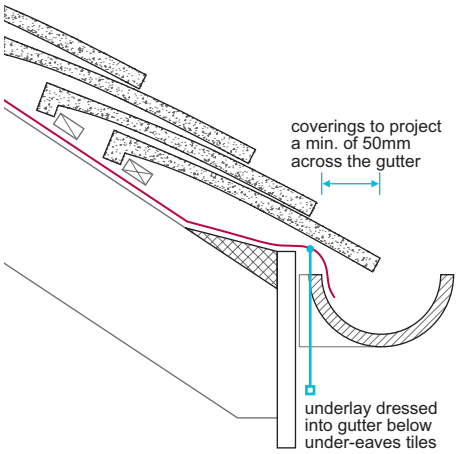
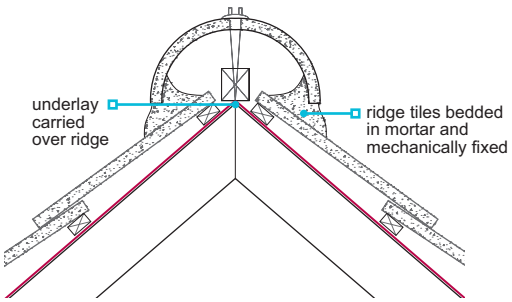


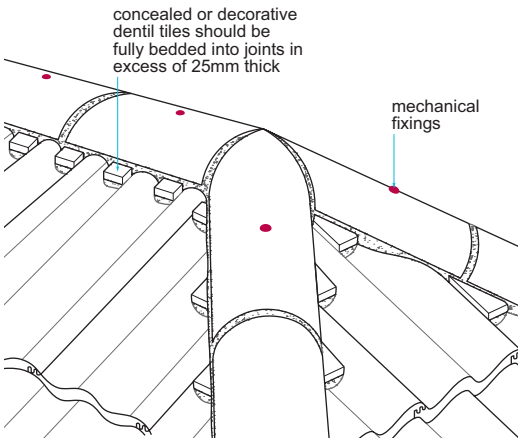
Figure 63: Mechanically fixed ridge



Wet bedded 'baby' hip/ridge tiles to low level roofs, such as those over porches and ground floor bay windows, may be bedded using mortar only, subject to self-weight being sufficient to resist the wind loads, in accordance with BS 5534 (Annex H). Where no wind uplift calculation is provided, baby hip/ridge tiles should be mechanically fixed, in accordance with manufacturer's recommendations.

Where proprietary dry fixed, ridge and hip systems are used, they should conform to BS 8612 and be installed in accordance with manufacturers requirements.

Figure 64: Wet bedded ridge with dentil tiles



Verges

Where proprietary dry verge systems are used, they should conform to BS 8612 and be installed in accordance with manufacturers requirements.

Unless a proprietary dry verge system or cloaked verge is used, tiles should be bedded into a 100mm wide bed of mortar on an undercloak of fibre-cement board, plain tile or slate. Undercloaks should be a minimum 150mm wide and laid face down. Plain tiles should not be used as an undercloak below 30° pitch or on a bargeboard.

Undercloak should be:

- fixed in accordance with manufacturer's recommendations
- installed to a true line
- installed at the correct level to ensure that the line of the tiling is maintained where it passes over the wall, and not tilt inwards
- bedded on roofing mortar and struck off flush with the external surface of the wall (alternatively, a suitable exterior grade bedding sealant should be used in accordance with the manufacturer's recommendations)
- securely nailed to a true line where a bargeboard is used.

Figure 65: Wet verge

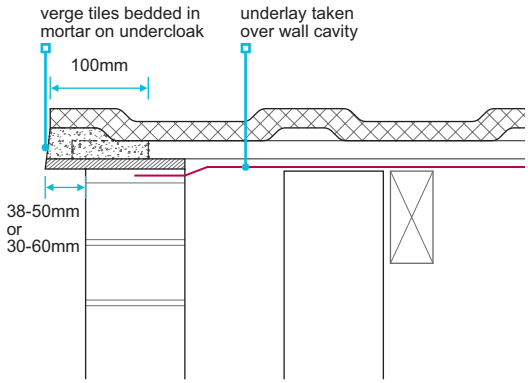
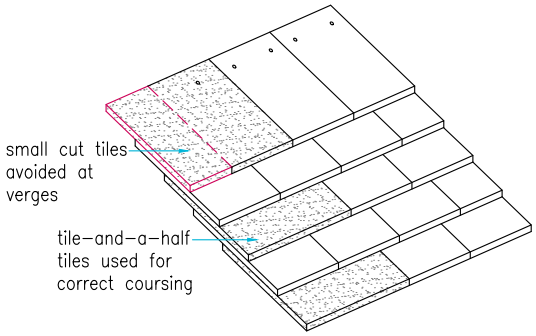


Figure 66: Verge - plain tiles



Where verge tiles and slates are wet bedded, pointing should be completed as soon as possible using the same mix.

Verge clips should be in full contact with the tile to resist uplift, nailed twice to battens and sized to ensure that they are in direct contact with the top surface of the verge tile.

Where plain tiles and slates are used at the verge:

- they should project 38-50mm beyond the gable wall or bargeboard
- cut plain tiles are not acceptable, and purpose-made plain tile-and-a-half tiles should be used, see Figure 66
- natural slate verges should be formed with full slates and either slate-and-a-half or half slates that are a minimum of 150mm wide.

Where interlocking tiles are used at the verge:

- they should project 30-60mm beyond the gable wall or bargeboard
- small sections (less than a half tile width) of cut interlocking tiles should be avoided. Where cut tiles (less than half a tile width) are used, these should be bonded to the adjacent tile in accordance with manufacturers recommendations.

Mortar

When bedding tiles or slates in mortar:

- the mortar should be 1:3 cement: sand with plasticiser
- the mortar should be a mix based on sharp sand with soft sand added to achieve workability; the proportion of sharp sand should not be less than one third of the total sand content (proprietary mixes may be accepted by NHBC where they are shown to have similar strength, durability and workability)
- pointing should be completed as soon as possible using the same mix
- tiles should be wetted on their contact surface, and surface water allowed to drain away before fixing
- concealed or decorative dentil tiles should be fully bedded into joints in excess of 25mm thick.

Tiling and slating of mansard roofs and dormers

When fixing tiling and slating to mansard roofs (75° or steeper) and dormers:

- all tiles and slates should be fixed in accordance with manufacturers requirements and BS 5534
- tiles and slates should be fully nailed; single lap tiles require additional tail clips, double lap tiles (nibbed) require two nails, fibre cement slates require additional disc rivets, slates should be centre nailed
- all tiling and slating should be laid over battens and counter battens, secured to the sheathing board in line with vertical supports
- batten and counter batten sizes should be in accordance with this chapter
- a suitable breather membrane/underlay should be provided in accordance with BS 5534
- the length of the top course should ensure that the minimum headlap is maintained
- the bottom edges (eave) should be finished with an under-course tile or slate, which extends a minimum 50mm below the tilting fillet
- the eave course should be supported by a tilting fillet or other proprietary product which substantially maintains the same plane as the main cladding
- at internal or external angles, purpose-made corner tiles or soakers should be used to form weathertight joints
- where pitched roofs abut a dormer, abutments should be formed in accordance with Clause 7.2.20 and BS 5534
- at dormer cheeks, the tiles or slates should be specified to be cut close to the slope of the roof
- where air impermeable outer weatherproof coverings eg fibre cement slates are used, ventilation behind the weatherproof covering should be in accordance with manufacturers requirements.

Vertical tiling and slating to walls should conform to Chapter 6.9 ‘Curtain walling and cladding’.

7.2.20 Weathering details

Also see: Chapter 6.8

Weatherproofing shall be provided at abutments, flat roof intersections, changes in slopes and projections to resist the passage of moisture to the inside of the building. Issues to be taken into account include:

a) abutments
b) flat roof intersection or changes in slope
c) projections through the roof
d) raking copings.

Flashing details should be appropriate for the roof and the type of roof covering used, in accordance with BS 5534. Where flashings come into contact with metal, they should be formed using non-ferrous material.

Table 22: Suitable materials for flashings

Material	Standard	Additional information
Rolled lead sheet(2)	BS EN 12588	Apron and cover flashings(1), saddles(1) and soakers should: ● be a minimum Code 4 (blue) and soakers minimum Code 3 (green) ● not exceed 1.5m in length
Aluminium and aluminium alloys	BS EN 485 and BS EN 573	0.7 - 0.9 mm thick and protected on both sides by a coating of bituminous paint where built into brick, stone or concrete
Zinc alloy	BS EN 998	Minimum of 0.8 mm thick
Copper	BS EN 1172	Flashings, soakers and saddles should be: ● fully annealed ● 0.55mm thick (0.7 mm thick for inclined valleys)
Proprietary products eg lead replacement products, GRP flashings etc	Technical Requirement R3(3)	

Notes:
1. Lead thickness may need to increase in line with the severity of exposure. Thicknesses quoted are for sheltered to moderate exposure zones.
2. Where lead flashings are turned into joints by more than 50mm, they will require bitumen paint protection on both sides.
3. Propriety products should hold a satisfactory assessment by an appropriate independent technical approval's authority acceptable to NHBC.

Abutments

Where a flat or pitched roof over an enclosed area abuts a wall, or a balcony abuts a wall, cavity trays should be linked to the flashing to prevent water penetrating into an enclosed area. Horizontal flashings should provide weathering to a minimum of 75mm above the intersection with the roof.

At abutments:

- flashings, soakers and gutters should be provided as necessary
- lead flashings should have a minimum upstand of 75mm and minimum lap of 100mm
- flashings should be tucked 25mm into a bed joint and wedged in place at not more than 450mm centres, or a minimum of one per step for stepped flashings
- joints between the masonry and flashing should be pointed with cement mortar or suitable exterior grade sealant in accordance with the manufacturer's recommendations
- free edges of lead flashings should be clipped to prevent lifting, in accordance with the Lead Sheet Training Academy 'The complete manual'.

Where a pitched roof abuts the wall at an angle:

- a preformed stepped cavity tray linked to a stepped flashing should be used
- stepped flashings should be cut from a strip a minimum of 150mm wide
- stepped flashings should be a minimum of 65mm wide.

Figure 67: Wall abutment

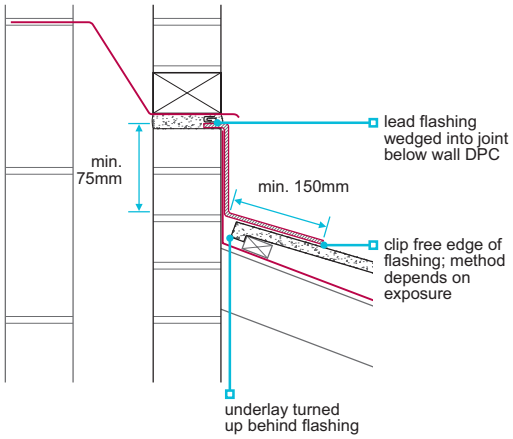
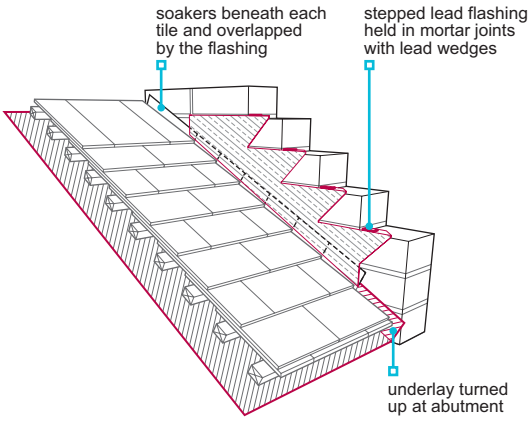


Figure 68: Side abutment (double lap clay or concrete plain tile and slate)



Roof side abutment details should be correctly formed, dependent upon the chosen tile or slate.

When using double-lap clay and concrete plain tiles, side abutments should be formed:

- using soakers and step flashings or
- an abutment gutter including a single step flashing, detailed in accordance with manufacturers recommendations (where there is a risk of blockage by debris, a step and cover flashing should be provided).

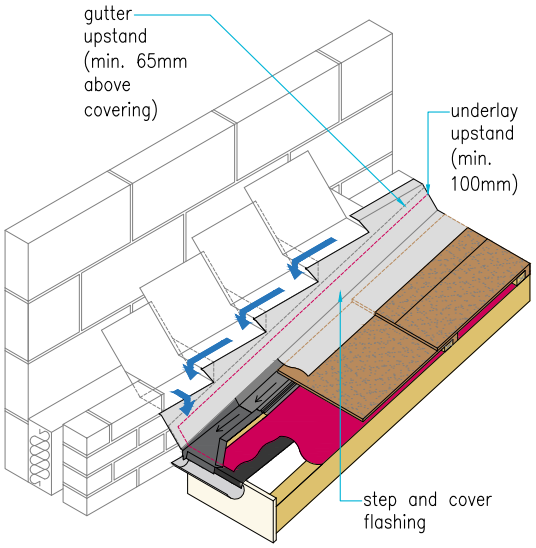
When using single-lap clay and concrete interlocking tiles, side abutments should be formed:

- for profiled tiles, a flashing detail conforming to the tile manufacturer's recommendations or an abutment gutter including a single step flashing, detailed in accordance with manufacturers recommendations (where there is a risk of blockage by debris, a step and cover flashing should be provided)
- for flat or substantially flat tiles, an abutment gutter including a single step flashing, detailed in accordance with manufacturers recommendations (where there is a risk of blockage by debris, a step and cover flashing should be provided).

When using natural or artificial slates, side abutments should be formed:

- using soakers and step flashings or
- an abutment gutter including single step flashing, detailed in accordance with manufacturers recommendations (where there is a risk of blockage by debris, a step and cover flashing should be provided).

Figure 69: Side abutment gutter



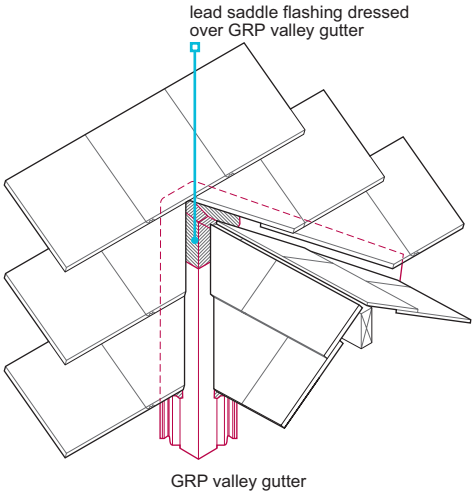
Where abutment gutters are constructed using sheet metal they should be detailed in accordance with the relevant sheet metal technical recommendations.

Flat roof intersection or changes in slope

Where there is a change in the slope, or an intersection with a flat roof and:

- the change is 5° or more (eg at mansards and sprockets), flashings or soakers should be used
- a saddle flashing should be used where a ridge meets the main roof.

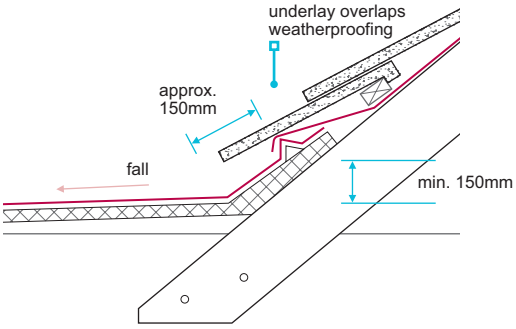
Figure 70: Dry valley - lead saddle



Where a flat roof adjoins a pitched roof:

- the waterproof membrane should be carried up under the tiling to a height of 150mm above the flat roof, and lapped by the roofing underlay
- the lowest course of tiles or slates should not touch the roof membrane.

Figure 71: Flat roof adjoining a pitched roof



Projections through the roof

Where there is a projection through the roof:

- components should be installed according to the manufacturer's recommendations
- flashings should be provided (eg at chimneys)
- where pipes penetrate tiling, a weathertight joint should be formed using a lead slate flashing and upstand or a purpose-made one-piece accessory. Where lead slates are used they should be supported (eg using exterior grade plywood) to prevent sagging.

Figure 72: Chimney - back gutter

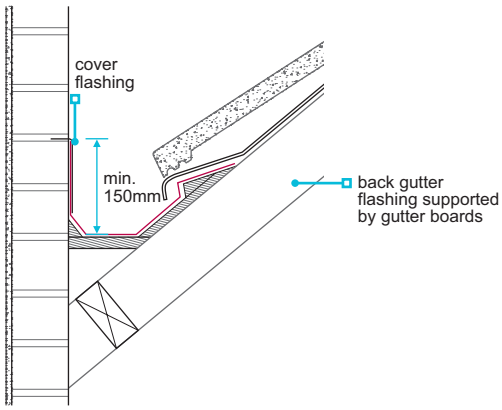
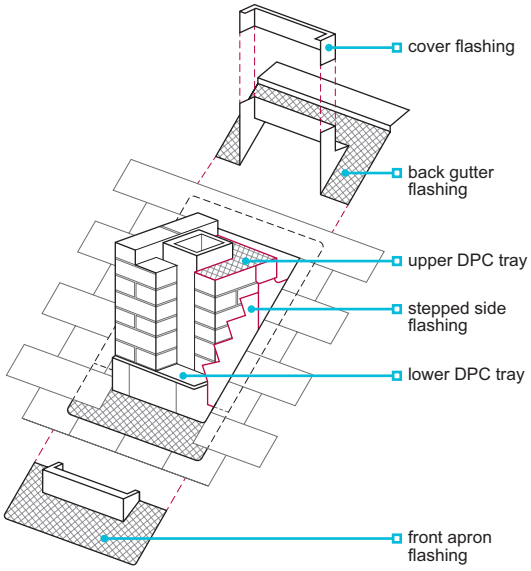


Figure 73: Chimney penetration



Raking copings

Copings, including those manufactured from natural stone, reconstituted stone and GRP, should be securely fixed to gable walls using suitably durable fixings, and be weathertight.

To resist wind uplift and gravitational forces, L-shaped brackets should be used to secure each stone coping to the head of the wall.

The brackets should:

- have dowel bars that fit into restraint holes in the copings
- be adequately durable and manufactured from stainless steel (such as grade 304/316 to BS EN 10088-2)
- be fixed to a solid piece of masonry, with fixings of a suitable length, gauge and durability.

DPCs should prevent the downward passage of moisture and be installed under the coping to ensure that the wall is weathertight. The DPC should:

- be bitumen-based material to BS 6398, BS EN 14967 or other material assessed in accordance with Technical Requirement R3
- extend the full width of the wall
- be fully bedded in mortar
- be supported over the cavity.

Fixing methods that penetrate the DPC should be designed to ensure weathertightness. This can be achieved by extending the lower DPC under the bracket, and installing the next section of the DPC over it to create a lap that covers the fixing point.

Copings should have an overhang with throatings a minimum of 30mm clear of the wall, 40mm where the wall is rendered.

Figure 74: Raking coping - masonry

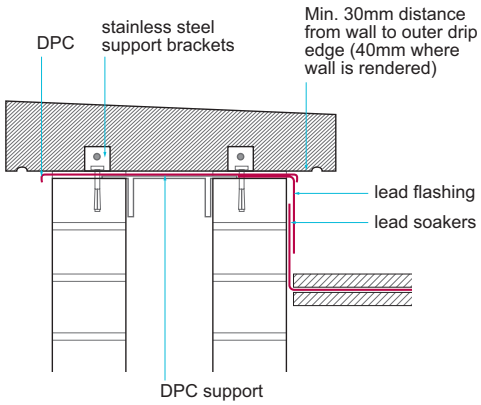
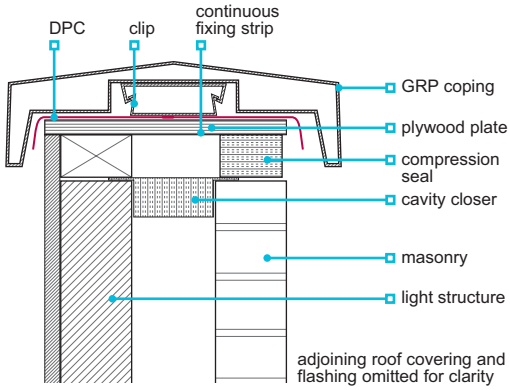


Figure 75: Raking coping - framed structure



Where GRP copings are used, they should:

- be fixed in accordance with the manufacturer's instructions
- include a DPC beneath
- be sealed using an appropriate sealant
- allow for normal differential movement in the timber or LSF structure
- hold a satisfactory assessment from an appropriate independent technical approvals authority acceptable to NHBC.

Further guidance can be found in Chapter 6.2 'External timber framed walls' and Chapter 6.10 'Light steel framing'.

7.2.21 Valleys and hidden gutters

Valleys shall have suitable weathering details, including flashings, to resist the passage of moisture to the inside of the building.

Valleys, and the components used, should:

- be in accordance with the design and BS 5534
- have a finished pitch which complies with the minimum recommended for the roof
- be fixed in accordance with the manufacturer's recommendations
- have a suitable saddle flashing (see Figure 70) or appropriately detailed lead flashing (minimum code 4) at the head of each valley
- be formed using: valley coursing tiles (plain tiles), valley trough tiles (interlocking tiles), non-ferrous metal or proprietary products which hold a satisfactory assessment from an appropriate independent technical approvals authority acceptable to NHBC.

Tiles either side of an open valley should:

- be cut from double tiles, tile-and-a-half or half tiles where available from the manufacturer
- where small pieces (less than half tile width) of cut single lap tiles are used, these should be bonded to the adjoining full width tile, in accordance with manufacturers recommendations.

Where the roof covering is slate or plain tiles, the following may be used:

- a laced valley
- a swept valley
- a mitred valley with soakers.

Horizontal valley gutters, where positioned over a compartment wall, should achieve the roof classification as required by the Building Regulations ie, $B_{ROOF}(t4)$ and be appropriately fire-stopped.

Valleys using valley tiles

Where valleys are formed using valley tiles:

- purpose-made valley coursing tiles should be used where the roof uses plain tiles
- purpose-made valley trough tiles should be supported by gutter boards where the roof uses single lap interlocking tiles
- they should be mechanically cut to the correct rake
- adjacent coverings should be neatly cut to form a smooth junction, and preferably be cut from tile-and-a-half tiles
- have a minimum 100mm wide channel (minimum 125mm for pitches below 30°)
- they should be fixed in accordance with manufacturers recommendations.

Lead-lined valleys

For lead-lined valleys, the tiles should be cut and bedded on mortar over an undercloak (to prevent direct contact between the lead and the mortar). Mortar should not bridge the welt detail.

Lead should be:

- either code 4 (blue) or code 5 (red)
- supported on gutter boards of a minimum 19mm exterior grade plywood to BS EN 636-3, or as specified in the design
- laid in strips no longer than 1.5m
- lapped by a minimum of 150mm, where pitches are above 30°
- used in accordance with the Lead Sheet Training Academy 'The complete manual'.

Proprietary valley or gutter systems

Proprietary valley systems should:

- be used in accordance with manufacturers recommendations and securely fixed to suitable supports (exterior grade materials should be used)
- be assessed in accordance with Technical Requirement R3.

Proprietary gutter systems should:

- be used in accordance with manufacturers recommendations and securely fixed to suitable supports (exterior grade materials should be used)
- be assessed in accordance with Technical Requirement R3.

7.2.22 Drainage

Roof drainage shall adequately carry rainwater to a suitable outlet.

Drainage should be:

- provided where roofs are greater than 6m^2; however, consideration should be given to providing drainage to smaller roofs such as dormer, porch roofs and balconies (see Clause 7.1.4)
- of a sufficient size to accommodate normal rainfall, and sized to cope with concentrated flows, ie, where there are dormer roofs
- designed and fitted to prevent erosion of the lower surface, where water from a large roof surface discharges onto another surface
- fixed in accordance with the design, using the correct type of fittings for internal and external angles, outlets etc to ensure efficient drainage of the roof
- supported and jointed in accordance with the manufacturer's recommendations
- insulated when passing through a home, in accordance with Part 8.0 'Internal services and low or zero carbon technologies'
- installed ensuring gutters are provided with stop ends, and are laid with a sufficient fall towards the outlet, unless designed to be flat.

The discharge of rainwater in gutters and pipes from one roof to another should be avoided, where practicable. Small quantities of rainwater discharge, from one roof to another, are acceptable, if the total quantity discharged does not exceed the normal drainage characteristics of the roof below.

Where gutters are behind parapet walls, an overflow should be provided:

- sized for effective flow rate and positioned to prevent water from entering the building
- of higher capacity than the combined capacity of the other outlets
- positioned to discharge safely away from the building
- be visible when in operation.

Where a downpipe discharges above ground level, or above a drainage gully, the downpipe should be fitted with shoes.

7.2.23 Fascias and trim

Also see: Chapter 3.3

Fascias, bargeboards and soffits shall be appropriately fixed and treated against decay.

Table 23: Materials acceptable for facia boards

Material	Standard	Minimum material specification	Additional information
Marine grade plywood	BS 1088	Standard grade	Coated
Exterior grade plywood	BS EN 636	Bond class 3	Preservative treated and coated
Natural solid timber boards	N/A	Timber should be preservative treated or naturally durable	See Table 1 in Chapter 3.3
High density fibre reinforced calcium silicate board	BS EN 12467	Category A	
Glass fibre reinforced cement (GRC) board			
Proprietary products	Technical Requirement R3		

When installing fascia boards and soffits:

- timber for external feature work should be free from waney edges, large knots, resinous pockets, splits and other unsightly defects
- where preservative treated timber is cut, preservative should be applied to the cut end
- where timber is to be painted, it should be knotted and primed on all surfaces before fixing
- where timber requires a stained finish, one coat of stain should be applied before fixing
- each joint should be cut and fixed neatly.

Fascia boards should be fixed:

- twice to each rafter
- with splayed butt joints.

7.2.24 Spandrel panels in cold roofs

Spandrel panels shall provide satisfactory performance.

Spandrel panels used in cold roof voids to create separation between dwellings or to form the inner leaf of gable walls should be designed, manufactured and installed to provide satisfactory performance. Items to be taken into account include:

- fire resistance
- acoustic transfer
- structural stability.

Spandrel panels that comply with guidance from the Structural Timber Association or the Trussed Rafter Association will generally be acceptable to NHBC.

7.2.25 Roof cassette systems

Also see: Chapter 3.3

Roof cassette systems shall form the roof structure and habitable space beneath and safely transmit loads to the supporting structure without undue movement or deformation. Issues to be taken into account include:

a) provision of information
b) structural performance
c) thermal and acoustic performance
d) fire
e) condensation and ventilation
f) moisture protection
g) durability
h) installation.

Roof cassette systems are building systems consisting of prefabricated roof panels which may also be supplied with prefabricated wall panels, beams and other supporting structure. Systems can be open or closed panel.

Provision of information

Clear and fully detailed drawings should be available on site to enable work to be carried out in accordance with the design. Design and specification information should be issued to site supervisors, relevant specialist subcontractors and other appropriate personnel, and include the following:

- a full set of drawings
- material specifications
- fixing schedules
- junction details eg steps and staggers in both the horizontal and vertical plane
- the position and material specification for cavity barriers and fire-stopping
- manufacturer's requirements relating to ancillary items eg chimneys, dormers, etc
- site installation manual.

Structural performance

The structure of the roof cassette system should be adequately designed to support dead, imposed and wind loads in accordance with the requirements of Clause 7.2.3.

Compound deflection of the roof cassette system should be designed to acceptable limits, particularly where they are supported by roof purlins.

Thermal and acoustic performance

The roof and walls of roof cassette systems, shall be insulated in accordance with the Building Regulations.

The roof and walls to roof cassette systems, shall be constructed to ensure that sound transmission is adequately limited between homes, in accordance with the Building Regulations.

Fire

The roof cassette system should meet the fire performance requirements of the Building Regulations, including all critical junctions eg where walls and roof cassettes intersect.

The roof cassette system should:

- have adequate structural fire protection
- provide adequate compartmentation between dwellings
- have cavity barriers and fire-stopping in accordance with the Building Regulations.

Condensation and ventilation

The elements of the roof cassette system shall adequately limit the risk of interstitial condensation and be constructed in accordance with BS 5250. Air and vapour control layers should be provided in accordance with the manufacturer's recommendations.

Rooms formed by the roof cassette system shall be adequately ventilated in accordance with the Building Regulations.

Moisture protection

Walls and roofs should be adequately protected from moisture, using appropriate breather membranes and roofing underlays.

Wall and roof membranes shall form a continuous barrier to moisture and be adequately lapped.

Roof coverings should be in accordance with this Chapter.

Wall cladding should be in accordance with the relevant NHBC Chapter(s).

Durability

The structure of the system shall have a life expectancy of at least 60 years. Timber members should be preservative treated or have adequate natural durability in accordance with Chapter 3.3 'Timber Preservation (natural solid timber)'.

Installation

The system shall be erected in accordance with the manufacturer's recommendations and provide satisfactory performance. Issues to be taken into account include:

- competence of installers
- preparation
- design tolerances
- structural connections
- sealing of joints.

The manufacturer should provide and make available on site a set of clear instructions in the form of a site installation manual and relevant accompanying drawings, detailing the assembly and installation for the system as appropriate.

Systems should be installed by operatives who:

- are competent
- are familiar with the system being installed and
- hold a certificate (or similar confirmation) confirming that they have been trained by the system manufacturer.

Ancillary components

Ancillary components ie, dormers, chimneys, roof windows, should be capable of integrating with the roof cassette system to ensure structural integrity and weathertightness is maintained.

7.2.26 Solar roof panels

Also see: Part 8.0

Solar roof panels should be securely fixed and not adversely affect the weather resistance of the building. Where the solar roof panels form the roof covering, they should be of suitable quality and durability to protect the building from weather. Issues to be taken into account include:

a) weather tightness
b) fixing
c) ventilation and vapour control
d) durability.

Weathertightness

Integrated solar roof panels should meet the weathertightness criteria in Part 8.0 'Internal services and low or zero carbon technologies'.

The installer should consult the tile or slate manufacturer prior to installing solar roof panels, to ensure compatibility with the tile or slate and weathertightness.

Connections may need to penetrate though the outer weatherproofing layer, which may potentially affect the roof covering, underlay and insulation of a roof. All penetrations should be carefully detailed, and appropriate flashings, etc used in accordance with the manufacturers recommendations, to ensure the weathertightness of the penetration.

Mounting brackets which pass through the tiling or slating should not affect:

- the weathertightness of the tiles or slates
- the stability of the tiles or slates.

Proprietary flashing kits should be used around integrated solar roof panels. Flashing kits should ensure the weathertightness of the array and be installed to avoid excess gapping, sagging or kicking of the tiles or slates and be fixed in accordance with manufacturer recommendations.

Fixing

Where solar roof panels are installed to the roof, these maybe either:

- the 'on-roof' type and sit above the roof covering or
- integrated into the tile or slate array, to also form the roof covering.

Solar roof panels maybe secured:

- to the roof framing or
- to roofing battens or
- to both the roof framing and roofing battens.

Solar roof panels should be secured in accordance with manufacturers requirements and be capable of resisting wind uplift and snow loads for the building and its specific location, see also Part 8 'Services'.

Roofing battens, should be adequately fixed where used to secure solar roof panels. Batten fixings should be capable of resisting wind forces in accordance with BS 5534 (Annex H.7 'Batten fixing penetration'), see also Clause 7.2.17.

Ventilation and vapour control

Where arrays of integrated solar roof panels are installed, forming the roof covering, then the roof covering should be treated as air impermeable and the whole roof ventilated accordingly, unless the panel manufacturer is able to demonstrate their system is air permeable, guidance on roof ventilation strategies can be found in Clause 7.2.15 of this chapter.

Solar roof panel manufacturers may also require a ventilated air space beneath the panel, to increase ventilation and cooling of the panel.

Durability

Solar roof panels and associated brackets, fixings, flashings and trims should be adequately durable and suitable for their location.

Appropriate materials should be selected for flashings, guidance can be found in Clause 7.2.20 of this Chapter.

In aggressive environments such as coastal locations, grade 316 stainless steel fixings are recommended.

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