

# Pitched roofs

## CHAPTER 7.2

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

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

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Raising Standards. Protecting Homeowners

### Compliance <sup>7.2.1</sup>

*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.

### Provision of information <sup>7.2.2</sup>

**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 should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include the following information:

- The layout of trusses and associated items.
- Details of mono-pitch, lean-to roofs and roof intersections (i.e. 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 vapour control layers.
- Details of restraint/holding-down strapping, including coatings and fixings.
- The position and thickness of insulation.
- The means of providing eaves ventilation.
- Details of firestopping 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.

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.

### Design of pitched roofs <sup>7.2.3</sup>

*Also see: TRADA Eurocode 5 span tables (3rd edition) and BS 8103*

**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 and imposed 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 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 should be of a suitable grade and specified according to the strength classes in BS EN 338, e.g. C16, C24 or TR26. When using the BS 4978 grading rules:

- the timber specification should be in accordance with BS EN 1912, or the timber species and strength class identified
- the timber should be marked accordingly.

### 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 (e.g. 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, e.g. 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:

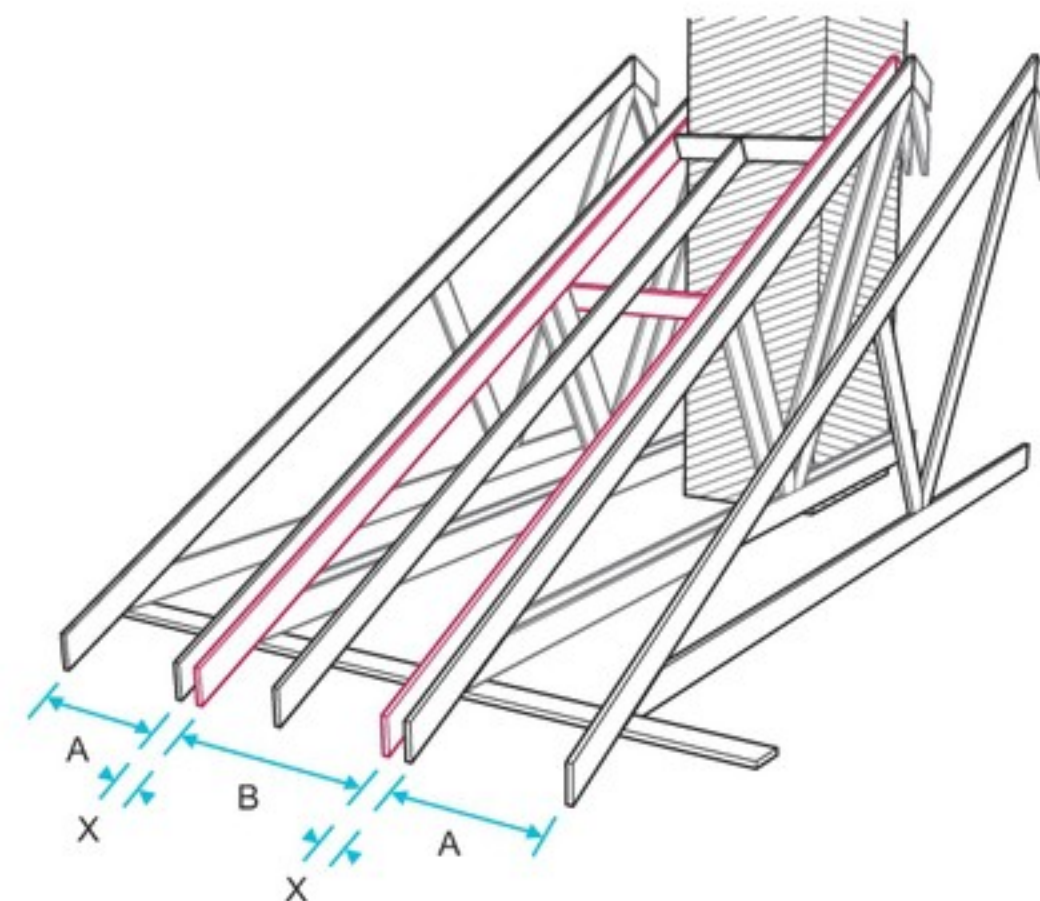
- $X$  = distance between centres of trussed trimmed rafters and the adjacent trussed rafter
- $A$  = design spacing of trussed rafters
- $B$  = nominal width of opening.

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.



trussed trimmed rafters

**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.

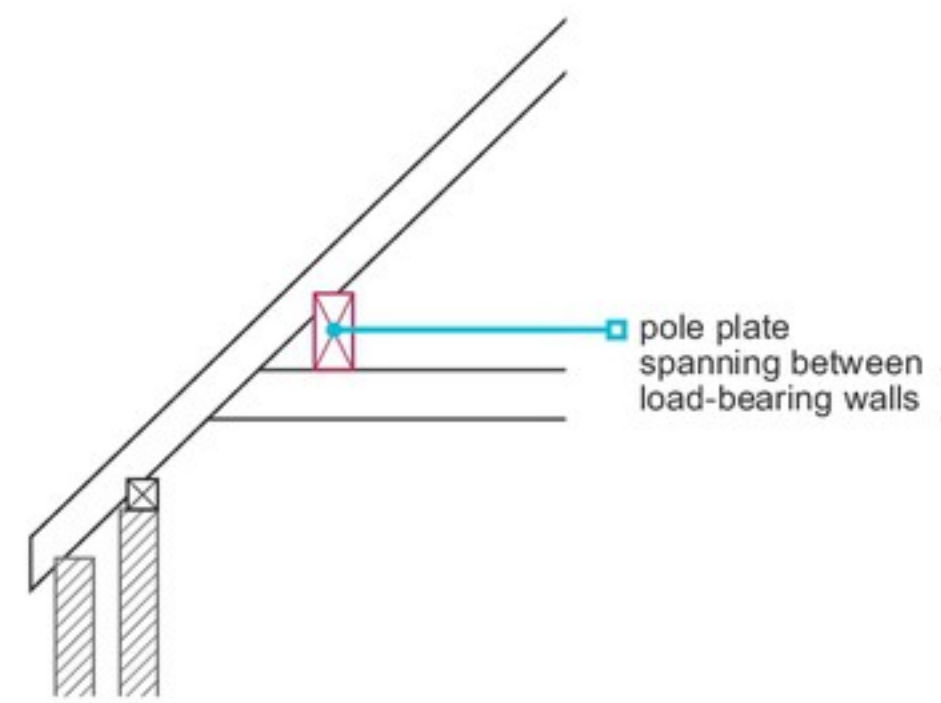
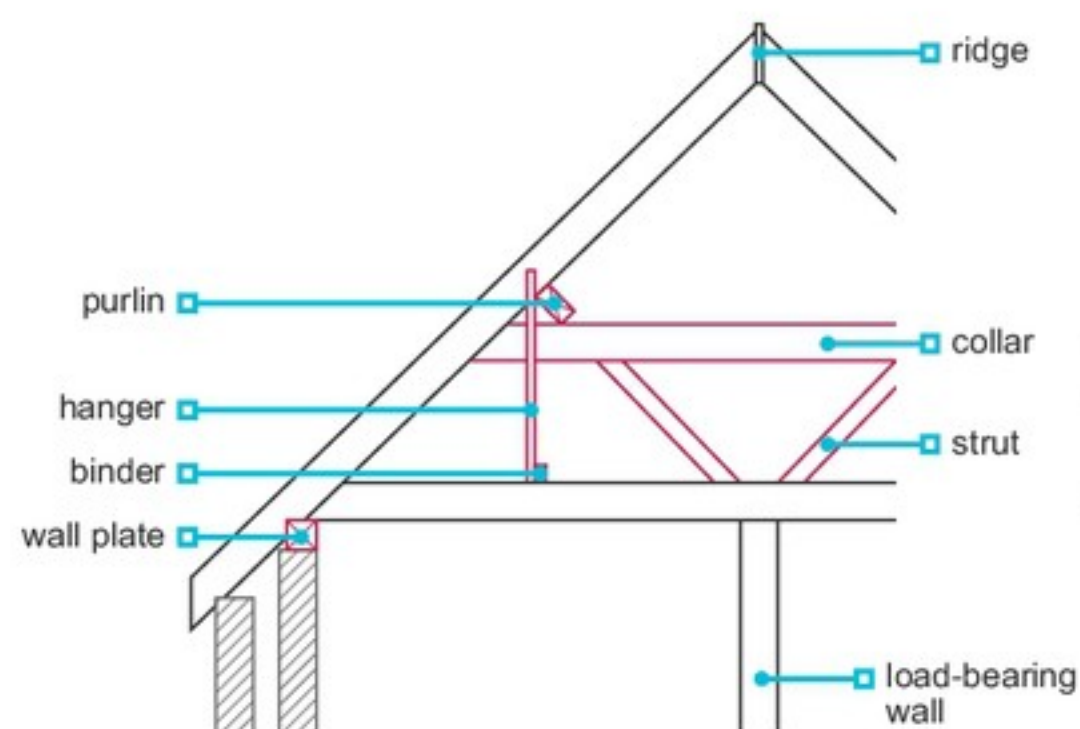
### Traditional cut roofs

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

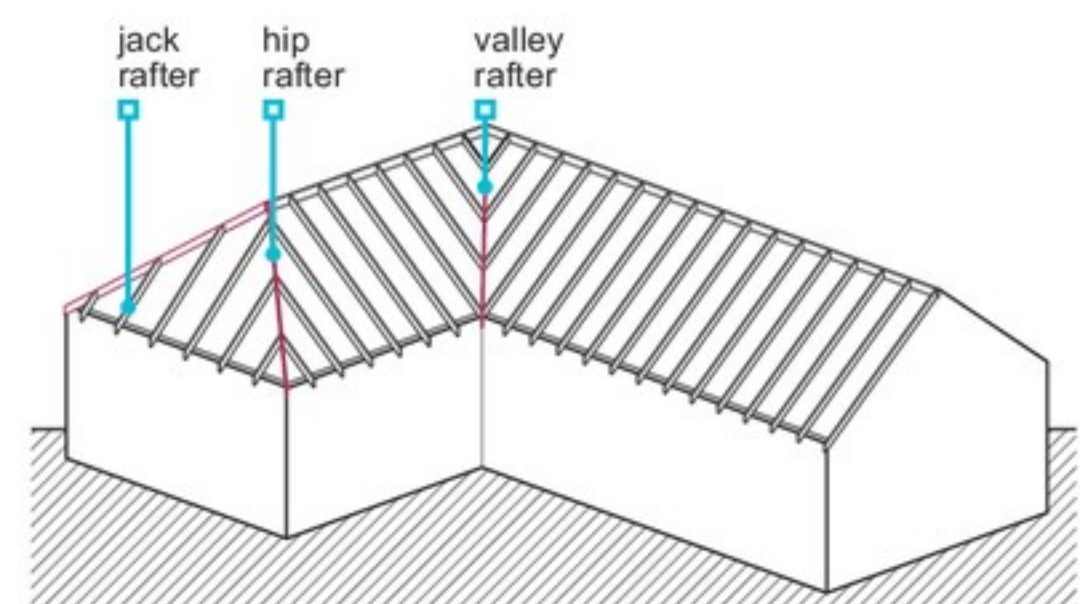
Member	Notes
Valley rafter	Provides support for loads from both sections of the roof and should: <ul style="list-style-type: none"> <li>■ be larger than ordinary rafters to take the additional load</li> <li>■ provide full bearing for the splay cut of jack rafters</li> <li>■ be provided with intermediate support where required.</li> </ul>
Hip rafter	Provides spacing and fixing for jack rafters and should: <ul style="list-style-type: none"> <li>■ have a deeper section than the other rafters to take the top cut of the jack rafters.</li> </ul> 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: <ul style="list-style-type: none"> <li>■ stop the walls and roof spreading outwards</li> <li>■ provide support to the ceiling finish and walkways, etc.</li> </ul>
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.



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
Valleys	32mm thick
Ridges and hips	Rafter cut + 25mm



### Protection of trusses <sup>7.2.4</sup>

**Trusses shall be protected from damage.**

Where the trusses or timber members are damaged, they should be rejected and not repaired. 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).

*Also see: International Truss Plate Association Technical Handbook*

### Durability 7.2.5

**Timber shall be of suitable durability.**

The following timber members should be naturally durable or treated in accordance with Chapter 3.3 'Timber Preservation (natural solid timber)':

- Porch posts.
- Tiling battens.
- Soffits.
- Bargeboard.
- Fascias and other trim.

Where the roof is to include a fully supported weatherproofing membrane, the following timber components should either be naturally durable or suitably treated:

- Rafters.
- Purlins.
- Ceiling joists.
- Bracing.
- Sarking.
- Wall plates.
- Battens for fixing vertical cladding.

### Wall plates 7.2.6

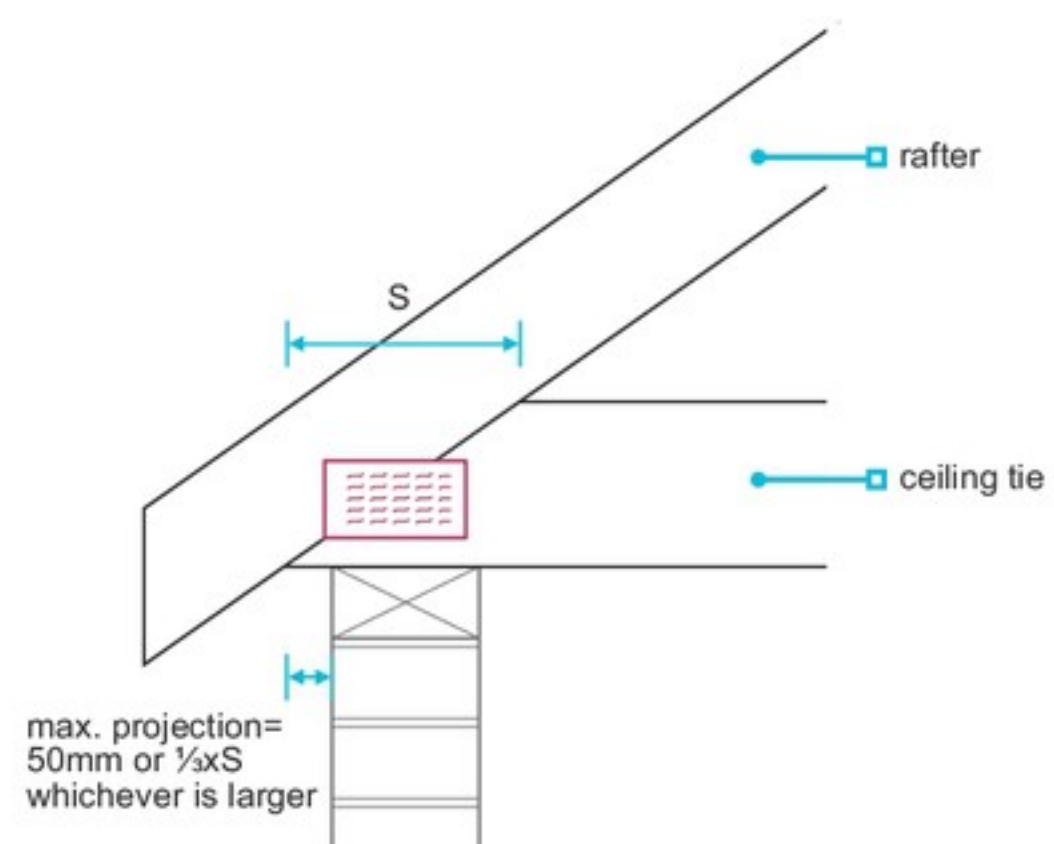
**Wall plates and the roof structure shall be bedded and fixed to distribute and transmit loads, and to prevent uplift.**

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, e.g. as a cantilever.

Wall plates should be:

- bedded to line and level
- fixed using nails or straps
- a minimum of 3m, extending over at least three joists, rafters or trusses
- joined using half-lapped joints, including at corners.

In Scotland, wall plates should be in long lengths, butt-jointed and fixed with nails appropriate to the size of the wall plate.



**Table 4:** Suitable sizes for wall plates

Northern Ireland and the Isle of Man	100mm x 38mm minimum
Scotland	100mm x 25mm minimum
Other areas	75mm x 50mm minimum

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 cross section of 30mm x 2.5mm and spaced at a maximum of 2m centres (galvanised steel straps are generally acceptable)
- fixed to the wall, or turned into a bed joint.

Fixings for straps should be:

- in accordance with the design, and the lowest fixing should be within 150mm of the bottom of the vertical strap
- of a material or finish which is compatible with the straps
- where into masonry, hardened 4mm x 75mm nails or 50mm long No 12 wood screws (into suitable plugs).

### Joints and connections <sup>7.2.7</sup>

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

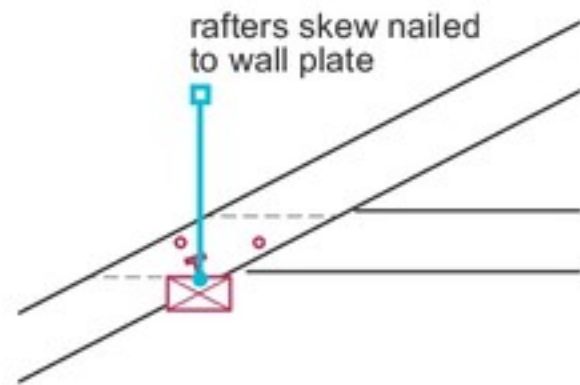
Members should:

- 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:

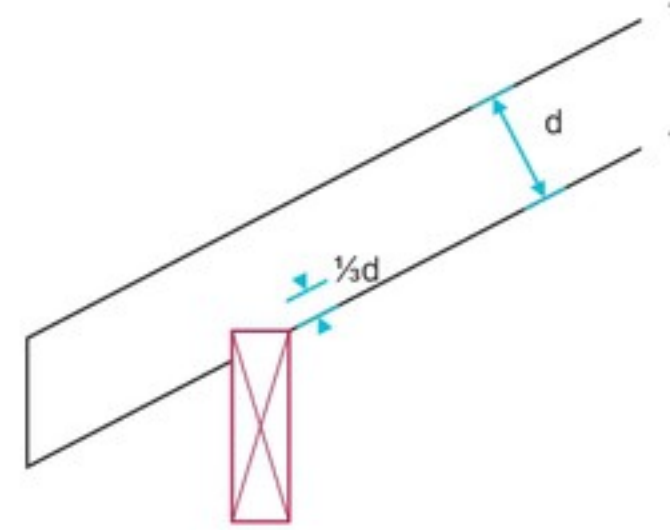
#### Rafters to ceiling joists using a nailed lapped joint

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



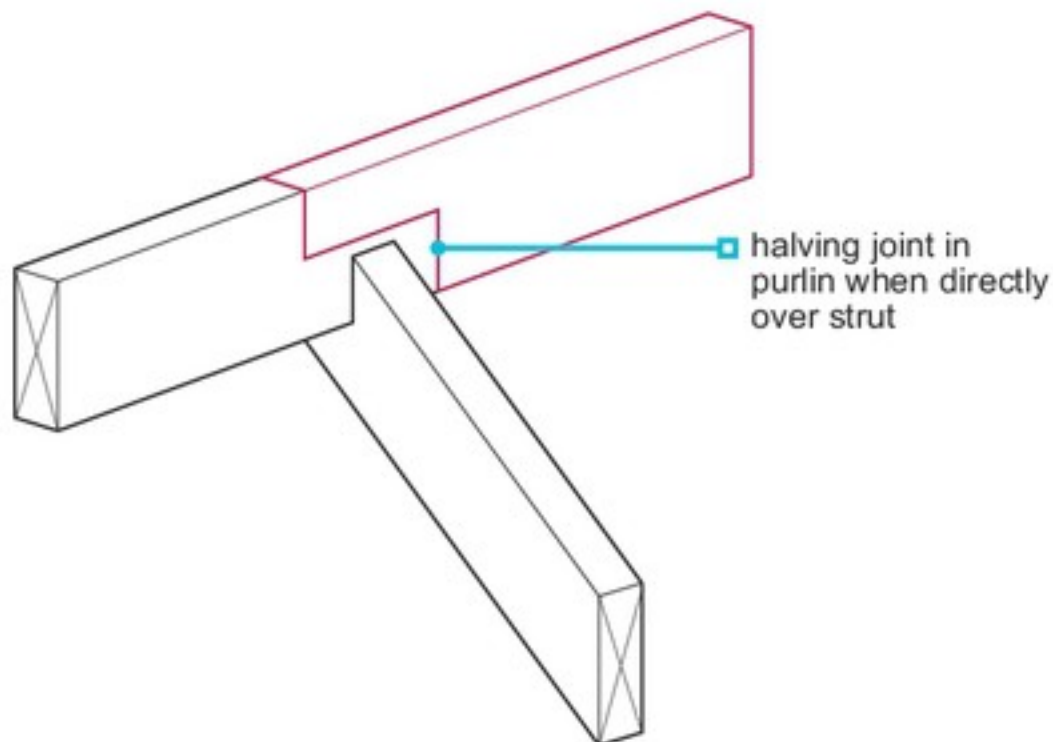
#### Rafter to purlin

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



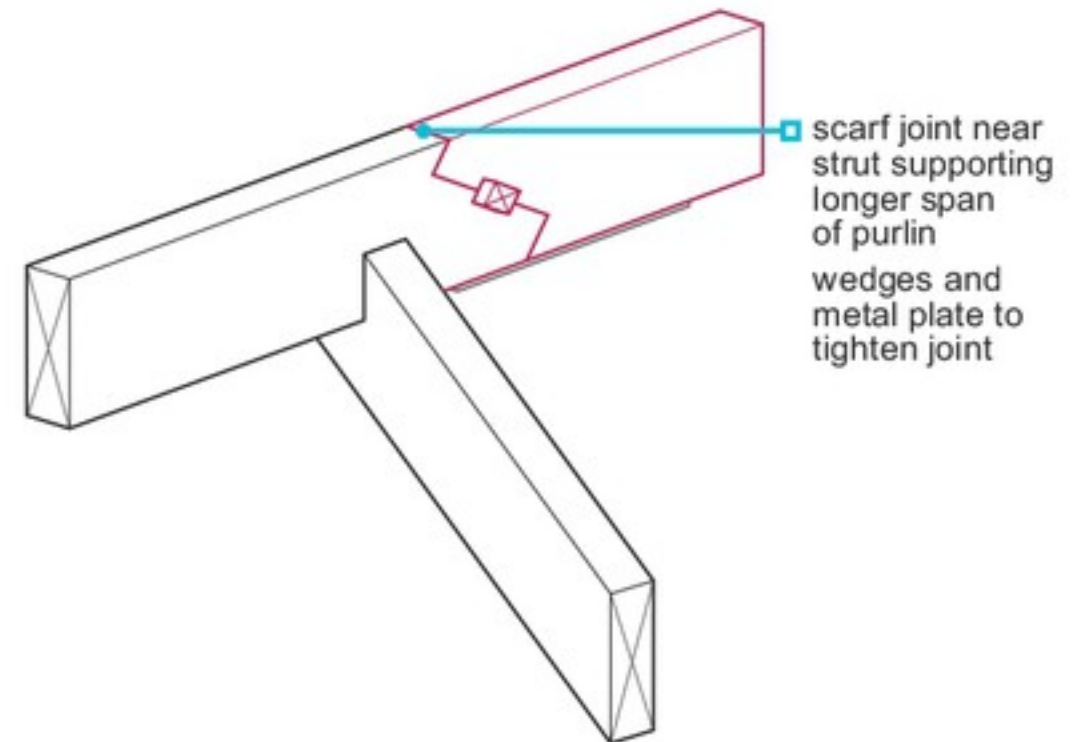
#### Purlin connections

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.



#### Scarf joint

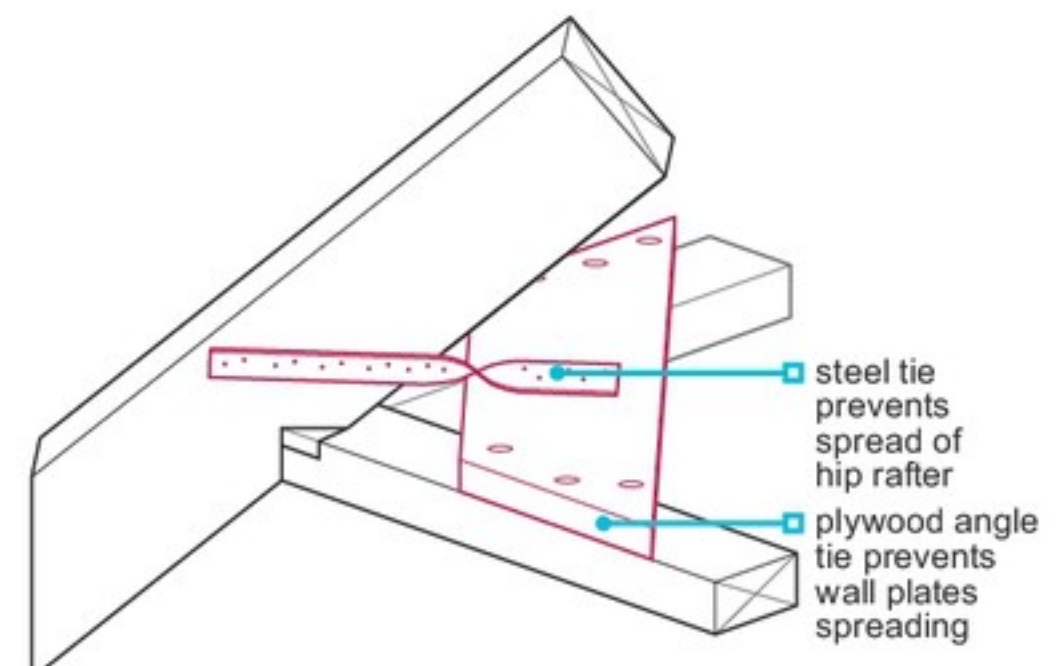
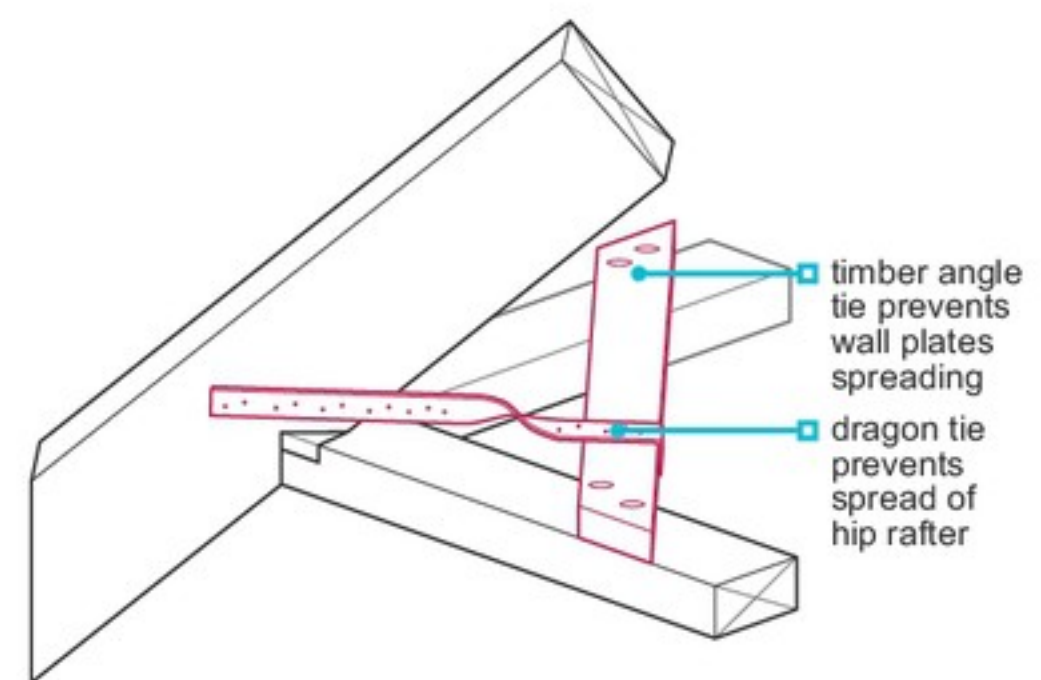
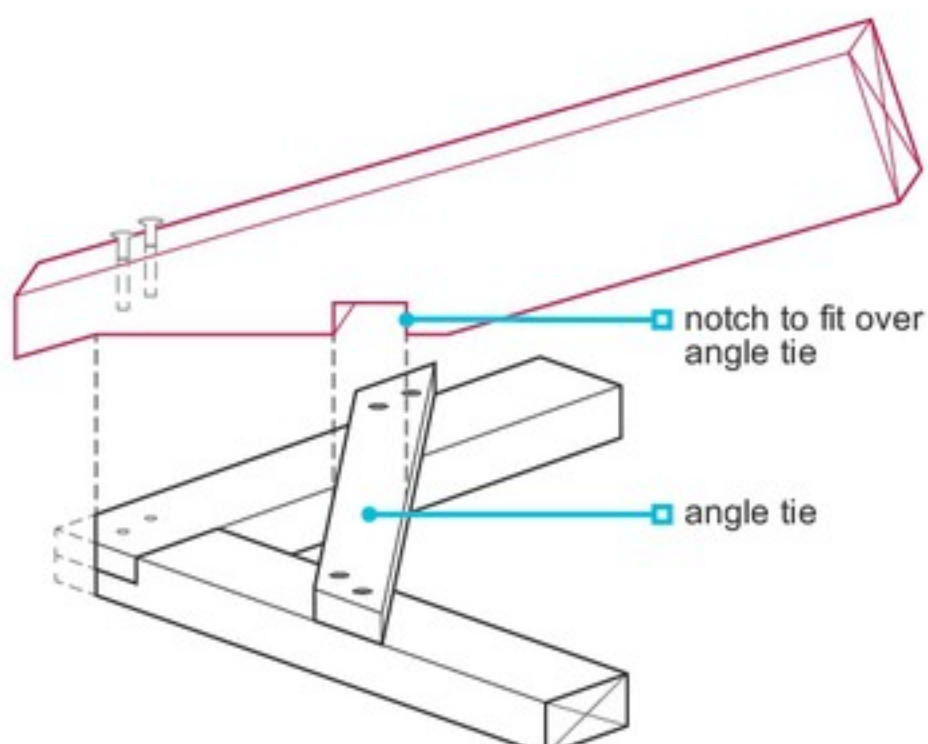
Used to support the long span of the purlin.



#### 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, e.g. carrying purlins, they should be jointed using dragon ties, or similar, to prevent the hip rafter spreading.



## Restraint <sup>7.2.8</sup>

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 installed in accordance with the design.

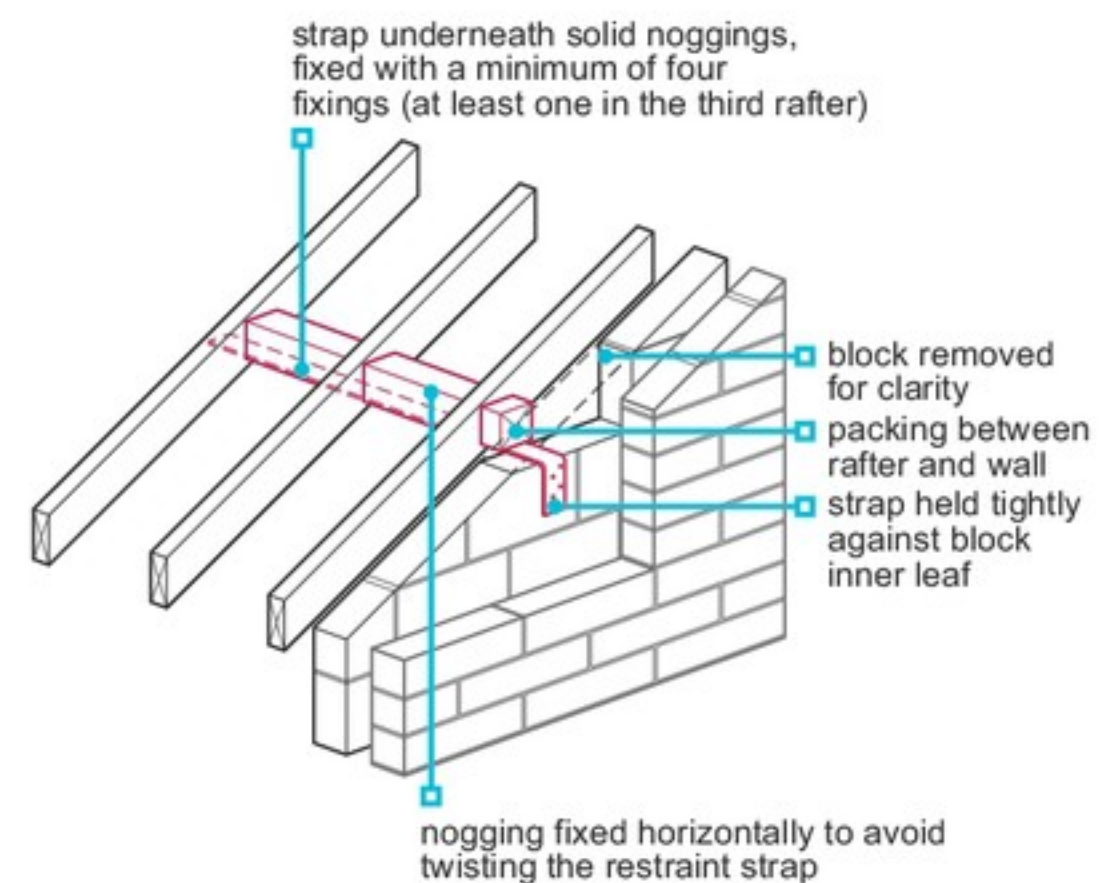
Restraint straps should be:

- ordered and supplied according to the design, i.e. the correct length and number of bends and twists
- for homes up to and including three storeys (two storeys in Scotland), fixed at a maximum spacing of 2m
- for homes over four storeys, fixed at a maximum spacing of 1.25m.

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.

Lateral restraint straps should be:

- 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 – Tables A.1 and A.2
- 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 of 100mm
- fixed to solid noggings, with one fixing in the third rafter, using four steel screws or four 75mm x 4mm (8 SWG) round nails
- placed under rafters and over ceiling joists (joists should not be notched to make the straps flush with the rafter)
- fixed with the downturn on a substantial piece of blockwork, preferably fixed to the centre of an uncut block
- in accordance with BS EN 1995-1-1, where the home is of timber frame construction.



In Northern Ireland and the Isle of Man, sheradised straps or fixings are not acceptable.

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

- there is blocking between the last trussed rafter and the inner leaf (maximum 2m spacing)
- the soffit board is cut carefully and then fixed securely to restrain the outer leaf.

## Bracing for trussed rafter roofs <sup>7.2.9</sup>

Also see: ITPA Technical Handbook BS 5268-3 (AMD.5931) Appendix A

**Trussed rafters shall be suitably braced to support applied loads and self-weight without undue movement.**

For the purposes of this chapter, the guidance and use of standard trussed rafter bracing does not apply to homes on or near exposed sites, e.g. flat coastal fringes, fens, airfields and moorland. In such cases, bracing should be designed by an engineer in accordance with Technical Requirement R5.

Standard trussed rafter bracing, in accordance with Table 5, is generally acceptable, where the home:

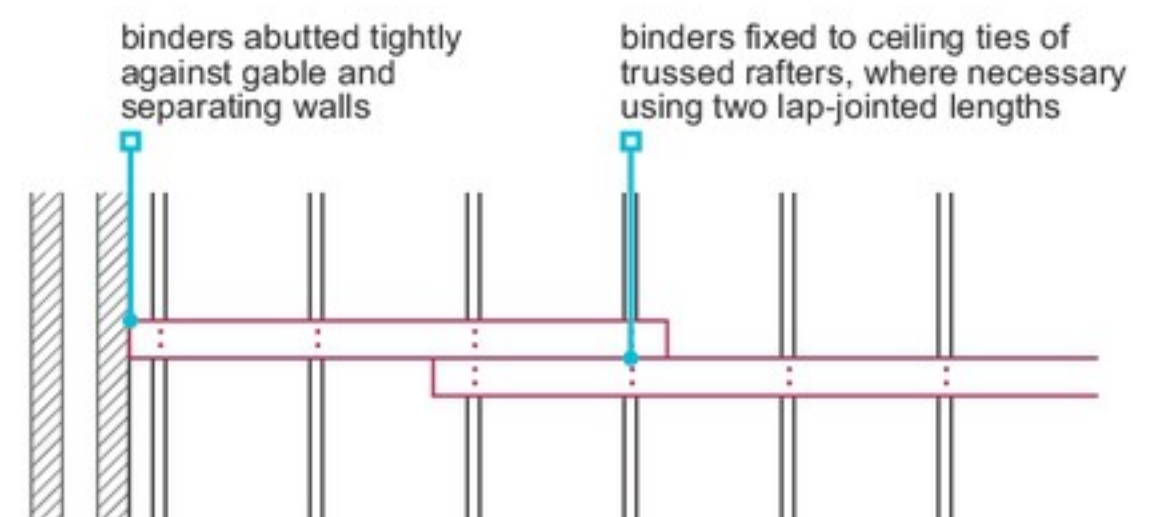
- has a rectangular roof (including hip ends) and is either a duo-pitched or a mono-pitch structure
- is not taller than 8.4m (to the underside of the ceiling tie)
- is braced in accordance with this chapter
- is braced according to the conditions of the site and in accordance with the design
- does 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, i.e. garages, additional diagonal ceiling bracing and longitudinal binder bracing at each ceiling node point is required).

**Table 5:** Location, height and span for standard bracing conditions

	Type	Duo-pitch						Mono-pitch								
	Maximum 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 and Wales	10.6	9.1	8.5	12	11.5	10.2	5.6	4.5	4.3	6.6	5.8	5.1	8.1	7.2	6.4
	Scotland	9.8	7.7	7.2	11.6	10.0	8.8	4.9	4.2	3.6	5.8	5.0	4.4	7.3	6.4	5.6
	Areas north or west of Ullapool	8.6	7.2	6.0	10.6	8.7	7.5	4.3	3.6	3.0	5.1	4.4	3.7	6.5	5.6	4.5
	Northern Ireland and the Isle of Man	9.8	7.7	7.2	11.6	10.0	8.8	4.9	4.2	3.6	5.8	5.0	4.4	7.3	6.4	5.6
	Areas north-east of Londonderry	8.6	7.2	6.0	10.6	8.7	7.5	4.3	3.6	3.0	5.1	4.4	3.7	6.5	5.6	4.5

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 (where the site is in an exposed location, the design should be checked for additional requirements, and the bracing completed as specified suitably fixed to the wall plate)
- 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
- where braces and binders are not continuous, they should be lap jointed and nailed to a minimum of two trusses.



When bracing pitched roofs:

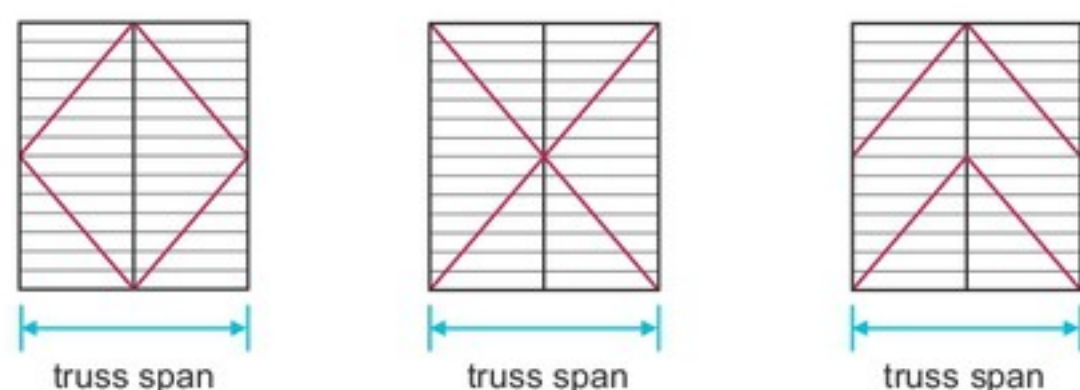
- diagonal and longitudinal bracing should be provided at rafter level (this may be omitted where rigid sarking boards are used, e.g. chipboard, plywood or OSB, which are fixed to each trussed rafter with 3mm x 50mm galvanised round wire nails at 200mm spacing)
- diagonal and chevron bracing should pass 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 and mono-pitched roofs, where the braces cross, the intersection detail (below) should be used.

### Diagonal rafter bracing

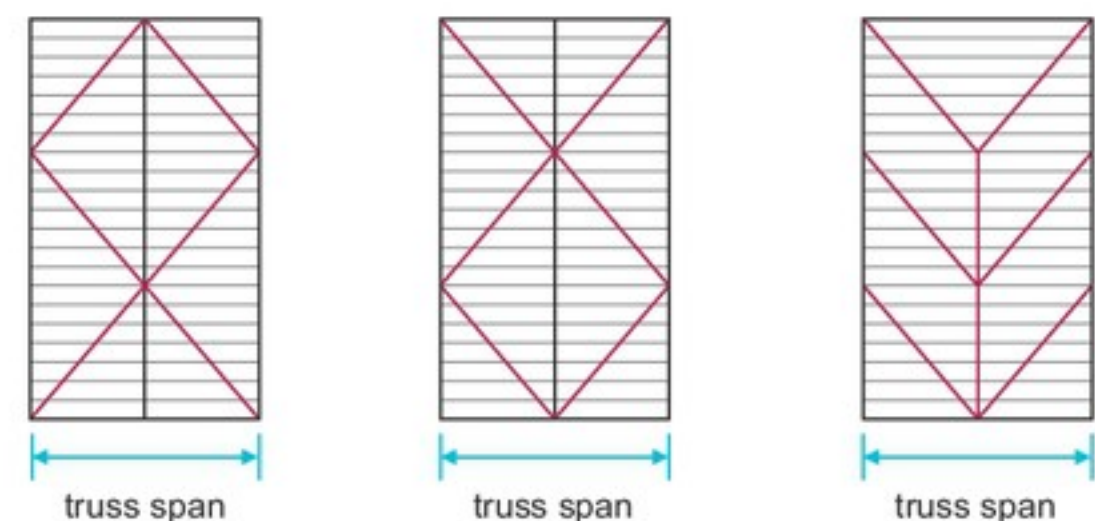
Applicable to all trussed rafter roofs unless rigid sarking, such as timber boarding or plywood, is used.

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

### Bracing for roofs that are approximately square

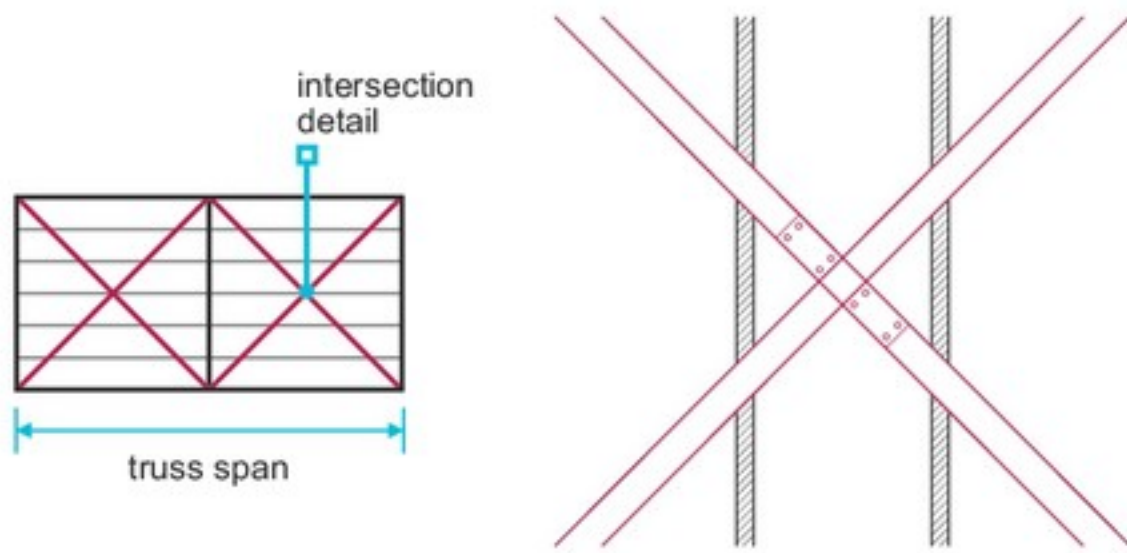


### Bracing for larger roofs





**Bracing for roofs less than 6.6m wide on detached or staggered/stepped buildings**

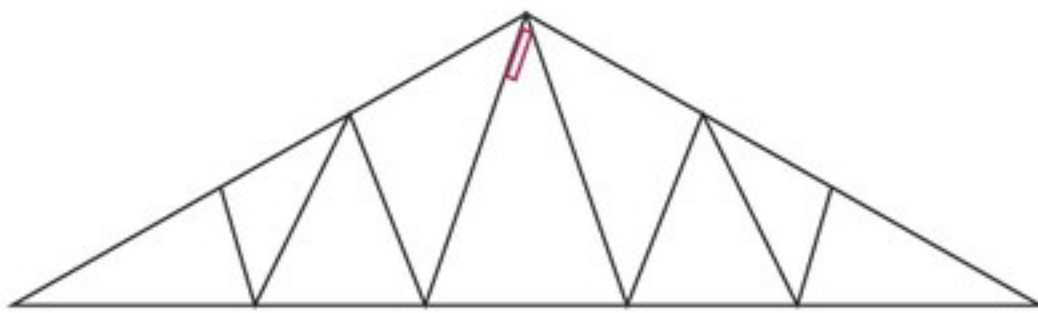


Intersection details should be formed by:

- 22mm x 97mm x 600mm timber splice plate

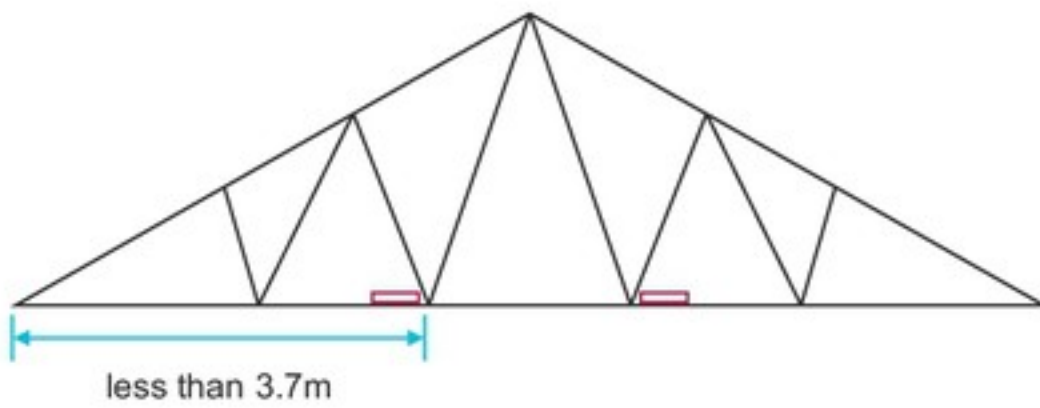
**Longitudinal bracing member at ridge node point**

Applicable to all trussed rafter roofs. Not necessary where rigid sarking, such as OSB, timber boarding or plywood sheeting, is used.



**Longitudinal binders at ceiling node points**

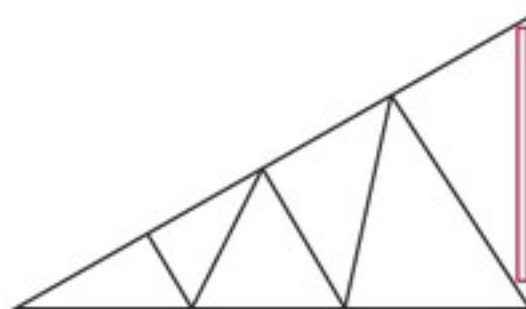
Applicable to all ceiling node points. Not necessary where the spacing between braced nodes is less than 3.7m.



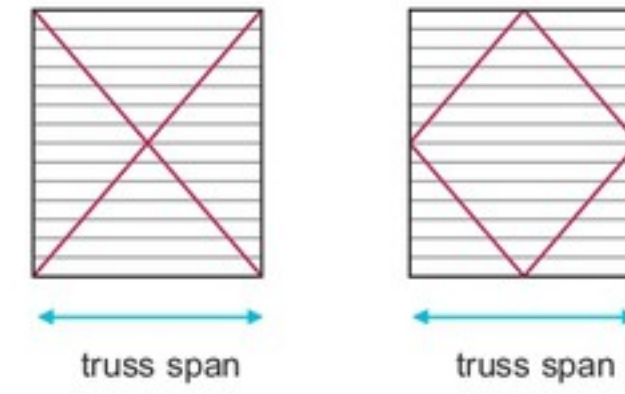
**Diagonal bracing to end vertical of mono-pitch trusses**

Applicable where the truss is not restrained by:

- a masonry wall, or
- cladding, i.e. plywood.



**Bracing for mono-pitch trusses**

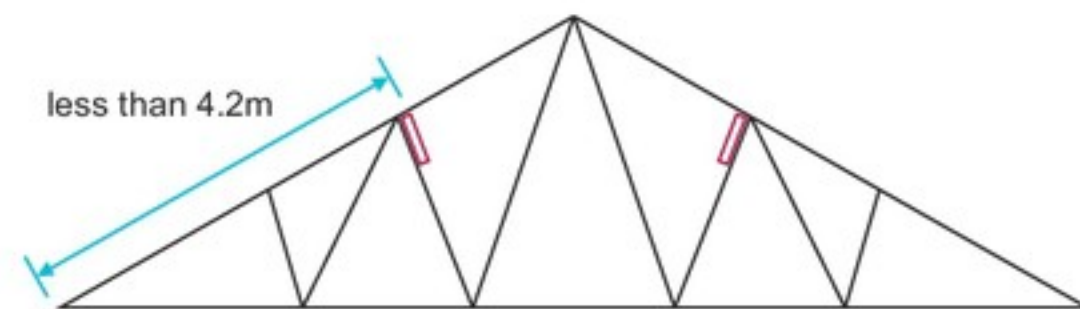


- nailing, using a minimum of four 35mm x 65mm galvanised round wire nails to each side of the intersection, with nails driven through bracing and clenched over.

**Longitudinal bracing member at rafter node point**

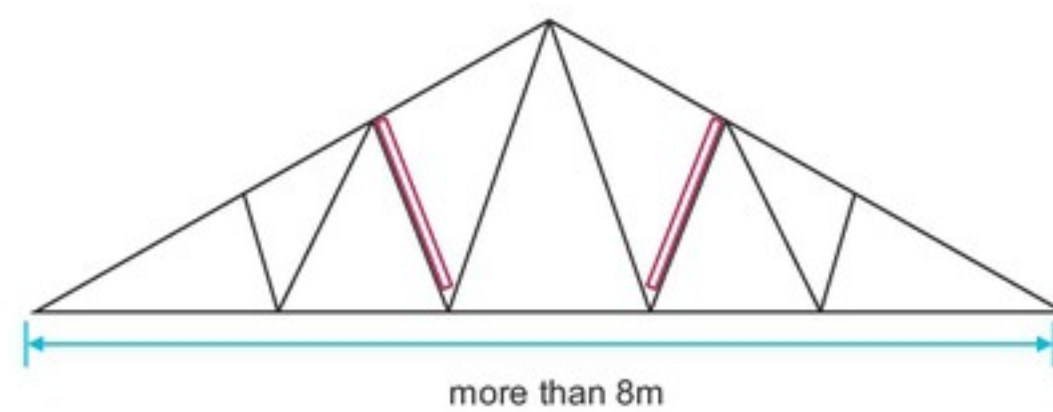
Applicable to all rafter node points. Not necessary where:

- spacing between braced nodes is less than 4.2m, or
- rigid sarking, such as OSB, timber boarding or plywood sheeting, is used.



**Chevron bracing between webs**

Where the span exceeds 8m. For mono-pitch roofs of any span and duo-pitch roofs over 11m span, bracing should be designed by an engineer in accordance with Technical Requirement R5. It should be approximately 45° to the web members.



### Strutting for attic trusses and cut roofs that form a floor <sup>7.2.10</sup>

Strutting to 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 6:** 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)

### Support for equipment <sup>7.2.11</sup>

Permanent equipment in roof voids shall be adequately supported.

Where equipment (e.g. 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.

### Access <sup>7.2.12</sup>

*Also see: Clause 7.2.15*

Roof voids shall be provided with suitable access.

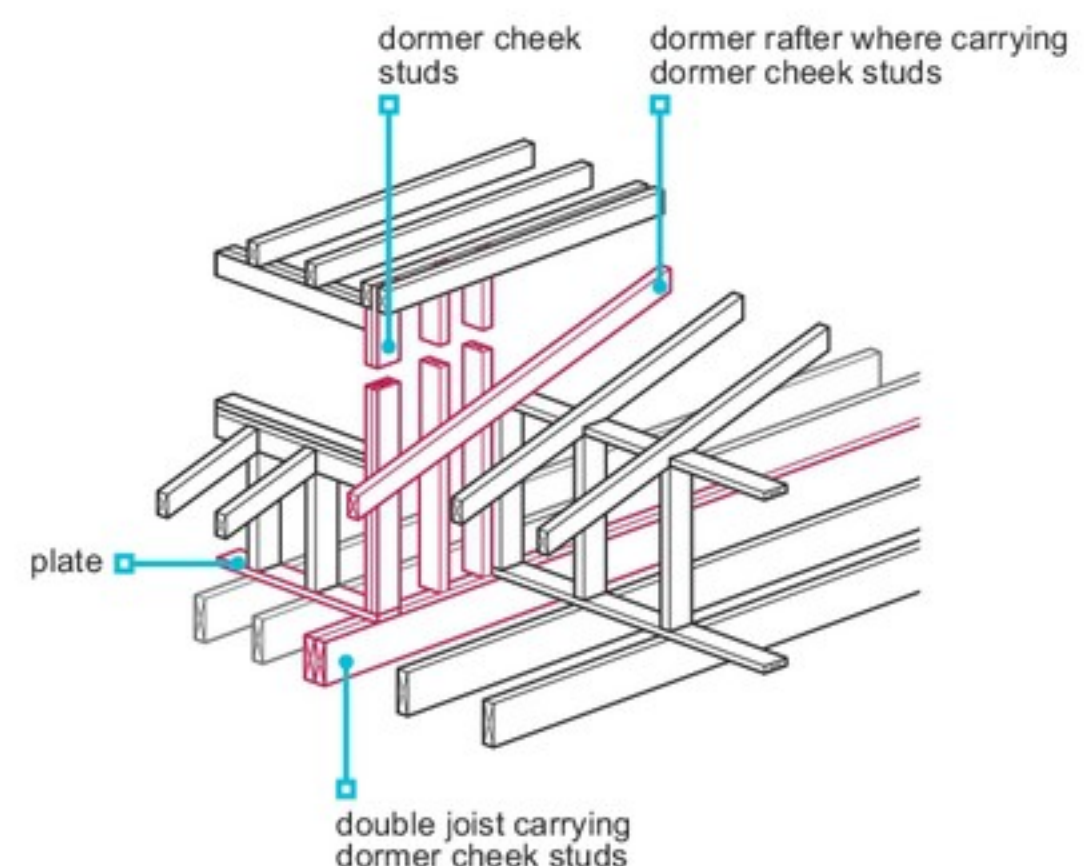
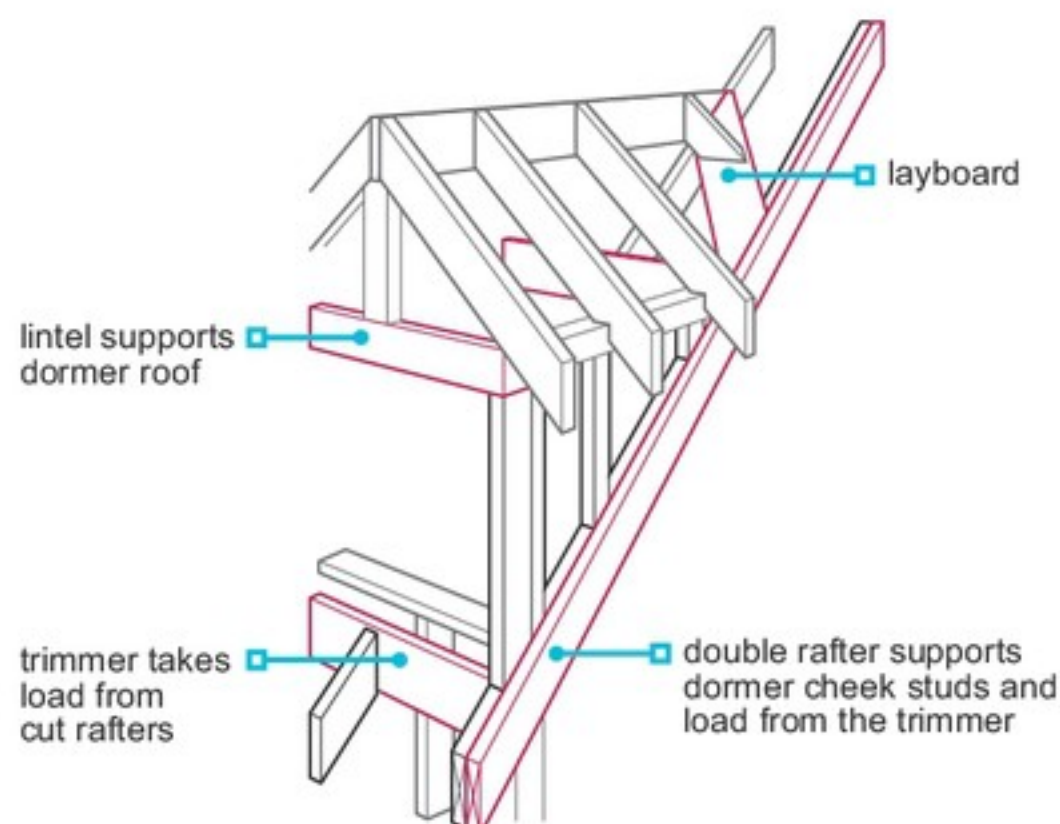
Access should:

- be provided to the main roof space and voids which contain cisterns and tanks etc. though it is not required to roof spaces which contain only water pipes
- permit the removal of permanent equipment (e.g. heating and ventilation plant) 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 cistern or other permanent equipment; boarding should be securely fixed without compressing the insulation; at each piece of permanent equipment or cistern, a minimum 1m<sup>2</sup> platform should be provided to facilitate maintenance.

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.

### Dormer construction <sup>7.2.13</sup>

Dormer constructions shall be of adequate structural stability.



For dormer roofs:

- construction should be in accordance with the design
- cheek studs should be supported by either a double rafter or a double floor joist
- where cheek frames do not extend to floor level, two fixed rafters should be used to provide the necessary support
- trimming members should be large enough to support additional loads from the main roof members, dormer framing and cladding
- a suitable lintel should be provided over the opening
- lintels should be structurally independent from the window frame.

### Underlay and sarking 7.2.14

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

Underlay and sarking should:

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

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

**Table 7:** Acceptable materials for use as underlay and sarking

Material	Standard
Tongued and grooved or square-edged boarding	BS 1297
Bitumen impregnated insulating board	BS 1142-3 (sarking and sheathing grade)
Exterior grade plywood	BS EN 636 service class 3
Chipboard (type P5)	BS EN 312
OSB (type OSB3)	BS EN 300
Felt	BS EN 13707
Proprietary products	Technical Requirement R3

Underlay should:

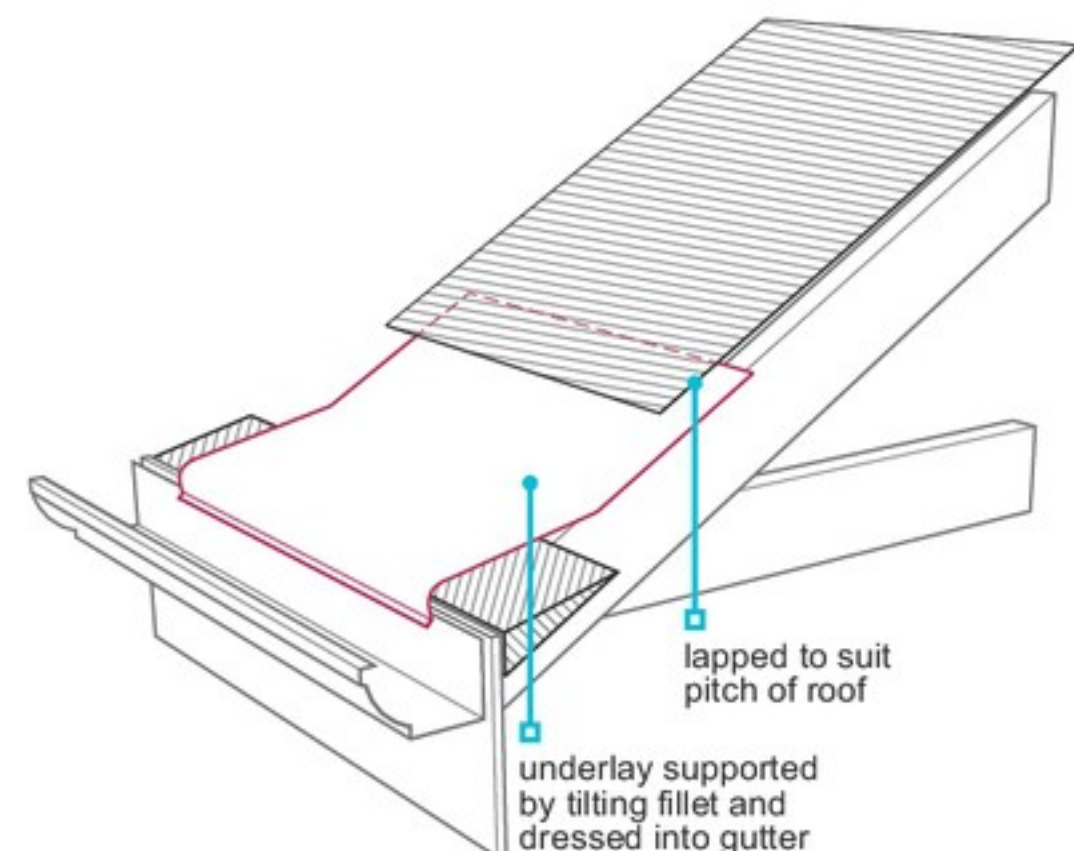
- be provided to all tiled roofs
- where it is above rigid sarking (fully supported), be of low vapour resistance, i.e. less than 0.25MNs/g (where the underlay is highly vapour-resistant, increased ventilation to the roof space or between the underlay and sarking should be provided as necessary)
- where exposed at eaves level, be UV resistant or of type 5U felt or a proprietary eaves guard used (type 1F may be used for the remainder of the roof)
- be supported by a continuous fillet or proprietary eaves support tray to prevent sagging (which can form a water trap)
- be securely fixed
- at vertical laps, be fixed only over rafters, and at horizontal laps, be held in place by battens (spaced at regular intervals)
- be cut neatly, fit tightly and not be torn, i.e. where pipes project through the underlay
- be dressed into the gutter and cut neatly to fit tightly around service penetrations
- where traditional mortar pointing is used to bed ridge tiles, extend over the ridge
- 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.

**Table 8:** Horizontal laps for unsupported underlay

Pitch	Minimum horizontal laps
Less than 15°	225mm
15-34°	150mm
35° and above	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).



### Ventilation, vapour control and insulation <sup>7.2.15</sup>

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

- a) ventilation, vapour control and insulation
- b) dormer construction
- c) pipework.

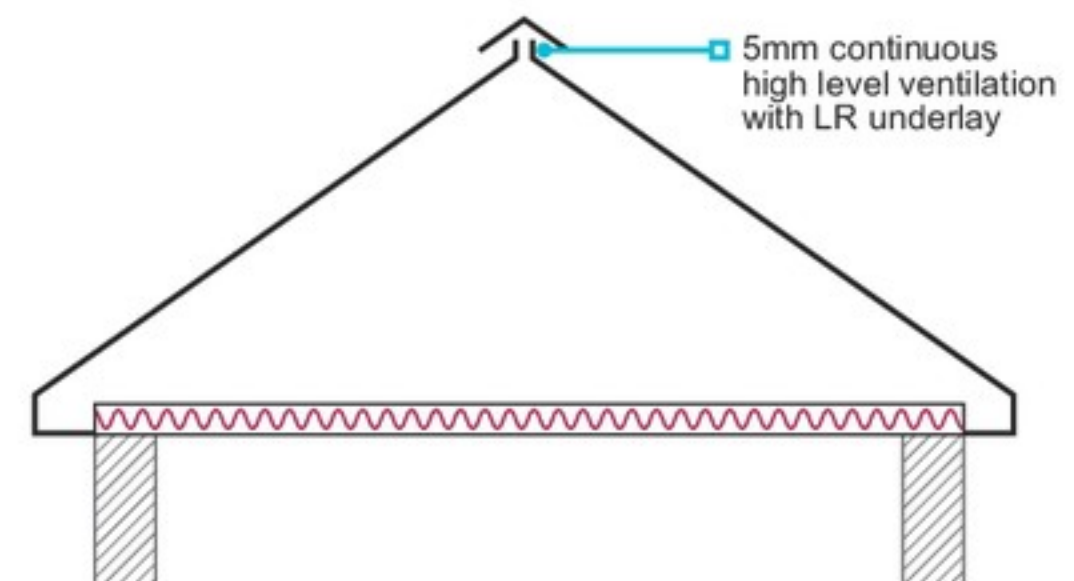
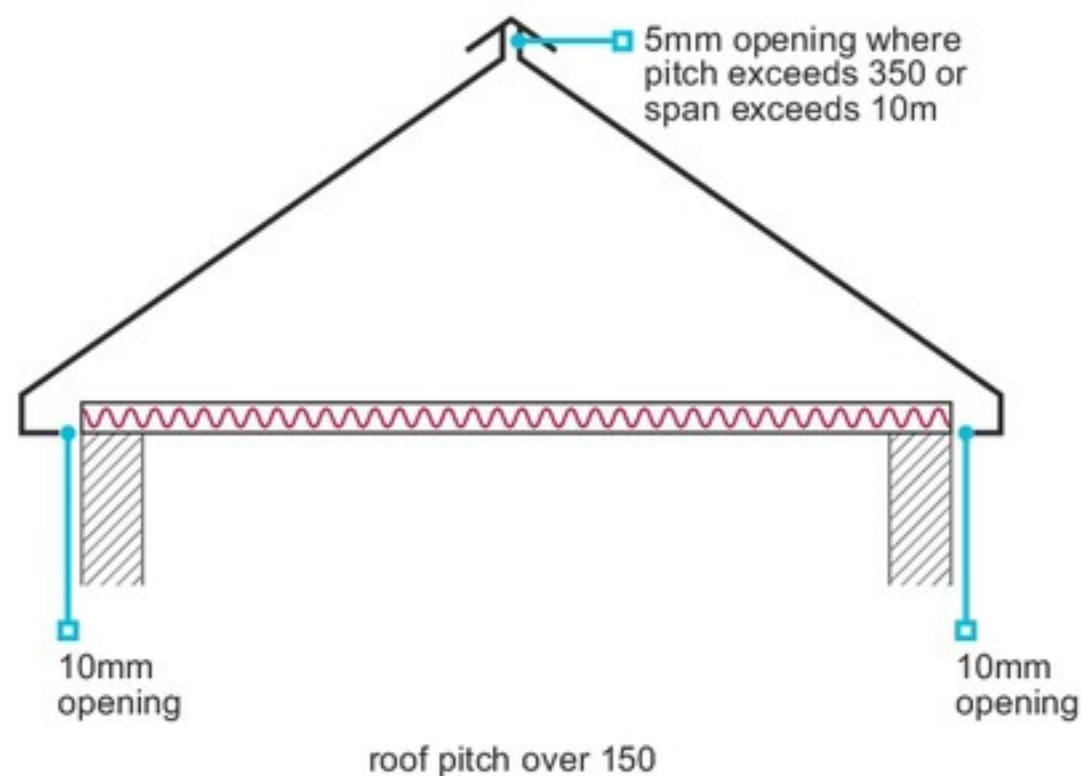
#### Ventilation, vapour control and insulation

To provide adequate ventilation and to avoid condensation:

- roof voids and pitched roofs that have insulation at ceiling level should be ventilated to the outside air
- ventilation openings should prevent the entry of birds, etc. (fabrications with 3mm-10mm openings are acceptable)
- ventilation paths should remain clear, i.e. not blocked by insulation or the structure
- a spacer in the eaves should be used to allow insulation to be installed over and beyond the wall plate to minimise the cold bridge without blocking the ventilation path (the spacer should be of sufficient length to maintain ventilation above the insulation)
- where proprietary eaves ventilators are used, they should be fixed in accordance with the manufacturer's instructions.

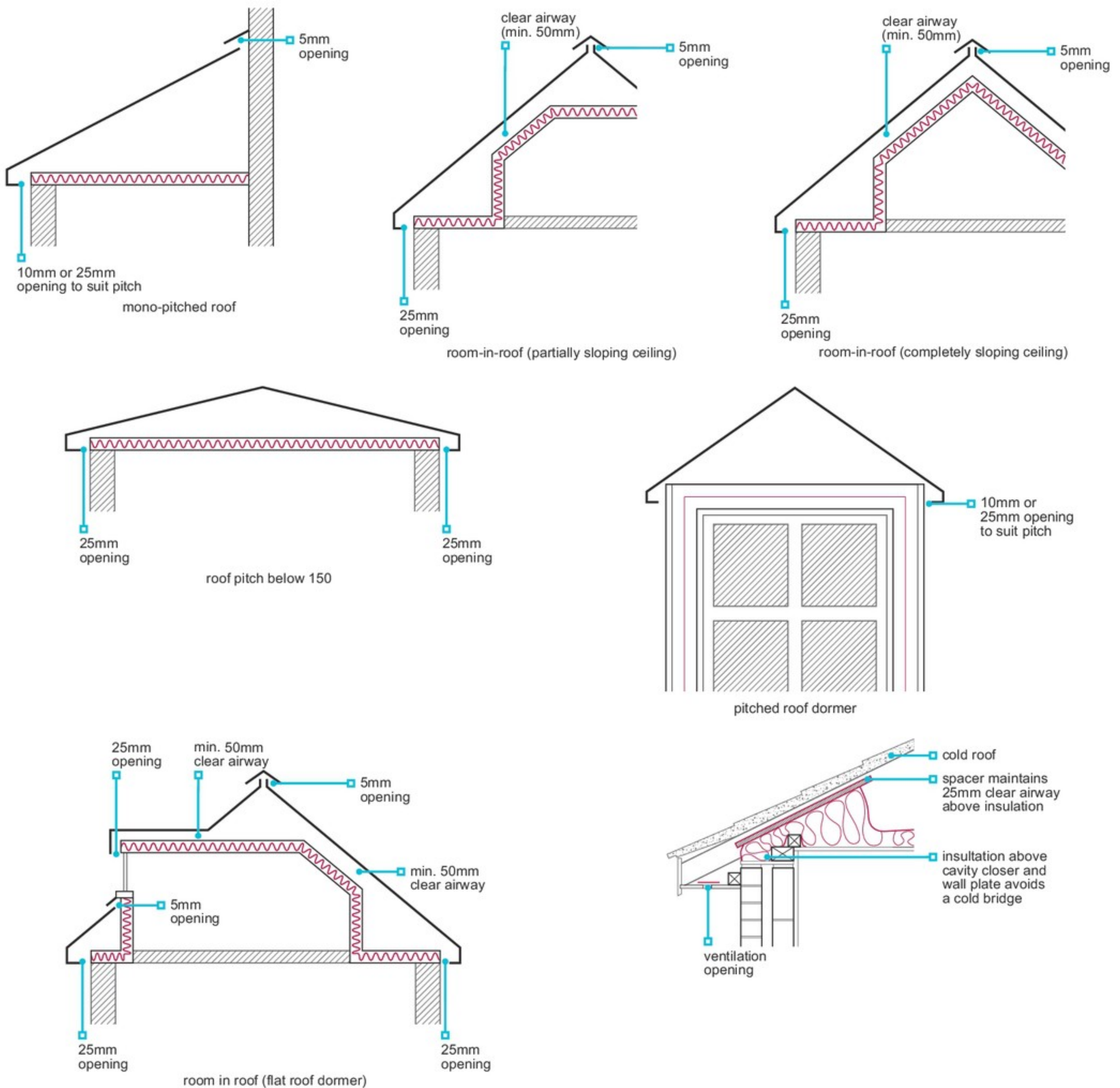
Ridge or high-level ventilation (at the highest point of each roof slope) equivalent to a continuous opening of 5mm should be provided in accordance with BS 5250 where:

- unventilated cold roofs have insulation placed over a horizontal ceiling and a vapour-permeable underlay (type LR) is used
- vapour permeable underlays are used on sloping roofs with areas covered by non-permeable materials (e.g. flat roofed areas of mansard roofs)
- the roof is covered with high water vapour resistant (type HR) underlay and the pitch exceeds 35° or the span exceeds 10m (this is in addition to eaves ventilation).



Where high water vapour-resistant (type HR) underlay (e.g. types 1F/5U felts) is used, eaves ventilation should be provided on opposite sides of the roof to permit cross ventilation, and:

- where the roof pitch is 15° or more, ventilation equivalent to a 10mm slot running the full length of the eaves should be provided
- where the ceiling follows the slope of a roof, regardless of pitch, or where a cold roof has a pitch less than 15°, ventilation equivalent to a 25mm slot running the full length of the eaves should be provided (a nominal clearance of 50mm should be maintained between the insulation and the roof underlay)
- for mono-pitched roofs, cross ventilation should be in accordance with BS 5250 and have ventilation equivalent of a continuous high-level 5mm slot, in addition to eaves ventilation.



To reduce moist air entering the roof space:

- gaps should be sealed where services pass through the ceiling

- where used, downlighters should be specified and sealed to limit air leakage.

Vapour control layers should be provided in accordance with the design, and where required should be:

- placed on the warm side of insulation

- used in roof constructions where the ceiling board is fixed to the rafters.

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

Access hatches to cold roof voids should have:

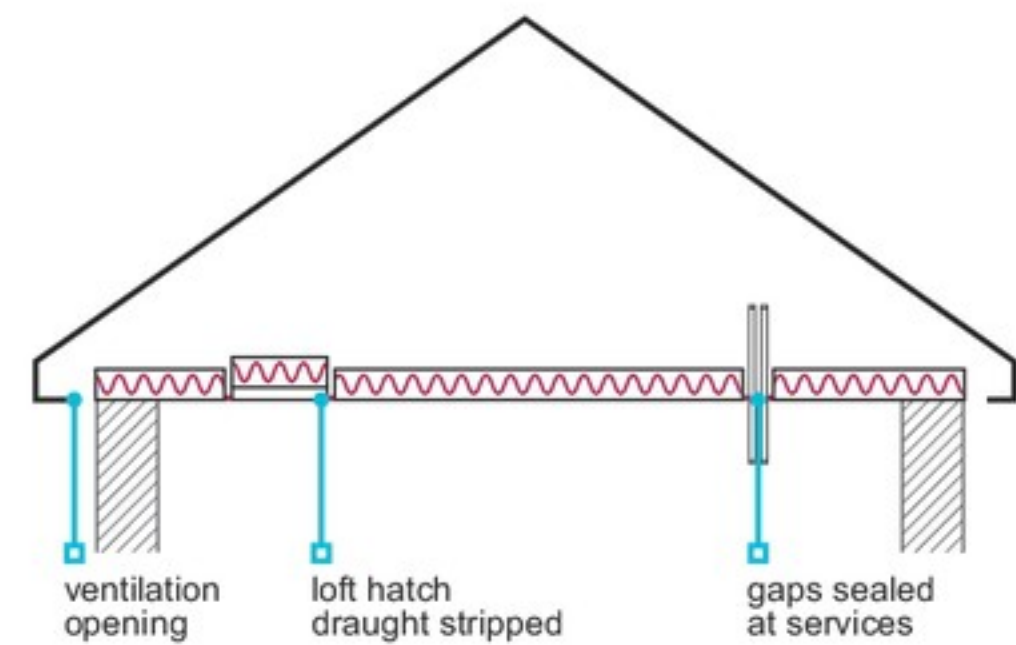
- an air leakage rate not more than 1 M<sup>3</sup>/h at a pressure of 2 Pa when tested to BS EN 13141-1, or

- 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).

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

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

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



**Table 9:** Suitable materials for roof insulation

Material	Standard
Mineral fibre mats	BS EN 13162
Blown mineral fibre	BS 5803-2
Blown cellulose fibre	BS 5803-3
Proprietary products	Technical Requirement R3

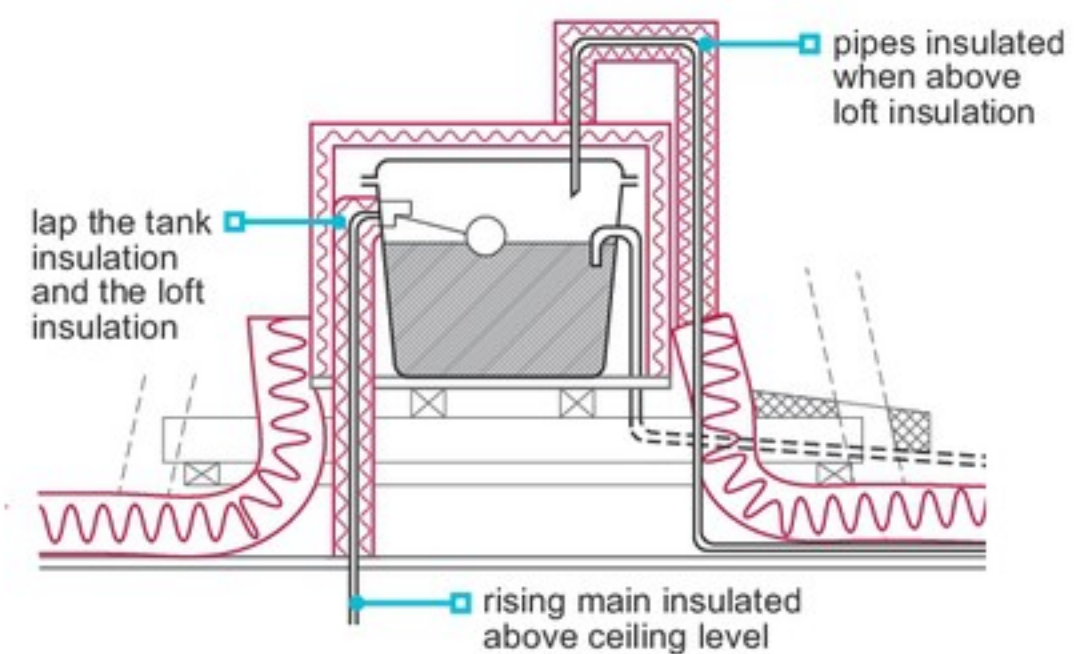
### Dormer construction

Ventilation to dormers should be provided from eaves to eaves or from eaves to ridge.

### Pipework

To reduce the risk of freezing or condensation forming on pipework, 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 Chapter 8.1 'Internal services'.
- 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.



In England and Wales, account should be taken of Accredited Construction Details.

## Firestopping and cavity barriers <sup>7.2.16</sup>

Also see: Chapter 6.8

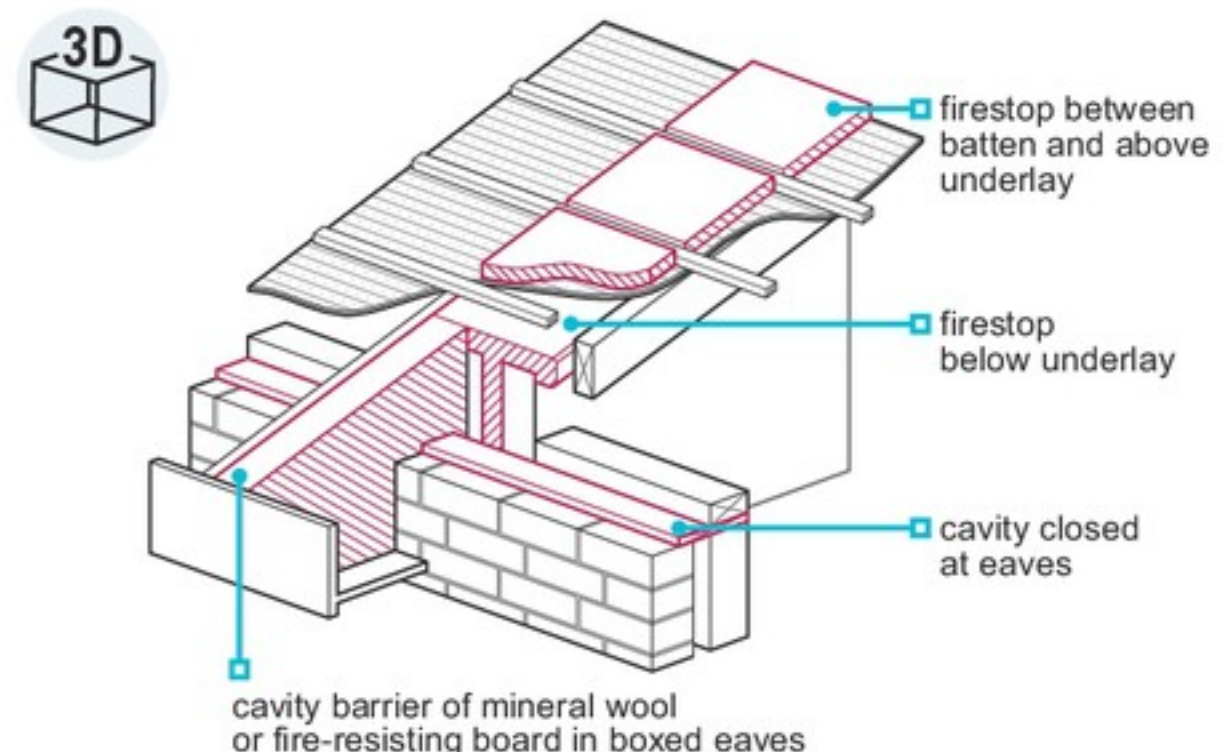
**Pitched roofs shall be constructed to provide adequate fire resistance and separation.**

Firestopping should be provided in accordance with building regulations, including:

- at the junctions between a separating or compartment wall and a roof
- at the junctions between cavities
- above separating walls
- within the boxed eaves at separating walls.

When providing firestopping:

- gaps between compartments should be sealed
- separating walls should stop approximately 25mm below the top of adjacent roof trusses, and a soft fire-resistant packing, such as mineral wool, should be used to allow for movement in roof timbers and prevent 'hogging' of the tiles
- a cavity barrier of fire-resisting board or a wire reinforced mineral wool blanket (50mm minimum) nailed to the rafter and carefully cut to fully seal the boxed eaves should be installed (ordinary mineral wool quilt is acceptable as firestopping above separating walls)
- a minimum 30min fire separation should be provided between the home and an integral garage.



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

**Battens** 7.2.17

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

Battens and counter battens should be:

- in accordance with BS 5534, accompanied by a delivery note and marked with the supplier, origin, grade and size
- preservative treated
- where cut ends are in contact with mortar, 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 the joint.

Counter battens should be fixed to the rafters and not only to sarking boards.

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 rigid sarking boards, 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 manufacturer's recommendations, but not less than shown in Table 10.

**Table 10:** Suitable batten sizes

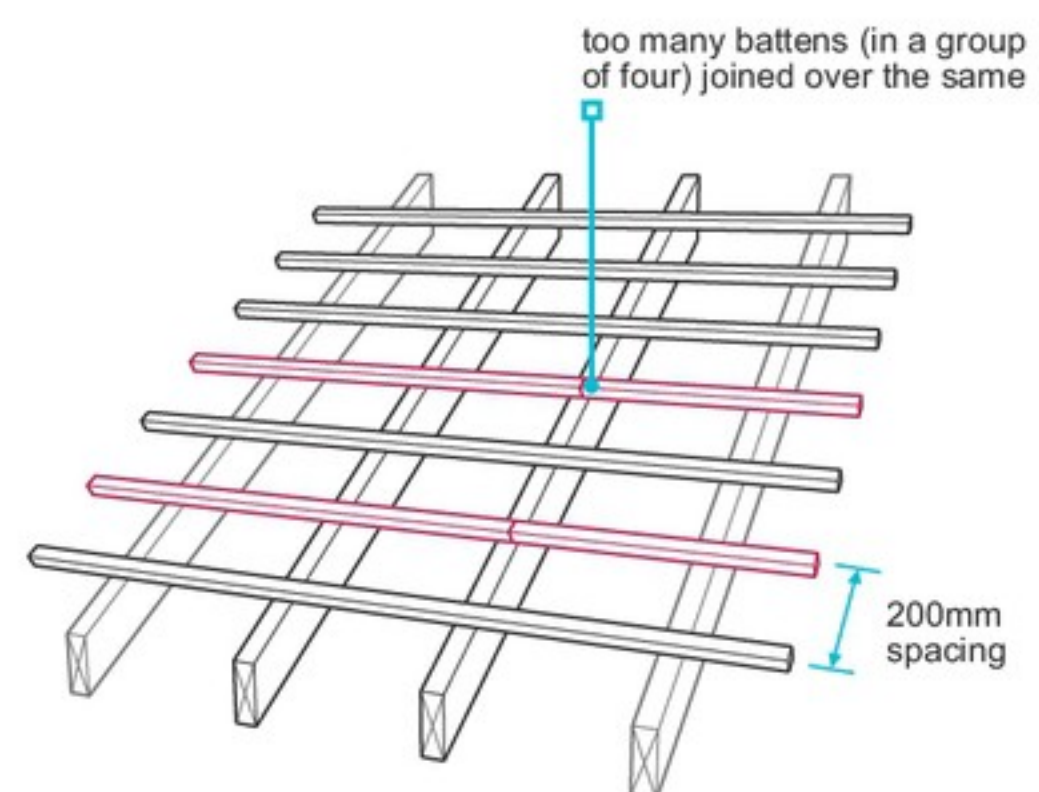
		450mm span	600mm span
Double lap slates	Natural: sized or random	25mm x 50mm	25mm x 50mm
	Fibre cement or concrete	25mm x 38mm	25mm x 50mm
Clay/concrete tiles	Double lap	25mm x 38mm	25mm x 38mm
	Single lap	25mm x 38mm	25mm x 50mm

Notes

- 1 Actual size should be within +/-3mm of the nominal size).

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
- 200mm or less, no more than three joints should be made over any 12 consecutive battens.



Batten fixings should be:

- cut or wire nails in accordance with BS 5534
- a minimum of 3.35mm x 65mm long (10 gauge) and a minimum of 30mm longer than the batten thickness
- ring shank nails where specified (where the maximum basic wind speed is over 26m/s (National Annex Figure NA.1 of BS EN 1991-1-4), galvanized smooth round nails are not acceptable and ring shank nails should be used)
- hot dip galvanised steel or aluminium, when used in coastal areas.

**Roof coverings** 7.2.18

**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 11:** Standards relevant to roof coverings

Material	Standard
Clay tiles and fittings	BS EN 1304
Concrete tiles and fittings	BS EN 490 and BS EN 491
Natural slates	BS EN 12326
Fibre cement slates and fittings	BS EN 492
Natural stone	Established practices
Lead sheet roofing	BS 6915
Rolled lead sheet	BS EN 12588
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
Sheet metal roofing, including lead, copper and zinc	Technical Requirement R3
Proprietary roofs, roof lights, dry fixed systems and coverings	Technical Requirement R3
Other roof coverings	CP 143

Where slates and concrete or clay tiles are designated AA to BS 476-3, they can be used without limitation on pitched roofs.

**Table 12:** Acceptable characteristics for natural slates

Characteristics	Grade (to BS EN 12326)
Water absorption less than 0.6%	A1
Thermal cycle	T1
Carbonate content less than 20%	S1

### Fixing tiles and slates <sup>7.2.19</sup>

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 | c) mortar                       |
| b) verges                     | d) vertical tiling and slating. |

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)
- the bottom edges of double-lapped slate and plain tile roofs should be finished with an under-eaves course.

**Table 13:** 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 <sup>(2)</sup>
Slates (double lap)	Maximum 1/3 length lap	54mm <sup>(1)</sup> minimum, increased with lower pitch and severe exposure conditions	20 subject to headlap

Notes

- 1 For pitches greater than 45° 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
- slates and tiles should be fixed using clout or slate nails (these should be either silicon bronze, aluminium to BS 1202-3 or copper to BS 1202-2).
- galvanized steel nails should not be used for slates and tiles (but are acceptable for fixing battens or underlay)
- fixings should be a minimum of 38mm long, and penetrate a minimum of 15mm into battens
- tile clips should be of aluminium or stainless steel
- slates should be fully nailed over the whole roof, and nailed twice where centre nailed.

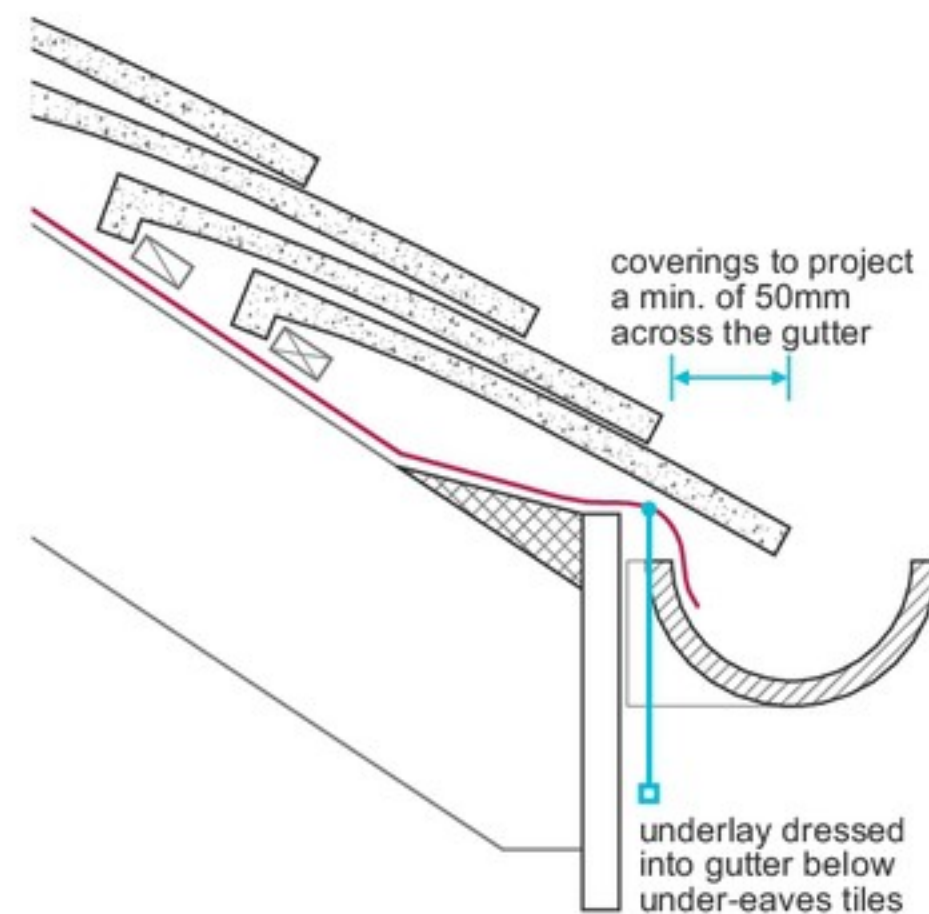
### Eaves, ridge and hip tiles

At eaves:

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

At ridges:

- the underlay should extend over the ridge where traditional mortar pointing is used to bed ridge tiles.

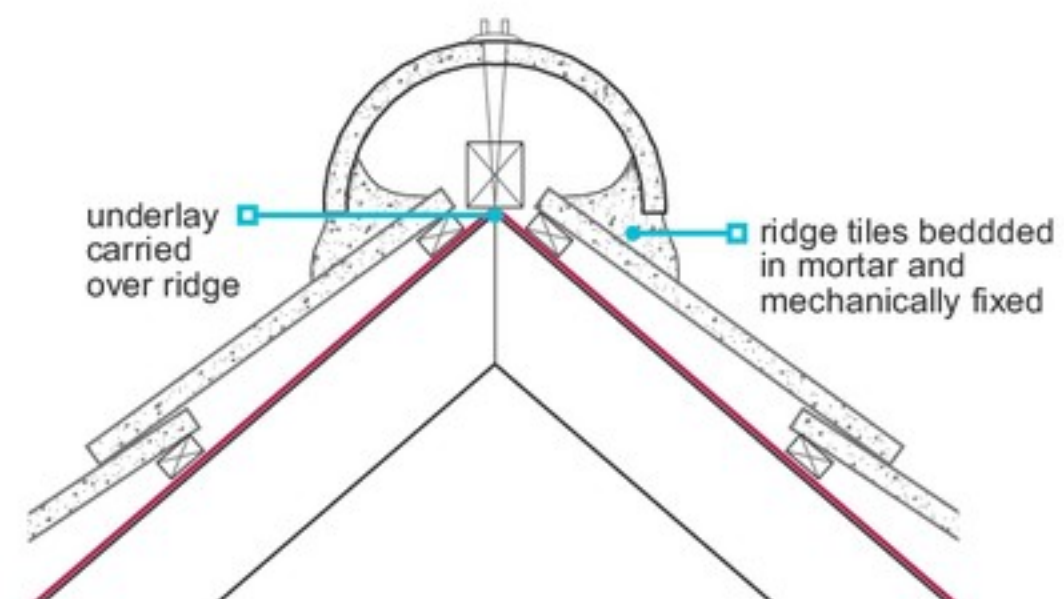
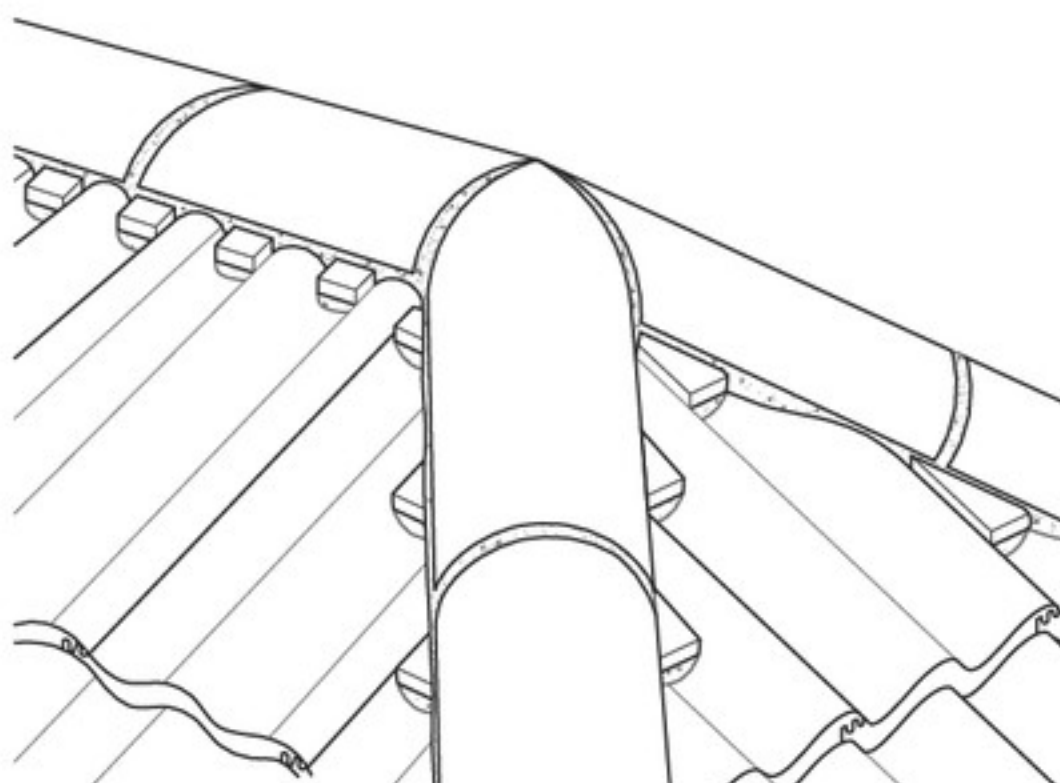


At hips:

- 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.

All 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.

Proprietary dry fixed systems should be assessed in accordance with Technical Requirement R3.

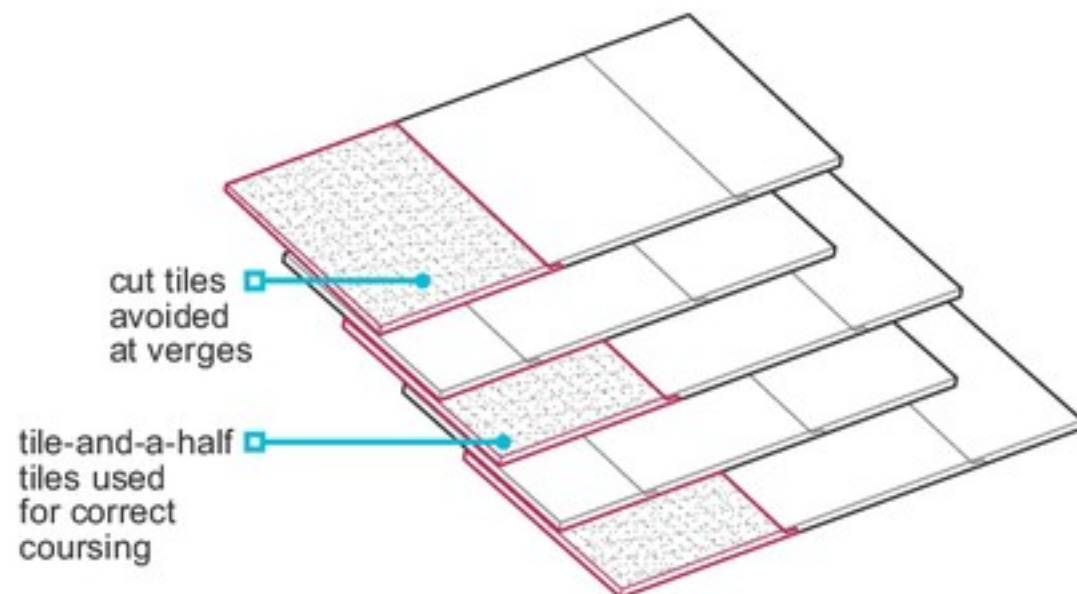


### Verges

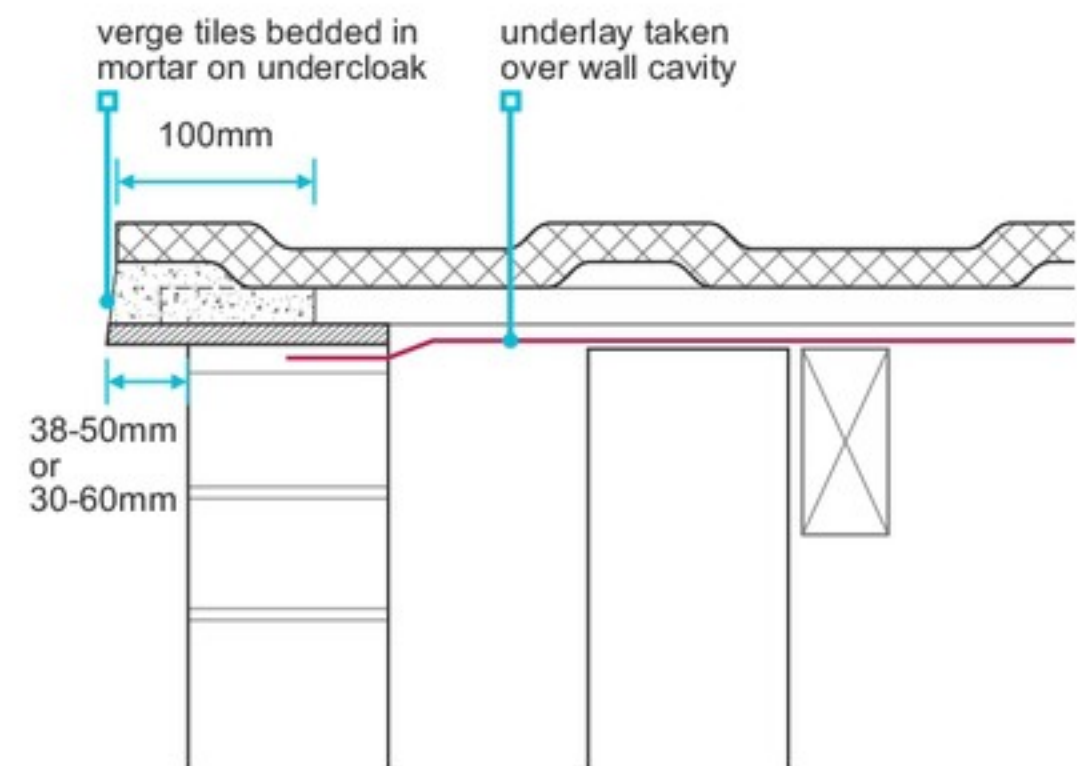
Unless a proprietary dry verge system or cloaked verge is used, tiles should be bedded into a 100mm wide bed of mortar on an undercloak of cement-based board, plain tile or slate. Plain tiles should not be used as an undercloak below 30° pitch or on a bargeboard.

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
- lapped over the roof underlay but should 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.



Where verge tiles and slates are wet bedded, it should be completed in one operation.

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

- 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 not be used.

### 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)

- bedding and pointing should be completed in one operation
- 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.

### Vertical tiling and slating

When fixing vertical tiling and slating:

- a suitable moisture barrier should be used
- where the wall structure is solid brickwork or blockwork, the moisture barrier should be underfelt or equivalent
- where the supporting structure is of timber construction, the moisture barrier should be used with a breather membrane
- batten sizes should be in accordance with this chapter
- every tile or slate should be nailed twice and the bottom edges should be finished with an under-course tile

- at internal or external angles, purpose-made corner tiles or soakers should be used to form a weathertight joint
- where pitched roofs abut tiled walls, a stepped flashing should be specified and turned in behind the tiles
- at dormer cheeks, the tiles or slates should be specified to be cut close to the slope of the roof and over a flashing fixed to the side of the dormer.

**Weathering details** <sup>7.2.20</sup>

*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) 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 14:** Suitable materials for flashings

Material	Standard	Additional information
Aluminium and alloys	BS 1470	0.6-0.9mm thick, and protected from contact with mortar by a coating of bituminous paint
Copper	BS 2870	Flashings, soakers and saddles should be: <ul style="list-style-type: none"> <li>■ fully annealed</li> <li>■ 0.55mm thick (0.7mm thick is suitable for gutters)</li> </ul>
Rolled lead sheet	BS EN 12588	Flashings, gutter linings etc. should: <ul style="list-style-type: none"> <li>■ be a minimum of code 4, and soakers a minimum of code 3</li> <li>■ sections should not exceed 1.5m in length</li> </ul>
Zinc alloy	BS 6561	Should be a minimum of 0.6mm thick
Proprietary products	Technical Requirement R3	Should be securely fixed in accordance with the manufacturer's recommendations

**Abutments**

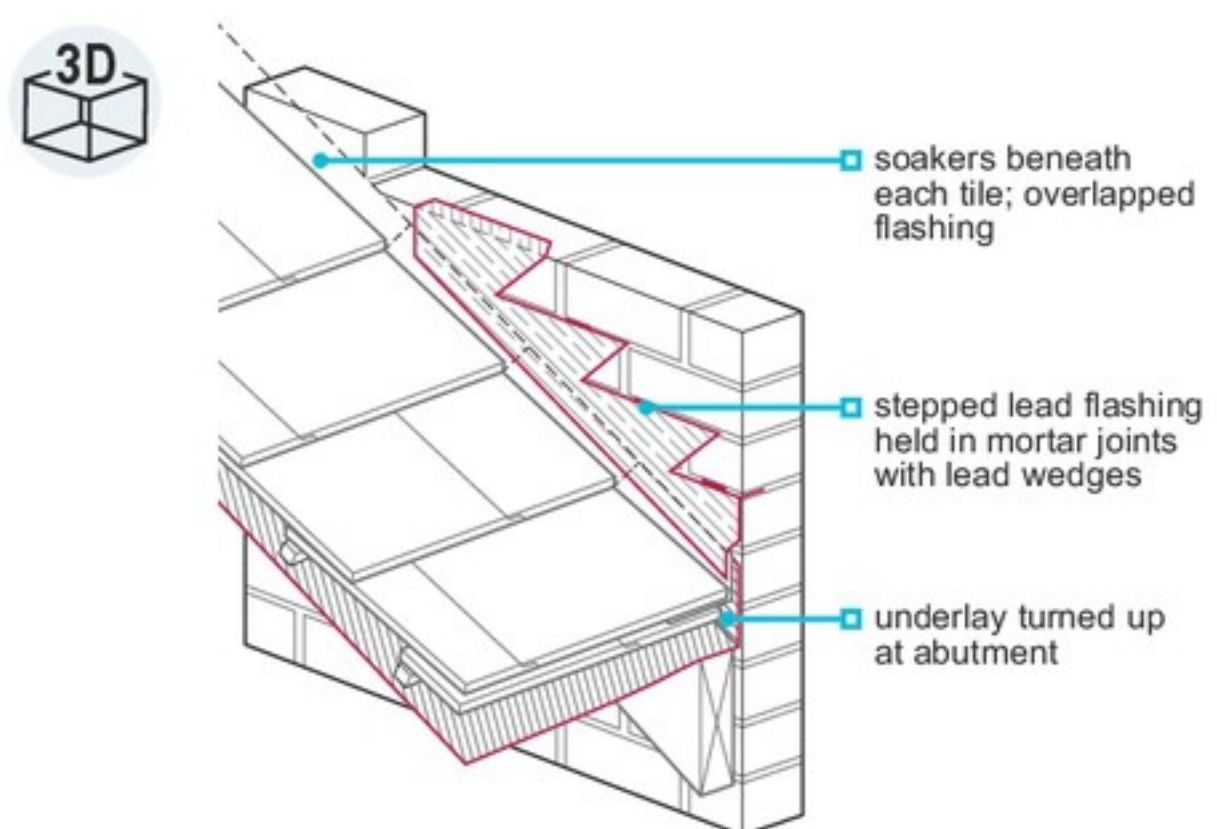
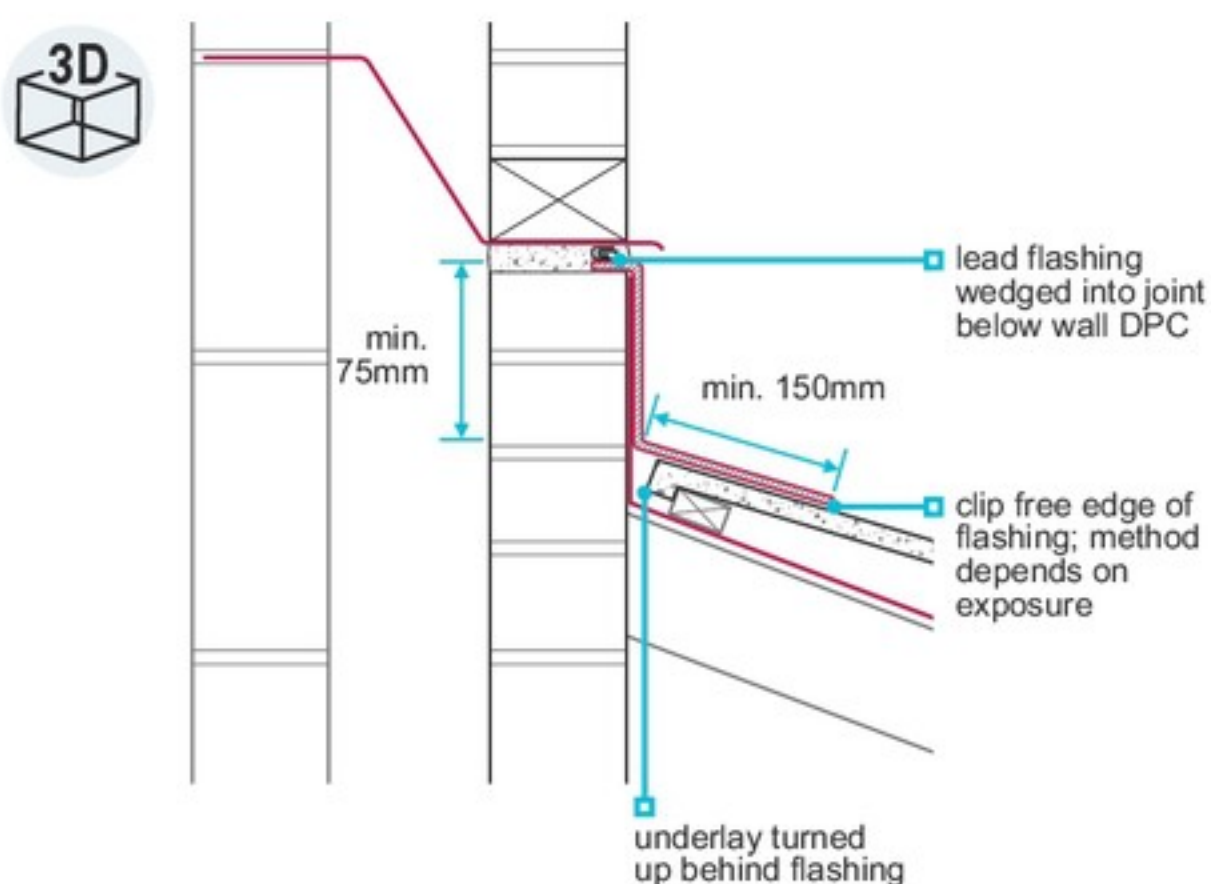
At abutments:

- flashings, soakers and gutters should be provided as necessary
- lead flashings should have a minimum lap of 100mm
- flashings should be tucked 25mm into a brick 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.

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.

Where a pitched roof abuts the wall at an angle:

- a 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
- where slates, flat interlocking tiles or plain tiles are used, soakers (or a secret gutter) should be installed.



### Flat roof intersection or changes in slope

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

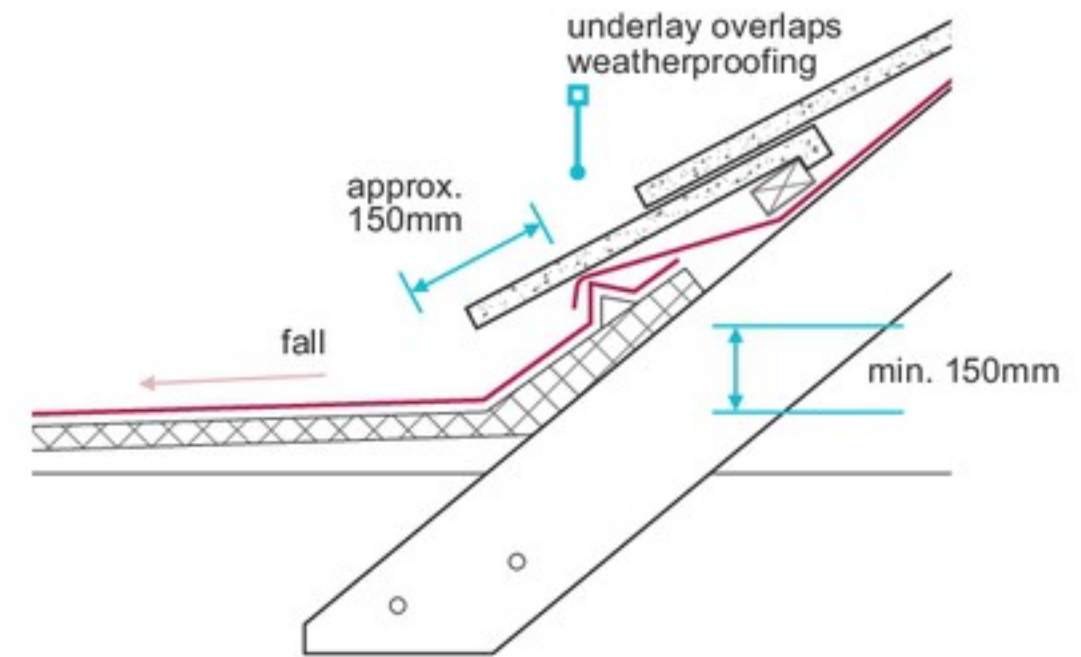
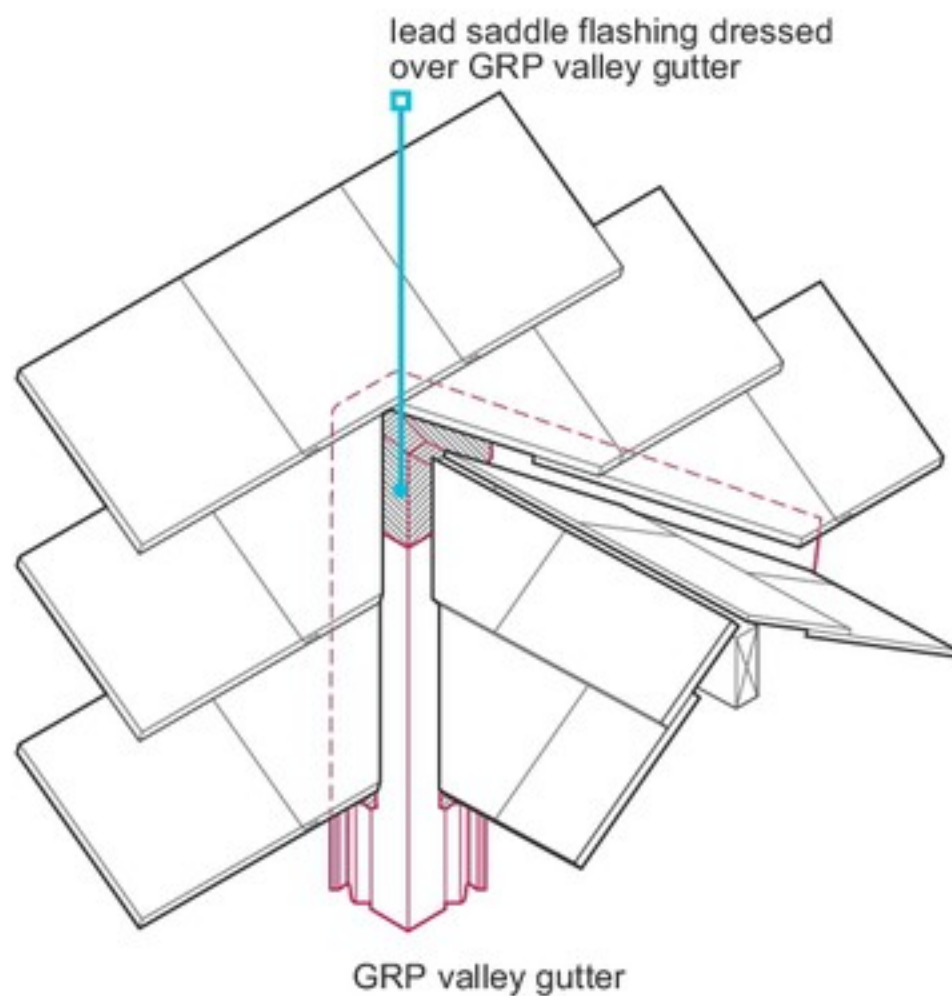
- the change is 5° or more (e.g. at mansards and sprockets), flashings or soakers should be used

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

- a ridge meets the main roof, a saddle flashing should be used where a ridge meets the main roof.

- where the flat roof is over a dormer, the flat roof should have a fall to the front or sides.

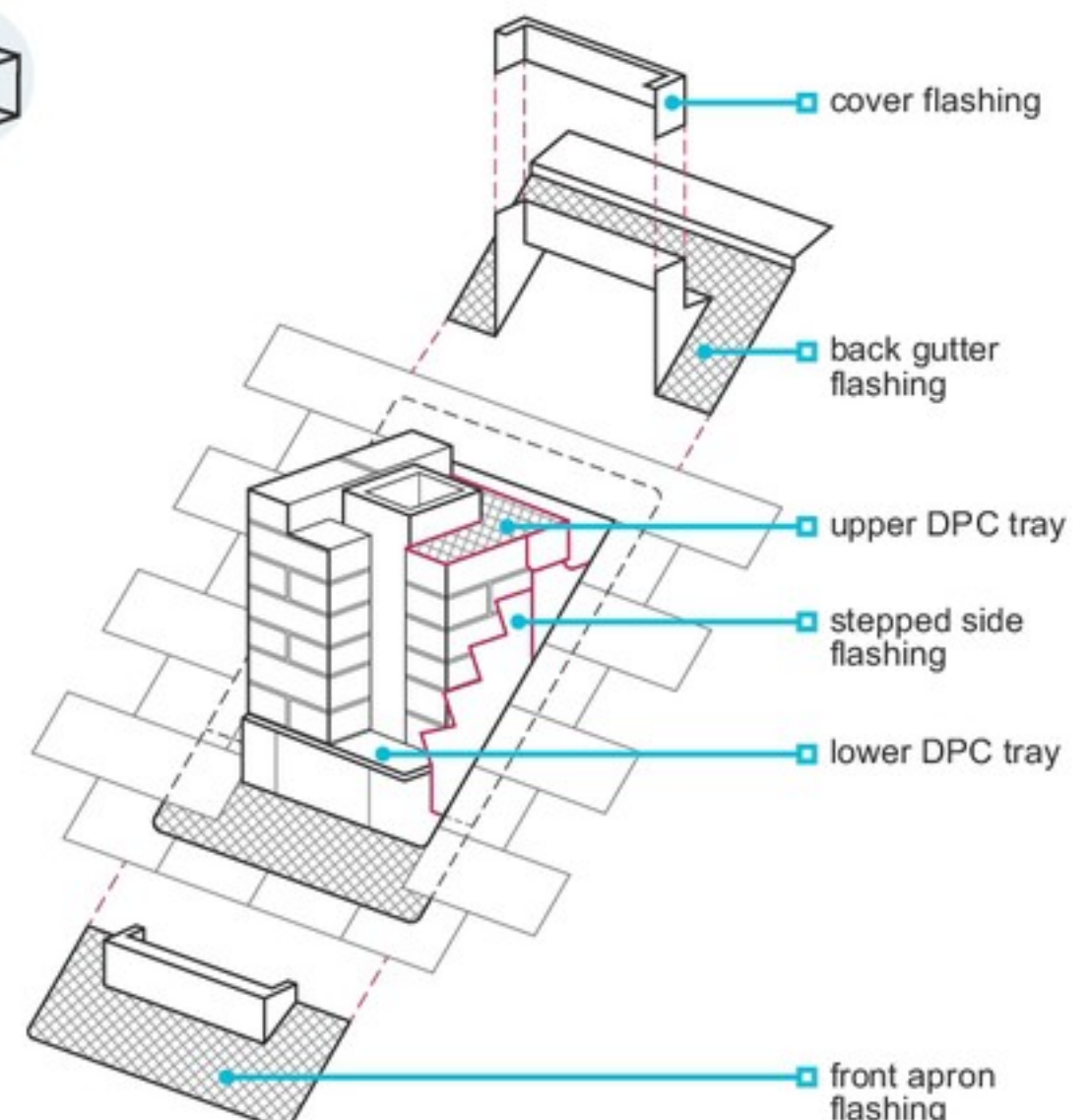
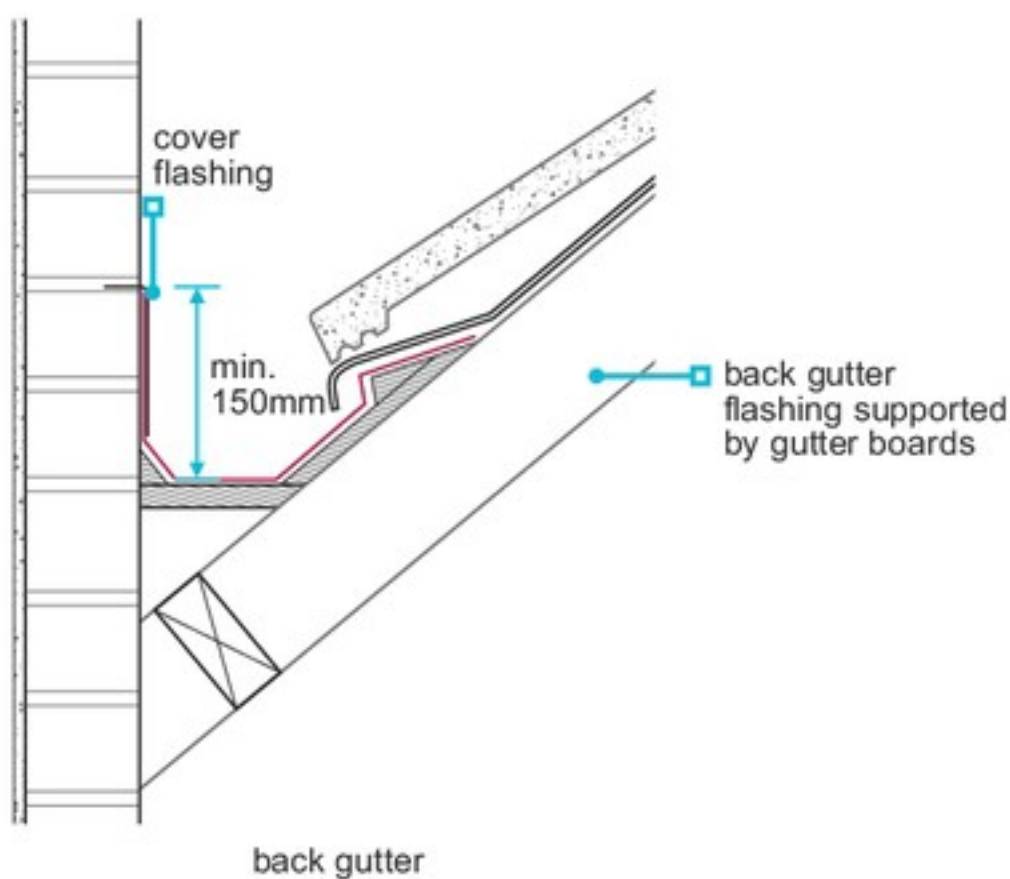


### Projections through the roof

Where there is a projection through the roof:

- components should be installed according to the manufacturer's recommendations
- flashings should be provided (e.g. 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 (supplied by the roof covering manufacturer); where lead slates are used they should be supported (e.g. using exterior grade plywood) to prevent sagging.



## Copings

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

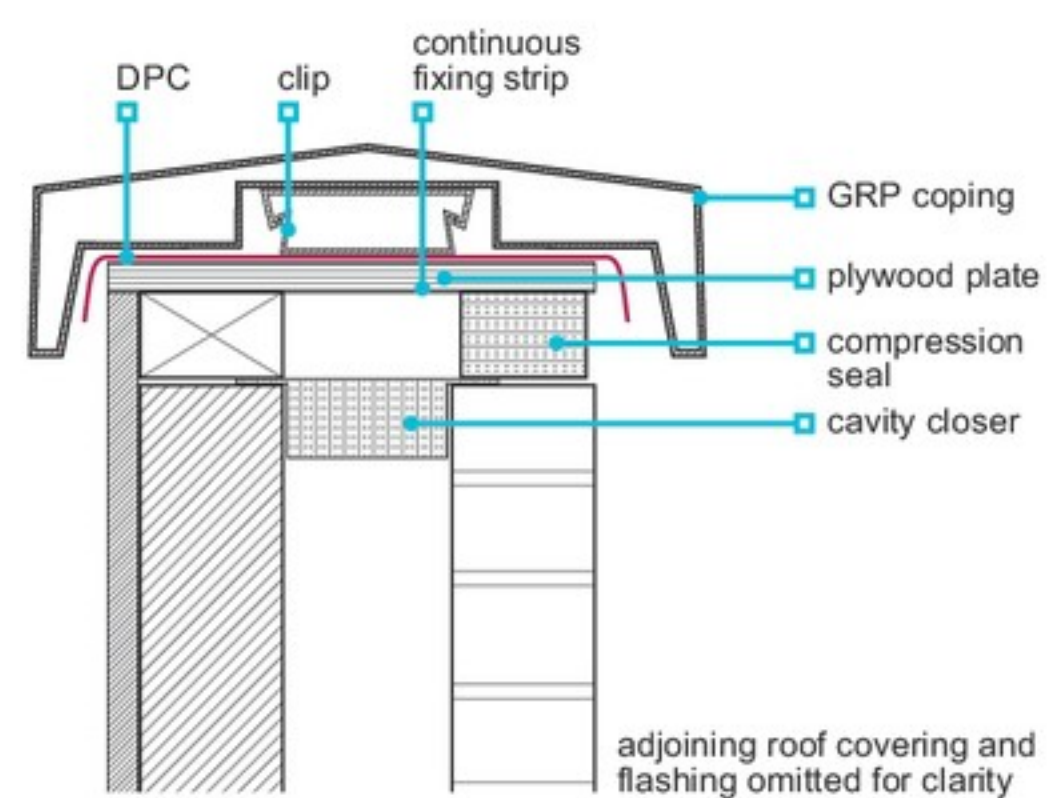
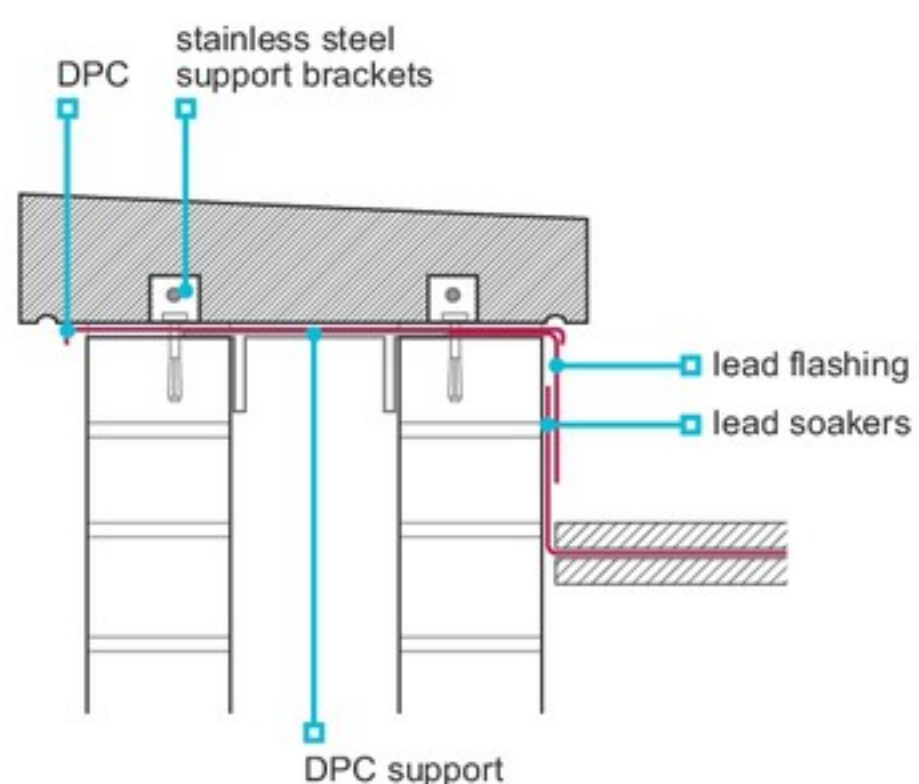
To resist wind uplift and gravitational forces, L-shaped brackets should be used to secure stone copings to masonry walls. The brackets should:

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

DPCs should be installed under the coping to ensure that the wall is weathertight. The DPC should:

- be bitumen-based material to BS 6398, 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.



Where GRP copings are used, they should:

- be fixed in accordance with the manufacturer's instructions
- include a DPC
- allow for normal downward movement in the timber frame.

Further guidance can be found in Chapter 6.2 'External timber framed walls'.

## Valleys and hidden gutters <sup>7.2.21</sup>

**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
- have a finished pitch which complies with the minimum recommended for the roof
- be fixed in accordance with the manufacturer's recommendations
- small cut tiles should be avoided
- have a lead flashing (minimum code 4) or other suitable saddle flashing, at the head of each valley
- be formed using either preformed GRP, valley coursing tiles (plain tiles), valley trough tiles (interlocking tiles), non-ferrous metal or a proprietary system to Technical Requirement R3.

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.

### 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
- they should be bedded in mortar with a minimum 100mm wide channel (minimum 125mm for pitches below 30°).

**VLead-lined valleys**

For lead-lined valleys, the tiles should be cut and bedded as for valley tiles, except that the mortar should be bedded on 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 (colour-coded blue) or code 5 (colour-coded red)
- supported on gutter boards of 19mm exterior grade ply, 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°.

**Proprietary gutter or valley systems**

Proprietary gutter or valley systems should be in accordance with the manufacturer's recommendations, and securely fixed to suitable supports (exterior grade materials should be used).

**Drainage <sup>7.2.22</sup>**

**Roof drainage shall adequately carry rainwater to a suitable outlet.**

Drainage should be:

- provided where roofs are greater than 6m<sup>2</sup>; however, consideration should be given to providing drainage to smaller roofs such as dormer, porch roofs and balconies (see Clause 7.1.12)
- of a sufficient size to accommodate normal rainfall, and sized to cope with concentrated flows, i.e. 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 Chapter 8.1 'Internal services'
- installed ensuring gutters are provided with stop ends, and are laid with a sufficient fall towards the outlet, unless designed to be flat.

Where gutters are behind parapet walls, a suitably sized overflow should be provided.

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

**Fascias and trim <sup>7.2.23</sup>**

*Also see: Chapter 3.3*

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

**Table 15:** Materials acceptable for fascia boards

Exterior grade plywood	BS EN 636 Class 3
High density fibre reinforced calcium silicate board	BS 3536
Glass fibre reinforced cement (GRC) board	BS 3536
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
- timber for fascias, bargeboards and soffits should be pretreated with preservative
- where preservative treated timber is cut or planed, preservative should be applied to the cut edge
- 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.