

# Flat roofs and balconies

## CHAPTER 7.1

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

Waterproofing using profile sheet is outside the scope of this chapter.

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## Definitions for this chapter

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

<b>Flat roof</b>	A roof with a maximum slope of 10° from the horizontal. Systems may be used at a greater pitch where they meet the requirements of this chapter, and materials are adequately held in place.
<b>Deck</b>	The structural substrate of the flat roof.
<b>Decking</b>	The upper trafficked surface of the balcony.
<b>Warm roof</b>	Insulated above the deck.
<b>Cold roof</b>	Insulated below the deck.
<b>Inverted warm roof</b>	Insulated above the waterproofing.
<b>Intensive green roof</b>	Vegetation contained within soil.
<b>Extensive green roof</b>	Vegetation contained in the sedum.

### 7.1.1 Compliance

Also see: Chapter 2.1

**Flat roofs and balconies shall comply with the Technical Requirements.**

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

Other sources of information include:

- BS 6229 'Flat roofs with continuously supported coverings. Code of practice'
- National Federation of Roofing Contractors (NFRC)
- Mastic Asphalt Council (MAC)
- Single Ply Roofing Association (SPRA)
- Liquid Roofing and Waterproofing Association (LRWA).

Where the flat roof or balcony is a terrace above another home, it should provide satisfactory acoustic performance in accordance with relevant building regulations.

### 7.1.2 Provision of information

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

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

- Extent and direction of falls, and position of rainwater outlets.
- Sections through the construction, indicating how falls are formed and ventilation is provided.
- Size, specification and position of the components, including treatments for durability and the position of the vapour control layer, insulation and waterproofing layers.
- Details at critical junctions.
- Details of fixings and fixing methods, including those for insulation and surfacing.
- Specification for intensive, or extensive green roofs.
- Details and fixing methods of balcony support and guarding components.

### 7.1.3 Flat roof and balcony design

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

The structural design of flat roofs and balconies should:

- be produced by an engineer in accordance with Technical Requirement R5, and be in accordance with BS EN 1991-1-1, BS EN 1991-1-3 and BS EN 1991-1-4
- resist wind uplift by either being of sufficient self-weight or by being anchored to the main structure – where required, holding-down straps should be provided at a maximum spacing of 2m
- have adequate provision for the additional loads where a flat roof is to act as a roof terrace, roof garden or car parking area
- have adequate provision for movement in larger roofs, particularly where the span of the roof deck changes, e.g. in L-shaped buildings; joints should be continuous through the vertical upstands, walls and edges of the building
- include support steelwork and purlins which are square, true and free from twists or sagging.

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

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

### 7.1.4 Timber and timber decks

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

- a) structure and durability
- b) joist hangers, straps and strutting
- c) installing timber substrates.

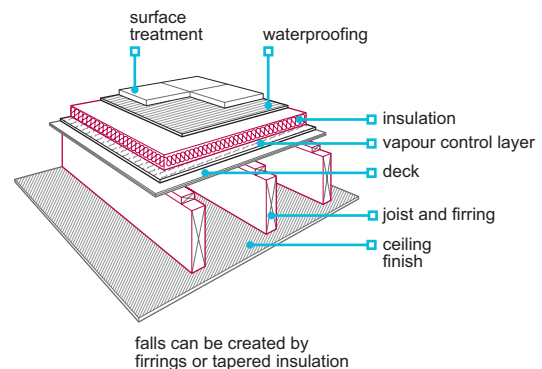
#### Structure and durability

Timber should be:

- checked for conformity with the design upon delivery
- rejected where excessively wet, damaged or not of a suitable quality or shape
- stored under cover to prevent wetting
- preservative treated or naturally durable, in accordance with Chapter 3.3 'Timber preservation (natural solid timber)'
- retreated along the cut edges with a coloured preservative, where preservative treated timber has been cut.

Timber decks should:

- be in accordance BS EN 1995-1-1 or appropriate load/span tables published by TRADA in support of building regulations
- be from regularised timber, dry graded to BS 4978 and marked 'DRY' or 'KD' where softwood is used internally
- have I-joists or metal web joists specified in accordance with the manufacturer's recommendations and not used where any part of the joist is exposed to external conditions



- have joists which are sized and spaced in accordance with the design and at a maximum of 600mm centres
- be temporarily covered to prevent wetting, unless the waterproofing is to be installed immediately
- be level and, where necessary, using hard packing such as tiles or slates bedded in mortar to adjust joists (loose or soft packing, including timber, should not be used)
- formed with one of the materials listed in Table 1.

**Table 1:** Materials used for decks

Material	Thickness of deck (mm)	
	450mm joist centres	600mm joist centres
Plywood to BS EN 636, Class 3	15	18
Oriented strand board, type OSB3	15	18
Pretreated timber planking, tongue and grooved (close boarded timber) Maximum board width 100mm	19	19

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

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

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

Decking boards should be specified and fixed in accordance with:

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

### Joist hangers, straps and strutting

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

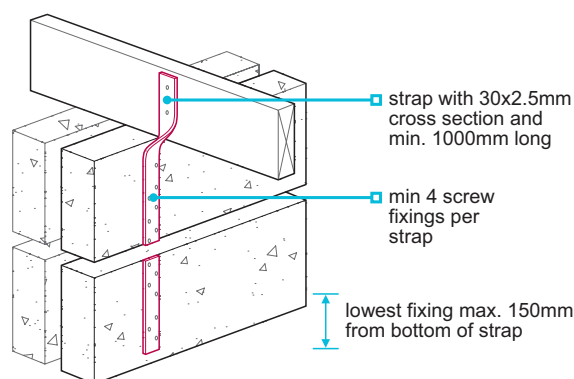
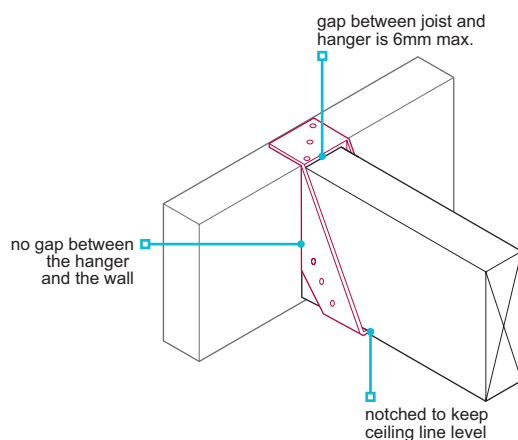
Mild steel straps and fixings should be protected against corrosion in accordance with BS EN 845-1.

Joist hangers should be:

- in accordance with BS EN 845
- the correct size for the timber joist or trimmer
- fixed in accordance with the design.

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

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



Strutting should be provided to prevent excessive movement, and::

- be either herringbone type (timber 38mm x 38mm), solid blocking (38mm thick timber x 0.75 depth of joist) or proprietary steel strutting
- not prevent cross ventilation in cold deck roofs.

**Table 2:** Spacing for strutting

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

### Installing timber substrates

When installing timber substrates:

- conditions should be dry, and materials protected from wetting until the roof is complete
- the area of deck installed should be of a size which can be quickly covered in the event of rain
- joints in sheet materials which are precovered or coated should be sealed immediately after fixing
- materials that have been damaged or adversely affected by moisture should be discarded.

Plywood and oriented strand board should:

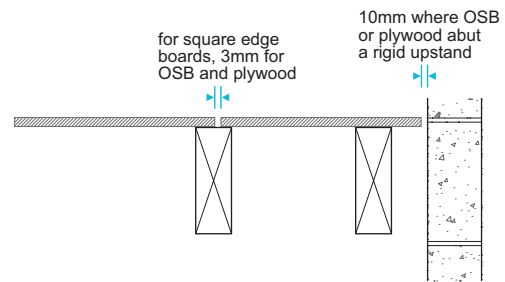
- have tongued and grooved boards installed with the long edge at right angles to the joists, and short edges supported on a joist or noggings
- have a maximum movement gap between boards of 3mm for square edge boards
- have a minimum movement gap of 10mm where boards abut a rigid upstand
- be supported on noggings where the edges of boards situated along the roof perimeter do not coincide with joists
- be fixed at a maximum of 100mm centres (unless the design specifies closer)
- be fixed with flat-headed ring shank nails (50mm long x 3mm for plywood, 3mm x 2.5 x board thickness for OSB).

OSB should be:

- installed over supports in the direction indicated on the boards, with the stronger axis installed at right angles to the supporting joists
- fixed a minimum of 9mm from the edge of the board.

Softwood tongued and grooved boarding should be:

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

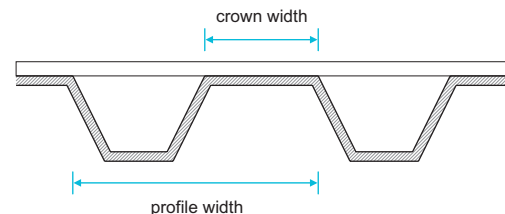
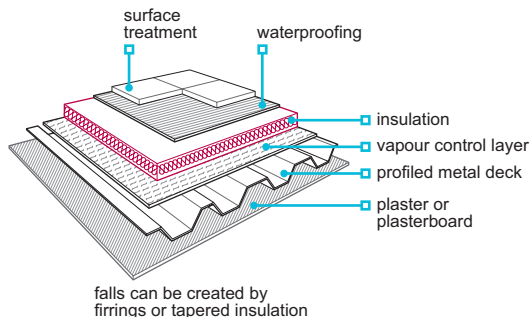


### 7.1.5 Profiled metal decks

**Profiled metal flat roofs and balconies shall form a satisfactory substrate for the waterproofing system.**

Profiled metal flat roofs should:

- be constructed to ensure they achieve the required strength and durability, and be checked for conformity with the design upon delivery
- be suitably stored to prevent damage
- comply with the manufacturer's load and span tables and the relevant applied safety factor
- resist loads in accordance with BS EN 1991-1-4 and be fixed in accordance with the manufacturer's instructions
- be galvanised steel to BS EN 10147 or aluminium to BS EN 485-2 and used in accordance with BS EN 1993-1-3
- have a crown which is a minimum of 50% of the profile width (for bonded systems)
- have a crown which is a minimum of 45% of the profile width (for mechanically fixed systems)
- be side stitched to ensure it performs as a continuous plane layer (unless the manufacturer recommends otherwise)
- be fixed and installed in accordance with the design and variations approved by the designer
- be adequately protected from construction loads
- be of suitable quality and finish before the waterproofing and insulation system is installed.



### 7.1.6 Concrete decks

**Concrete flat roofs and balconies shall form a satisfactory substrate for the waterproofing system.**

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

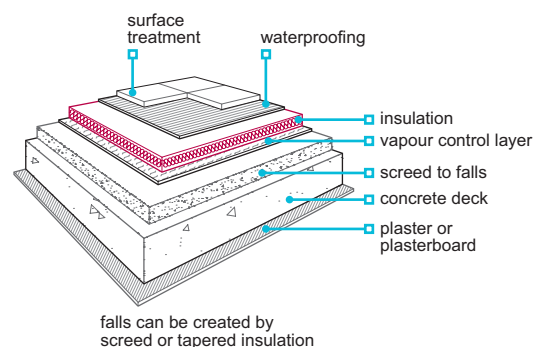
In-situ reinforced concrete decks should:

- be formed using a mix which has low shrinkage characteristics
- have accurately constructed and suitably supported formwork

Precast concrete decks should:

- be installed on an even and true supporting structure
- have a minimum 90mm bearing (unless the design specifies a smaller dimension)
- have allowance for continuity or anti-crack reinforcement
- have allowance for movement approximately every 15m and at abutments
- be installed to provide an even surface
- be grouted, as specified in the design.

- be protected until adequately cured and dried (permanent waterproofing should not be installed until the deck has fully dried).



### 7.1.7 Thermal insulation and vapour control

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

**Thermal insulation, vapour control and ventilation shall ensure satisfactory performance, and prevent the formation of condensation which could adversely affect the construction.**

Insulation should be:

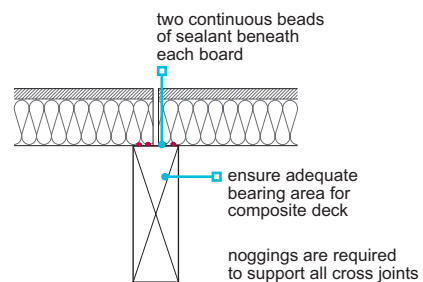
- bonded or mechanically fixed in accordance with the manufacturer's recommendations; where mechanically fixed, it should be installed using fixings of sufficient length to ensure adequate penetration into the supporting structure
- kept dry and installed in quantities which can be quickly covered if it rains (to aid bonding and to avoid trapping moisture).

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

- an effective vapour control layer at ceiling level
- an unobstructed 50mm ventilation space above the insulation
- adequate cross ventilation (openings at both ends of each joist void).

Composite decks should:

- have two beads of sealant along each board joint at the foil underface (to maintain the integrity of the vapour control layer).



Insulation for inverted roofs should be:

- extruded polystyrene (XPS), extruded polystyrene with a cementitious surface or suitably assessed in accordance with Technical Requirement R3
- suitable for external use

Vapour control layers should be provided to warm roofs, and:

- include at least one layer of bitumen roofing membrane (S2P3) below the insulation, fully bonded or mechanically fixed to the structural deck as appropriate, or a suitable self-adhesive or torch-on membrane.
- sealed at laps to the waterproofing, at the perimeter and at each penetration, e.g. at outlets and pipes (where the roof is a single-ply system, the vapour control is generally not sealed to the waterproofing).
- suitable for the weight of the ballast and able to withstand anticipated traffic
- protected by a geo-textile layer to prevent fines from reaching the membrane surface.
- where a mechanically fixed system is used, the vapour control layer should consist of suitable polyethylene sheet sealed at all laps.

### 7.1.8 Waterproofing and surface treatments

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

- a) installation of waterproofing
- b) waterproofing systems
- c) surface treatments.

#### Installation of waterproofing

Prior to the waterproofing being installed:

- the structure and receiving surface should be checked and approved by the waterproofing contractor
- the manufacturer's recommendations for preparation, including priming upstands, roof outlets, etc. should be followed to achieve a satisfactory bond with the waterproofing
- the surface should be even and dry and nails should be punched below the surface
- the manufacturer's recommendations for conditioning, and unrolling in advance of laying, should be followed
- concrete and screed surfaces should be adequately dry.

Environmental conditions should be suitable for installing waterproofing. Issues to be taken into account include the following:

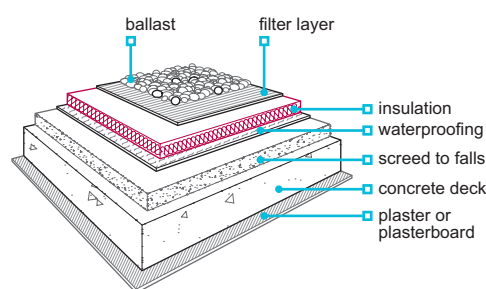
- Sheet membranes should not be installed or handled when the air temperature is 5°C or less (unless otherwise agreed with the manufacturer).
- Self-adhesive reinforced bitumen membranes should not be installed below 10°C, and the manufacturer's recommendations should be followed.
- Membranes should not be installed on damp or frosted surfaces or when any rain, sleet or snow is falling.

Waterproofing should be:

- installed in accordance with the design and the manufacturer's recommendations
- installed by a specialist roofing contractor approved by the manufacturer, where a proprietary system is used
- installed by the same contractor who installs the vapour control layer, insulation and surface finish
- checked by the contractor to ensure that the deck and insulation boards are waterproofed at the end of each day, and before inclement weather
- installed so that membrane laps near outlets do not impede drainage
- installed so that successive layers do not trap water.

Inverted roofs should:

- not be used for slopes greater than 10°
- be designed to support the loads, particularly from ballast needed to retain the insulation material
- be ballasted to the depth specified in the design
- be ballasted using paving slabs or minimum 19mm diameter rounded pebbles.



## Waterproofing systems

### Reinforced bitumen membrane

Reinforced bitumen membrane should be high performance and reinforced with polyester reinforcement, e.g. type 5U, 5B/180, 5E/250 to BS 747 (type 5 reinforced bitumen membranes are colour-coded blue for identification).

**Table 3:** Reinforced bitumen membrane used in warm roof construction

Insulation material	First/preparatory layer	Second layer/underlay	Final layer/cap sheet
Rigid urethane foam (RUF) boards – polyurethane (PU) and polyisocyanurate (PIR).	Type 3G perforated layer (loose laid and lapped, to produce partial bonding).	S2P3	S5P5 with either integral mineral finish or separate solar protection.
		Elastomeric underlay achieving S2P3	Elastomeric capsheet achieving S2P3, mineral surfaced where exposed.
Compressed cork, rock fibre or glass fibre boards, cellular glass slabs, perlite boards or composite products.	S2P3 (fully bonded in accordance with BS 8217).	S2P3	S5P5 with either integral mineral finish or separate solar protection.
		Elastomeric underlay achieving S2P3	Elastomeric capsheet achieving S2P3, mineral surfaced where exposed.

**Table 4:** Reinforced bitumen membrane for an inverted warm roof

Deck material	First/preparatory layer	Second layer/underlay	Final layer/cap sheet
Concrete, or concrete with sand/cement screed.	Type 3G perforated layer (loose laid and lapped, to produce partial bonding).	S2P3	S5P5 with either integral mineral finish or separate solar protection.
		Elastomeric underlay achieving S2P3	Elastomeric capsheet achieving S2P3, mineral surfaced where exposed.

Torching onto insulation boards, except rockwool or perlite, is not acceptable.

Elastomeric (i.e. SBS polymer-modified) bitumen membranes offer increased extensibility and flexibility, especially at low temperatures, and can provide a longer service life.

### Mastic asphalt

Mastic asphalt should be:

- to BS 6925, type 988 T25, 20mm thick on the flat and installed on black sheathing felt
- (for green roofs) 3 x 10mm layers on horizontal surfaces and 2 x 10mm layers on vertical surfaces, for green roofs.

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

### Thermoplastic single-ply membranes

Thermoplastic single-ply membranes, including materials such as PVC (polyvinyl chloride) and TPO (thermoplastic polyolefine) should be:

- either bonded to the insulation, mechanically fixed to the deck or loose-laid, and sealed and ballasted in accordance with the manufacturer's recommendations
- welded at laps using either hot air or a specific solvent
- assessed in accordance with Technical Requirement R3.

### Surface treatments

Surface treatments should be in accordance with Table 5.

**Table 5:** Surface treatments for flat roofs

	Access for maintenance only – roofs up to 10°	Access roof, walkway or terrace deck
Reinforced bitumen membranes	<ul style="list-style-type: none"> <li>■ Mineral surfaced capsheets (e.g. type S5P5).</li> <li>■ Reflective stone chippings<sup>(1)</sup>, bedded in a dressing compound.</li> <li>■ A suitable thickness of washed, rounded 20-40mm shingle ballast laid loose.</li> </ul>	<ul style="list-style-type: none"> <li>■ Precast semi-porous concrete tiles bedded in bitumen or approved adhesive.</li> <li>■ Precast concrete proprietary paving slabs on supports or sand/cement blinding<sup>(2)</sup>.</li> <li>■ Proprietary timber decking systems<sup>(3)</sup>.</li> </ul>
Mastic asphalt	<ul style="list-style-type: none"> <li>■ Reflective stone chippings<sup>(1)</sup>, bedded in a bitumen based compound.</li> <li>■ A solar reflective paint approved by the MAC.</li> </ul>	<ul style="list-style-type: none"> <li>■ Precast semi-porous concrete tiles bedded in bitumen or approved adhesive.</li> <li>■ Precast concrete proprietary paving slabs on supports or sand/cement blinding<sup>(2)</sup>.</li> </ul>
Thermoplastic single-ply membranes	<ul style="list-style-type: none"> <li>■ Supplementary solar reflective coatings or other finishes not required.</li> <li>■ Where laid loose, membranes can be ballasted with a suitable thickness of washed, rounded 20-40mm shingle installed on a non-woven polymeric protection layer.</li> </ul>	<ul style="list-style-type: none"> <li>■ Proprietary flexible, non-slip walkway sheets or tiles, compatible with the membrane product.</li> <li>■ Precast concrete proprietary paving slabs on adjustable supports or suitable non-woven polymeric protection layer.</li> <li>■ Proprietary timber decking systems with bearers set on an additional membrane or suitable non-woven polymeric protection layer.</li> </ul>
Cold applied liquid roofing membranes	<ul style="list-style-type: none"> <li>■ Products generally do not require supplementary solar reflective coatings or other finishes.</li> </ul>	<ul style="list-style-type: none"> <li>■ Proprietary surface treatments compatible with the membrane product.</li> <li>■ Proprietary flexible, non-slip walkway tiles, compatible with the membrane product.</li> <li>■ Precast concrete proprietary paving slabs on supports on a suitable non-woven polymeric protection layer.</li> <li>■ Proprietary timber decking systems with bearers set on additional pads on a suitable non-woven polymeric protection layer.</li> </ul>
Hot melt rubberised bitumen systems	<ul style="list-style-type: none"> <li>■ Use in inverted/buried roof membrane applications or in roof garden/green roofs.</li> <li>■ Must be protected with a substantial reinforced bitumen membrane protection sheet.</li> <li>■ All upstands/details where the membrane becomes exposed need a protective membrane to be applied to prevent UV degradation.</li> </ul>	

#### Notes

- 1 Loose surface finishes should be prevented from being removed by weather and discharged into gutters and drain pipes. Chippings should be a minimum of 12.5mm limestone or white spar, not pea gravel.
- 2 Cement/sand blinding should be installed on two layers of waterproof building paper or two layers of 1000 gauge polyethylene separating membrane. Slabs should be kept back 75mm at perimeters and a 25mm movement gap incorporated for every 9m<sup>2</sup> of paving.
- 3 Timber decking systems should only use compatible preservative treatments. The undersides of the bearers should have large, smooth contact areas, with no sharp edges or corners.

### 7.1.9 Green and proprietary roofs

**Green roofs and proprietary roofing systems shall be suitable for their intended use.**

Green roofs should:

- be clearly defined by the supplier as a complete system
- include waterproofing suitable for use in the green roof system.
- have supporting data to demonstrate compliance with relevant standards

Rainwater outlets should be accessible and have a visible inspection hatch.

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

The complete green roof should be installed by a contractor trained and approved by the system supplier.

Waterproofing for green roofs should be either:

- reinforced bitumen membrane
- mastic asphalt
- single-ply membrane, or
- a liquid applied system.

The system should be installed in accordance with the design and the membrane manufacturer's recommendations.

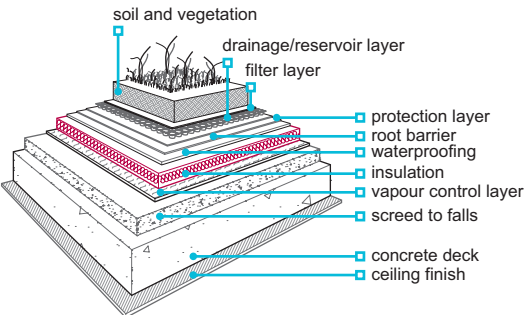
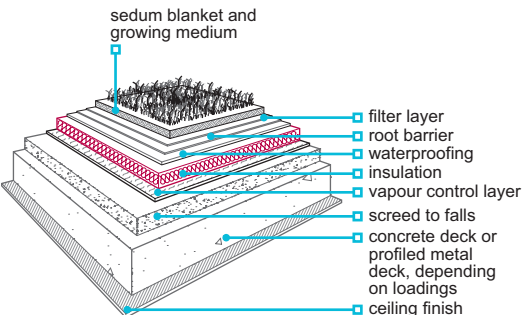
Before covering:

- the membrane should be visually inspected and electronically tested for waterproofing integrity, faults rectified, and retested before further layers are placed: the results should be made available to NHBC
- any damage to the vapour control layer should be repaired, using a full width section of membrane.

Other issues that should be taken into account when installing green roofs include the:

- provision of root barriers
- height of upstands in relation to soil height and flashings
- protection, reservoir and filter layers
- moisture control of the soil.

**Table 6:** Principles for green roofs

	Intensive	Extensive
		
<b>Features</b>	<ul style="list-style-type: none"> <li>■ Provides a normal garden environment.</li> <li>■ Uses natural topsoil 150mm deep and 'normal' plants.</li> <li>■ Requires regular 'intensive' maintenance, i.e. similar to a normal garden.</li> <li>■ Requires protection of the waterproofing membrane from possible damage during maintenance of the garden, e.g. from weeding/planting.</li> </ul>	<ul style="list-style-type: none"> <li>■ Requires minimal maintenance, i.e. annual attention.</li> <li>■ A sedum blanket contains the plants.</li> </ul>
<b>Structure</b>	<ul style="list-style-type: none"> <li>■ 20° maximum roof pitch, accounting for full weight of wet soil (generally supported by a concrete deck).</li> </ul>	<ul style="list-style-type: none"> <li>■ 45° maximum roof pitch deck (profiled metal decks may be an alternative to concrete, depending on loadings).</li> </ul>
<b>Drainage falls</b>	<ul style="list-style-type: none"> <li>■ 1:60min.</li> </ul>	
<b>Moisture control</b>	<ul style="list-style-type: none"> <li>■ Irrigation system may be required.</li> <li>■ Can be designed to retain some water in order to maintain the vegetation and to reduce run off.</li> </ul>	
<b>Vapour control layer</b>	<ul style="list-style-type: none"> <li>■ Fully bonded polyester-reinforced RBM (S2P3), a suitable self-adhesive membrane or torch-on membrane.</li> </ul>	
<b>Insulation</b>	<ul style="list-style-type: none"> <li>■ Insulation material should have adequate compressive strength to withstand likely applied loads. Where the insulation is above the weatherproofing, only extruded polystyrene (XPS) should be used.</li> </ul>	
<b>Roots</b>	<ul style="list-style-type: none"> <li>■ A root resistant element, such as a copper foil or Preventol treatment, is required above the waterproofing membrane. Alternatively, an approved root resistant waterproofing membrane can be used.</li> </ul>	
<b>Protection and filter layers</b>	<ul style="list-style-type: none"> <li>■ A protection layer (or board) should be placed above the waterproofing membrane.</li> <li>■ A filter layer should be placed above the reservoir layer.</li> </ul>	<ul style="list-style-type: none"> <li>■ In accordance with the manufacturer's recommendations.</li> </ul>

### 7.1.10 Detailing of flat roofs

**Flat roofs shall be detailed to ensure satisfactory performance.**

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

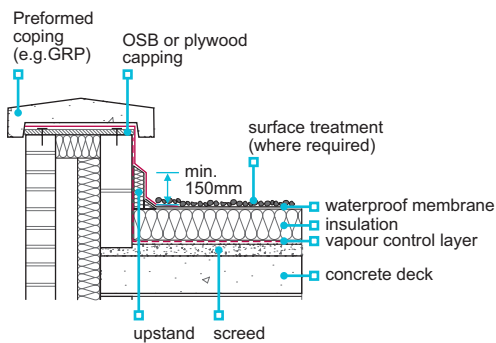
#### Concrete decks

##### Upstands

Upstands may be fixed to the wall.

Upstands should be a minimum of 150mm high.

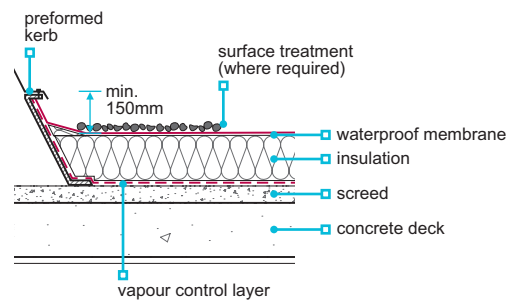
Similar details apply to inverted roofs with concrete decks.



##### Skirting to rooflights or ventilator kerb

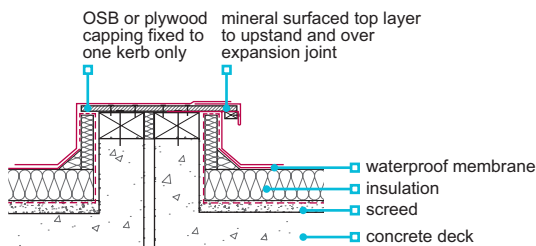
Similar details apply to inverted roofs.

Allow for thickness of ballast to achieve a minimum 150mm upstand.



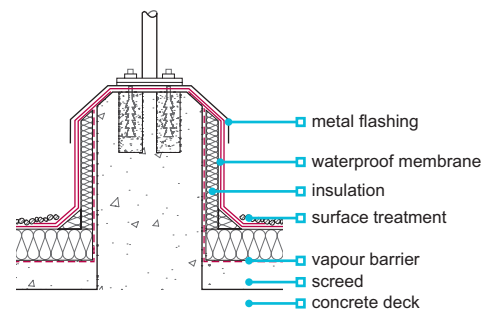
##### Twin-kerb expansion joint

Similar details apply to inverted roofs.



##### Handrail fixing

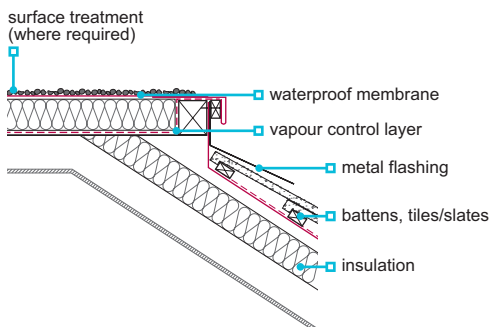
An upstand should be formed in concrete roofs.



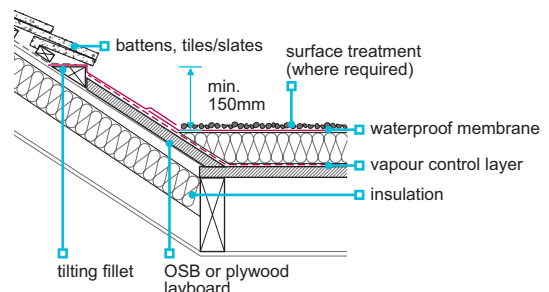
#### Timber decks

##### Mansard edge

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

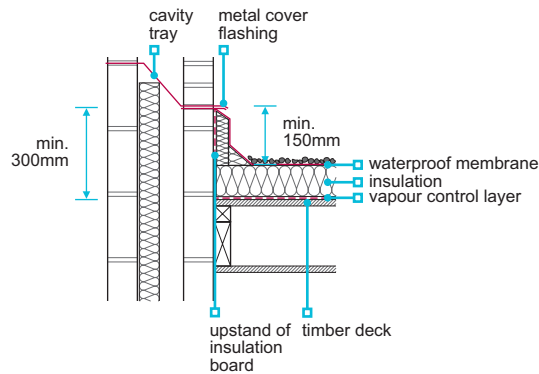


##### Pitched roof abutment

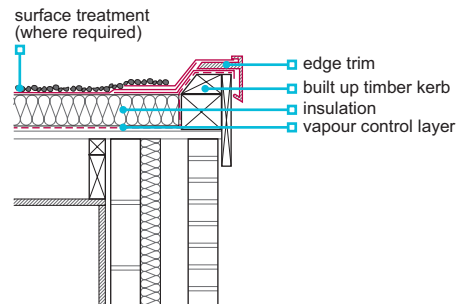


**Independent skirting detail**

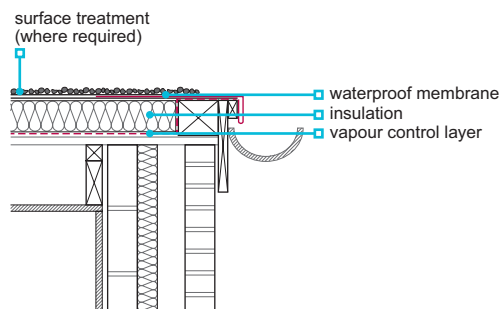
Upstand should be kept separate from wall, and allow for movement. Upstand should be a minimum of 150mm high. Similar details apply to cold deck timber roofs.

**Verge detail**

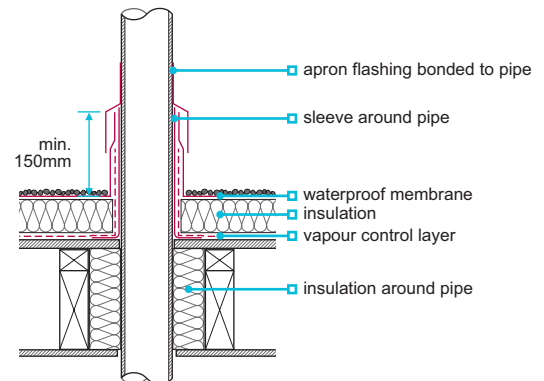
Similar details apply to inverted decks.

**Welted drip to external gutter**

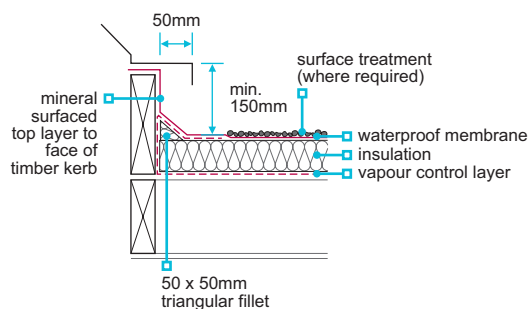
Inverted timber decks should be detailed to avoid insulation being lifted by wind suction and an alternative detail used.

**Pipe passing through roof**

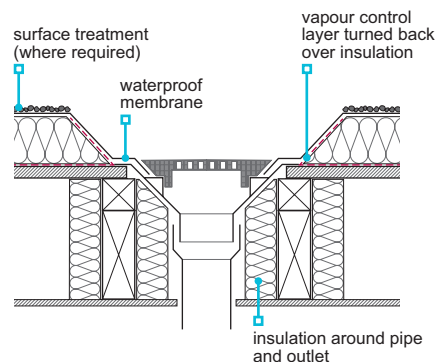
Vapour control layer should be bonded to the waterproofing. Detailing of upstand and flashing is similar for all roofs.

**Upstand to ventilator or rooflight kerb**

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

**Rainwater outlet**

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

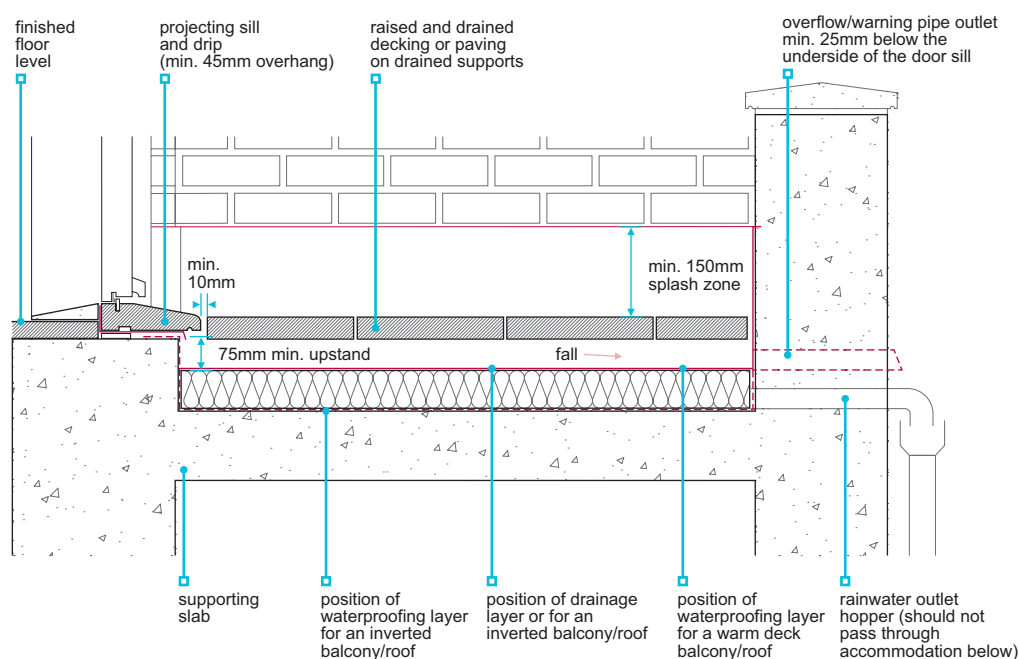


### 7.1.11 Accessible thresholds

**Accessible thresholds shall be protected by adequate weatherproofing and drainage.**

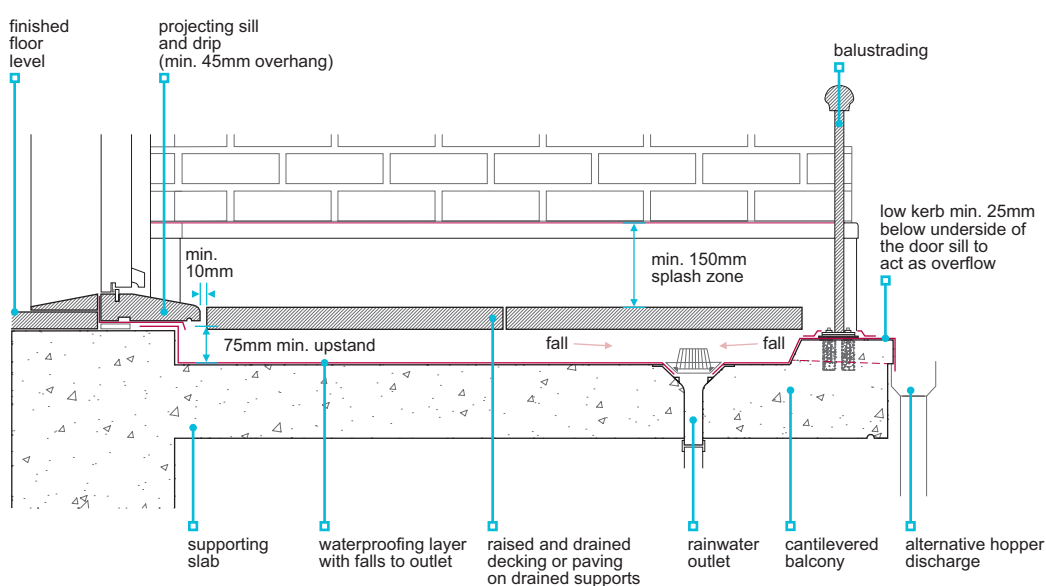
Accessible thresholds should:

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



Note

The drainage layer is not necessarily the waterproofing layer (i.e. the top of the insulation of an inverted roof should be considered as the drainage layer).



Waterproofing layers should:

- prevent ponding and associated stagnant water
- generally fall a minimum of 1:80 away from the building to the rainwater outlet(s)
- be subject to specific third-party assessment where falls are zero degrees
- be designed to ensure that where falls are towards or parallel to the building, blockage of the outlet(s) cannot cause flooding to the building

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

- at least one outlet and an overflow with the capacity of the outlet
- at least one outlet chute and hopper (sized to serve both the discharge and overflow capacities)

- be fully protected from direct trafficking
- be capable of withstanding point loads from supports to decking or paving
- be UV resistant or fully protected from daylight.

- two outlets connected to independent downpipes, or
- setting the balcony kerb a minimum of 25mm below the door threshold.

Outlets beneath decking or paving should be clearly identifiable and accessible for maintenance.

To ensure adequate drainage:

- gaps should be provided between decking and paving at balcony perimeters
- minimum 10mm gaps should be provided between individual units of decking or paving and the threshold sill, perimeter walls and kerbs

- spacers and supports which raise decking or paving should not obstruct the flow of rainwater to outlet(s).

A splash barrier should be provided:

- to ensure water does not reach any part of the wall that could be adversely affected by the presence of moisture
- to a minimum of 150mm above the decking or paving

- using an impervious wall finish or cladding, or extending the waterproofing layer to form an upstand with cover flashings and cavity trays.

### 7.1.12 Drainage

**Flat roofs and balconies shall have adequate and effective rainwater drainage to a suitable outfall. Issues to be taken into account include:**

- falls
- outlets.

The principles for drainage given in Chapter 7.2 'Pitched roofs' are applicable to flat roofs and balconies.

Rainwater disposal from roofs and balconies 6m<sup>2</sup> or less in area should be considered. Where run-off may cause damage or staining to a façade, or damage to landscaping, then rainwater gutters and downpipes should be provided. The cumulative effect of water discharging from multiple balconies in vertical alignment should be taken into account.

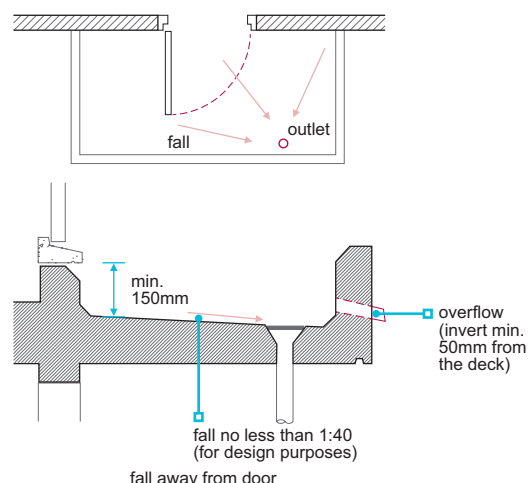
Open slatted balcony decking should drain away from the home.

### Falls

Flat roofs and balconies should:

- be designed with a fall no shallower than 1:40 to ensure a finished fall of no less than 1:80, unless a detailed analysis which includes overall and local deflection is used as justification
- have a minimum finished fall of 1:80 (green roofs 1:60), unless it has a metal sheet covering
- account for deflection in the structural design where falls are achieved using screeds (particularly on large roofs).

Where decking or paving is installed above the waterproofing and is less than 150mm below the sill, it should be of a type and design that prevents a build-up of standing water.



Where tapered insulation is used:

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

### Metal sheet roofs

Flat roofs with metal sheet roof coverings should be designed with a fall of no less than 1:30 to ensure a finished fall of no less than 1:60.

### Concrete roofs

Concrete roofs can be finished with sand/cement screed topping set to achieve the falls. Screed finishes should be:

- free from ridges and indentations
- finished with a wooden float to provide a smooth, even surface for the vapour control layer and waterproof finish
- installed by specialist contractors where a lightweight finish is used, and have a topping of 1:6 (cement:sand), 13mm thick
- to the minimum thickness in Table 7 where a cement/sand screed, 1:4 (cement:sand) is used
- suitably dry and primed to receive the waterproofing system.

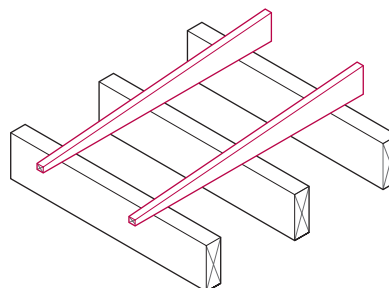
**Table 7:** Minimum screed thicknesses

Location of screed	Nominal thickness (mm)
Bonded monolithically to in-situ or precast concrete	40 (25 minimum.)
Unbonded (on separating layer)	70 (50 minimum.)

### Timber roofs

Furring pieces should be:

- used to form falls, unless the design specifies a sloping joist or ceiling
- of the sizes given in Table 8 where installed across the joists.



**Table 8:** Size of furring pieces used to form cross falls

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

### Rainwater outlets

Rainwater outlets should:

- be of the size and number required to deal with the expected rainfall intensity in accordance with BS EN 12056-3
- be recessed to facilitate the free flow of water
- be accessible for maintenance.

Where a flat roof or balcony has an upstand on all sides, drainage should consist of either two outlets or one outlet plus an overflow. The overflow should be:

- provided through parapet walls or perimeter upstands
- sized and positioned to prevent water from entering the building
- of higher capacity than the combined capacity of the other outlet(s).

**7.1.13 Guarding to balconies***Also see: Chapter 6.1*

**Balconies, and flat roofs to which persons have regular access other than for maintenance, shall be adequately guarded to minimise the risk of falling. Issues to be taken into account include:**

- a) guarding
- b) stability of guarding
- c) strength and movement of masonry balcony walls
- d) durability and fixing of balustrading and guard rails
- e) access for maintenance.

**Guarding**

Guarding should:

- not be easily climbed
- be to an adequate height
- be toughened glass, laminated glass or glass blocks where glazed balustrading is used
- not be fixed through the waterproofing unless suitable precautions are taken.

**Stability of guarding**

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

In balcony walls (especially long balconies) the structural stability should be checked, as the DPC at the base of the wall can create a slip plane that can seriously limit the ability of the wall to resist horizontal forces. In such cases, it may be necessary to incorporate a ring beam or other support to ensure stability.

**Strength and movement of masonry balcony walls**

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

- walls should incorporate strengthening as required by the design
- movement joints should be provided in accordance with the design
- copings should be firmly fixed.

**Durability and fixing of balustrading and guard rails**

Balustrading and guard rails should be of adequate durability and fixed securely. Also see Clause 7.1.4(a).

**Access for maintenance**

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

# 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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### 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 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.

### 7.2.3 Design of pitched roofs

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:

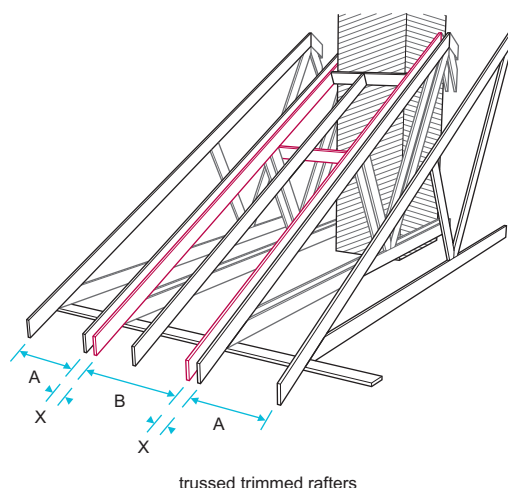
- $X$  = distance between centres of trussed trimmed rafters and the adjacent trussed rafter
- $A$  = design spacing of trussed rafters
- $B$  = nominal width of opening.

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.



**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.

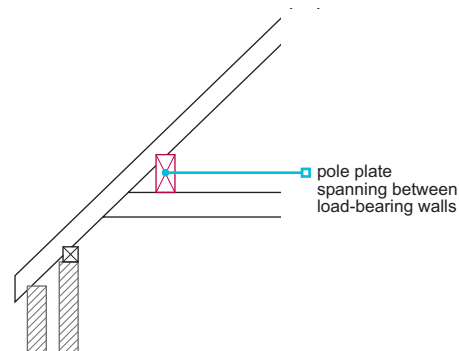
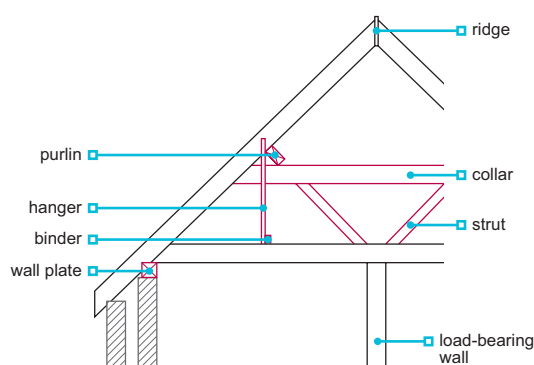
### Traditional cut roofs

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

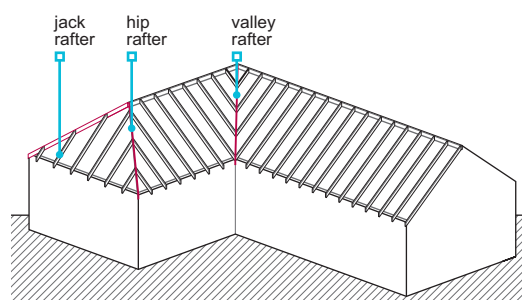
Member	Notes
Valley rafter	Provides support for loads from both sections of the roof and should: <ul style="list-style-type: none"> <li>■ be larger than ordinary rafters to take the additional load</li> <li>■ provide full bearing for the splay cut of jack rafters</li> <li>■ be provided with intermediate 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



### 7.2.4 Protection of trusses

Also see: *International Truss Plate Association Technical Handbook*

#### 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).

### 7.2.5 Durability

#### 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.

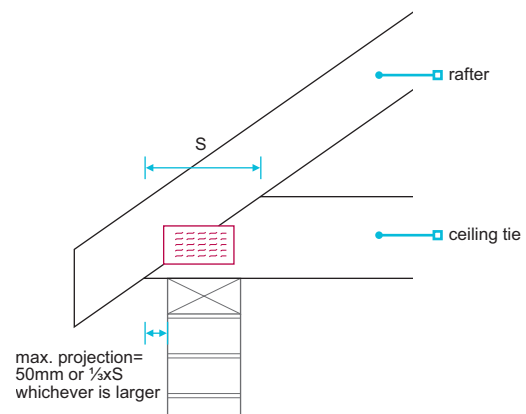
### 7.2.6 Wall plates

#### 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, 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
- 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 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).

### 7.2.7 Joints and connections

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

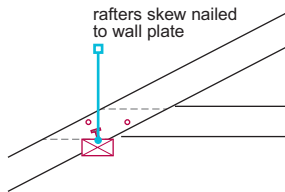
Members should:

- 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:

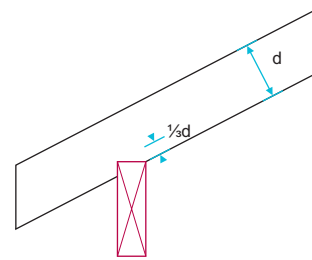
#### Rafters to ceiling joists using a nailed lapped joint

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



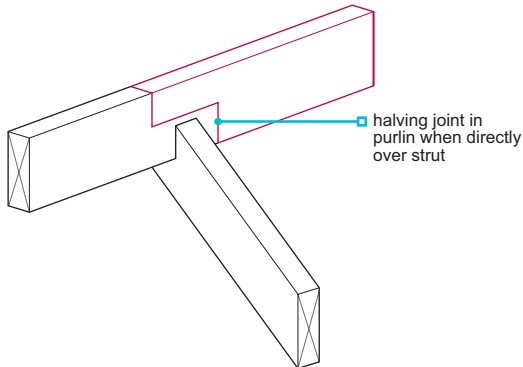
#### Rafter to purlin

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



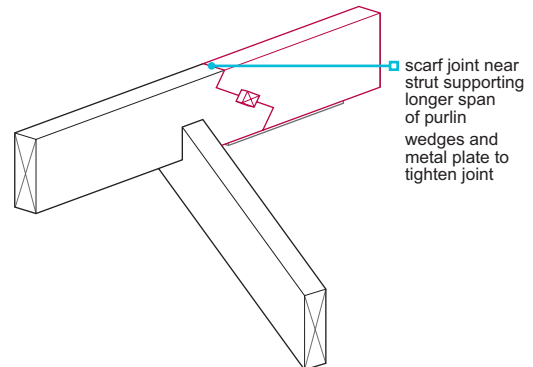
#### Purlin connections

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

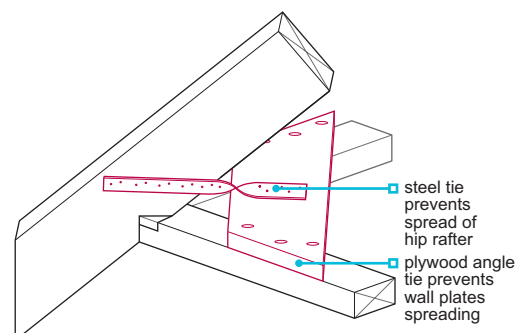
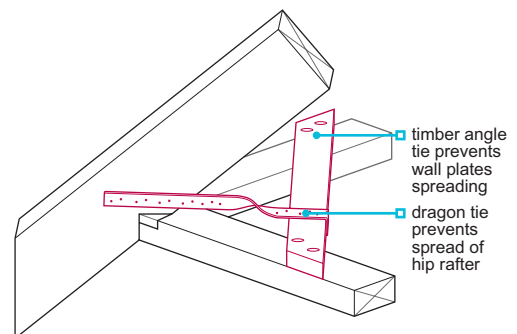
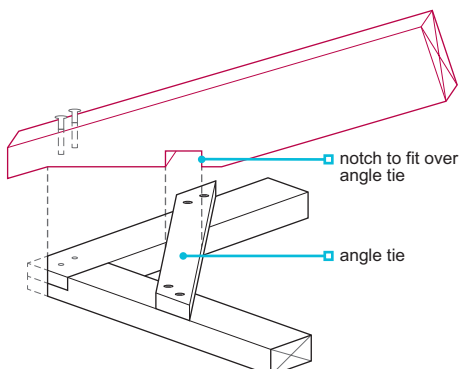
Used to support the long span of the purlin.



#### 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.



### 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.

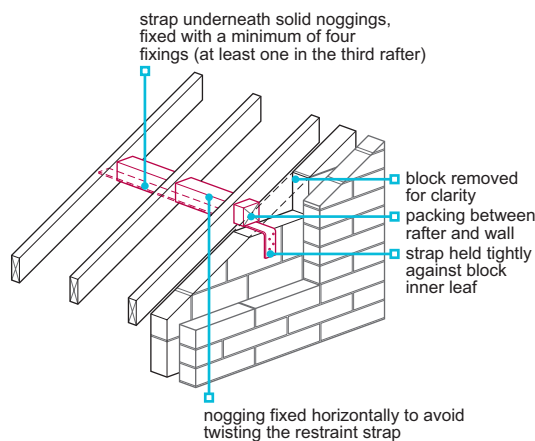
Lateral restraint straps should be located:

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

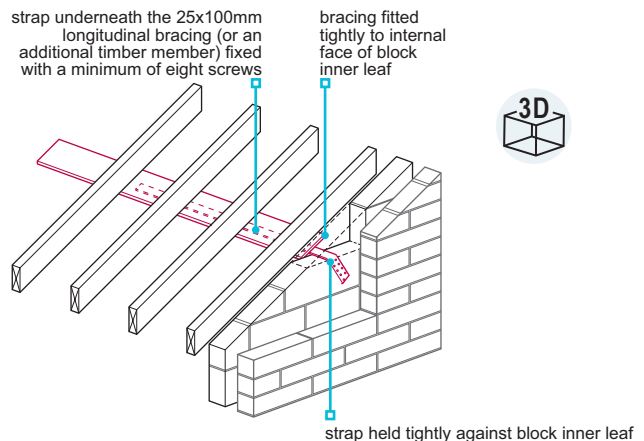
Lateral restraint straps should be fixed to the roof structure by either:

- fixing to solid noggings using four 50mm minimum x 4mm steel screws or four 75mm x 4mm (8SWG) round nails, with one fixing in the third rafter (Figure 1), or
- fixing to longitudinal bracing members using eight 25mm x 4mm steel screws evenly distributed along the length of the strap (Figure 2). 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 1**



**Figure 2**



Lateral restraint straps should be:

- ordered and supplied according to the design, i.e. 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 - Tables A.1 and A.2 (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 in accordance with Technical Requirement R3 and installed in accordance with the manufacturer's recommendations
- 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 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.

### 7.2.9 Bracing for trussed rafter roofs

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 4, is generally acceptable, where the home:

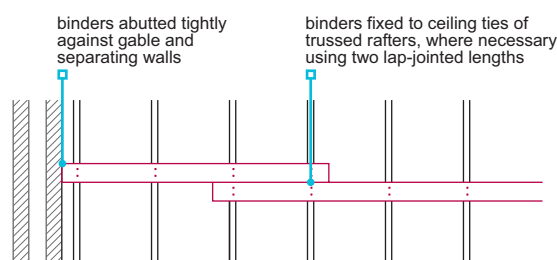
- has a rectangular roof (including hip ends) and is either a duo-pitched or a mono-pitch structure
- is not taller than 8.4m (to the underside of the ceiling tie)
- is braced in accordance with this chapter
- is braced according to the conditions of the site and in accordance with the design
- does 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 4:** 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:

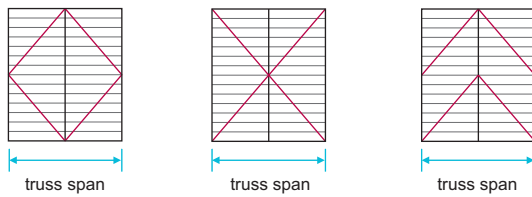
- diagonal and longitudinal bracing should be provided at rafter level (this may be omitted where rigid sarking boards are used, e.g. chipboard, plywood or OSB, which are fixed to each trussed rafter with 3mm x 50mm galvanised round wire nails at 200mm spacing)
- diagonal and chevron bracing should pass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

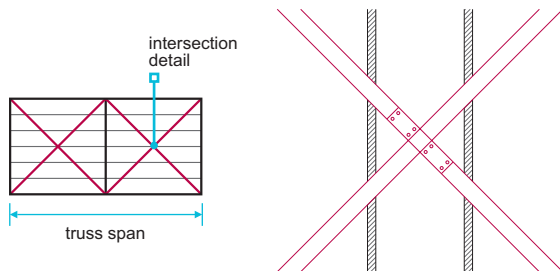
Applicable to all trussed rafter roofs unless rigid sarking, such as timber boarding or plywood, is used.

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

### Bracing for roofs that are approximately square



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

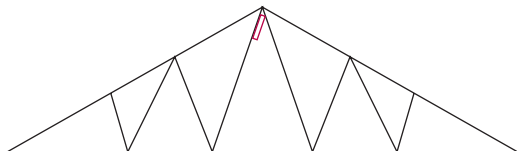


Intersection details should be formed by:

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

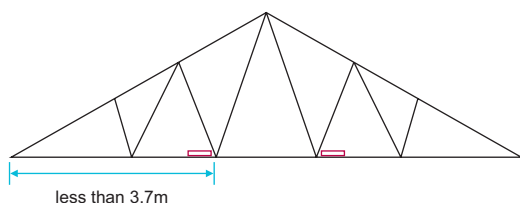
### Longitudinal bracing member at ridge node point

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



### Longitudinal binders at ceiling node points

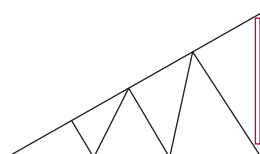
Applicable to all ceiling node points. Not necessary where the spacing between braced nodes is less than 3.7m.



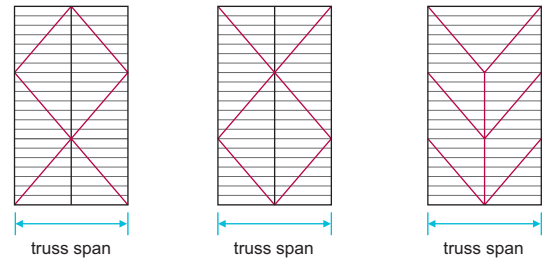
### Diagonal bracing to end vertical of mono-pitch trusses

Applicable where the truss is not restrained by:

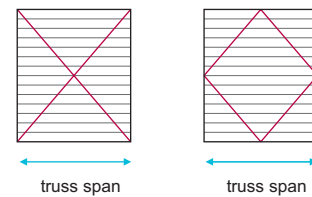
- a masonry wall, or
- cladding, i.e. plywood.



### Bracing for larger roofs



### Bracing for mono-pitch trusses

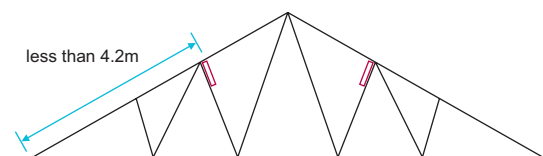


- nailing, using a minimum of four 35mm x 65mm galvanised round wire nails to each side of the intersection, with nails driven through bracing and clenched over.

### Longitudinal bracing member at rafter node point

Applicable to all rafter node points. Not necessary where:

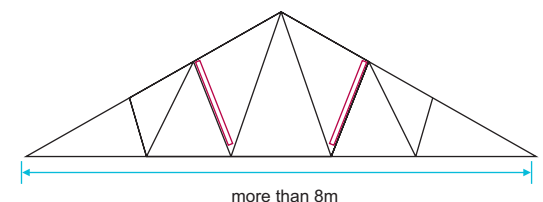
- spacing between braced nodes is less than 4.2m, or
- rigid sarking, such as OSB, timber boarding or plywood sheathing, is used.



### 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.



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

**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 5:** 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 (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.

### 7.2.12 Access

*Also see: Clause 7.2.15*

**Roof voids shall be provided with suitable access.**

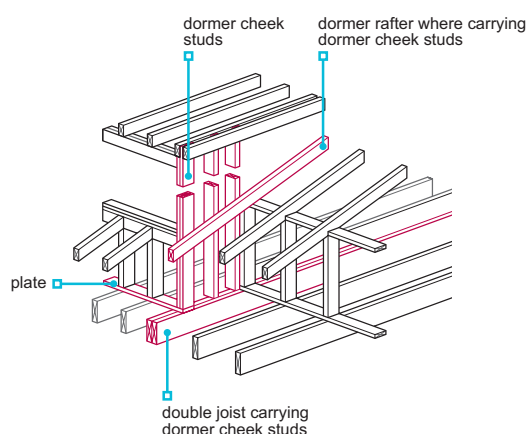
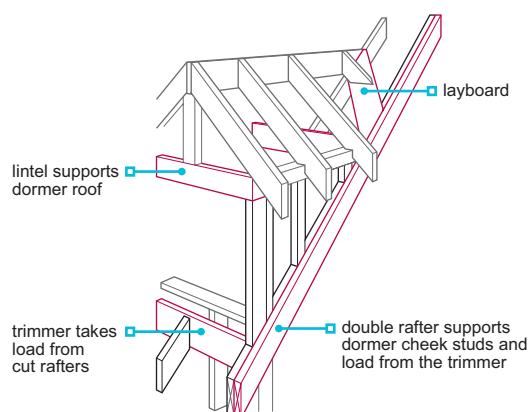
Access should:

- 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.

### 7.2.13 Dormer construction

**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.

### 7.2.14 Underlay and sarking

**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 with underlay is recommended.

**Table 6:** 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:

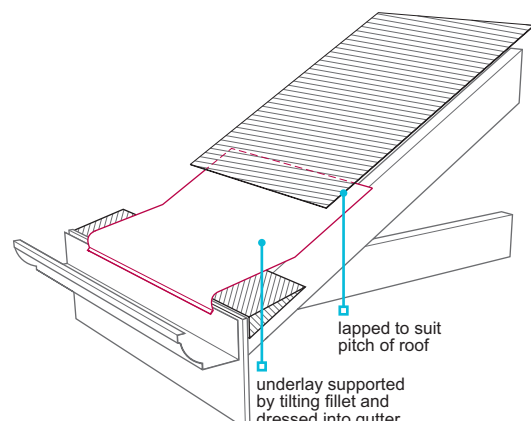
- be provided to all tiled roofs
- where it is above rigid sarking (fully supported), be of low vapour resistance, i.e. less than 0.25MNs/g (where the underlay is highly vapour-resistant, increased ventilation to the roof space or between the underlay and sarking should be provided as necessary)
- where 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
- be draped to allow water to drain behind the tiling battens.

**Table 7:** 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).



### 7.2.15 Ventilation, vapour control and insulation

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

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

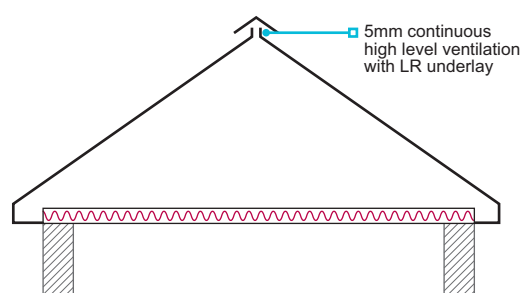
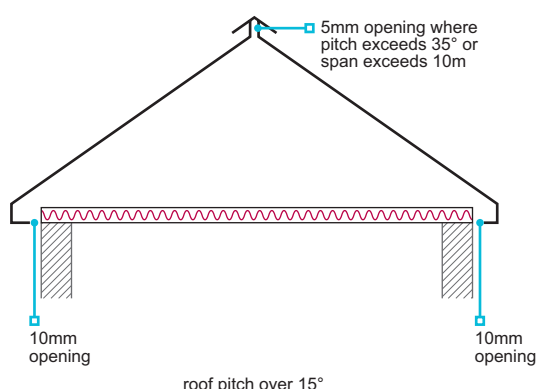
#### Ventilation, vapour control and insulation

To provide adequate ventilation and to avoid condensation in roof voids, 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.

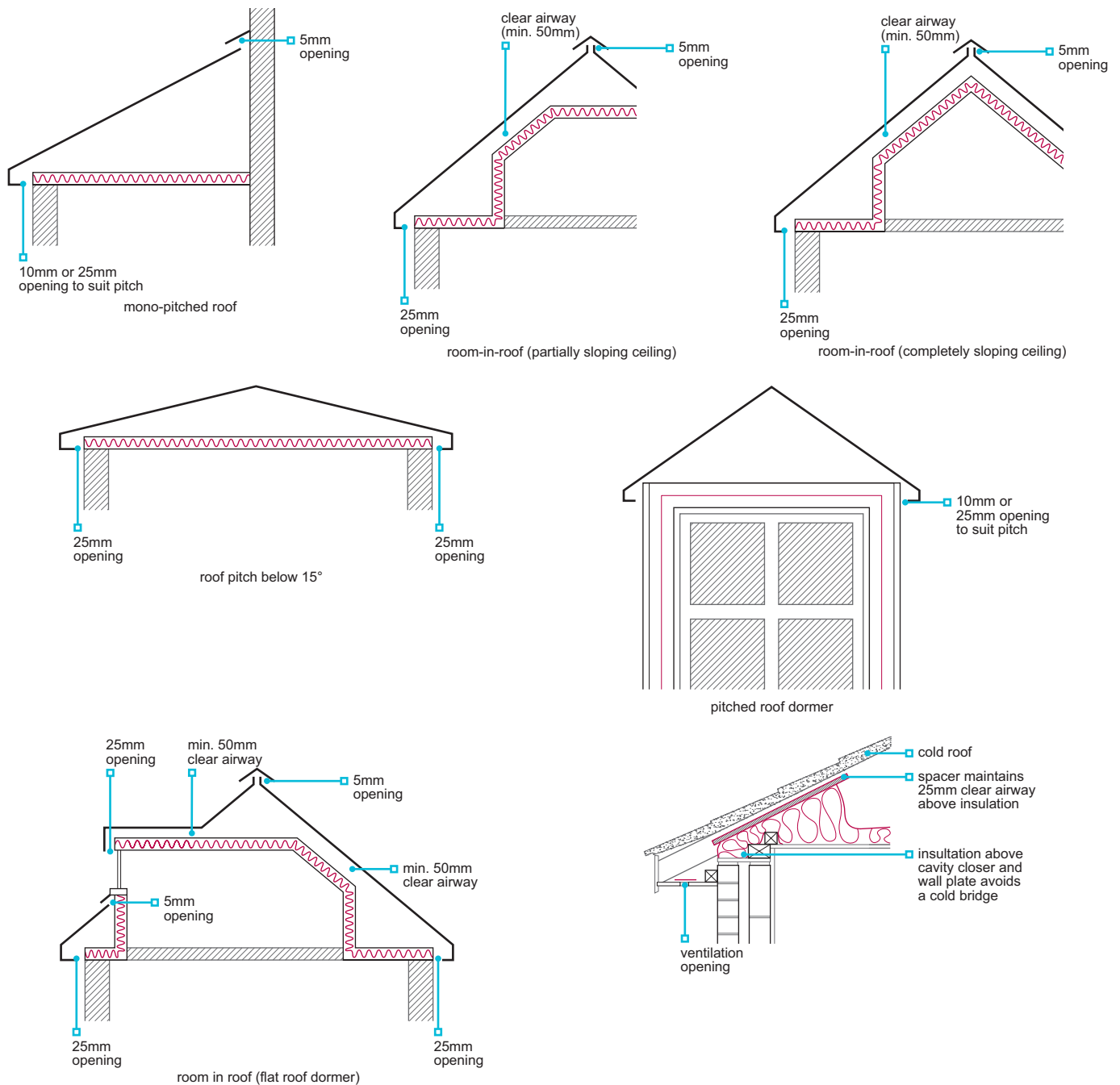
Ridge or high-level ventilation equivalent to a continuous opening of 5mm should be provided at the highest point of each roof slope in accordance with BS 5250 in the following situations:

- 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

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

- placed on the warm side of insulation

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

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

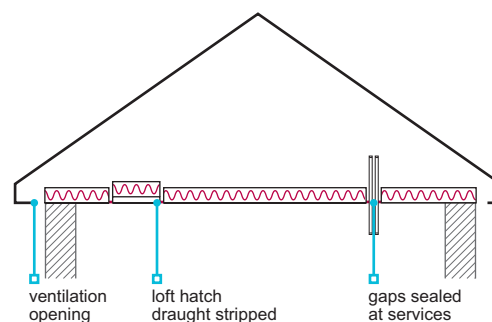
- used in roof constructions where the ceiling board is fixed to the rafters.

- 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 8:** 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

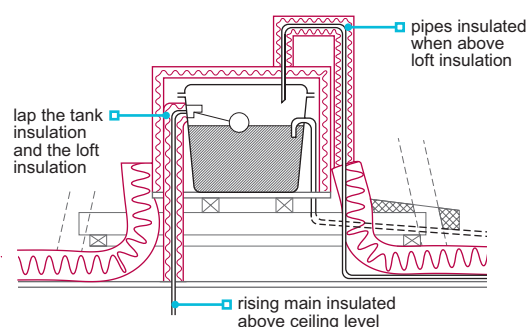
### Dormer construction

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.

### 7.2.16 Firestopping and cavity barriers

Also see: Chapter 6.8

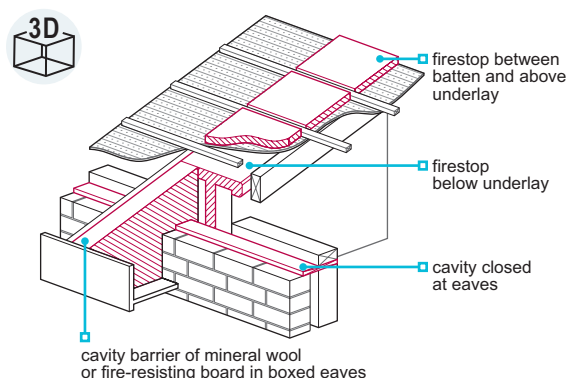
**Pitched roofs shall be constructed to provide adequate fire resistance and separation.**

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.

7.2.17 Battens

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 9.

Table 9: Suitable batten sizes

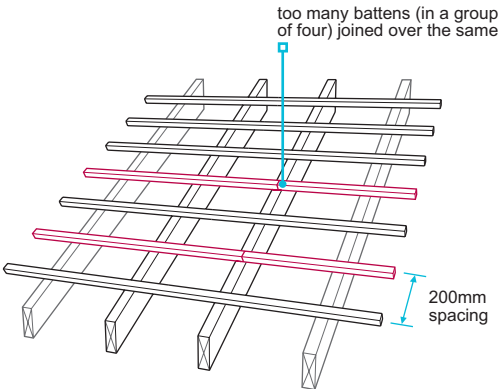
		450mm span	600mm span
Double lap slates	Natural: sized or random	25mm x 50mm	25mm x 50mm
	Fibre cement or concrete	25mm x 38mm	25mm x 50mm
Clay/concrete tiles	Double lap	25mm x 38mm	25mm x 38mm
	Single lap	25mm x 38mm	25mm x 50mm

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
- in accordance with manufacturer's guidance where mechanical nail guns are used.

7.2.18 Roof coverings

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 10:** 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 11:** 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

### 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 | 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). 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 12:** 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.

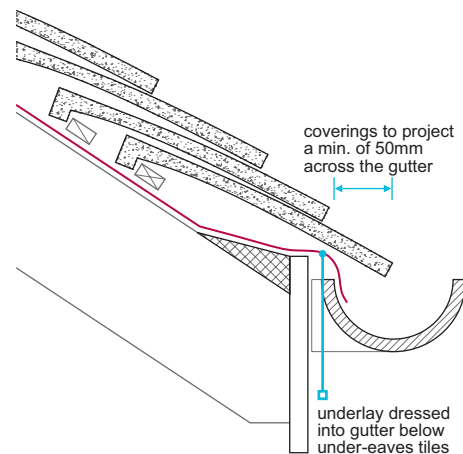
### Eaves, ridge and hip tiles

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.

Where ridge tiles are mortar bedded:

- the underlay should extend over the ridge.

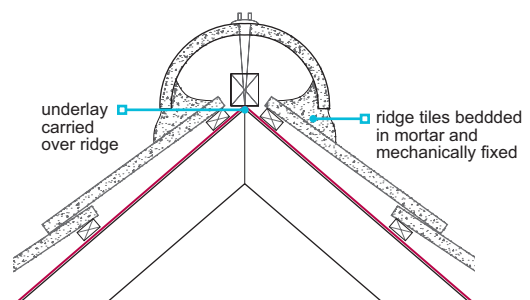
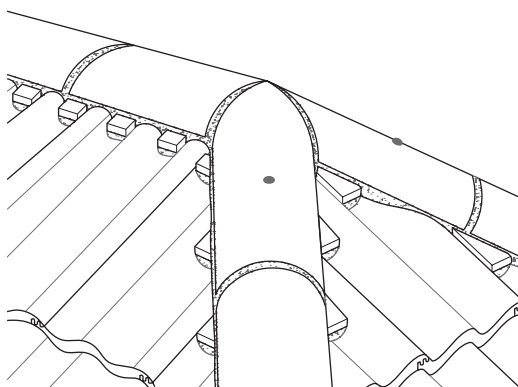


At hips:

- 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.

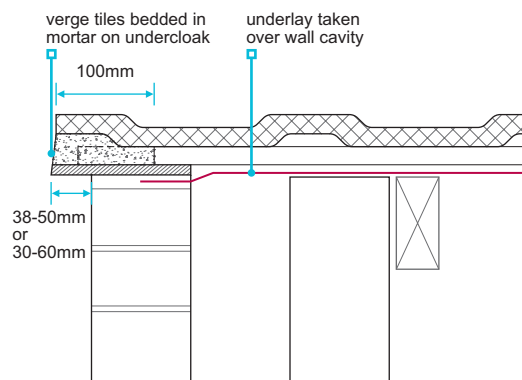
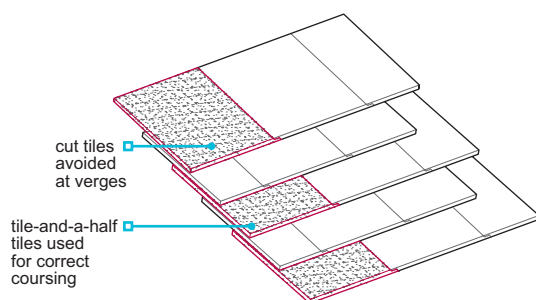


### Verges

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, 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.



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
- 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)
- 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.

### 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.

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) 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 13: Suitable materials for flashings

Material	Standard	Additional information
Aluminium and alloys	BS EN 515	0.6-0.9mm thick, and protected from contact with mortar by a coating of bituminous paint
Copper	BS EN 1172	Flashings, soakers and saddles should be: <div><div>■ fully annealed</div><div>■ 0.55mm thick (0.7mm thick is suitable for gutters)</div></div>
Rolled lead sheet	BS EN 12588	Flashings, gutter linings etc. should: <div><div>■ be a minimum of code 4, and soakers a minimum of code 3</div><div>■ sections should not exceed 1.5m in length</div></div>
Zinc alloy	BS EN 988	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.

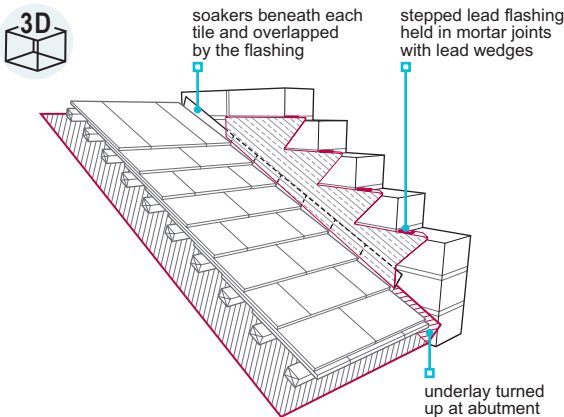
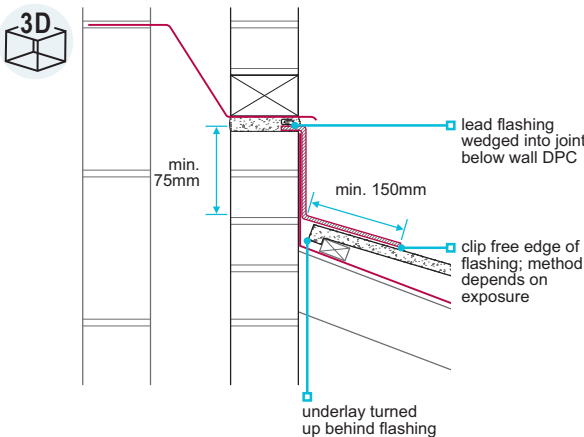
Where a flat or pitched roof over an enclosed area abuts a wall, or a balcony abuts a wall, cavity trays should be linked to the flashing to prevent water penetrating into an enclosed area. Horizontal flashings should provide weathering to a minimum of 75mm above the intersection with the roof.

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.



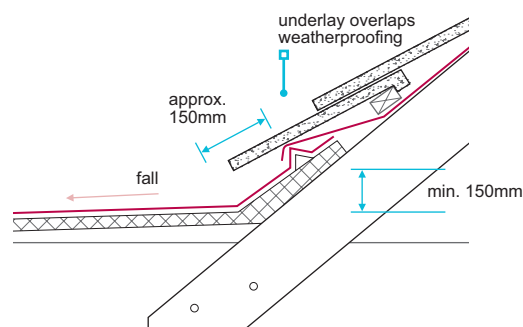
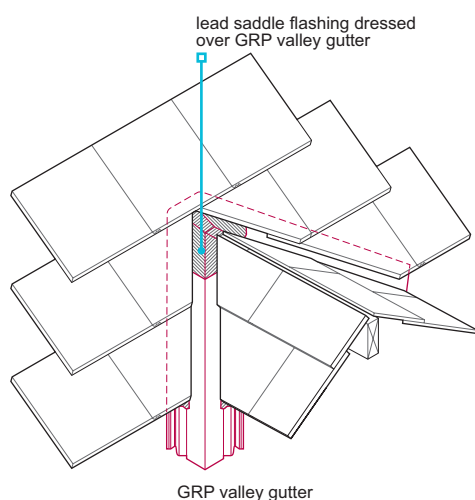
### Flat roof intersection or changes in slope

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

Where a flat roof adjoins a pitched roof:

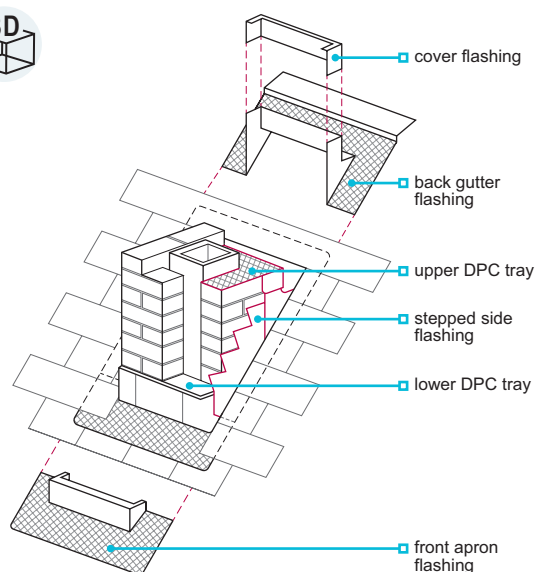
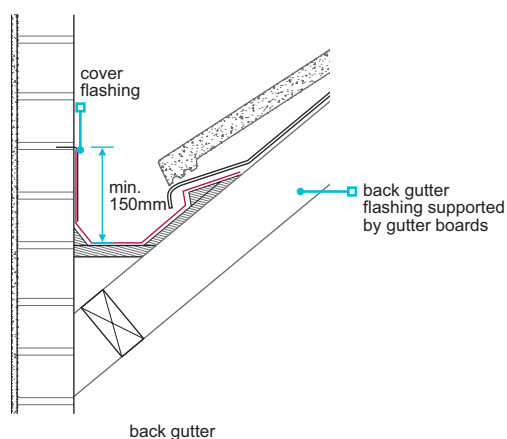
- the waterproof membrane should be carried up under the tiling to a height of 150mm above the flat roof, and lapped by the roofing underlay
- the lowest course of tiles or slates should not touch the roof membrane
- where the flat roof is over a dormer, the flat roof should have a fall to the front 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 to gable walls using suitably durable fixings, and be weathertight.

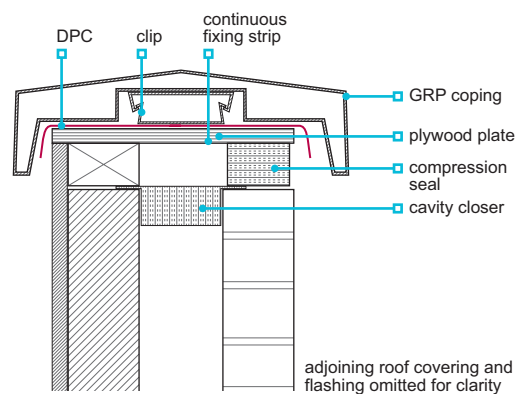
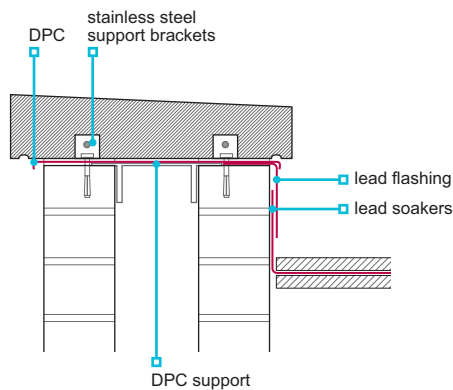
To resist wind uplift and gravitational forces, L-shaped brackets should be used to secure stone copings to masonry walls. The brackets should:

- 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'.

### 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
- 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°).

### Lead-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).

## 7.2.22 Drainage

**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.

## 7.2.23 Fascias and trim

*Also see: Chapter 3.3*

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

**Table 14:** 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.

### 7.2.24 Spandrel panels

**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
- structural stability.
- acoustic transfer

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

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