8.1 Pitched Roofs

Part 8 – Roofs

8.1 Pitched Roofs

GENERAL

Statutory Requirements

All structural timber used in a conventional cut roof (i.e. rafters, purlins, ceiling joists, binders and other timber elements) should be stress graded. All such timber must be either stamped as 'DRY' or 'KD' (Klin Dry).

The use of ungraded or "green" timber is not acceptable.

Allowances for Wind Loading

The need for a roof to withstand wind pressure and suction will be met if the proposed roof is braced effectively as discussed elsewhere in this Manual and secured to the structure as detailed below with walls adequately restrained.

Securing of Roofs to the Supporting Structure

Roof timbers are normally supported on a timber wall plate or similar which should be levelled using a spirit level so that loadings from the roof are directed perpendicularly down the supporting wall.

The wall plate may, as good practice, be fixed to ensure correct positioning when roof timbers or trusses are being installed, by means of galvanised mild steel holding down straps (30mm x 5mm x 1000mm long at maximum 2.0 metres centres) nailed to the wall plate and securely fixed to the inner surface of the wall with compatible fixings.

Ensure that holding down and restraint straps are provided at the relevant positions.

Diagram 8.1: Ceiling following roof pitch
8.1 Pitched Roofs

**Treatment of Timber**

Preservative treatment of new and existing roof timbers may be required under relevant standards or codes of practice, and in the following circumstances:

- Roof timbers should be treated with preservative where the insulation and ceiling line follow the roof pitch (see diagram 8.1). The Approved Document of Regulation 7 of the Building Regulations for England and Wales requires that in certain geographical areas, all softwood roof timbers should be treated against attack by the House Longhorn Beetle. Please check with the Local Building Control Body for details but the areas known to be currently as risk are:
  - The District of Bracknell Forest
  - The Borough of Elmbridge
  - Locations within the Borough of Guildford
  - Locations within the District of Hart
  - The District of Runnymede
  - The Borough of Spelthorne
  - The Borough of Surrey Heath
  - Locations within the Borough of Rushmoor
  - The District of Waverley (other than the parishes of Godalming and Haslemere)
  - In the Royal Borough of Windsor and Maidenhead, the parishes of Old Windsor, Sunningdale and Sunninghill
  - The Borough of Woking

The treatment should be impregnation with a preservative suitable for use in hazard class 2 in accordance with BS8417:2003, or equivalent, for a 60 year anticipated service life. Cut ends must be liberally brushed or dipped with an end-grain preservative. It is strongly recommended that where punched metal fasteners are proposed to roof trusses, only micro-emulsion or organic solvent preservatives should be used for timber treatment to limit the possibility of corrosion of the fasteners and so as not to adversely affect glued joints.

**TRUSSED RAFTER ROOFS**

**Information and Design Criteria Necessary for Ordering**

BS EN 1995-1-1:2004+A1:2008 provides a comprehensive list of criteria that should be supplied by the building designer or site supervisor to the trussed rafter designer/fabricator to enable a design to be prepared. This includes:

- Span of the trussed rafter, wall plate to wall plate plus the width of wall plate at each end
- Pitch of the roof
- Method of support
- Position of support
- Anticipated loading of the roof structure, i.e. the weight of the roof tiles and the exposure of the site should it attract excessive wind loads (See diagram 8.13)
- Position and size of water tanks
- Position and size of openings (i.e. loft hatches, roof windows, chimneys)
- Due to the site locality, any particular preservative treatment necessary for the timber (e.g. to protect against House Longhorn Beetle)
- Eaves details (e.g. overhang required etc.) (See diagram 8.2).

In return the trussed rafter designer should supply the following details for site use:

- Position, bearing and spacing of trussed rafters
- Position, fixings and sizes of lateral supports to prevent buckling of compression members such as rafters and struts
- Deviations from standard spacings, etc. to accommodate openings
- Support details for water tanks
- Any special handling equipment.
8.1 Pitched Roofs

Diagram 8.2: Explanation of terms

Site Storage

The delivery of trussed rafters should be planned so as to minimise the period of storage necessary on site.

When delivered, the trusses should, at all times, be kept clear of the ground and vegetation and be supported on level bearers sited under or adjacent to the points of support assumed by the design.

Ensure that, to prevent any distortion, the trusses are stored in a vertical position as in diagram 8.3.

Horizontal storage is sometimes possible as in diagram 8.4. In both cases stacks of trusses should be covered with a weatherproof cover, whilst maintaining adequate ventilation to prevent the occurrence of condensation.

Trusses should be checked visually upon arrival at site for damage occurring during transportation and again before site use to check for damage occurring during storage.

Trusses where moisture content exceeds 20% should not be installed.

Diagram 8.3: Truss storage (vertical)
8.1 Pitched Roofs

Diagram 8.4: Truss storage (horizontal)

Handling and Transportation

When transporting and handling trussed rafters, sagging and flexing should be avoided at all times. Whether handling is manual or by using mechanical equipment, trusses should be moved in a vertical position unless support can be provided to every joint.

Manual Lifting

On long span trusses it may be necessary to employ additional labour at intermediate positions. If required the truss may be inverted so that the apex hangs down (see diagram 8.5).

See-sawing the truss across walls and scaffolding must be avoided (see diagram 8.6). Individual designs and site conditions may dictate different requirements in order to install trusses in their final position.

Diagram 8.5: Correct manual lifting  Diagram 8.6: Incorrect manual lifting

Mechanical Lifting

Ideally where mechanical lifting is used, the trusses should be lifted in banded sets and lowered onto suitable supports. Lifting points should be rafter or ceiling intersections or node points (see diagram 8.7).

Lifting trusses singly should be avoided but where unavoidable a suitable spreader bar should be used to withstand the sling force (see diagram 8.7).
It is essential when erecting a trussed rafter roof to ensure that the first trussed rafter is erected and braced rigidly in the correct vertical position so that it provides a base model against which all the other trusses can be set out (See diagram 8.8).

Any temporary bracing should not be removed until permanent bracing has been installed. Immediately prior to the fixing of permanent bracing the trussed rafters should be checked again for alignment and verticality.

Procedure for erection using diagram 8.8:

- Before placing first truss, mark required position of trussed rafters on opposing wall plates.
- Erect and brace first trussed rafter (A), using brace B as temporary support (only one shown but fix others as necessary).
- Erect next adjacent trussed rafter (C) and brace back to A using brace D.
- Erect other trussed rafters as with (C).
- When the final accurate positioning of the trussed rafters has been confirmed, the rafter feet can be fixed in position (See diagram 8.9).
- Fix permanent diagonal bracing (E) (only one brace shown for clarity).
- Fix longitudinal bracing (F). (Only 3 shown for clarity).
- Fix all remaining bracing.
- Remove all temporary bracing.
8.1 Pitched Roofs

Diagram 8.9: Fixing of trusses to a wall plate

The International Truss Plate Association Technical Handbook, available from trussed rafter suppliers, provides additional advice on trussed rafter erection.

Bracing to Duo-Pitched Roofs

This section comments with regard to duo-pitched (double pitched) trusses.

FIXING

To achieve a stable and wind resistant roof and gable wall structure, the roof must be secured to the gable wall, if applicable, and fully braced by 100 x 25mm timber twice nailed to roof timbers using 65mm long, 3.35mm diameter galvanised wire nails. Where nail guns are used 3.1mm x 75mm long annular ring-shank nails are allowed. They do not need to be galvanised.

LIMITATIONS

The details given relate to standard bracing for trussed rafters. They do not apply in the following circumstances, when advice from the roof designer should be sought:

- When the height of the building exceeds 8.4 metres to plate level (3 storeys) or where the building is in a particularly exposed position such as open land in exposed areas (e.g. West Coast of Scotland etc.)
- When the building is non-rectangular in shape
- When the trussed rafter spacing exceeds 600mm
- When the maximum span of the roof is greater than that given in the tables 8.10 – 8.12.

Tables 8.10 – 8.12 show the maximum spans of roofs using standard bracing in relation to location. The wind zones referred to are illustrated in diagram 8.13.
### 8.1 Pitched Roofs

<table>
<thead>
<tr>
<th>Maximum height to underside of ceiling tie in metres</th>
<th>Pitch of roof</th>
<th>Maximum span of roof in metres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Duo pitched</td>
<td>Mono-pitched</td>
</tr>
<tr>
<td>3.0</td>
<td>30°</td>
<td>12</td>
</tr>
<tr>
<td>5.7</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>8.4</td>
<td></td>
<td>11.8</td>
</tr>
<tr>
<td>3.0</td>
<td>35°</td>
<td>12</td>
</tr>
<tr>
<td>5.7</td>
<td></td>
<td>10.5</td>
</tr>
<tr>
<td>8.4</td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

Table 8.10: Wind Zone A

<table>
<thead>
<tr>
<th>Maximum height to underside of ceiling tie in metres</th>
<th>Pitch of roof</th>
<th>Maximum span of roof in metres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Duo pitched</td>
<td>Mono-pitched</td>
</tr>
<tr>
<td>3.0</td>
<td>30°</td>
<td>12</td>
</tr>
<tr>
<td>5.7</td>
<td></td>
<td>11.5</td>
</tr>
<tr>
<td>8.4</td>
<td></td>
<td>10.2</td>
</tr>
<tr>
<td>3.0</td>
<td>35°</td>
<td>10.6</td>
</tr>
<tr>
<td>5.7</td>
<td></td>
<td>9.1</td>
</tr>
<tr>
<td>8.4</td>
<td></td>
<td>8.5</td>
</tr>
</tbody>
</table>

Table 8.11: Wind Zone B

<table>
<thead>
<tr>
<th>Maximum height to underside of ceiling tie in metres</th>
<th>Pitch of roof</th>
<th>Maximum span of roof in metres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Duo pitched</td>
<td>Mono-pitched</td>
</tr>
<tr>
<td>3.0</td>
<td>30°</td>
<td>11.6</td>
</tr>
<tr>
<td>5.7</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>8.4</td>
<td></td>
<td>8.8</td>
</tr>
<tr>
<td>3.0</td>
<td>35°</td>
<td>9.8</td>
</tr>
<tr>
<td>5.7</td>
<td></td>
<td>7.7</td>
</tr>
<tr>
<td>8.4</td>
<td></td>
<td>7.2</td>
</tr>
</tbody>
</table>

Table 8.12: Wind Zone C
Diagram 8.13: Wind zones – British Isles

NOTE: Parts of Scotland are outside Zone C and roofs in this area should be designed by an Expert

TYPES OF BRACING
There are three main types of wind bracing:

- Diagonal rafter bracing
- Longitudinal bracing
- Chevron bracing (only necessary on trussed rafter spans over eight metres)

Permanently fixed diagonal and longitudinal bracing are required in all trussed rafter roofs.

Bracing for wind loads can also be enhanced by adequately fixed tiling battens and/or sarking boards. The ceiling plasterboard (12.5mm thickness) or a similar rigid material will also contribute to the bracing process.

Sarking boards such as moisture resistant plywood (minimum thickness 9mm) and moisture resistant chipboard (minimum thickness 12mm) may provide adequate bracing without the need for additional wind bracing to the roof. Sarking boards should be laid with staggered joints and nailed at 200mm centres on every truss with 50mm long x 3mm diameter galvanised round wire nails. Sarking boards are commonly used in Scotland.
Diagonal Bracing

Diagonal braces should be fixed at an angle of about 45° (but not less than 35° or greater than 50°) to the plane of the rafters (See diagram 8.14). There are other forms of diagonal bracing (See diagram 8.15).

BS EN 1995-1-1:2004+A1:2008 requires that narrow fronted houses (where frontage does not exceed 6.6 m) adopt a 'cross' approach to diagonal bracing. Diagonal bracing is taken up from the wall plate at either end of the roof and cross over in the approximate centre of the roof slope. The crossover should be arranged as in diagram 8.16.
8.1 Pitched Roofs

Longitudinal Bracing

Longitudinal bracing is shown in diagram 8.17, it should be positioned tightly to abut separating and gable walls. In timber frame construction you should ensure that longitudinal braces are fixed to timber frame gables/separating walls to provide additional lateral restraint.

Chevron Bracing

Chevron bracing is only required for roof spans exceeding 8 metres. Chevron bracing can be identified as diagonal bracing to the web members of the roof truss.

For spans of between 8 and 11 metres such bracing may only be required to a single web member on either side of the roof (See diagram 8.18). For spans exceeding 11 metres more extensive chevron bracing may be necessary.

Mono-Pitched Roof Bracing

In mono-pitched trussed rafter roofs the diagonal bracing pattern for narrow fronted houses (See diagram 8.16) should be adopted. The requirement for longitudinal bracing is the same as for duo-pitched trussed rafter roofs.

Chevron bracing is required to the webs in roofs exceeding 5 metres span and also to upright members where inadequate lateral restraint is provided at the apex of the roof, i.e. not connected to a masonry wall or rigid frame cladding (see diagram 8.19).

Diagram 8.16: Cross-over bracing – narrow fronted houses (view from inside of roof)

Diagram 8.17: Longitudinal bracing

Diagram 8.18: Mono-pitched roof bracing

Diagram 8.19: Chevron bracing on mono-pitched roofs
### 8.1 Pitched Roofs

#### Diagram 8.18: Chevron bracing to common truss patterns (roof span exceeding 8 metres)

#### Diagram 8.19: Chevron bracing: mono-pitched roofs

#### Diminishing Roof Trusses

The truss roof designer should provide details of fixings for the diminishing truss to the main roof truss (see diagram 8.21).

- Where the diminishing truss has a splayed bottom chord which matches the pitch of the main truss (usually where the roof pitch is less than 30°) the truss can be skew-nailed to the main truss with 2 no 3.35mm dia x 75mm galvanised wire nails (see diagram 8.20).
- Where the diminishing truss has a square bottom chord the truss can be skew-nailed to the main truss and supported on a continuous binder also fixed to the main truss. The top of the binder should be splayed to suit the bottom chord to 2 no 3.35mm dia x 75mm galvanised wire nails should be used for the fixing (see diagram 8.21).

#### Diagram 8.20: Splayed bottom chord

#### Diagram 8.21: Supported on a continuous binder
8.1 Pitched Roofs

Mono-Pitch and Girder Trusses on Trussed Rafter Hipped-End Roofs

Mono-pitch trussed rafters can be used in conjunction with girder trusses on trussed rafter hipped roofs (see diagram 8.24). Mono-pitched trusses are fixed to girder trusses by metal shoes. The bearing of mono-pitched trusses onto the mild steel proprietary girder shoe should be confirmed with the roof designer before site installation is attempted (see diagram 8.23). Girder trusses being metal, or timber/metal composite are strengthened trusses designed to support loads in another plane (such as mono-pitched trusses).

Multiple-Trussed Rafters

Multiple trussed rafters may be specified for a particular purpose. The trussed rafters may be delivered to site already fastened together. Alternatively, fixing together on site of multiple rafters may be necessary, in which case full details will be necessary from the roof designer.

Provision for Openings i.e. Loft Hatches, Chimneys, etc

Wherever possible a trussed rafter roof should be designed to accommodate necessary openings within the trussed rafter spacing (e.g. a loft hatch). If this is not possible the spacing of trussed rafters may be extended to accommodate an opening as in diagram 8.25. The roof designer should provide all necessary details.
8.1 Pitched Roofs

Tank Stands

Confirmation should be obtained from the roof designer that a trussed rafter roof design is capable of supporting water storage tanks. Tanks should be supported by bearer beams, as shaded in diagrams 8.26 & 8.27, supported on the ceiling ties portion of the truss. Bearers should be skew-nailed to supports as appropriate. Alternatively, proprietary joist hangers can be used.

All tank bearers should be situated as close as possible to the node or intersection points of the trussed rafter. The water tank and base should be located centrally over the bearers in both directions. The dimensions of the bearers depend upon the size of the supported tank and the span of the trussed rafters (see table 8.29). If an alternative position is required for a water storage tank within a loft void, all bearer members must be designed by the truss designer in accordance with BS EN 1995-1-1:2004+A1:2008 or other suitable design criteria.

![Diagram 8.25: Openings in trussed rafter roofs](image)

<table>
<thead>
<tr>
<th>Truss Span (metres)</th>
<th>Size of Bearer B (dimensions in mm)</th>
<th>230 litre</th>
<th>300 litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5</td>
<td>100 x 50, 125 x 50 or 2nr (100 x 38)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.0</td>
<td>125 x 50 or 2nr (100 x 38) 125x50 or 2nr (100x38)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.0</td>
<td>150 x 50 or 2nr (125 x 38) 2nr (150 x 38)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: All truss spans up to 12m for both 230 & 300 litre tanks, bearers A & C should be a minimum 75mm x 60mm C16 KD or dry timber

![Diagram 8.26: Tank stand across 3 No. trusses (max 230 litre tank)](image)

![Diagram 8.27: Tank stand across 4 No. trusses (max 300 litre tank)](image)

Table 8.29: Bearer sizes (See diagrams 8.26 and 8.27)
8.1 Pitched Roofs

**Modifications to Trussed Rafters**

Trussed rafters should never be cut, altered or repaired for use without the full agreement of the trussed rafter designer. Remedies for defects to erected trusses can be found in BS EN 1995-1-1:2004 & BS EN 1995-1-1:2004+A1:2008, but the roof designer's advice should be sought prior to repairs being carried out.

**Combined Trussed Rafter and Traditionally Framed Roofs**

Extra care is necessary where the two principal timber pitched roof types are being used in conjunction. The trussed rafters should be specifically designed to accept any additional loadings imposed by an adjacent traditional roof. Similarly, account should be taken of any loadings imposed by trusses on traditional roofs where only nominal loadings have been allowed for. If in doubt consult the roof designer.

**TRADITIONALLY FRAMED ROOFS**

The moisture content of structural timber should not exceed 20% at the time of stress grading and at the time of erection. All structural timber for use within the building fabric should be stress graded marked 'KD' (Kiln Dry) or 'DRY'.

An example of a traditionally framed roof is shown in diagram 8.30. The arrangement illustrated shows the various timber members that make up the roof but the internal configuration of members may vary from roof to roof. Short span roofs can be constructed using rafters and ceiling joists. Ceiling ties or collars are necessary to relieve horizontal thrust from the roof pushing out the walls.

In longer spanning roofs, purlins and binders are used to reduce the effective span of the rafter/joist and avoid the necessity for uneconomic larger dimension timbers.

Purlins and binders should be located at mid-rafter/joist span. Purlins may be located higher in the roof where attic rooms are desired and the roof is to be designed by an Expert.

The purlins/binders should be adequately supported to contribute fully to the roof structure. For example, they could be built into the inner leaf of a gable end wall and supported by struts onto the load-bearing structure at centres specified in the design.

Always ensure that the correct strength class of timber is both ordered and used. Structural timbers are allocated a strength class by BS 5268-2:2002. The most common strength classes used are C16 and C24 (see table 8.31).

![Diagram 8.30: Traditionally framed roof](image)

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Struts and braces</td>
<td>100x50mm</td>
</tr>
<tr>
<td>Wall plates (generally)</td>
<td>100x50mm</td>
</tr>
<tr>
<td>Hips</td>
<td>Splayed rafter depth = Rafter depth + 25mm (for pitches exceeding 30°)</td>
</tr>
<tr>
<td></td>
<td>Under 30° a specific design is required</td>
</tr>
<tr>
<td>Ridges</td>
<td>Splayed rafter depth = Rafter depth + 25mm</td>
</tr>
<tr>
<td></td>
<td>To be designed</td>
</tr>
<tr>
<td>Valleys</td>
<td></td>
</tr>
</tbody>
</table>

Table 8.31: Roof member sizes
The timber supplier will normally require the following information before supplying timber:

- Type and strength class of timber required
- Required sizes of timber
- Any treatment required

The dimensions of rafter, ceiling joist and binder timbers for use in traditionally framed roofs can be found in the tables 8.32 – 8.35 for the majority of loading cases (England & Wales) with live loadings of 0.75 kN/m² (snow loading). For other loading situations, further guidance can be taken from Approved Document A (E&W), Section 1, Scotland and Part D-N, N. Ireland.

Purlin

<table>
<thead>
<tr>
<th>Size of purlin mm x mm</th>
<th>Spacing of purlins (mm) – distance between centres of purlin and/or wall plate or ridge and purlin</th>
<th>C16 1</th>
<th>C24 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>47 x 175</td>
<td>1500 1800 2100 2400 2700 3000</td>
<td>2.04 1.90</td>
<td>2.13 1.99 1.88</td>
</tr>
<tr>
<td>47 x 200</td>
<td>2.32 2.17 2.04 1.90</td>
<td>2.43 2.27 2.15 2.04 1.95 1.87</td>
<td></td>
</tr>
<tr>
<td>47 x 225</td>
<td>2.61 2.44 2.28 2.13 2.00 1.89</td>
<td>2.73 2.56 2.42 2.30 2.19 2.13</td>
<td></td>
</tr>
<tr>
<td>47 x 250</td>
<td>2.90 2.71 2.51 2.35 2.01 2.09</td>
<td>3.03 2.84 2.68 2.55 2.44 2.34</td>
<td></td>
</tr>
<tr>
<td>47 x 275</td>
<td>3.19 2.97 2.75 2.57 2.41 2.28</td>
<td>3.33 3.12 2.95 2.80 2.68 2.57</td>
<td></td>
</tr>
<tr>
<td>63 x 150</td>
<td>1.94 1.82</td>
<td>2.03 1.90</td>
<td></td>
</tr>
<tr>
<td>63 x 175</td>
<td>2.26 2.12 2.00 1.91 1.82</td>
<td>2.36 2.21 2.09 2.00 1.91 1.84</td>
<td></td>
</tr>
<tr>
<td>63 x 200</td>
<td>2.58 2.42 2.29 2.18 2.08 1.97</td>
<td>2.70 2.53 2.39 2.28 2.18 1.10</td>
<td></td>
</tr>
<tr>
<td>63 x 225</td>
<td>2.90 2.72 2.57 2.45 2.33 2.20</td>
<td>3.03 2.84 2.69 2.56 2.45 2.36</td>
<td></td>
</tr>
<tr>
<td>63 x 250</td>
<td>3.22 3.02 2.85 2.72 2.57 2.43</td>
<td>3.37 3.16 2.99 2.84 2.72 2.62</td>
<td></td>
</tr>
<tr>
<td>63 x 275</td>
<td>3.54 3.32 3.14 2.98 2.81 2.66</td>
<td>3.70 3.47 3.28 3.13 2.99 2.88</td>
<td></td>
</tr>
<tr>
<td>75 x 150</td>
<td>2.06 1.94 1.83</td>
<td>2.16 2.02 1.91 1.82</td>
<td></td>
</tr>
<tr>
<td>75 x 175</td>
<td>2.41 2.26 2.13 2.03 1.95 1.87</td>
<td>2.51 2.36 2.23 2.13 2.04 1.96</td>
<td></td>
</tr>
<tr>
<td>75 x 200</td>
<td>2.75 2.57 2.44 2.32 2.22 2.14</td>
<td>2.87 2.69 2.55 2.43 2.33 2.24</td>
<td></td>
</tr>
<tr>
<td>75 x 225</td>
<td>3.09 2.89 2.74 2.61 2.50 2.40</td>
<td>3.22 3.02 2.86 2.73 2.61 2.52</td>
<td></td>
</tr>
<tr>
<td>75 x 250</td>
<td>3.42 3.21 3.04 2.90 2.77 2.66</td>
<td>3.58 3.36 3.18 3.03 2.90 2.79</td>
<td></td>
</tr>
</tbody>
</table>

Key:
1. Timber is approximately equivalent to SC3 timber
2. Timber is approximately equivalent to SC4 timber

Further guidance is given in: “Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings” Published by TRADA

Table 8.32: Span Tables (pitch 15° – 22.5°)
### 8.1 Pitched Roofs

#### Pitched Roof

<table>
<thead>
<tr>
<th>Size of post mm x mm</th>
<th>C16</th>
<th>Spacing of rafters mm</th>
<th>C24</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>400</td>
<td>450</td>
<td>600</td>
</tr>
<tr>
<td>47 x 100</td>
<td>2.35</td>
<td>2.28</td>
<td>2.10</td>
</tr>
<tr>
<td>47 x 125</td>
<td>2.99</td>
<td>2.88</td>
<td>2.61</td>
</tr>
<tr>
<td>47 x 150</td>
<td>3.57</td>
<td>3.44</td>
<td>3.13</td>
</tr>
</tbody>
</table>

#### Purlin

<table>
<thead>
<tr>
<th>Size of purlin mm x mm</th>
<th>Spacing of purlins (mm) – distance between centres of purlin and/or wall plate or ridge and purlin</th>
<th>C16</th>
<th>C24</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1500</td>
<td>1800</td>
</tr>
<tr>
<td>47 x 175</td>
<td>Maximum clear span of purlin (m)</td>
<td>2.08</td>
<td>1.95</td>
</tr>
<tr>
<td>47 x 200</td>
<td></td>
<td>2.38</td>
<td>2.23</td>
</tr>
<tr>
<td>47 x 225</td>
<td></td>
<td>2.67</td>
<td>2.50</td>
</tr>
<tr>
<td>47 x 250</td>
<td></td>
<td>2.97</td>
<td>2.78</td>
</tr>
<tr>
<td>47 x 275</td>
<td></td>
<td>3.26</td>
<td>3.05</td>
</tr>
</tbody>
</table>

### Table 8.33: Span Tables (pitch 22.5° – 30°)

<table>
<thead>
<tr>
<th>Pitched Roof</th>
<th>Pitch 22.5° to 30°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of post mm x mm</td>
<td>C16</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>400</td>
</tr>
<tr>
<td>47 x 100</td>
<td>2.45</td>
</tr>
<tr>
<td>47 x 125</td>
<td>3.09</td>
</tr>
<tr>
<td>47 x 150</td>
<td>3.69</td>
</tr>
</tbody>
</table>

### Table 8.34: Span Tables (pitch 30° – 45°)

<table>
<thead>
<tr>
<th>Pitched Roof</th>
<th>Pitch 30° to 45°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of post mm x mm</td>
<td>C16</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>400</td>
</tr>
<tr>
<td>47 x 175</td>
<td>2.16</td>
</tr>
<tr>
<td>47 x 200</td>
<td>2.46</td>
</tr>
<tr>
<td>47 x 225</td>
<td>2.77</td>
</tr>
<tr>
<td>47 x 250</td>
<td>3.07</td>
</tr>
<tr>
<td>47 x 275</td>
<td>3.38</td>
</tr>
</tbody>
</table>

Key:
1. Timber is approximately equivalent to SC3 timber
2. Timber is approximately equivalent to SC4 timber

Note: Further guidance is given in: "Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings" Published by TRADA
Part 8: Roofs

8.1 Pitched Roofs


- Tiling should be fixed in accordance with the manufacturer’s instructions, due account being taken of the site exposure and the pitch of the roof. Non-ferrous or stainless steel fixing nails should be used.

- Clipping should be used as recommended by the manufacturer.

---

### Table 8.35: Span Tables (ceiling joists)

**WEATHER-TIGHTNESS**

The roof underlay to a pitched roof should be fixed in accordance with the underlay or tile manufacturer’s recommendations, with care taken to ensure that water will run off into the gutter, e.g. by use of a tilting fillet where required.

A type 5U quality felt should be used at eaves (above the tilting fillet) and drop into the gutter to prevent solar degradation.

Roofing felt should be fixed with non-corrodible clout nails. Horizontal laps should be not less than 150mm for roof pitches below 35°, and 100mm for pitches greater than 35°. Vertical laps should not be less than 100mm and occur only over rafters, to which they should be securely fixed. The underlay should extend into the gutter and the bottom row of tiles should overhang to the centre of the gutter.

Particular care should be taken in ensuring weather-tightness at eaves, verges and valleys. Movement joints should, where required, extend through the roof covering and be adequately weather-proof, or the roof covering should be of a flexible type and designed to accommodate any movement.

Ensure that roof insulation extends fully to perimeter walls in order to avoid cold bridging and that roof ventilators are not obstructed.

**Tiling**


- Tiling should be fixed in accordance with the manufacturer’s instructions, due account being taken of the site exposure and the pitch of the roof. Non-ferrous or stainless steel fixing nails should be used.

- Clipping should be used as recommended by the manufacturer.
8.1 Pitched Roofs

BZSS’s experience shows that tiles are often not fixed on site as they should be and in accordance with an agreed nailing schedule. Builders and Designers should determine the required tile fixing specifications necessary for their area (and taking account of the wind tables as per the relevant Approved Documents) e.g. by contacting the tile manufacturer who often provides an advisory service and through the provision of an acceptable nailing schedule.

Fixings may also consist of either nailing, clipping or both and proprietary dry verge and ridge fixing systems.

As an alternative to BS 5534 contractors can use the Zonal Method for Roof Tile Fixing Specification which is a joint publication prepared by the Concrete Tile Manufacturers’ Association, Clay Roof Tile Council, and the National Federation of Roofing Contractors. For more detail see the following websites:

www.britishprecast.org
www.clayroof.co.uk
www.nfrc.co.uk

The assumptions made in the simplification process may produce a specification with more or stronger fixings than required if the full BS5534 calculation is undertaken.

The Zonal Method is not applicable in the following circumstances:

- For buildings where the site altitude is greater than 300m
- For buildings on sites where the maximum gradient of the land within 200m of the building is greater than 10%
- Where the building is within 6 kilometres of an airport and is plus or minus 10 degrees each side of the runway centre line measured from the touchdown point
- Where the ridge height of the building is greater than 15m
- Where the roof pitch is greater than 54° for single lap tiles and 59° for double lap tiles
- For buildings where the roof substructure does not provide a shielding factor of 1 as defined in BS5534 e.g. the roof does not have an underlay or sub-roof system such as liner trays or sandwich panels
- For tiles or slates not made of concrete or clay
- Heritage, listed or historic buildings requiring restoration using traditional skills
- For buildings on sites located in wind zones where the wind speed is greater than 25 m/s e.g. Zone 3 as detailed within the Approved Documents.

The fixing specification for the roof covering of any excluded site or building must be determined by calculation in accordance with the methods described in BS 5534:2014 & BS 5534:2014+A1:2010 and BS EN 1991-1-4:2005. For example, in some extreme cases, special nails or clips may be required.

INTERLOCKING TILES

In the case of interlocking tiles, as a minimum all perimeter tiles at eaves, ridges, verges and tiles adjacent to hips and valleys require some form of fixing. Where the pitch exceeds 45° all tiles need to be nailed (and clipped where the pitch exceeds 55°). A copy of the manufacturer’s specification together with relevant nailing schedules should be made available to BZSS’s appointed Technical Auditor prior to the fixing of the roof tiling.

PLAIN TILES

Plain tiles should be twice nailed every fifth course and at perimeters and other areas subject to high wind uplift.

Where the pitch exceeds 60°, all plain tiles should be twice nailed.

Slates

Slates over 150mm wide should be twice nailed over the whole roof. The minimum pitch at which slate maybe used is 20°.

Slates should have a reasonably straight cleavage and should ring true when struck. The grain must run longitudinally and not transversely. Whilst the surface may contain stripes it should not be so uneven as to not allow the proper laying of the slates.

All natural slates should be certified to show that they meet the requirements of BS EN 12326-1:2004 and that they are free of iron pyrites and other impurities. Certification will be required by Build-Zone.
8.1 Pitched Roofs

SLATE CREEP

If the maximum angle of creep for a particular slate is less than the minimum shown in tables 8.36 and 8.37 the side lap of the slate will be inadequate for the conditions of use. The minimum width of a slate is given by the following equation:

\[ \text{Min. slate width} = \left( \frac{9DE - 3DG}{\tan \theta} \right) = 2NF \] (See the relevant British Standard)

<table>
<thead>
<tr>
<th>Roof pitch (min)</th>
<th>Minimum Headlap mm</th>
<th>500mm or longer</th>
<th>Nominal length of slate Angle of creep (degrees)</th>
<th>Less than 460mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>45°</td>
<td>65</td>
<td>26</td>
<td>500mm</td>
<td>26</td>
</tr>
<tr>
<td>40°</td>
<td></td>
<td></td>
<td>460mm</td>
<td>26</td>
</tr>
<tr>
<td>35°</td>
<td></td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>30°</td>
<td></td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>27.5°</td>
<td></td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>25°</td>
<td></td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>22.5°</td>
<td>100</td>
<td></td>
<td></td>
<td>---</td>
</tr>
<tr>
<td>20°</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.36: Recommended minimum headlaps and roof pitches and angles of creep for double lap natural, fibre cement and other artificial slates (driving rain exposure <56.5 l/m² per spell)

- The headlap may be increased in calculating the width of double lap product.
- These recommendations are minimum values which are more critical at roof pitches below 30° (driving rain exposure <56.5 l/m²) and below 40°. The thickness of slates will reduce the effective slope of the slate surface.
- For steeper roof pitches it is possible to use a greater angle of creep to allow a loss of side lap where it is necessary to cut the slates.
- For artificial double lap slating (fibre cement or artificial slates) these recommendations for headlaps and sidelaps apply, except at roof pitches below 25° (driving rain exposure <56.5 l/m²) and 30° (driving rain exposure ≥56.5 l/m²) in which case manufacturers should produce evidence of satisfactory performance.
- For triple lap shingles or shakes, refer to manufacturer’s technical literature.
- The minimum roof pitch for double lap slating in UK climatic conditions is 20°.
- The calculation of the minimum slate width using the relevant angle of creep is normally based upon a nail hole to side edge distance (NF) of 20mm to 25mm. Any greater nail hole to side edge distance will require recalculation of slate width in accordance with the following: Min. slate width = \((9DE - 3DG)\tan \theta\) = 2NF
- The headlap should not exceed one third of the length of the slate.
- Hook fixing of slates may require greater handicap than those recommended in tables 8.36 and 8.37.

For head and shoulder nailed and hook-fixed slates the value of NF is zero in the equation above.

<table>
<thead>
<tr>
<th>Roof pitch (min)</th>
<th>Minimum Headlap mm</th>
<th>500mm or longer</th>
<th>Nominal length of slate Angle of creep (degrees)</th>
<th>Less than 460mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>45°</td>
<td>65</td>
<td>32</td>
<td>500mm</td>
<td>32</td>
</tr>
<tr>
<td>40°</td>
<td></td>
<td></td>
<td>460mm</td>
<td>32</td>
</tr>
<tr>
<td>35°</td>
<td></td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>30°</td>
<td></td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>27.5°</td>
<td></td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>25°</td>
<td></td>
<td></td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>22.5°</td>
<td>100</td>
<td></td>
<td></td>
<td>---</td>
</tr>
<tr>
<td>20°</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.37: Recommended minimum headlaps and roof pitches and angles of creep for double lap natural, fibre cement and other artificial slates (driving rain exposure ≥56.5 l/m² per spell)

Recommendations for Minimum Roof Pitch, Headlaps and Sidelaps

When considering the minimum recommendations for pitch and laps for slate and tile products, the specifier should take into account any abnormal conditions which may apply to the proposed use of a generic or proprietary product.

Where abnormal weather conditions may be expected, for example on elevated sites, near to the coast, in localities where heavy snow falls are commonly experienced or in conditions of severe exposure, the recommendations given for pitches and laps may not ensure full protection from the weather. In such conditions, the specifier using generic products should seek guidance from an experienced roofing contractor who is conversant with local conditions and is aware of any special precautions or acceptable local building practices which should be taken into account in designing the roof covering.
Reclaimed Roof Coverings

The use of reclaimed roof coverings is acceptable when:

- They have, where possible, certification to show that they have a minimum life expectancy of 15 years.
- They have been checked by suitably qualified professional or roofing contractor for their suitability in the proposed location.
- A fixing detail/nail schedule is provided. Where such materials are no longer manufactured then a fixing schedule for a covering type that is very similar may be acceptable to Build-Zone. Natural slates must be graded to take account of their variable thickness. They should be selected so that the overall thickness of any one batch of 100 slates do not exceed, in thickness, by more than 25% any other batch of 100 slates.

Battens

Battens should be spaced depending on the roof finish so as to ensure adequate laps at each course and provide a neatly aligned and uniform gauge of tiling over the whole area. While the gauge may be reduced, it should not be increased.

Battens should be preservative treated, (BS 8417:2003, or equivalent, hazard class 2), at least 1200mm in length and span across at least three supports. Sizes for battens are given in table 8.38.

Eaves tiles should be supported by a fascia board or by a batten on a tilting fillet.

<table>
<thead>
<tr>
<th>Table 8.38: Recommended batten sizes (roofing and vertical work)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of slate or tile</td>
</tr>
<tr>
<td>Slates (double lapped)</td>
</tr>
<tr>
<td>Natural: Sized or random</td>
</tr>
<tr>
<td>Fibre Cement or concrete</td>
</tr>
<tr>
<td>Clay or Concrete tiles</td>
</tr>
<tr>
<td>Double lap</td>
</tr>
<tr>
<td>Single lap</td>
</tr>
</tbody>
</table>

Fixing

Dry verge systems should be fixed in accordance with the manufacturer’s recommendations.

Plain tiles should have a tile under-course at the eaves.

Verges should be built so as to provide an upward cant and project beyond the supporting wall or barge-board by a minimum of 38mm.

Undercloak courses of fibre cement board, slate or tile should be neatly bedded in cement based mortar, and neatly jointed in line with the face of the verge.

Plain tile verges should comprise alternate courses of tile and tile and a half widths.

Ridge and verge tiles should be set true to line, securely bedded on a suitably gauged cement based mortar, neatly jointed and double fixed.

Valleys should be made with purpose made tiles or formed in metal, PVC or other durable sheet materials so as to provide a continuous channel. The junction between tiles and valleys should be neatly jointed with a cement-based mortar. Valley tiles should not be laid below the minimum pitch recommended by the manufacturer. Where tiles are used, these should be set true to line, securely bedded on a suitably gauged cement based mortar, neatly jointed and double fixed.

Hips and ridges should be formed with purpose made tiles of appropriate section, these should be set true to line, securely bedded on a suitably gauged cement based mortar, neatly jointed and double fixed.

Flashings should be fixed in accordance with the recommendations of the Lead Sheet Association and not less than the following:

- soakers in Code 3 lead
- flashings in Code 4 lead
- saddles in Code 4 lead
- valley gutters in Code 4/5 lead
- gutters in Code 5 lead.

Generally the length of each piece should not exceed 1.5m.
8.1 Pitched Roofs

In timber frame construction, flashings should allow for up to 30mm in vertical differential movement between the roof surface and abutments such as chimneys, parapets and around pipes.

Mortar for roofing work should be a suitably gauged, cement based mortar (1:3 cement:sand).

Workmanship should comply with BS 8000-6:1990.

FIXING MATERIALS

Non-corrosive nails should be used for fixing slating and tiling e.g. stainless steel, aluminium, copper or bronze. Galvanised nails do not have sufficient durability and should not be used.

Aluminium nails should not be used with timber treated with Copper Chrome Arsenic (CCA).

It is common practice to fix roofing battens with ordinary wire nails. However in coastal areas or other regions having an aggressive atmosphere, corrosion resistant nails should be used (e.g. galvanised wire nails).

Gutters

<table>
<thead>
<tr>
<th>Code No</th>
<th>Maximum length between drips (mm)</th>
<th>Maximum overall Girth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1500</td>
<td>750</td>
</tr>
<tr>
<td>5</td>
<td>2000</td>
<td>800</td>
</tr>
<tr>
<td>6</td>
<td>2250</td>
<td>850</td>
</tr>
<tr>
<td>7</td>
<td>2500</td>
<td>900</td>
</tr>
<tr>
<td>8</td>
<td>3000</td>
<td>1000</td>
</tr>
</tbody>
</table>

Table 8.39: Recommended gutter sizes

AVOIDING LEAKING VALLEY GUTTERS

Valleys are a common source of roof leaks. Ensure that proprietary gutter linings are fixed in accordance with manufacturer’s recommendations. Where valleys are formed by roof pitches that differ by more than 5 degrees the use of preformed valley systems are not generally acceptable. Lead valleys should be used and lead-lined gutters must be:

- Made with code 4 or 5 lead sheets 1.5m long with minimum 150mm lap joints
- Fully supported on boarding
- Dressed to a minimum of 200mm under tiles and sarking felt and dressed over an upstand fillet
- Have a geotextile matting under the lead.

Diagram 8.40: Tapered gutters

Diagram 8.41: Tapered gutters - high points

BOX or HIDDEN GUTTERS

Box gutters should be constructed in accordance with the recommendations of the Lead Development Association.

Tiles adjacent to valleys should be secured by neatly bedding in mortar or using a proprietary dry fixing system.
THATCHED ROOFS - NEW PROPERTIES AND EXTENSIONS

All forms of thatched roofs should only be constructed by a suitably experienced (Master) Thatcher. Work should be in accordance with the following recommendations:

- The recommended type of thatch is Norfolk water reed. Combed wheat straw may be required by some Planning Authorities but is subject to greater maintenance.
- Depth of thatch must be 300 to 375mm or to local conditions.
- Fixings should be mild steel thatching nails.
- Thatch must be under-drawn with a mineral fibre blanket. A metal foil barrier should also be provided beneath the thatch to provide protection during the construction work and to reduce the risk of accumulation of debris within the roof void and consequential increase of fire risk.
- Electrical cables in roof spaces should be mineral insulated copper covered (MICC) or located in a metal conduit.
- Smoke detectors should be provided in the roof space and within the dwelling, together with an audible warning device located on the upper landing.
- Party walls must be fire stopped at junction with the thatch.
- Galvanised wire netting should be provided to prevent entry of vermin. Galvanised wiring should be 19mm net 20 gauge.
- The Developer/Builder must advise the Purchaser that the ridge should be renewed every five years and the roof must subject to an annual inspection and maintenance contract.
- Chimneys should be mortar rendered within the roof space after having ensured that all mortar joints are properly filled and that an appropriate flue lining has been provided.
- Thatching materials must be properly stored and protected prior to, and during, erection.
- A suitable flashing system should be provided within the thatch layer around chimneys and at abutments/changes in level (usually code 4 lead).
- A suitable valley gutter should also be incorporated in the thatch at all valley intersections.
- Television aerials, satellite dishes, etc., should be sited on gable walls (not on chimneys etc.) in order that thatch may not be damaged during cleaning or maintenance of these items.
- The pitch of roof must be not less than 50° (45° permitted for dormers).
- Detailed fire precautions must be carried out as advised by the Building Control Authority. The roof system should incorporate a connected fire barrier which must remain unbroken during fire fighting operations.
- Pea shingle drainage trench must be provided around perimeter of building or paving slabs laid to falls to shingle trench.
- Where a wood burner or a multi fuel appliance is to be installed, the Designer should take great care and attention as to its location due to the extreme temperatures generated over prolonged periods.

Diagram 8.42: Traditional crook fixing
Diagram 8.43: Stainless wire & screw fixing
Additional guidance can be found in the LABC guidance document – ‘The Dorset Model’. Relevant extracts are reproduced below.

The following guidelines are to advise you of certain requirements if you are considering extending or constructing a thatched roof building less than 12m from your boundary.

Each proposal will be considered upon its merits, therefore early consultation with a member of the Building Control staff is recommended.

A uniform approach to thatched buildings is now being advocated across Dorset where compensatory requirements are considered acceptable to achieve compliance with the Building Regulations.

**REQUIREMENTS**

- **Rafters** are to be overdrawn with a minimum 30 minute fire barrier (integrity and insulation) and this barrier should also be water resisting. 50 x 25mm counter battens are recommended on a micro-porous boarding to allow the thatch to breathe. (Dorset Fire and Rescue Service recommend a 60 minute barrier under the thatch for property protection).
- **The chimney**, including the pot, should terminate at least 1.8m above the height of the ridge. Due to the risk of condensation forming as hot gases cool, the chimney pot should be limited to a maximum height of 600mm.
- **A domestic mains and battery powered, interlinked smoke alarm system** will be required with one smoke alarm fitted in the roof void. The system should generally be in accordance with that specified in Approved Document B to B.S. 5839 Pt. 6:2004.
- **A terrace** may not consist of more than three thatched dwellings together.
- The use of intumescent mastic is required to help seal the fire barrier along all its junctions.
- The written comments of the adjoining property owner will be requested by the Local Authority for consideration.

In addition to the measures that may be required by Building Control there are a number of recommendations that you should carefully consider at an early stage.

**RECOMMENDATIONS**

- **The provision of a loft hatch** is recommended for fire fighting purposes. The minimum recommended size is 600mm x 900mm.
- Advice should be sought from an approved electrical contractor regarding the most appropriate type of wiring system. Effects from rodent damage and straw debris need to be considered and the National Inspection Council for Electrical Installation Contracting have issued guidance to their members.
- It is NOT recommended to cut recessed lighting into the ceilings below the thatch. Light fittings within the roof space to be in a bulk head fitting. External floodlights should not be located just under thatch.
- **Spark arrestors on the flues** are NOT recommended because they can clog and restrict the flow of flue gases.
- It is recommended that an external water tap supplied from the rising main, is fitted with a hose capable of reaching all parts of the roof.
- Any metal plumbing in roof space should use compression joints to avoid the use of blow torches.
- In order to achieve a ‘U’ value of 0.2w/m²K for thatched roofs, the following was taken from CIBSE Guide A3: Reed = thermal conductivity 0.09 and a resistivity of 11.1 Straw = thermal conductivity 0.07 and a resistivity of 14.3 This gives a ‘U’ value of 0.2/m²K for 450mm of reed and 350mm of straw. On this basis ceilings may require additional insulation.

Our recommendation is that further advice is sought from the National Society of Master Thatchers [www.nsmtltd.co.uk](http://www.nsmtltd.co.uk).

**CONDENSATION CONTROL IN ROOF SPACES**

**Avoiding Build Up of Condensation in Roof Voids**

Excessive condensation in roof spaces can cause decay of damp susceptible materials such as timber, plaster, etc. and reduce the efficiency of thermal insulation.

Cold bridges should be avoided at roof/wall junctions by ensuring continuity of thermal insulation (see diagrams 8.44 and 8.45).

All extraction fans should terminate to the outside of the building and not within the roof void.

**Venting Pitched Roofs**

Ensure that roof spaces to pitched roofs are vented on two opposite faces by a 10mm continuous ventilation gap (25mm if roof pitch is less than 15 degrees). A proprietary tray should also be provided to ensure that the ventilation is maintained where the roof insulation abuts the eaves (See diagram 8.44).
8.1 Pitched Roofs

CEILINGS (SKIELING) FOLLOWING PITCH OF ROOF

Provide a 25mm continuous ventilation gap along two opposite eaves and provide additional proprietary ridge or tile vents along ridge line to provide additional ventilation area of 5,000mm² per metre run (see diagram 8.45).

Should the air flow be blocked, for example by a roof light, the use of tile vents above and below the blockage should be considered to maintain an air flow.

Pitched roof timbers should be preservative treated where the insulation and ceiling line follow the roof pitch (referred to as a cold pitched roof).

Ensure continuity of the ventilation by preventing the insulation blocking the air flow and maintaining a 50mm air gap between the insulation and the felt. This could be achieved by:

- the use of board fixed to battens between the rafters
- the use of rigid insulation fixed to the sides of the rafters
- or paper backed quilt stapled to the underside of the rafter (see diagram 8.48).

LEAN-TO ROOFS

Examples of lean-to roofs are monopitched roofs, flat roofs and situations where a party wall is located parallel to the ridge.

- Provide 10mm continuous gap at eaves (25mm if roof pitch is less than 15°) and ventilation of 5,000mm² per metre run at ridge level using proprietary ridge or tile vents (10,000mm² run if the roof pitch is less than 15°) (see diagram 8.46).
- Small insulated cold pitched roofs (less than 3m²) do not normally need to be provided with cross ventilation.
- Cross ventilation must be provided to insulated flat roofs or where the ceiling follows the pitch of the roof irrespective of its size. In these cases it may be better to consider an alternative design such as a warm roof or the use of a breathable membrane.

Diagram 8.44: Venting of pitched roof

Diagram 8.45: Venting of cold pitched roof
WARM PITCHED ROOFS

Even with the use of vapour impermeable insulant it is necessary to provide means to allow vapour to exit the system.

The use of a Third Party accredited vapour permeable membrane, when used in accordance with the manufacturer’s’ guidance, negates the need to ventilate above the insulation, which may be difficult in roofs with hips, valleys, roof lights and other roofline interruptions (see diagram 8.47).

Further guidance on the control of condensation in roof spaces can be found in BS 5250:2002 and BRE publication BR 262 "Thermal Insulation: avoiding the risks" 2002 edition.

Diagram 8.46: Venting of mono pitched roofs at eaves and ridge

Diagram 8.47: Warm roof at eaves

Diagram 8.48: Maintaining a 50mm gap over insulation in a cold pitched roof
8.1 Pitched Roofs

Additional Guidance for the use of Vapour Permeable Membranes

Alternatively, condensation in warm and cold pitched roofs may be controlled by the use of a Third Party accredited vapour permeable membrane as the underlay in a non-ventilated system. This approach allows for the escape of water vapour through the membrane and exit freely to atmosphere, via laps in the tiles/slates. This method does not require ventilation at eaves, ridges or mid-slope when used in accordance with the manufacturer’s guidance.

When using Third Party accredited vapour permeable membranes to control condensation in roof spaces, it is important that the manufacturer’s recommendations are followed:

- Particular attention should be given to the fitting of eaves carriers to prevent UV light degradation of the membrane. This will also reduce noise by vibration or ‘flapping’ of the membrane in the gutter.
- The type of roof covering may require the use of ventilation to the batten/counter batten area. Man-made slates and sheet metal profile roof coverings are of particular concern.
- The use of vapour permeable membranes over sarking boards may require the use of ventilation to the batten/counter batten area.
- For guidance refer to diagrams 8.49 and 8.50. A service is usually offered by manufacturers to perform dew point calculations. This will confirm the suitability of the system and compliance with the recommendations in BS 5250:2002.

Diagram 8.49: Vapour permeable membrane at eaves

Diagram 8.50: Vapour permeable membrane at eaves with sloped ceiling
8.2 Flat Roofs

GENERAL

The moisture content of structural timber should not exceed 20% at the time of stress grading and at the time of erection. All structural timber for use within the building fabric should be stress graded marked 'KD' (Kiln Dry) or 'DRY'.

Flat roofs should be designed as one of the following:

- warm deck roof
- inverted roof
- ventilated cold deck roof

A flat roof should have a maximum slope of 10° from the horizontal. "Decking" or "deck" is the substrate of a flat roof or the upper surface of a balcony.

Flat roofs should be laid to a minimum fall of 1 in 40 or to a fall in accordance with manufacturer’s details provided the product has a Third Party accreditation acceptable to Build-Zone.

Where a cold deck roof is used, ensure that a vapour control layer and minimum ventilation are provided in accordance with BS6229:2003. The vapour control layer should be carefully fitted with lapped joints and no perforations (see diagram 8.54).

Glass fibre Reinforced Plastic (GRP) roof systems are acceptable where designed and installed to the manufacturer’s recommendations.

Flat roof construction should comply with the following:

- All roof timbers (with the exception of inverted warm deck roof timbers) to be preservative treated to BS EN 1995-1-1:2004 with all site cut ends treated.
- Weatherproof covering to be hot bonded and consist of 3 layers of high performance felt holding appropriate independent Third Party certificates acceptable to Build-Zone.
- Single layer weatherproofing systems are acceptable with current independent Third Party certificates acceptable to Build-Zone.
- Chipboard must not be used as a decking material (exterior quality WBP plywood is recommended).
- Work on site should comply with BS 8000-4:1989.
- Flat roofing systems should not be laid during wet weather or when the roof deck has not fully dried out.
- Metallic roof trims should be of a non-corrodible material and resistant to sunlight. In addition to the manufacturer’s recommended fixings, roof trims should be fixed within 30mm from any joint.
- All flat roofing systems should be provided with an accredited minimum 10 year Insurance Backed Guarantee (IBG) for both materials and workmanship.

VENTING FLAT ROOFS

Warm deck flat roofs should be used in preference to cold deck flat roofs (see diagrams 8.54 and 8.56). Cold deck flat roofs are not permitted in Scotland.

Where cold deck flat roofs are used, the roof void should be vented along two opposite faces by a 25mm continuous gap and a vapour control layer provided to the warm side of the insulation (see diagram 8.55).

Where the span of cold deck flat roofs exceeds 5m, additional provision for ventilation should be made at mid-span using proprietary roof ventilators providing a ventilation area of not less than 50% of the required rate for perimeter ventilation. The type and thickness of flat roof decking should be not less than as set out in table 8.52.
Diagram 8.51: Warm deck flat roofs – details at eaves and verge. See also diagram 8.53 for more details

<table>
<thead>
<tr>
<th>Type of decking</th>
<th>Recommended deck thickness (mm) and joist centres 450</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preservative treated softwood boarding</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Orientated Strand Board type 3 or 4 BS EN 300:2006</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>WBP bonded plywood to BS EN636:2003</td>
<td>12</td>
<td>15-16</td>
</tr>
<tr>
<td>Cement bonded particle board to BS EN 634-1:1995</td>
<td>51mm thick type SB</td>
<td></td>
</tr>
</tbody>
</table>

Thickness and spans are recommended and not a minimum. Recommendations for specific plywood grades issued by the American Plywood Association, Council of Forest Industries or Finnish Plywood International may allow greater spans. In all cases, fixing and other recommendations of these associations should be followed.

Spans shown apply to warm and cold deck roofs accessible for maintenance only. Deck thickness for inverted roofs is directly related to the weight of the top surface and should be in accordance with the manufacturer’s recommendations.

Roof timbers to flat roofs should be preservative treated with cut ends dipped or liberally brushed.

**Table 8.52: Flat Roof Construction**

**Venting Junctions at Pitched And Flat Roofs**

Provide 25mm ventilation to eaves of cold deck flat roof and 10mm to eaves of pitched roof, ensuring continuity of ventilation at the flat roof/pitched roof junction (see diagram 8.55). In the case of a warm deck flat roof (which is not ventilated) abutting a pitched roof, provide tile vents adjacent to the roof junction to give a ventilation area of 10,000mm² per metre run (see diagram 8.56).
8.2 Flat Roofs

Diagram 8.53: Typical warm deck flat roof

Diagram 8.54: Venting of cold deck flat roof
8.2 Flat Roofs

Diagram 8.55: Venting of pitched/cold deck flat roof junction

Diagram 8.56: Venting of pitched/warm deck flat roof junction
8.3 Rainwater Gutters and Downpipes

ENSURING DOWNPIPES DISCHARGE DIRECTLY TO A DRAIN

Rainwater downpipes should not discharge directly onto adjacent flat roofs or gutters as this can cause dampness and staining of walls and early failure of flat roof surfaces.

Downpipes should discharge directly to a drain or gully (gullies must be trapped), not on to gardens, paths, drives or highways.

During construction downpipes should be fully connected as early as possible to a drain in order to avoid rainwater discharge weakening the strength of the foundation subsoil.

AVOIDING OVERFLOWING RAINWATER GUTTERS

Where appropriate, rainwater gutters and downpipes can be sized in accordance with the Building Regulations or BS EN 12056-2:2000.

Diagram 8.57: Location of downpipes

Diagram 8.58: Location of downpipes – corners

PROVISION OF GUTTERS AND DOWNPIPES

Roofs greater than 6m² in area should be provided with rainwater gutters and downpipes. Consideration should also be given to the provision of rainwater drainage to roof areas less than 6m², e.g. dormer and porch roofs.

Discharge of gutters into downpipes can be substantially improved by careful location of downpipes e.g.:

- Where more than one downpipe is required, locating downpipes at end quarter positions will double the flow capacity (see diagram 8.57).
- Where changes in the line of the gutter occur, the downpipe should be located within 200mm of the change in direction in order to maintain the flow capacity of the gutter (see diagram 8.58). Where thermal or differential movement joints are placed within the superstructure

GUIDANCE FOR DESIGN OF GUTTERS

Gutters and water run-off should be designed in conjunction with the relevant Approved Documents.

First calculate the area of roof to be drained (see table 8.59).

Next decide which gutter size is appropriate for the designed roof plan area (see table 8.60).
Avoiding Deformed Gutters and Downpipes

Gutters must not have a back fall or be designed with no fall. Gutters should instead slope towards downpipes preferably at a 1 in 350 fall. If this not possible, additional down pipes should be provided.

Gutters and downpipes should be fixed at centres as recommended by the manufacturer. Typically gutters require brackets at 800 – 1000mm centres and downpipes at 1800 – 2000mm centres.

Downpipes should not be located closer than 300mm to balanced flue outlets.

Avoiding Leaking Internal Gutters

Internal gutters and associated gutter outlets are common sources of roof leaks. For this reason, wherever possible, internal gutters should be avoided. If this is not possible, rainwater should drain to the outer edge of the roof and discharge into an external rainwater gutter.

Avoiding Ponding on Flat Roof Surfaces

Rainwater should efficiently discharge to a gutter without causing ponding of the roof surface. If ponding occurs, the life of the weatherproof membrane may be reduced.

PROVIDE A MINIMUM 1:40 FALL FOR FLAT ROOF DECKING

Although slopes as low as 1:80 provide flat roofs with an adequate self draining fall, in practice greater falls are necessary in order to accommodate inaccuracies in levels of supporting walls and the permanent deflection of the roof structure under its own weight.

ENSURE THAT RAINWATER DISCHARGES EFFECTIVELY INTO ROOF GUTTERS

Flat roof drips should extend to the middle of the rainwater gutter and a minimum 50mm turndown provided.

Verges to flat roofs should be provided with a minimum 50mm upstand in order to prevent blown water spilling over non draining edges.

<table>
<thead>
<tr>
<th>Type of surface effective design area (m²)</th>
<th>Max effective roof area (m²)</th>
<th>Gutter Size (mm dia)</th>
<th>RWP outlet Size (mm dia)</th>
<th>Flow Capacity (litres/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paved areas - plan area</td>
<td>6.0</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Flat roof plan - area of roof</td>
<td>18.0</td>
<td>75</td>
<td>50</td>
<td>0.38</td>
</tr>
<tr>
<td>30° roof pitch – plan area x 1.29</td>
<td>37.0</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45° roof pitch – plan area x 1.50</td>
<td>53.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60° roof pitch – plan area x 1.87</td>
<td>65.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70° roof pitch – elevational area x 0.5</td>
<td>103.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.59 – Calculation of roof area

Table 8.60 – Gutter sizes and outlet sizes
8.4 Balconies

GENERAL

Balconies should comply with the following:

- Balconies functioning as roofs must have adequate rainwater disposal to a suitable outfall.
- Balconies and flat roofs to which persons have regular access other than for maintenance must be guarded adequately.
- Balconies and flat roofs including associated elements such as support and guarding must be designed to resist the applied loading and should be calculated in accordance with BS EN 1991-1-4:2005 and have adequate durability.
- Structural design must be undertaken to a recognised standard to ensure that loads are transmitted to the supporting structure without undue movement and should be in accordance with BS EN 1995-1-1:2004 and BS 8103-3:2009 for timber and BS EN 1992-1-1:2004 for concrete.
- The durability of the structure should be 60 years.

The use of timber in balconies should be limited to secondary elements which are in turn are supported by materials other than timber. Timber can be used in the following circumstances:

- Cantilevered solid timber joist balconies with a waterproof membrane above the joist
- Open balcony constructions with timber decking.

The decking may be supported on solid timber joists which are supported by materials or components other than timber balustrading.

Timber should not be used for:

- Gallows brackets supporting a balcony
- Posts or columns supporting a balcony
- Guard rails or their support.

GUARDING TO BALCONIES

Guarding should be provided to the perimeter of all balconies, unless the drop is less than 600mm. The minimum height of guarding should be 1100mm and should be designed as follows:

- The balustrade should not be easily climbed.
- No opening in the balustrade should be large enough for a 100mm diameter sphere to pass through.
- Any glazing should be toughened or laminated glass or glass blocks. Wired glass is not safety glass and should not be used.
- Balustrading should not be fixed through the weatherproofing unless special precautions are taken.

FALLS

Balconies should be designed to have a fall of not less than 1:40. To ensure that balconies and flat roofs have an adequate finished fall of 1:80, twice this figure (1:40) should be used for design purposes unless a detailed analysis of the roof is carried out, including overall and local deflections.

Falls should be away from and parallel to the dwelling.

Suitably drained decking may be incorporated above the waterproofing but less than 150mm below the sill.

Where a balcony or flat roof has an upstand on all sides, an overflow outlet should be provided through the parapet walls or perimeter upstands to prevent build-up of water.

The size of the overflow should be the same size as the outlets (see diagram 8.61).

Movement joints should be allowed for in the design of parapet walls.
Diagram 8.61: Balcony Falls

- fall away from door
- fall
- outlet
- overflow
- dimension at least 1\(\text{\textdegree}\)20mm
- at least 50mm
- fall not less than 1:40 (for design purposes)