**BRITISH STANDARD**

**BS 5268-3:2006**

*Incorporating corrigendum no. 1 and corrigendum no. 2*

# Structural use of timber —

## Part 3: Code of practice for trussed rafter roofs

ICS 91.060.20; 91.080.20



British Standards

# Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee, B/525, Building and civil engineering structures, to Subcommittee B/525/5, Structural use of timber, upon which the following bodies were represented:

APA — The Engineering Wood Association
British Woodworking Federation
CTE — Centre for Timber Engineering
HSE — Health and Safety Executive
Institution of Civil Engineers
Institution of Structural Engineers
National House-building Council
ODPM — Building Division
ODPM (represented by BRE — Building Research Establishment)
Scottish Building Standards Agency
Timber Research and Development Association
Timber Trade Federation
Trussed Rafter Association
United Kingdom Forest Products Association
Co-opted members

The following bodies were also represented in the drafting of the standard, through a Working Group:

DEFRA — Northern Ireland
ODPM — British Board of Agrément
Glued Laminated Timber Association

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| 16541 Corrigendum No. 1 | 31 July 2006 | Correction to formatting errors at the printing stage |
| 16972 Corrigendum No. 2 | 28 February 2007 | Correction to equation on page 20 |
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# Contents

# Foreword

This part of BS 5268 has been prepared by Subcommittee B/525/5. It supersedes BS 5268-3:1998, which is withdrawn.

Other parts of this British Standard code of practice are as follows:

— *Part 2: Code of practice for permissible stress design, materials and workmanship;*

— *Part 4: Fire resistance of timber structures*

— *Section 4.1: Recommendations for calculating fire resistance of timber members;*

— *Section 4.2: Recommendations for calculating fire resistance of timber stud walls and joisted floor constructions;*

— *Part 5: Code of practice for the preservative treatment of structural timber;*

— *Part 6: Code of practice for timber frame walls*

— *Section 6.1: Dwellings not exceeding four storeys;*

— *Part 7: Recommendations for the calculation basis for span tables.*

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

The primary reason for producing this revised standard has been the need to implement new European Standards, and the wish to extend the range of standard bracing solutions contained in Annex A. Standard bracing solutions are now provided for roof spans up to 17 m, extending the previous limit from 12 m, and guidance on the design of bracing systems beyond the scope of these standardized solutions has also been moved to Annex A, such that it now deals with all aspects of roof bracing design.

Where necessary new definitions have been added and changes made to the design provisions in Clause **6**, either to clarify the existing design guidance, or update it in line with recent research or current industry best practice. Finally new harmonized European Standards covering, for example, timber connectors and timber structures manufactured using punched metal plate fasteners have been implemented, by suitable reference in the appropriate clauses.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Annex A and Annex B are normative.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

**Summary of pages**

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 66, an inside back cover and a back cover.

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## Introduction

For the purposes of this part of BS 5268 trussed rafters are assumed to be made from timber members of the same thickness fastened together in one plane by metal plate fasteners or plywood gussets. The metal plate fasteners may be either punched metal plates with integral teeth or plates with holes, through which single nails are driven into the timber. The plywood gussets may be nailed or glued to the timber members. Trussed rafters normally span between external load-bearing walls without the need for intermediate supports from internal walls, lintels or purlins. Ridge boards are not required, but adequate bracing of the whole roof and satisfactory connections to the supporting structure are essential to ensure overall stability.

The design of trussed rafters and trussed rafter roofs is based on the results of extensive research and testing and on experience gained with the use of trussed rafter roofs in the United Kingdom and other countries. Design should be entrusted to chartered civil or structural engineers, or other suitably qualified persons experienced in timber engineering. The fabrication and erection of trussed rafters should be carried out under competent supervision.

## 1 Scope

This part of BS 5268 provides guidance on the design, fabrication and use of trussed rafters for roofs in service classes 1 and 2 as defined in **3.1** and **3.2**.

Guidance is provided on structural analysis methods, engineering design criteria and design by testing. Performance requirements for roof bracing are given, together with standard bracing arrangements for domestic scale roofs. Production requirements are also given for truss manufacture, along with guidance on their handling, storage and erection. Maximum spans for two common truss configurations for a range of member sizes and roof pitches are given, based on extensive tests.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 1230-1, *Gypsum plasterboard — Part 1: Specification for plasterboard excluding materials submitted to secondary operations.*

BS 4978, *Specification for visual strength grading of softwood.*

BS 5268-2, *Structural use of timber — Part 2: Code of practice for permissible stress design, materials and workmanship.*

BS 5268-5, *Structural use of timber — Part 5: Code of practice for the preservative treatment of structural timber.*

BS 5534, *Code of practice for slating and tiling (including shingles).*

BS 6100-4, *Glossary of building and civil engineering terms — Part 4: Forest products.*

BS 6399-1, *Loading for buildings — Part 1: Code of practice for dead and imposed loads.*

BS 6399-2, *Loading for buildings — Part 2: Code of practice for wind loads.*

BS 6399-3, *Loading for buildings — Part 3: Code of practice for imposed roof loads.*

BS 6446, *Specification for manufacture of glued structural components of timber and wood based panel products.*

BS 8103-1, *Structural design of low-rise buildings — Part 1: Code of practice for stability, site investigation, foundations and ground floor slabs for housing.*

BS 8212, *Code of practice for dry lining and partitioning using gypsum plasterboard.*

BS EN 301, *Adhesives, phenolic and aminoplastic for classification and performance requirements.*

BS EN 336, *Structural timber — Coniferous and poplar — Sizes — Permissible deviations.*

BS EN 385, *Finger jointed structural timber — Performance requirements and minimum production requirements.*

BS EN 595, *Timber structures — Test methods — Test of trusses for the determination of strength deformation behaviour.*

BS EN 10088-2, *Stainless steels — Part 2: Technical delivery conditions for sheet/plate and strip for general purposes.*

BS EN 10326, *Continuously hot-dip coated strip and sheet of structural steels — Technical delivery conditions.*

BS EN 14081-1, *Timber structures — Strength graded structural timber with rectangular cross section — Part 1: General requirements.*

## 3 Terms, definitions and symbols

For the purposes of this part of BS 5268 the terms and definitions given in BS 6100-4 and the symbols given in BS 5268-2 and the following apply.

**3.1**
**service class 1**
service class characterized by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air only exceeding 65% for a few weeks per year

NOTE In service class 1 the average equilibrium moisture content in most softwoods will not exceed 12%.

**3.2**
**service class 2**
service class characterized by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air only exceeding 85% for a few weeks per year

NOTE In service class 2 the average equilibrium moisture content in most softwoods will not exceed 20%.

**3.3**
**trussed rafter**
structural assemblage of timber members of the same thickness, fastened together in one plane by metal plate fasteners or plywood gussets

**3.4**
**principal trussed rafter**
trussed rafter upon which the integrity of the roof structure depends, e.g. girder trusses

**3.5**
**girder truss**
multiple trussed rafter that

a) supports a width of roof greater than 2½ times the normal truss spacing within the roof or greater than 1.5 m whichever is the lesser or

b) directly supports other trusses or

c) supports another girder

**3.6**
**attic truss**
trussed rafter which is designed to allow a habitable room within the roof space

**3.7**
**wind girder**
horizontal lattice trussed rafter designed to transmit external wind forces from the head of the wall back to effective restraints which can transfer these loads to the ground

**3.8**
**chord member**
member on the external profile of the truss (e.g. a rafter or a ceiling tie)

**3.9**
**rafter member**
chord member which is restrained against lateral or torsional buckling at intervals no greater than 400 mm (e.g. by battens or sarking boards)

**3.10**
**node**
point of intersection of members on the analytical model (see Figure 1)

**3.11**
**bay**
length of a member measured between adjacent nodes (see Figure 1)

**3.12**
**fastener bite**
distance from the joint member interface to the furthest effective anchorage point on a chord member, measured perpendicular to the joint interface (see Figure 2)

**3.13**
**common production end**
one (consistent) end, with respect to the production jig, of a batch of like trusses

**3.14**
**metal plate fastener**
fastener made of metal plate having integral holes through which single nails are driven, or integral teeth punched out in one direction and bent perpendicular to the base of the plate, being used to join two or more pieces of timber of the same thickness in the same plane

**3.15**
**width**
greater of the two transverse dimensions in a rectangular section

## 4 Assessment of structural adequacy

The following methods of establishing the structural adequacy of trussed rafters are equally acceptable, subject to the limitations given in this part of BS 5268.

a) Calculations based on the methods of analysis and engineering design criteria given in clause **6**, using data on material properties and joint strength characteristics given in BS 5268-2 or a national technical specification (e.g. a certificate from the British Board of Agrément, BRE Certification or BM TRADA), or derived and declared in accordance with prEN 14545 when it becomes a full national standard (BS EN 14545[1)]).

b) Load testing of trussed rafters in accordance with the test method described in BS EN 595 and the acceptance criteria described in **10.6** of this part of BS 5268.

c) Fabrication and use in accordance with Annex B.

## 5 Materials

### 5.1 Timber

#### 5.1.1 *Species*

The species of timber used in the fabrication of trussed rafters should be capable of forming satisfactory joints and adequate data should be available to permit safe joint design. Some of the species of timber suitable for trussed rafter construction are listed in Table 1.

[1)] Currently still a draft European Standard. To be published by CEN as EN 14545 and adopted in the UK as BS EN 14545.

**Table 1 — Species of timber**

| Standard name | Origin |
|---|---|
| Whitewood (imported)<br>Redwood (imported) | Europe |
| Hem-fir<br>Douglas fir-larch<br>Spruce-pine-fir | Canada |
| Southern pine<br>Hem-fir<br>Douglas fir-larch | USA |
| Scots pine<br>Corsican pine | United Kingdom |
| Radiata pine | New Zealand<br>Chile |

**5.1.2** ***Grades***

All timber used in the fabrication of trussed rafters should be strength graded prior to fabrication in accordance with BS 4978, BS EN 14081-1 or as recommended in BS 5268-2. In addition to the specified strength grade requirements, timbers should meet the following visual criteria, as defined in BS 4978, relating to a moisture content of 20%.

| | |
|---|---|
| Spring: | 4 mm maximum per 2 m length. |
| Bow: | 10 mm maximum per 2 m length. |
| Twist: | 1 mm maximum per 25 mm width per 2 m length. |
| Cup: | 2 mm maximum per 100 mm of face. |
| Wane: | Up to a maximum of a quarter of the thickness or width of the piece over the full length, or a third of the thickness or width of the piece in any 300 mm length. |
| Fissures: | a) Fissures less than half the thickness may be disregarded.<br>b) Fissures greater than half the thickness are only permitted at the ends and for a length not greater than the width of the piece. |

All timber resawn from strength graded stock should be regraded before use.

NOTE Additional requirements concerning the location of knots, wane and fissures which should be considered during timber selection are given in **8.2**.

**5.1.3** ***Sizes***

Timber should be sized in accordance with BS EN 336 with permitted deviations not exceeding those for tolerance class 2. In addition the target sizes for chord members should be not less than 72 mm in depth for members of at least 35 mm thickness and not less than 69 mm in depth for members of at least 38 mm thickness, related to a moisture content of 20%. Similarly the target size for internal web members should be not less than 60 mm in depth irrespective of thickness, related to a moisture content of 20%.

**5.1.4** ***Finger jointed timber***

Finger jointed timber may be used in the manufacture of trussed rafters provided it conforms to the recommendations in BS 5268-2. Finger joints should not be used in principal trussed rafters. The finger joints should be manufactured in accordance with BS EN 385 using adhesives which conform to the Type I specification, as defined in BS EN 301.

Where trussed rafters are designed with randomly finger jointed timber and punched metal plate fasteners with integral teeth, allowance should be made for a finger joint to occur within the area of a fastener. In such cases, for fasteners having teeth with an average length not greater than 15 mm, the efficiency rating of the finger joint in bending and tension should be multiplied by the appropriate modification factor given in Table 2. This reduced efficiency rating should be not less than:

a) the efficiency rating recommended in BS 5268-2 for timber of the strength grade specified in the trussed rafter design; or

b) the efficiency rating required to make the sum of the stress ratios of actual to permissible stress less than or equal to 1.0 at any position where a finger joint may occur.

**Table 2 — Modification factors for finger joint efficiency ratings**

| **Finished thickness of timber**[a] mm | **Modification factor** | |
|---|---|---|
| | **Finger profile**<br>**Length** 15 mm<br>**Pitch** 3.8 mm<br>**Tip width** 0.5 mm | **All other finger profiles** |
| 35 | 0.80 | 0.70 |
| 47 | 0.85 | 0.80 |

[a] Linear interpolation for other thicknesses is permitted.

The efficiency ratings for finger joints subject only to axial compression need not be reduced.

NOTE Efficiency ratings for some common profiles of finger joints are given in BS 5268-2.

## 5.2 Plywood

**5.2.1** ***Grades***

Any of the types and grades of plywood for which grade stresses are published in BS 5268-2, except the American C-D grade, are suitable for gussets for trussed rafter construction. The particular type and grade of plywood assumed in the design of the joints should be specified.

**5.2.2** ***Glued plywood gussets***

In addition to conforming to the requirements of the particular type and grade of plywood specified in BS 5268-2, both faces of plywood to be used for glued gussets should have a solid repaired surface.

## 5.3 Fasteners

**5.3.1** ***Nails and bolts***

All nails and bolts used in trussed rafter roof construction, including those used with metal plate fasteners or plywood gussets, should either be inherently corrosion resistant or coated protectively by hot-dip galvanizing, sherardizing or other types of corrosion protection that give the same level of performance to Fe/Zn 12c.

NOTE If hot dip zinc coating is used, Fe/Zn 12c should be replaced by Z275 in accordance with BS EN 10326.

#### 5.3.2 *Metal plate fasteners*

Metal plate fasteners should be manufactured from hot-dip zinc coated steel sheet or coil of a grade defined in BS EN 10326, or austenitic stainless steel of a grade defined in BS EN 10088-2. In addition the hot-dip galvanized steel should have a maximum ultimate tensile strength of 450 N/mm$^2$ and a minimum elongation of 20% over an 80 mm gauge length. Metal plate fasteners should not be less than 0.9 mm and not more than 2.5 mm in thickness and should bear a mark that readily identifies the producer or supplier and type of plate.

Metal plate fasteners should possess a minimum corrosion protection specification equivalent to hot-dip zinc coating Z275 of BS EN 10326 or should be manufactured from stainless steel.

The fastener manufacturer should maintain a third party quality control system to ensure a satisfactory standard of product with respect to quality of steel, plate and coating thickness and tooth profile.

### 5.4 Adhesives

The adhesives used for glued plywood gusset joints and for finger joints in members should conform to the Type I specification as defined in BS EN 301.

Special precautions may be necessary when gluing timber treated with a wood preservative or flame retardant. The species of timber, adhesive and wood preservative or flame retardant should be compatible.

NOTE Guidance on the fabrication of glued assemblies can be found in BS 6446.

### 5.5 Preservative treatment

The risk of rot or insect attack in timber of well ventilated pitched roofs is regarded by BS 5268-5 as low, except in those areas specified in the Building Regulations [1] (applicable to England and Wales), the Building Standards Scotland [2] and the Building Regulations (Northern Ireland) [3] as subject to infestation by the house longhorn beetle (*Hylotrupes bajulus L*).

The type of preservative used should neither increase the risk of corrosion of metal plate fasteners or nails, nor adversely affect glued joints. The recommendations given in BS 5268-5 should be followed.

Where cross cutting is carried out after treatment, all sawn ends should be given the appropriate treatment required by the relevant preservative or treatment specification before assembly.

Since metal plate fasteners may be pressed into the timber shortly after treatment, organic solvent type preservatives together with the new generation of water-borne organic wood preservatives are readily suited to the production methods used for trussed rafters.

NOTE More information on the range of preservative products available is given in BS 8417.

Galvanized metal plate fasteners and nails should not be used in timber which has been treated with a flame retardant unless the formulation is a non-salt (i.e. organic) type.

## 6 Trussed rafter design

### 6.1 General

Trussed rafters should support safely, without excessive deflection, the dead and imposed loads specified in BS 6399-1, the imposed roof loads specified in BS 6399-3 and the wind loads specified in BS 6399-2. In addition, they should be capable of resisting, without damage, the forces and deflections arising from transportation and erection, assuming that reasonable care is exercised during these operations.

The design of trussed rafters should be based on the following assumptions:

a) the dead and imposed loads and the forces due to wind act in the plane of the trussed rafter;

b) members are initially straight and are restrained in a straight condition in the completed roof structure;

c) trussed rafters are erected and maintained in a vertical position, parallel to each other, at the correct spacing with restraint against lateral movement.

A general method of structural analysis for trussed rafters is given in **6.5**, along with an optional simplified method for triangulated frameworks. Maximum spans for two common configurations of monopitch and duopitch trusses, based on extensive tests, are given in Annex B for a range of member sizes and roof pitches. Where their specific conditions of use are satisfied, these spans may be used without further calculations or proof testing and should not be exceeded even when larger spans can be justified by structural calculation.

The trussed rafter designer is responsible for designing and detailing individual trussed rafters in accordance with the recommendations of Clause **6**. In order to carry out this task, the trussed rafter designer should receive the information listed in **11.1** and in return provide the information listed in **11.2**.

### 6.2 Limitations

To take account of practical factors such as handling, the size of members and span need to be restricted and the following limits should be observed. Where necessary, intermediate values may be obtained by linear interpolation.

a) The target thickness of trussed rafters should be a minimum of 35 mm up to 11 m span and 47 mm for 16 m span. Within and above this range of spans the minimum thickness should be obtained by linear interpolation or extrapolation. The thickness may be made up from appropriate timber or multiple trussed rafters consisting of two or more trussed rafters, each not less than 35 mm thick, and permanently fastened together at the manufacturer's works.

b) The maximum bay length of any rafter or ceiling tie member, when measured on plan on the lower-edge position, should not exceed the appropriate value given in Table 3. These limits may be increased by 50% when applied to rafter extensions such as eaves overhangs or hip flying rafters.

c) The overall length of any internal member should not exceed the appropriate value given in Table 4. The lengths are the actual cut length as measured on the centre-line of the member. This restriction is supplementary to that determined by the slenderness ratio of internal members subject to compressive forces, as calculated in **6.5.5**.

NOTE The lengths referred to above and in Table 3 and Table 4 are not those shown in Figure 1. The lengths shown in Figure 1 are those used in the design of the members.

**Table 3 — Maximum bay length of chord members**

| Depth of member | Maximum length[a] (measured on plan between node points) | | | |
|---|---|---|---|---|
| | 35 mm thick | | 47 mm thick | |
| | Rafter | Ceiling tie | Rafter | Ceiling tie |
| mm | m | m | m | m |
| 72[b] | 1.9 | 2.5 | 3.3 | 3.3 |
| 97 | 2.3 | 3.0 | 3.6 | 4.3 |
| 120 | 2.6 | 3.4 | 3.9 | 5.0 |
| 145 | 2.8 | 3.7 | 4.1 | 5.3 |

[a] Linear interpolation may be used for intermediate timber sizes.

[b] The maximum bay length for 35 mm by 72 mm timber should also apply to 38 mm by 69 mm timber.

**Table 4 — Maximum length of internal members**

| Depth of member mm | Maximum length[a] (measured on plan between node points) | |
|---|---|---|
| | 35 mm thick m | 47 mm thick m |
| 60 | 2.4 | 3.5 |
| 72[b] | 3.6 | 5.2 |
| 97 | 4.5 | 6.0 |

[a] Linear interpolation may be used for intermediate timber sizes.
[b] The maximum bay length for 35 mm by 72 mm timber should also apply to 38 mm by 69 mm timber.

## 6.3 Permissible stresses, fastener loads and nail spacing

### 6.3.1 *Stresses*

The grade stresses for plywood and timber, including that which is finger jointed in accordance with **5.1.4**, should be those given in BS 5268-2 for service class 2 and the particular strength grade and species or strength class used. These grade stresses should be modified in accordance with BS 5268-2.

### 6.3.2 *Joints*

The permissible loads for all jointing devices should take account of the effects of gaps permitted between abutting members, the orientation of the teeth or nails with respect to grain and the angle of load to grain and teeth.

Permissible loads for metal plate fasteners with integral teeth or separate nails should be determined from tests carried out on actual joints. Further testing is not necessary where design data derived from such tests is published in a British Standard, a British Board of Agrément Certificate or is derived and declared in accordance with prEN 14545, when it becomes a full national standard (BS EN 14545[2)]). For metal plate fasteners with integral teeth, where testing and assessment has been carried out in accordance with prEN 14545, the characteristic anchorage strength properties should be divided by 2.5, and the characteristic steel strength properties (tension, compression and shear) should be divided by 1.75, to arrive at long-term permissible design values appropriate for use with this standard.

Alternatively for metal plate fasteners with separate nails and nailed plywood gussets the appropriate nail loads and spacings in BS 5268-2 should be used. However, tests have shown that for 1 mm thick metal plate fasteners nailed with 3.35 mm × 30 mm round wire nails or 3.75 mm × 30 mm square twisted nails the minimum nail spacings given in Table 5 are satisfactory and may be used in preference to those in BS 5268-2.

**Table 5 — Minimum nail spacing for metal to timber joints[a]**

| Spacing[a] | Distance[b] |
|---|---|
| End distance parallel to grain | 10*d* |
| Edge distance perpendicular to grain | 5*d* |
| Distance between lines of nails, perpendicular to grain | 7*d* |
| Distance between adjacent nails in any one line, parallel to grain | 10*d* |

[a] The spacings given are suitable for 1 mm thick metal plate fasteners nailed with 3.35 mm × 30 mm round wire or 3.75 mm × 30 mm square twisted nails only.
[b] Where *d* is the nail diameter in millimetres (mm).

[2)] Currently still a draft European Standard. To be published by CEN as EN 14545 and adopted in the UK as BS EN 14545.

## 6.4 Loads

### 6.4.1 *Dead loads*

An estimate should be made of the actual dead load acting on the trussed rafter. Where the common type of concrete interlocking tile is used, the dead load on the rafter members should be taken as 0.685 kN/m$^2$ measured along the slope. This consists of 0.575 kN/m$^2$ for the weight of the tiles and 0.110 kN/m$^2$ for the combined weights of felt, battens and rafter. Where sarking boards are used, in the absence of more detailed information a minimum additional dead load allowance of 0.1 kN/m$^2$ should be used.

The normal dead load on a ceiling tie carrying 12.5 mm plasterboard and common types of insulation, including self weight, should be taken as 0.25 kN/m$^2$. In addition, unless there is specific information to the contrary, allowance should be made for a water tank (see **7.5**), the concentrated loads to apply at each of the two ceiling tie node points nearest the tank in each trussed rafter. These loads are summarized in Table 6 and Table 7.

To recognize the possibility of future change of use of domestic trussed rafters, for any trussed rafter having an attic truss configuration, the designer should apply to the habitable room area a minimum long term imposed load of 1.5 kN/m$^2$ and an appropriate dead load which should include an allowance for partitions. In the absence of detailed loading information a minimum floor dead load allowance of 0.55 kN/m$^2$ should be used.

Account should also be taken of the weight of any plant or special services which are supported permanently by the trussed rafters.

When calculating uplift forces, all dead loads should be assessed at their minimum values.

**Table 6 — Summary of rafter loads**

| Type | Load | Position on rafter | Duration |
|---|---|---|---|
| 1 | *Dead* | | |
| | See **6.4.1** | Full length | Long-term |
| 2 | *Imposed* | | |
| | Uniformly and asymmetrically distributed loads as specified in BS 6399-3 | As described in BS 6399-3 dependent upon load type | Medium-term[a] |
| 3 | 0.9 kN concentrated load as specified in BS 6399-3 | Centre of any rafter bay and on unsupported overhangs ≥ 600 mm (see **6.4.2**) | Short-term |
| 4 | *Wind* | | |
| | Wind calculated according to BS 6399-2 | Full length | Very short-term |

[a] In the case of local drifted snow loadings reference should be made to BS 5268-2 regarding modifications to grade stresses and and fastening loads.

**Table 7 — Summary of ceiling tie loads**

| Type | Load | Position on ceiling tie | Duration |
|---|---|---|---|
| 5 | *Dead* | | |
| | See **6.4.1** | Full length | Long-term |
| | plus | | |
| 6 | 2 × 0.45 kN concentrated loads for 300 l or 230 l water tanks or 2 × 0.675 kN for 450 l water tank or actual load if greater — see Figure 7 | At two nodes nearest water tank | Long-term |
| | plus | | |
| | Plant and special services | As appropriate | Long-term |
| 7 | *Imposed* | | |
| | 0.25 kN/m$^2$ UDL | Full length | Long-term |
| 8 | 0.9 kN concentrated load | Centre or either end of any ceiling bay (see **6.4.4**) | Short-term |
| NOTE The weight of water tanks and their contents together with any other permanent plant or special services should be considered as dead load in accordance with BS 6399-1. | | | |

**6.4.2** ***Imposed and wind loads***

Where no access is provided to a roof (other than that necessary for cleaning or repair) the imposed loads applicable to rafter members are specified in BS 6399-3. However, for roof pitches greater than 30° the specified concentrated load may be disregarded.

The imposed loads specified in BS 6399-1 for ceiling tie members are a uniformly distributed load of 0.25 kN/m$^2$ over the whole ceiling area and a concentrated load of 0.9 kN placed in order to produce maximum stresses in the affected members. Additionally unsupported eaves overhangs ≥ 600 mm in length measured on plan should be designed to carry a concentrated load of 0.9 kN 300 mm from the tip of the overhang measured on plan. In exceptional circumstances, where no access to the roof space is provided, both the uniformly distributed and concentrated imposed loads may be disregarded.

The wind loads acting on roofs should be calculated in accordance with BS 6399-2. These loads are summarized in Table 6 and Table 7.

**6.4.3** ***Handling load***

In addition to the service loads, trussed rafters will be subjected to handling loads during transportation and erection. To take account of this, joints between members should be capable of sustaining a short-term force of 1.5 kN in any direction in the plane of the trussed rafter.

**6.4.4** ***Load combinations***

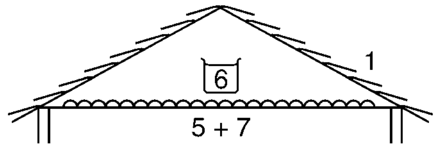
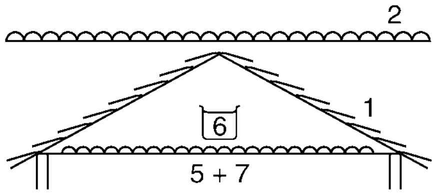
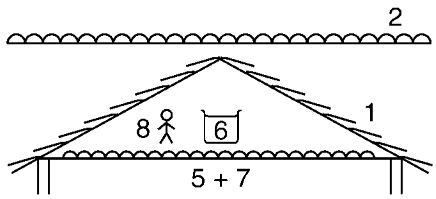
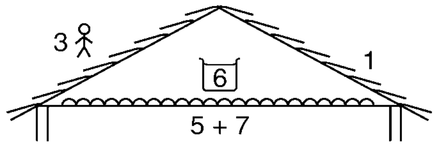
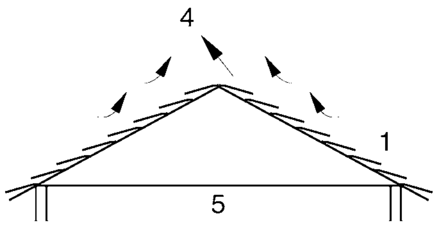
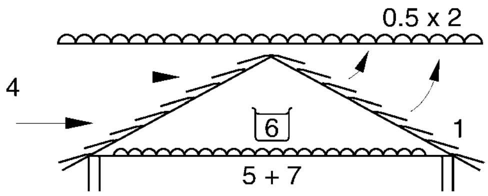
As a minimum for all trussed rafters, the load combinations which should be considered in design are summarized in Table 8 and illustrated for a duopitch configuration. Due account should be taken of the different durations of loading in accordance with BS 5268-2.

Load type 3 should be assumed to act at the centre of the rafter bay in which it produces the most adverse effect. Load type 8 should be assumed to act either at the centre of a ceiling tie bay or at a node point, whichever produces the most adverse effect. For load types 3 and 8 in a load-sharing system it may also be assumed that 75% of this concentrated load is supported directly by the chord member to which it is applied, the remainder being carried by neighbouring trussed rafters due to load distribution through the plasterboard or other equivalent boarding attached to the chord member.

When calculating uplift forces no allowance should be made for any imposed loads, and dead loads should be assessed at their minimum values. The dead load due to the roof covering may be taken into account, provided that the covering is adequately fixed to the supporting structure to prevent removal by wind suction.

**Table 8 — Example load combinations**

| Case | Duration | Loads[a] | | Illustration |
|---|---|---|---|---|
| | | Rafter | Ceiling tie | |
| a) Dead | Long-term | 1 | 5 + 6 + 7 |  |
| b) Dead plus snow | Medium-term | 1 + 2 | 5 + 6 + 7 |  |
| c) Man on ceiling tie | Short-term | 1 + 2 | 5 + 6 + 7 + 8 |  |
| d) Man on rafter | Short-term | 1 + 3 | 5 + 6 + 7 |  |
| e) Wind uplift | Very short-term | 1 + 3 | 5 |  |
| f) Wind sway | Very short-term | 1 +(0.5 × 2) + 4 | 5 + 6 + 7 |  |

[a] As defined in Table 6 and Table 7.

## 6.5 Method of design

### 6.5.1 *General*

The analysis of the forces, moments and deformations of a trussed rafter may be by:

a) a generalized consideration of the behaviour of the truss (see **6.5.3**); or

b) a simplified method for trusses meeting specified geometrical conditions (see **6.5.4**).

### 6.5.2 *Representation of the trussed rafter for structural analysis*

For the purpose of structural analysis, trussed rafters may be represented by beam elements set along system lines and connected together at nodes (see Figure 1). For the greatest accuracy, system lines should coincide with the member centre line using fictitious nodes and members at joints if necessary [see Figure 1a)]. Alternatively chord members may be represented to an acceptable degree of accuracy by system lines set along their lower edge and system lines may be assumed to pass through a common node point [see Figure 1b)]. The system lines should always lie within the member profile in both methods.

### 6.5.3 *Generalized method of analysis*

It should be assumed that joints are rotationally pinned unless satisfactory published information is available which describes the degree of fixity present. Where the physical arrangement of members at a joint is such that their centre lines do not pass through or close to a common point, the resulting eccentricity should be allowed for in the design of the fasteners and the jointed members.

NOTE Figure 2 shows some examples of joints where eccentricities are small and may be ignored.

The effects of joint slip on bending moments and axial forces may be disregarded provided that the height of the trussed rafter measured at the centre of the span exceeds 0.15 times the span.

### 6.5.4 *Simplified analysis*

As an alternative to the general analysis method in **6.5.3**, a simplified method may be used for fully triangulated trussed rafters which conform to the following conditions:

— the trussed rafter supports are level and connected with a continuous horizontal ceiling tie;

— the trussed rafter is supported in accordance with Figure 3, with a value of $S_2$ no greater than $S_1/3$ or 50 mm whichever is the greater;

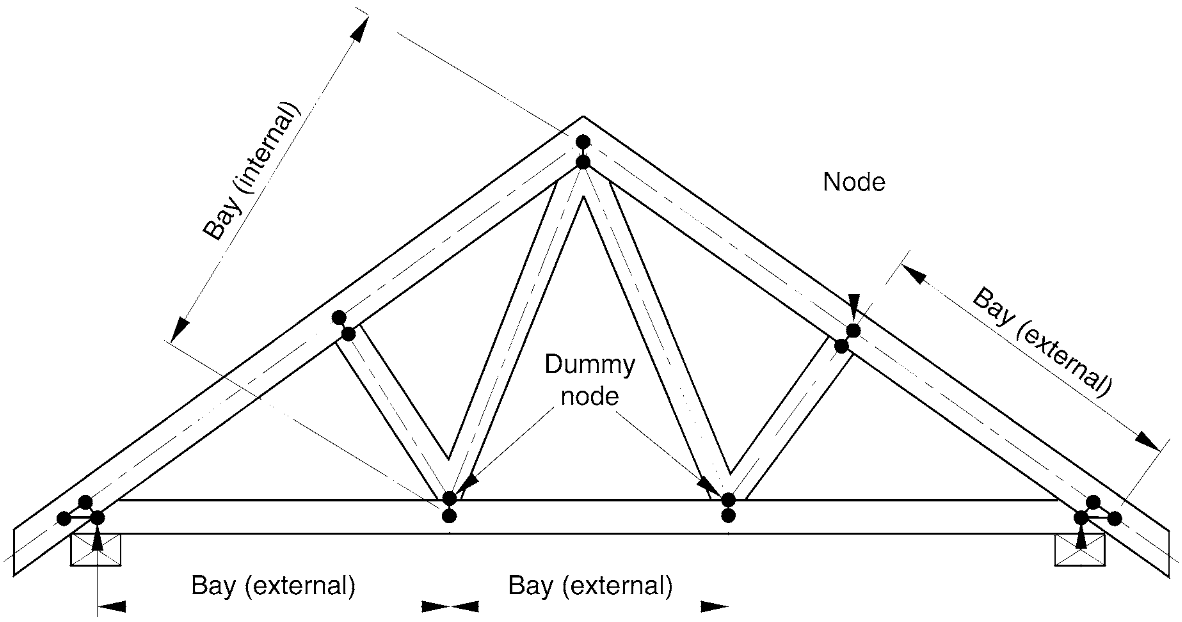
— the height of the trussed rafter measured at the centre of the span exceeds 0.15 times the span and 10 times the maximum chord depth.

Axial forces should be determined assuming a pin-jointed framework.

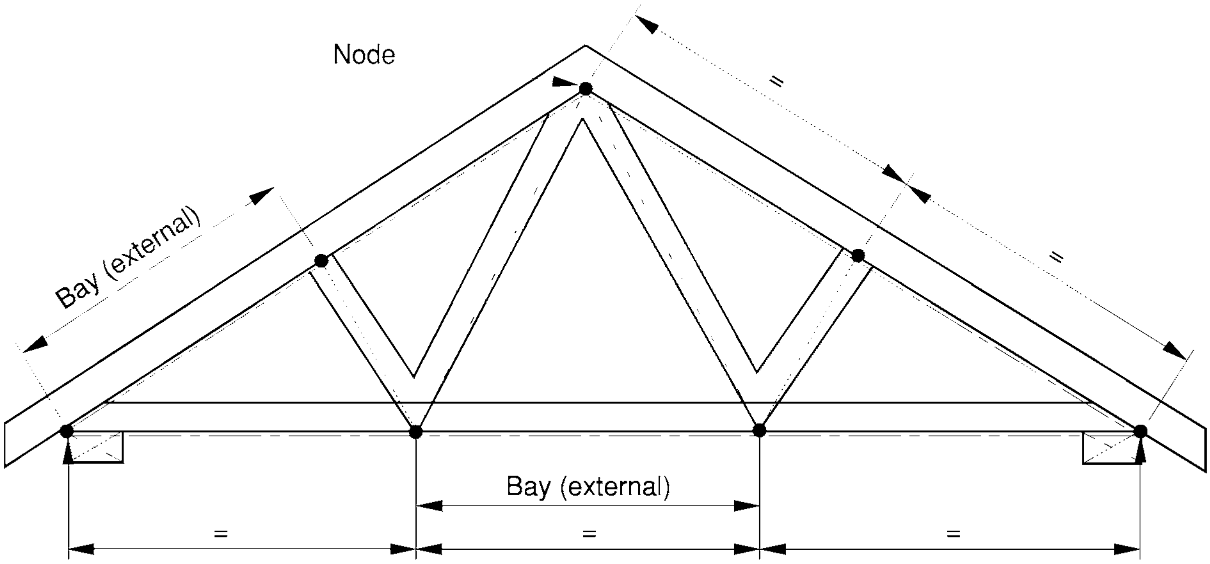
Bending moments should be determined assuming that members are continuous throughout their length with pin supports at the nodes. Deflection at the nodes and partial fixity at the joints should be allowed for by a reduction of 10% in the bending moment which would occur at the nodes with no deflection and no joint fixity. These reduced node moments should be used to calculate bending moments between nodes.

Bending moment coefficients, which take account of the 10% reduction in node moments, are given in Table 9 for all node and bay positions in members with equal bay lengths and loads as shown.

Provided bay lengths and/or loads in adjacent bays do not differ by more than 15%, the bending moment coefficients given in Table 9 can continue to be used provided the largest bay length and load is used in its calculation.




a) Centre line model (including fictitious nodes and members)




b) Lower edge model (coincident nodes)

**Figure 1 — Alternative trussed rafter models for structural analysis**

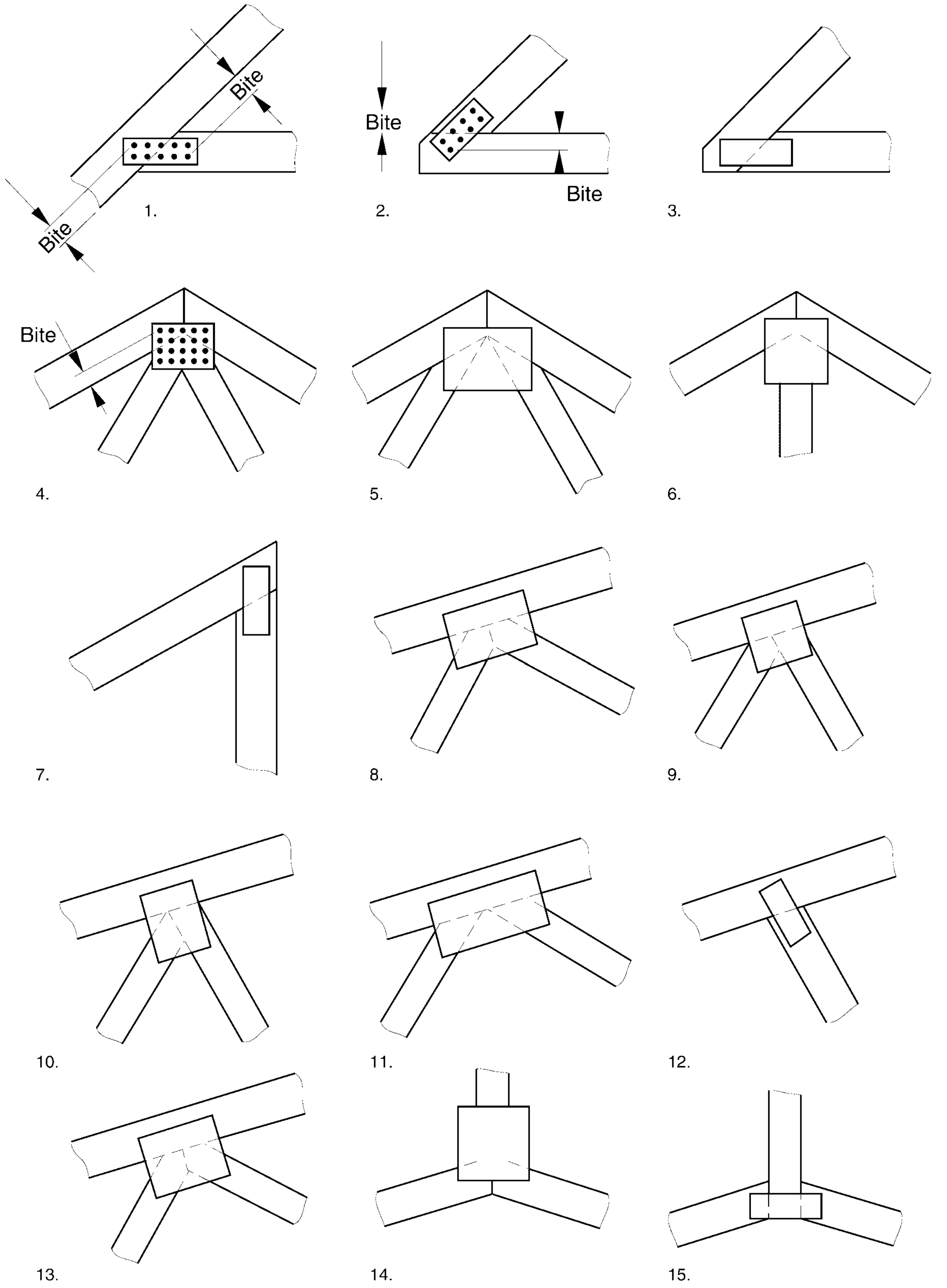



**Figure 2 — Examples of joints**

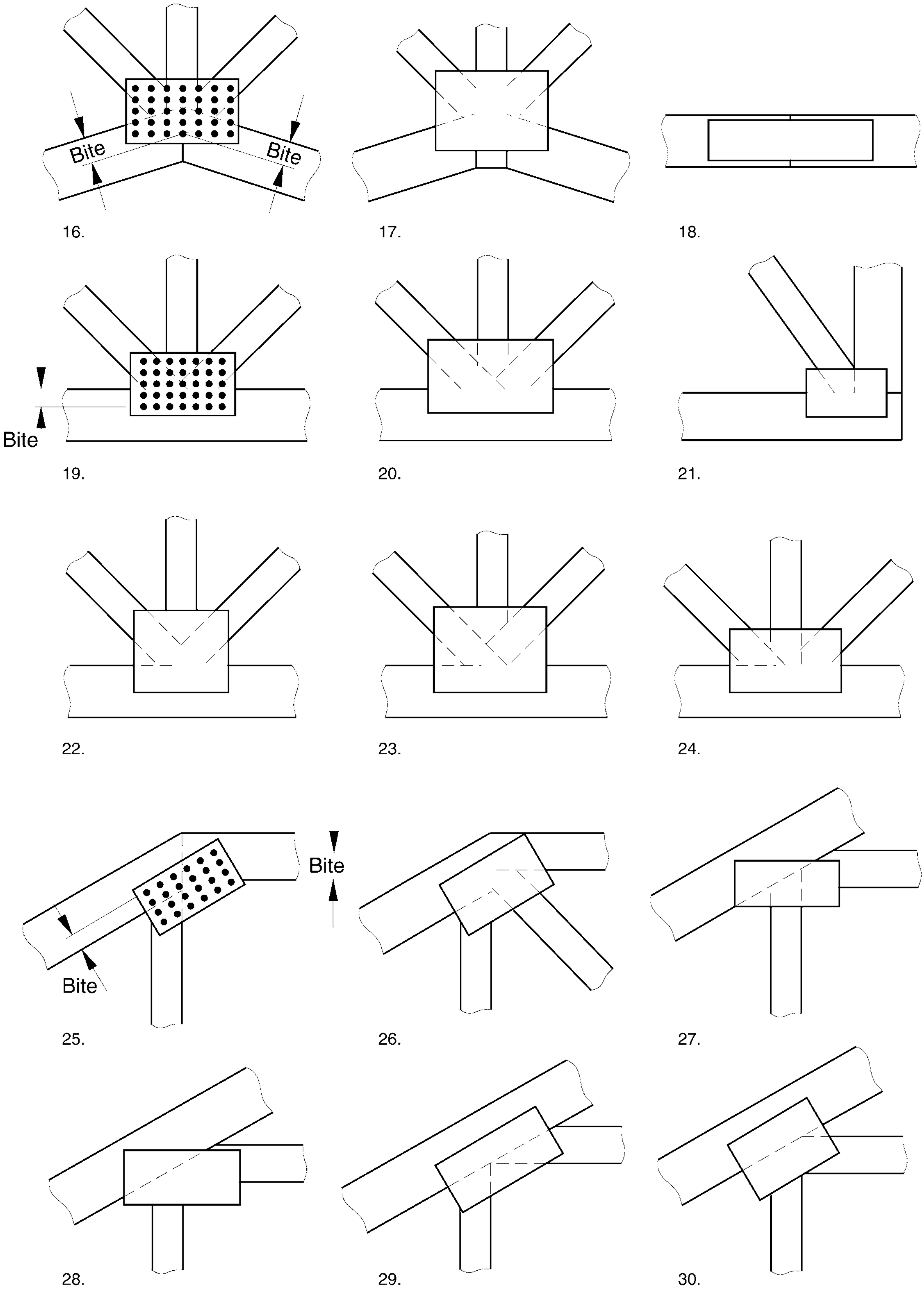



**Figure 2 — Examples of joints** (*continued*)

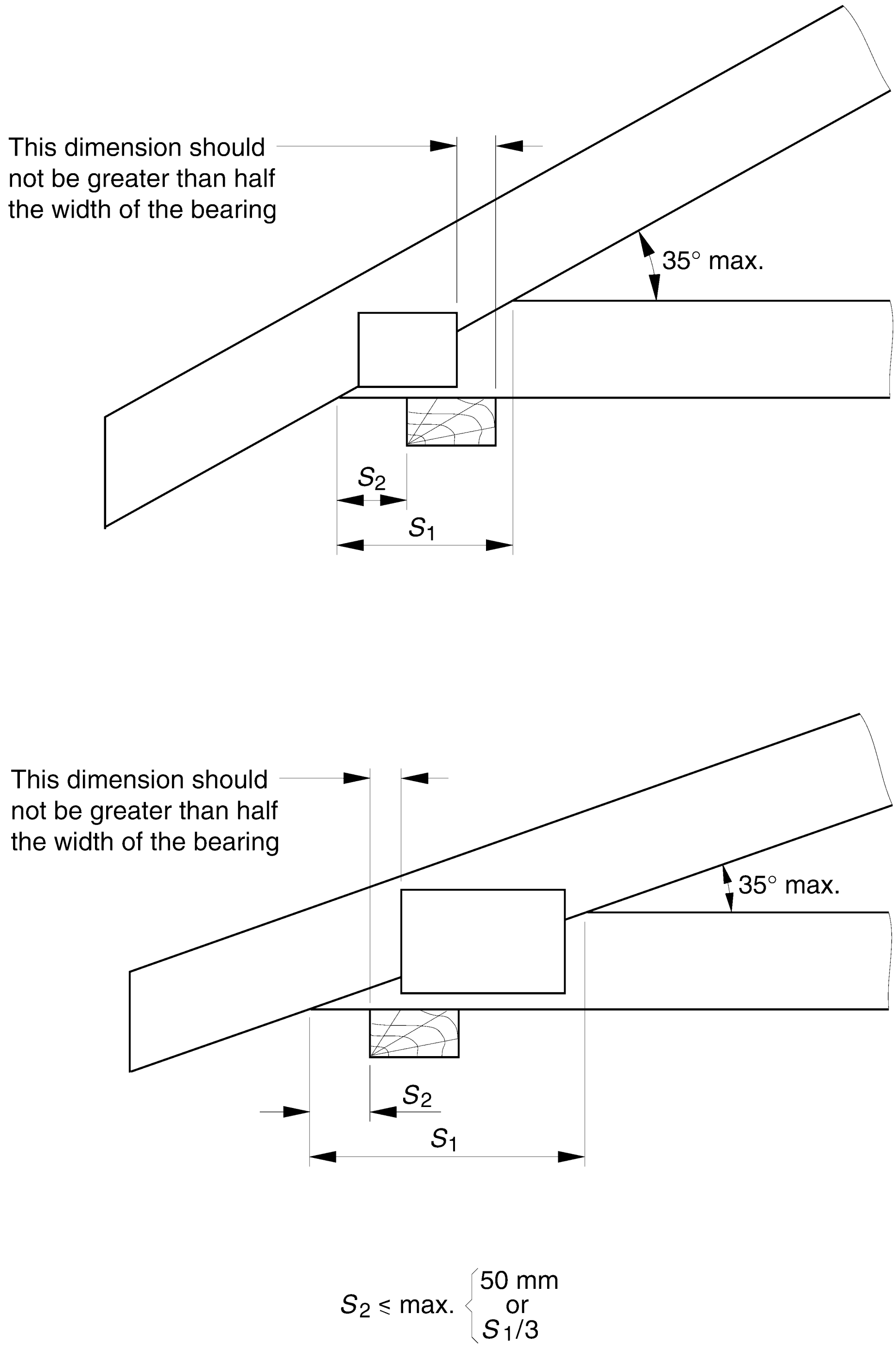
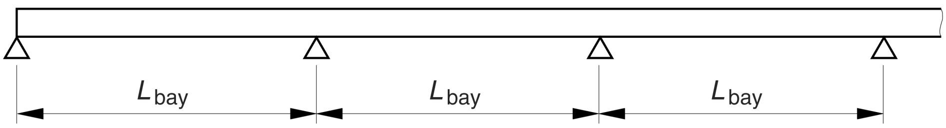



**Figure 3 — Wall plate location for simplified analysis**

**Table 9 — Bending moment coefficients ($K_m$)**

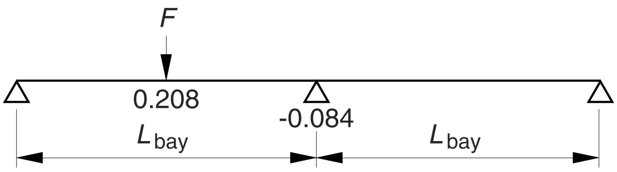
| Number of bays | $K_m$ | | | | |
|---|---|---|---|---|---|
| | *Uniformly distributed load* — Bending moment ($M$) $= K_m w L^2_{bay}$; $w$ = load perpendicular to member/unit length | | | | |
| 2 | 0.075 | −0.113 | | | |
| 3 | 0.084 | −0.090 | 0.035 | | |
| 4 | 0.081 | −0.096 | 0.045 | −0.065 | |
| 5 | 0.082 | −0.095 | 0.042 | −0.072 | 0.053 |



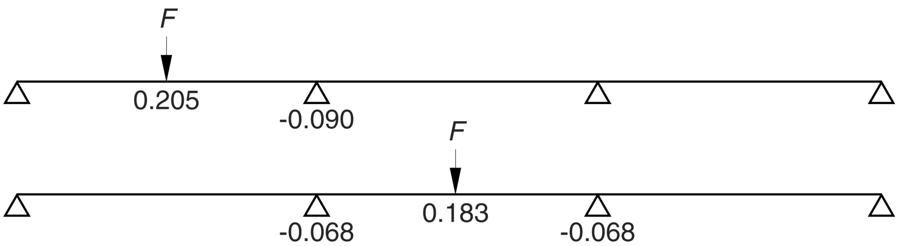

*Concentrated load* — Bending moment ($M$) $= K_m F L_{bay}$

Load $F$ is located midway between supports

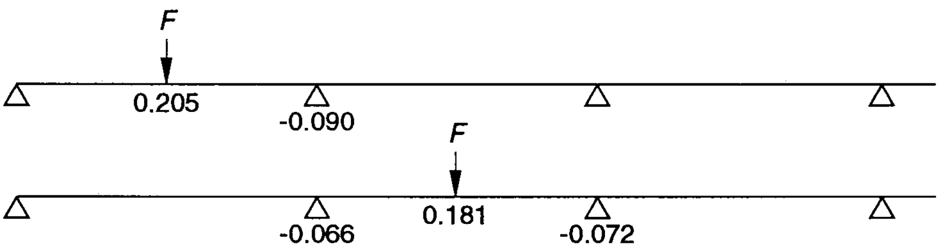
2



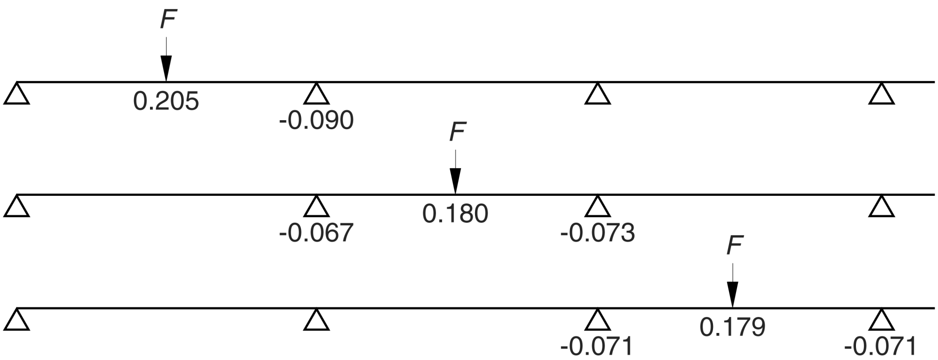

3




4




5




NOTE The loads and bay lengths used in this table should be compatible i.e. both should either relate to the plan or to the slope length.

**6.5.5** ***Member design***

Truss members should be designed in accordance with the recommendations of BS 5268-2. Each member should be capable of resisting safely the appropriate direct forces and bending moments. Generally, the stresses at all mid-bay positions and at all internal nodes of multi-bay members should be checked.

In a trussed rafter where uplift occurs, the trussed rafter designer should ensure that all members and joints are capable of withstanding any stress reversal which may occur under this loading condition.

Compression members should be designed in accordance with the following criteria.

a) Internal compression members should be checked for buckling in the direction of their plane and perpendicular to their plane. The effective length of internal members for both purposes should be taken as 0.9 times the distance between nodes.

b) Chord compression members should be checked for buckling in their plane, both within the bay section and across their nodes. For this purpose their effective lengths should be taken as the distance between adjacent points of contraflexure. Where the simplified analysis in **6.5.4** is used, their effective lengths should be taken as 0.8 times the bay length for mid-bay checks of multi-bay members and 0.2 times the sum of adjacent bay lengths for node checks.

c) Chord compression members should also be checked for buckling in the direction perpendicular to their plane in the bay section. An out-of-plane buckling check is not necessary at nodes where longitudinal binders are fixed and suitably restrained.

Considerable restraint against rafter members buckling in a direction perpendicular to the plane of the trussed rafter is normally provided by the tiling battens, provided they are adequately nailed and effectively restrained and braced (see **7.2** and **9.3.2**). However, lateral and torsional instability can reduce the capacity of rafters to sustain combined bending and compression forces and unless a specific analysis is made for this type of instability, the applied stresses at mid-bay should be such that:

$$\frac{\sigma_{m,a,\parallel}}{\sigma_{m,adm,\parallel}} + \frac{\sigma_{c,a,\parallel}}{\sigma_{c,adm,\parallel}} \le 1$$

where

$\sigma_{m,a,\parallel}$ is the applied bending stress due to bending in the plane of the trussed rafter;

$\sigma_{m,adm,\parallel}$ is the permissible bending stress;

$\sigma_{c,a,\parallel}$ is the applied compression stress;

$\sigma_{c,adm,\parallel}$ is the permissible compression stress with respect to lateral buckling (i.e. in the weaker direction).

When calculating $\sigma_{c,adm,\parallel}$ for rafter members in diagonally braced roofs, the restraining effect of the tiling battens should be recognized by taking an effective length ($L_e$) in metres as:

$$L_e = 0.01 b L_{bay}$$

where

$b$ is the thickness of the member in millimetres (mm);

$L_{bay}$ is the length of the rafter bay along the slope in metres (m).

The slenderness ratio ($L_e/i$) used in calculating $\sigma_{c,adm,\parallel}$ should be not less than 50

where

$i$ is the radius of gyration of the rafter member about its weaker axis in metres (m).

The trussed rafter designer should consider the need to provide adequate lateral restraint to individual members subject to compression in order to reduce their effective lengths and prevent buckling.

Where additional intermediate restraint is required to rafter members or to internal compression members, the trussed rafter designer should clearly state the sizes, positions and fixing of such restraints, preferably in the form of drawings.

Special consideration should be given to lateral and torsional stability of trussed rafter members in the following circumstances:

— where purlins are used instead of tiling battens or tiling battens are omitted (e.g. junctions between roofs);

— where the batten spacing is greater than 400 mm;

— where the bracing system is unconventional;

— where low strength or low density sarking or insulation material, such as expanded polystyrene, fibreboard or plasterboard, thicker than 3 mm, is sandwiched between the tiling battens and the rafters causing a reduction in the ability of the batten nails to sustain lateral forces.

In the absence of specific design data determined from actual tests, the effective length in these situations should be taken as the purlin centres or 0.9 times the distance between restrained nodes, whichever is the lesser.

The stress modification factors recommended in BS 5268-2 are applicable to trussed rafter design but the load-sharing factor of 1.1 should not be used for bending stresses in ceiling ties unless binders and rigid boarding other than plasterboard are provided to ensure adequate load distribution.

Principal trussed rafters (e.g. girder trusses) should be designed as multiple trussed rafters having two or more plies. They should be permanently fastened directly together, preferably at the place of manufacture, to provide flat and level bearing surfaces and designed using load-sharing factors applied to the grade stresses and the minimum modulus of elasticity appropriate to the number of plies, as shown in Table 10.

Where principal or girder trussed rafters are fastened together on site, the fastening of at least the ceiling tie members should be by bolts, using the appropriate washers, or screws, as specified by the trussed rafter designer. Gaps greater than 3 mm between chord members should be packed with suitable material. Rafter and web members may be site-nailed in accordance with the manufacturer's directions. The fastenings should be designed in accordance with BS 5268-2 and should be sufficient to ensure common action under load. In determining the radius of gyration of compression members in such components, due account should be taken of the effectiveness of the fastenings used.

In the absence of a more detailed design check, to take account of the fact that fastenings between multiple trusses do not produce a homogeneous compound girder, the effective thickness of the girder should be taken as $k_r nb$ in the calculation of the slenderness ratio:

where

$k_r$ = 2 ply units 0.7
3 ply units 0.6
4 ply units 0.5

$n$ = number of plies

$b$ = thickness of each ply.

Special consideration should be given to the effects of torsion created by out-of-plane eccentric loading. In particular where out-of-plane eccentric loadings occur the fastenings should be designed to distribute adequately the enhanced forces calculated using the methods in **6.5.6**.

**Table 10 — Load-sharing factors for principal trussed rafters**

| Number of plies | Load-sharing factor | |
|---|---|---|
| | For stresses | For minimum modulus of elasticity |
| 2 | 1.1 | 1.14 |
| 3 | 1.1 | 1.21 |
| 4 or more | 1.1 | 1.24 |

### 6.5.6 *Joint design*

Joints should be designed to resist, in tension, compression and shear, the axial forces in abutting members subjected to the loadings given in **6.4.4**. Where these loads are applied eccentrically, the forces at the joint should be enhanced to allow for torsional effects using the methods described in this clause. In addition, all joints should be able to sustain the handling load given in **6.4.3**.

It should be verified that sufficient anchorage area is provided in the various members being jointed and that the net section of the plate or gusset material itself is adequate to transfer these various forces. Compression joints should be designed assuming that all of the compression force is transferred directly through the plate or gusset.

**Figure 4 —** (*deleted*)

Plated or gusseted butt joints in the chord members of trussed rafters should be designed to fully resist the axial forces, shear forces and bending moments which occur at the joint. However, where a butt joint is located at a distance of between 0.1 $L_{bay}$ and 0.25 $L_{bay}$ from a node point, i.e. at a position of low bending moment, in a fully triangulated trussed rafter, the effect of the bending moment may be allowed for empirically in the design of the metal plate fasteners or plywood gussets used at the joint, by multiplying the axial force in the member by the appropriate factor as follows:

a) 1+ 0.2 $L_{bay}$ for bays subject to a concentrated load of 0.9 kN; [load cases c) and d) in Table 8];

b) 1+ 0.1 $L_{bay}$ for all other cases

where

$L_{bay}$ is the bay length in metres (m) measured along the rafter or ceiling tie bay in which the butt joint occurs.

For other cases moment splices should be designed to carry the axial forces, shear forces and moments which occur at a joint considering all load cases. The design moment should be the greatest of:

— the actual moment at the joint in all load cases;

— 20% of the maximum moment occurring in the member containing the splice joint in all load cases;

— the actual moment at the joint plus the moment due to a 0.9 kN point load applied at the joint location; this check applies to the short-term load cases only.

Irrespective of the theoretical design requirements, and in order to ensure a butt joint sufficiently robust to withstand normal forces during transportation and erection, the minimum dimensions of the metal plate fasteners on a butt joint should be as follows:

1) width: not less than 0.7$h$;

2) length: not less than (0.8$h$ + 80 mm)

where

$h$ is the depth of member in millimetres (mm).

Subject to practical limitations imposed by the configuration and size of members, all joints should be designed with the provision of a specified tolerance to allow for the possible misplacement of the plates or gussets. Unless experience indicates that a larger tolerance is necessary, the joint design should allow for a minimum misalignment of +5 mm simultaneously in two directions parallel to the edges of the plate or gusset.

At joints where a net tension force exists perpendicular to the grain direction, except those where the fastener bite is within 10 mm of the chord depth, the following condition should be satisfied in the chord member (see Figure 5):

$$\sigma_{t,90,adm} \geq K_e \left( \frac{0.025\,T}{w + 1.1 d^{1.4}} \right)$$

where

$\sigma_{t,90,adm}$ is the permissible tension stress perpendicular to the grain in the timber in newtons per square millimetre (N/mm$^2$);

$T$ is the net direct tension force at the joint interface in the direction perpendicular to the grain in newtons (N);

$K_e$ is a tension force enhancement factor from Table 11 where loads are applied eccentrically to the chord member ($K_e$ = 1.0 for concentrically applied loads);

$w$ is the length of the plate or gusset measured parallel to the grain of the chord member in millimetres (mm);

$d$ is the fastener bite in millimetres (mm).

NOTE Modification factors for load-sharing should not be used when calculating permissible tension stresses perpendicular to grain at joints.

Where joints subjected to a net tension force are within 250 mm of a member end, and the member end is not supported, the fastener bite should extend to within 10 mm of the member depth.

Finger joints should be avoided within the area of fasteners subjected to tension forces perpendicular to the grain.

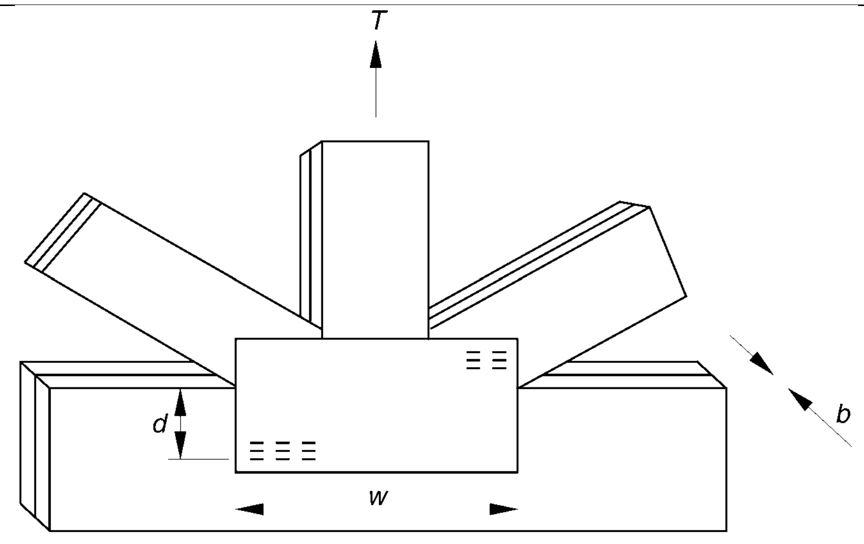



**Figure 5 — Tension stress condition perpendicular to grain at joints**

Where the member is loaded eccentrically out-of-plane, the net direct tension force perpendicular to grain at the joint ($T$), should be multiplied by an eccentricity factor ($K_e$) given in Table 11 to allow for the effects of torsion.

**Table 11 — Force modification factor ($K_e$) for joints in eccentrically loaded components subject to tension perpendicular to grain**

| **Number of piles** (n) | **Eccentricity factor** ($K_e$) |
|---|---|
| 1[a] | 1.00 |
| 2 | 1.33 |
| 3 | 2.00 |
| 4 | 3.00 |

[a] Principal trussed rafters should have at least two plies (see **6.5.5**).

Restraint systems may be used to ameliorate the effects of torsion induced by out-of-plane eccentric loading, provided their adequacy is verified by laboratory tests.

For the purposes of calculating forces in the plates or gussets on joints loaded eccentrically out-of-plane, the resultant tensile force determined from the above method should be increased by a further 10% to allow for stress concentration effects.

The minimum fastener bite on to a chord member after due allowance has been made for fastener mispositioning, irrespective of any other design or fabrication requirements, should be not less than any of the following:

— $(0.2l + 15)$ mm, where $l$ is the overall size of the metal plate fastener or plywood gusset in millimetres (mm), measured at right angles to the chord member;

— 30 mm;

— 0.25 times the depth of the member in millimetres (mm).

Where multiple trussed rafters are fastened together to form a principal truss or girder which is eccentrically loaded, the minimum fastener bite in any member subject to tension forces perpendicular to the grain should be 0.5 times the depth of the member.

Where the trussed rafter is supporting imposed floor loads greater than or equal to 1.5 kN/m$^2$, all joints other than butt joints should be designed for 50% greater forces than those assumed in the member design and the minimum fastener bite on to all chord members should be 0.5 times the depth of the member. Butt joints should be designed according to the recommendations given in this clause.

**6.5.7** ***Deflection***

Calculations of deflection should take account of axial forces in the members, bending and shear in the members, and slip at joints unless glued plywood gussets are used when joint slip will be negligible.

The influence of joint slip should either be modelled by slip moduli in newtons per millimetre (N/mm) or prescribed slips in millimetres (mm) at joints. Suitable values should be obtained from tests on actual joints. For simplicity it may be assumed that all nails or teeth are stressed to their maximum permissible value, and the average slip at this load may be used to calculate the slip component of the total deflection.

The deflection, $u_n$, in millimetres (mm) of a node point due to axial strain and joint slip may be calculated as follows:

$$u_n = \sum \frac{F F_u L_m}{AE} + \sum F_u s n \left( \frac{F}{|F|} \right)$$

where

$F$ is the force in the member due to the design load;

$|F|$ is the modulus value of the force $F$;

$F_u$ is the force in the member due to a unit load applied at the node points whose deflection is to be calculated;

$L_m$ is the length of the member;

$A$ is the cross-sectional area of the member;

$E$ is the appropriate modulus of elasticity;

$s$ is the average slip of the nail or tooth at maximum permissible load;

$n$ is the number of components of slip per member.

NOTE It may be assumed that each end of each member in a rafter or ceiling tie has one component of slip and each end of the internal members has two.

When checking the vertical deflections under cases c) and d) below, the calculated deflections should be multiplied by 1.25 to allow for long-term effects.

Unless other criteria are stipulated by the building designer the following deflection limits, with reference to Figure 6, should be used in the trussed rafter design.

a) Local deflection of rafters:

$\leq$0.004 times $L_{bay}$ under load case a) given in Table 8.

NOTE This limit may be doubled for cantilever situations e.g. rafter overhangs.

b) Local deflection of ceiling ties:

$\leq$0.003 times $L_{bay}$ under load case a) in Table 8; and

$\leq$14 mm where the bay forms a floor to a habitable room;

$\leq$0.006 times $L_{bay}$ under load case c) in Table 8.

c) Overall deflection of ceiling ties:

$\leq$0.003 times span under load cases a) and b) in Table 8.

d) Node deflections should not exceed the following values:

vertical deflection:

any node: $\leq$0.001 times span or 12 mm, whichever is the greater, under load case a) in Table 8.

horizontal deflection:

any node: $\leq$18 mm under load case f) in Table 8.

any raised tie truss support: $\leq$6 mm under load cases a) and b) in Table 8.

Trussed rafters may be cambered to counteract deflections due to long-term loads as a means of satisfying these deflection limits.

## 7 Roof design

### 7.1 Design responsibilities

On every project it is essential that one person assumes overall responsibility as building designer and is clearly defined as such. The building designer is responsible for providing the information listed in **11.1** to the trussed rafter designer and for ensuring adequate provision is made for the stability of the roof structure as a whole as distinct from, and in addition to, the stability of the individual trussed rafters.

The building designer is responsible for detailing all elements of bracing required in the roof, including that necessary to provide the lateral restraints to truss members required by the trussed rafter designer. The building designer is also responsible for detailing suitable fixings for both the trussed rafters and the wall plates to provide the restraint against uplift required by the trussed rafter designer.

It is important that the deflection of wind girders be limited. To avoid structural damage to walls or wall and ceiling finishes the building designer should provide the trussed rafter designer with the maximum permitted deflection for wind girders. In the absence of any other guidance it is suggested that the maximum permitted deflection of wind girders should be taken as 10 mm.

### 7.2 Overall stability

#### 7.2.1 *Bracing functions*

The building designer should specify all bracing.

All roofs require permanent bracing. Bracing in roofs can be considered to serve two clear and separate functions as follows.

a) *Roof stability*. Roof stability bracing is provided to ensure that the roof, as an independent structure, acts in a robust stable manner with adequate overall stiffness when subject to design dead, imposed and wind loadings. It also prevents lateral buckling of compression members and serves to limit any unfavourable consequences arising from poor construction or misuse of the structure.

It is essential that the trussed rafter designer clearly specifies on drawings the location of lateral restraints assumed in the truss design, in order that the building designer may detail a suitable bracing arrangement and support system capable of providing such restraint. Roof stability bracing to trussed rafter roofs can typically be provided by a combination of the following elements: longitudinal bracing at node points, rafter diagonal bracing, tiling battens/purlins, web chevron bracing, lateral bracing at the mid point of compression members, sarking boards.

Particular attention should be given to the need to ensure that principal trussed rafters (e.g. girder trusses) are properly braced back to the main roof structure to assist in resisting any torsional tendency induced by out-of-plane eccentric loading.

b) *Wall stability*. Wall stability bracing may be provided in the roof to assist in bracing the gable and/or supporting walls against wind loads and to ensure that the imposed forces are safely transmitted to other suitably braced parts of the building.

It can typically consist of diagonal bracing at rafter or ceiling levels, or wind girders or diaphragms placed in the plane of the rafters or the ceiling. At gable ends, wall stability bracing in the roof structure is used in conjunction with lateral restraint straps to stabilize the gable walls.

**7.2.2** ***Roof bracing***

Standard bracing details, suitable for fulfilling the functions of both roof and wall stability for spans up to 17 m, are given in Annex A. Provided that the design criteria and conditions of use are observed, no further calculations are required. When no standard bracing solution is available, **A.3** describes principles and procedures by which bracing systems may be designed for trussed rafter roofs which perform the functions given in **7.2.1**.

**7.2.3** ***Restraint against wind uplift***

The design of the roof should be checked by the building designer to determine if an adequate margin of safety exists against uplift due to wind forces. Particular attention should be given to roofs with low pitches, large overhangs or lightweight coverings and roofs on high buildings or in areas of high wind speed.

Where the dead load reaction from the roof is less than 1.4 times the uplift reaction, positive fixings should be provided between the trussed rafters and the supporting structure to mobilize sufficient additional dead load to ensure that an adequate resistance to wind uplift exists. Where positive mechanical fixings are provided their strength should be justified by calculation or by testing in an independent laboratory. For this purpose their short-term safe working load may be multiplied by 1.25 to allow for the very short-term nature of the wind forces involved.

Irrespective of the means by which restraint is provided, the sum of the resisting forces should be not less than 1.4 times the total uplift force, i.e. [(dead load reaction + mechanical anchorage reaction) $\geq$ 1.4 × total uplift reaction].

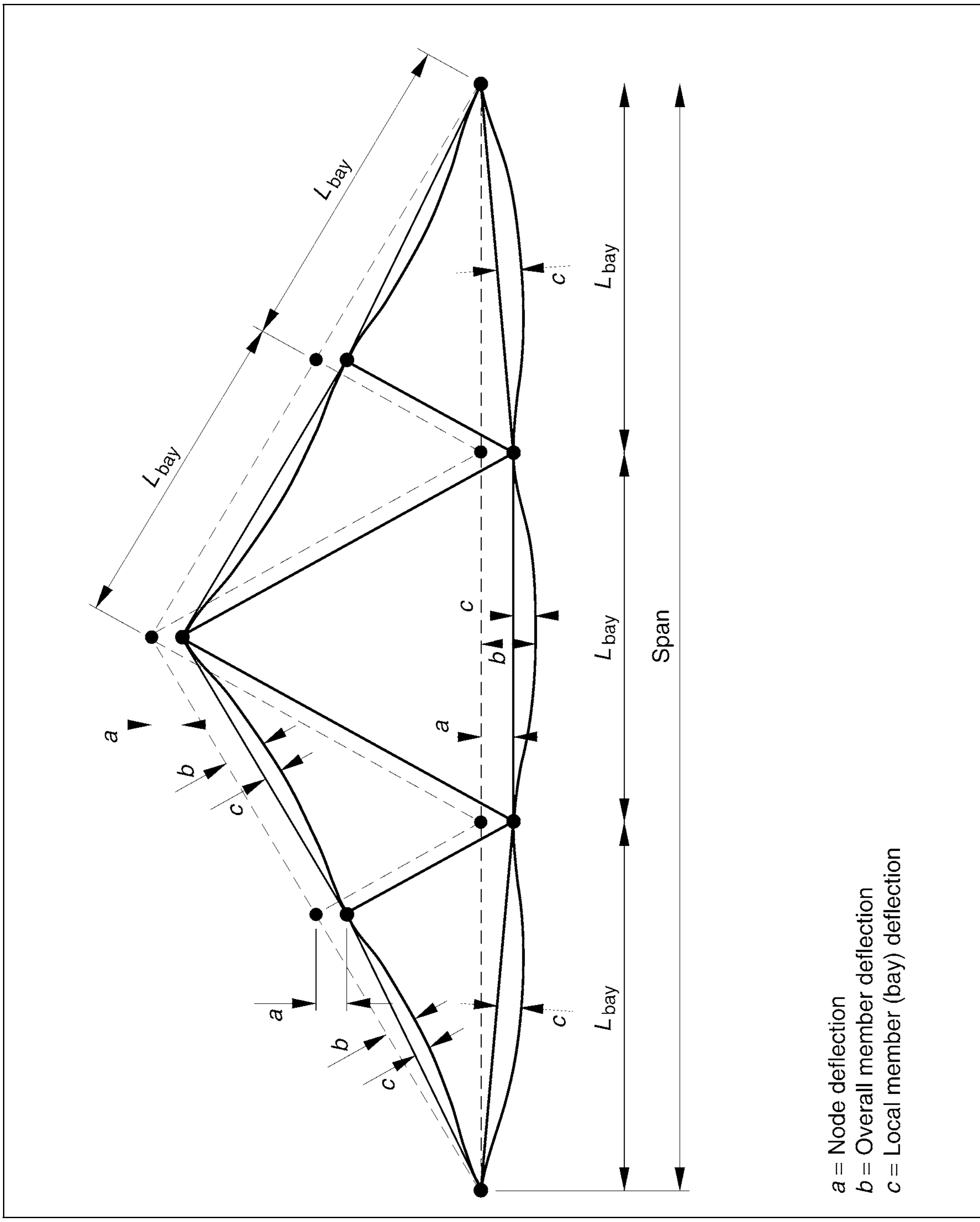



**Figure 6 — Truss deflection components**

### 7.3 Wall plates

Trussed rafters are normally supported on timber wall plates or similar flat bearing surfaces which should be carefully levelled and positioned to ensure that the ends of the trussed rafters are in the correct vertical alignment, with the bearings located at the positions assumed in the design and shown on the drawings.

In all cases, the area of the bearing surface should be sufficient to ensure that the permissible stresses for compression perpendicular to the grain are not exceeded in either the bearing or the trussed rafter. As a guide, the bearing length should be not less than 0.008 times the span of the trussed rafter, with a minimum value of 75 mm, unless design calculations show otherwise. Wane should not be permitted on wall plates where it will reduce the effective bearing surface below that required by design. Where wall plates are bedded on masonry construction, they should have a minimum target thickness of 47 mm.

To avoid multiple pieces of short lengths of wallplate, the lengths of timber used to make up the overall length of a wallplate should satisfy the following conditions.

a) For walls < 3.0 m in length the wallplate timber should be in a single length.

b) For walls > 3.0 m in length the wallplate timber should normally be greater than 3.0 m in length except up to two pieces may be shorter so long as they are not less than 1.5 m in length.

In general, it is preferable to use one of the proprietary types of fixings between the ends of the trussed rafters and the wall plates or bearings. Where proprietary fixings are not used, the minimum fixing at each bearing position should consist of two 4.5 mm diameter, 100 mm long galvanized round wire nails which are skew nailed from each side of the trussed rafter into the wall plate or bearing.

Where nailing through metal plate fasteners cannot be avoided, the nails should be driven through the holes in the fasteners. This method of fixing should not be used with stainless steel metal plate fasteners or where the workmanship on site is not of a sufficiently high standard to ensure that the fasteners, joints, timber members and bearings will not be damaged by careless positioning or overdriving of the nails.

The building designer should ensure that, when required, adequate fixings are specified for holding down both the trussed rafters and the wall plates or bearings in accordance with **7.2.3**.

### 7.4 Plasterboard ceilings

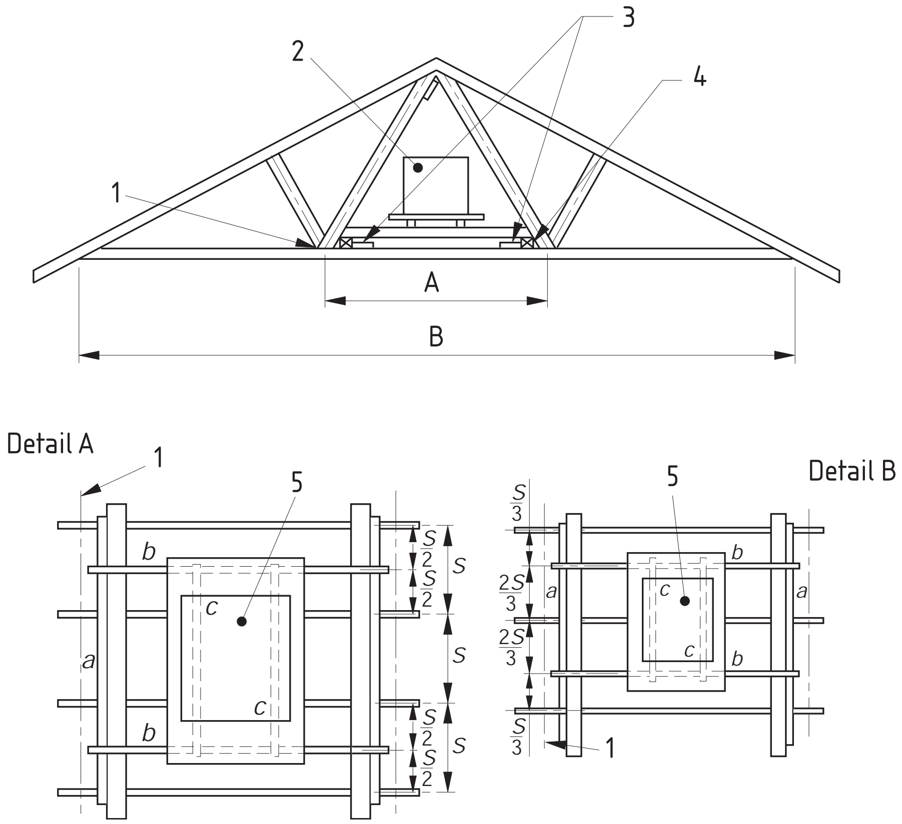
Many trussed rafter roofs are underlain by plasterboard ceilings. With careful setting out it has generally been found possible to joint plasterboard on 35 mm thick trusses. If the building designer is concerned that the requisite standard of workmanship may not be achieved, he may specify a suitable minimum timber thickness [see **11.1**n)], or adopt other appropriate details such as side battens or under battens.

### 7.5 Water tanks

Whenever possible, supports for water tanks should be independent of the trussed rafters. However, as water tanks are often required to be supported on trussed rafters, the additional loads of the tank and its contents should be distributed and supported as shown in Figure 7, provided the tank sizes shown are not exceeded.

Where the size or position of the tank is not in accordance with Figure 7 the spreader beams should be designed by the building designer in accordance with BS 5268-2. The actual location and method of support should be conveyed to the trussed rafter designer who should confirm that the trussed rafters are capable of safely supporting the load due to the tank and its contents [see **11.1**g) and **11.2**g)] and that the resulting truss deformations are not excessive.

The platform at the base of the cold water storage tank should fully support the tank over at least its entire plan area. The platform material should be a minimum 18 mm thick timber boarding or moisture resistant wood based material.




1) Node point
2) Tank placed centrally
3) Offset bracing to clear tank bearers
4) Bearer "A" placed as close to the node point as possible
5) Tank

A Bay size
B Trussed rafter span $L_S$
*S* Trussed rafter spacing

| Sizes for support members | | | | | |
|---|---|---|---|---|---|
| **Tank capacity to marked waterline** | **Min. member sizes** | | | **Max. trussed rafter span for Fink configuration** | **Max. bay size for other configuration** |
| | *a*<br>mm | *b*<br>mm | *c*<br>mm | m | m |
| Detail A<br>Not more than 450 l supported on four trussed rafters | 47 × 72 | 2 × 35 × 145<br>or<br>1 × 47 × 169 | 47 × 120 | 6.5 | 2.2 |
| | 47 × 72 | 2 × 35 × 169 | 47 × 120 | 9.0 | 2.8 |
| | 47 × 72 | 2 × 47 × 169 | 47 × 120 | 12.0 | 3.8 |
| Detail A<br>Not more than 300 l supported on four trussed rafters | 47 × 72 | 2 × 35 × 97<br>or<br>1 × 47 × 120 | 47 × 72 | 6.5 | 2.2 |
| | 47 × 72 | 2 × 35 × 120<br>or<br>1 × 47 × 145 | 47 × 72 | 9.0 | 2.8 |
| | 47 × 72 | 2 × 35 × 145 | 47 × 72 | 12.0 | 3.8 |
| Detail B<br>Not more than 230 l supported on three trussed rafters | 47 × 72 | 1 × 47 × 97 | 47 × 72 | 6.5 | 2.2 |
| | 47 × 72 | 2 × 35 × 97<br>or<br>1× 47 × 120 | 47 × 72 | 9.0 | 2.8 |
| | 47 × 72 | 2 × 35 × 120<br>or<br>1 × 47 × 145 | 47 × 72 | 12.0 | 3.8 |
| NOTE Support members to be of minimum strength class C16. | | | | | |

**Figure 7 — Supports for water tanks**

### 7.6 Hatch, chimney and other openings

Every effort should be made to accommodate openings within the trussed rafter design spacing. Where this cannot be achieved, the spacing of the trussed rafters near the opening may be increased as shown in Figure 8, Figure 9 and Figure 10 provided that the spacing between the centres of the trimming trussed rafters does not exceed twice the design spacing of the trussed rafter and that $b$ is smaller or equal to $2a - c$.

where

- $a$ is the design spacing of the trussed rafters;
- $b$ is the distance between the centres of the trimming trussed rafter and the adjacent trussed rafter;
- $c$ is the nominal width of the required opening.

Design details for the additional common rafter and for ceiling joists and their connections should be provided by the building designer in accordance with the recommendations of BS 5268-2

### 7.7 Roof environment

#### 7.7.1 *General*

Roofs incorporating trussed rafters should be designed to ensure that the moisture content of the timber in service does not exceed 20% for any significant period.

Where there is likely to be aggressive chemical pollution special precautions should be taken to ensure durability of the roof timbers and fasteners. Consideration should also be given to the possibility of corrosion of fasteners in contact with some types of insulation materials.

Reasonable access to the roof space should be provided to allow periodic inspection of the timber and fasteners.

#### 7.7.2 *Thermal insulation*

Trussed rafter roofs should be insulated to conform to statutory requirements for thermal transmittance.

#### 7.7.3 *Ventilation*

It is essential that cold roof spaces are effectively ventilated to the outside to prevent condensation which may cause decay in roof timbers and corrosion of metal fasteners. The location and size of ventilation openings should be determined by the building designer. In addition, to minimize ingress of water vapour into the roof space from rooms below, all joints and service entry holes in the ceiling construction should be sealed effectively.

NOTE Guidance on the prevention of condensation in roofs is given in BS 5250.

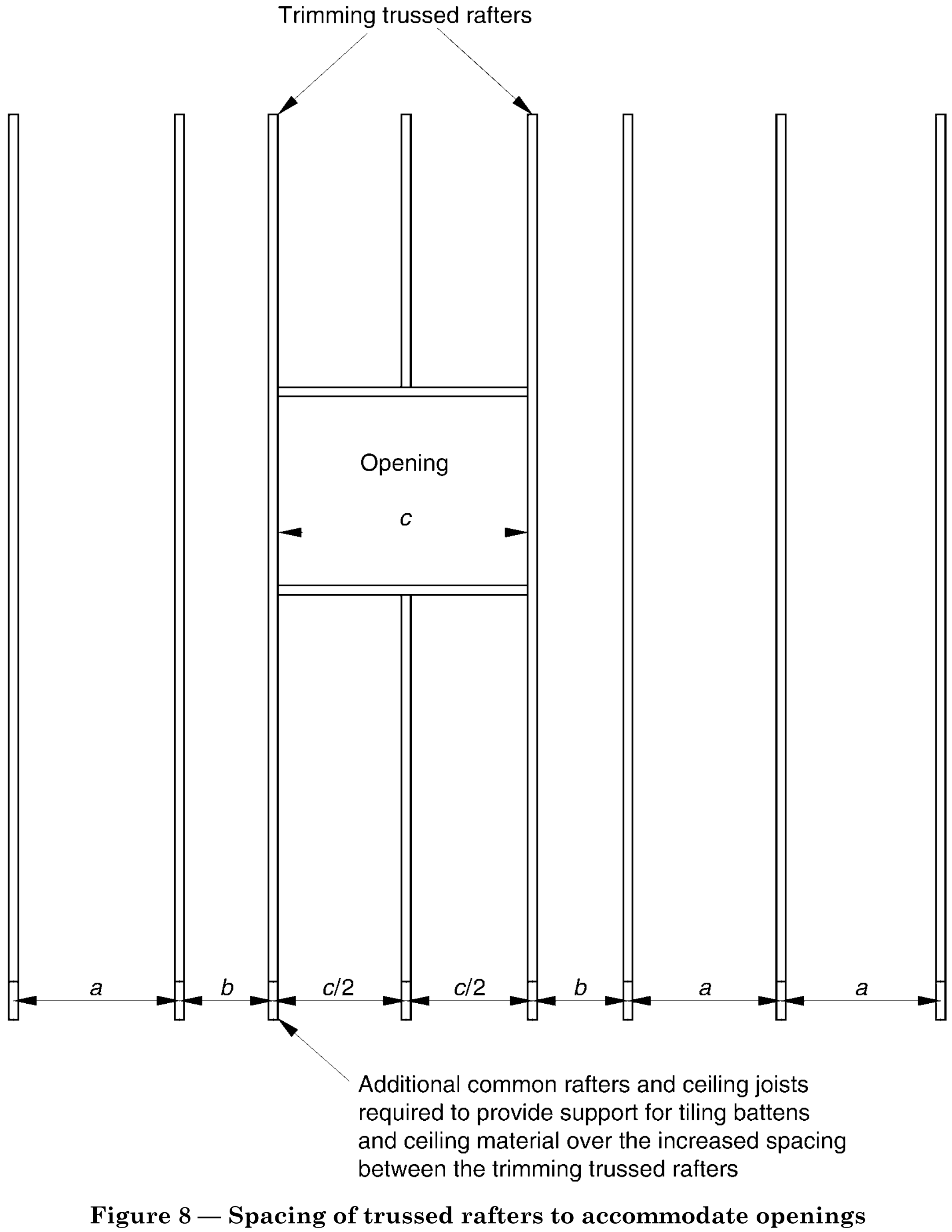



**Figure 8 — Spacing of trussed rafters to accommodate openings**

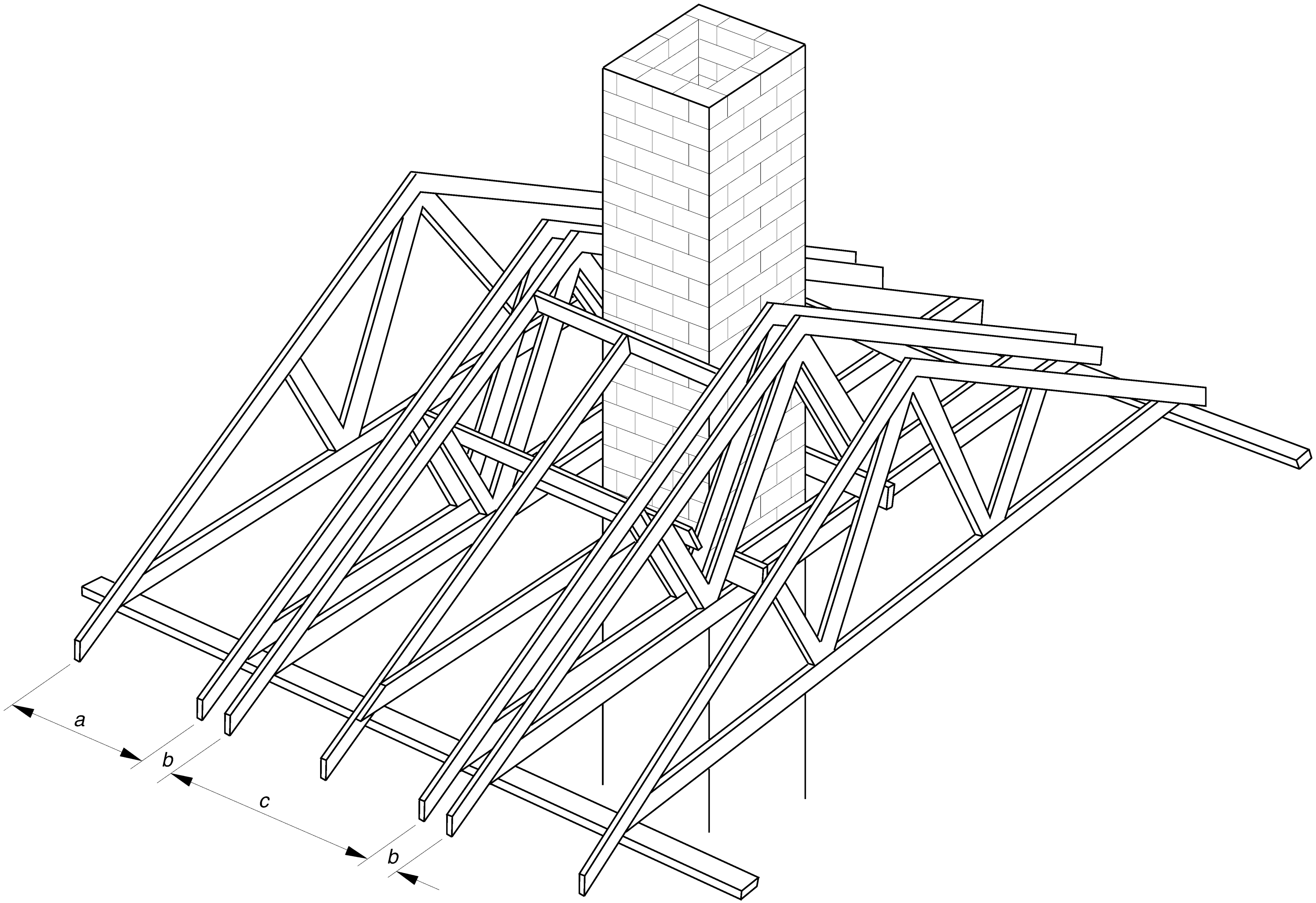



**Figure 9 — Chimney opening**

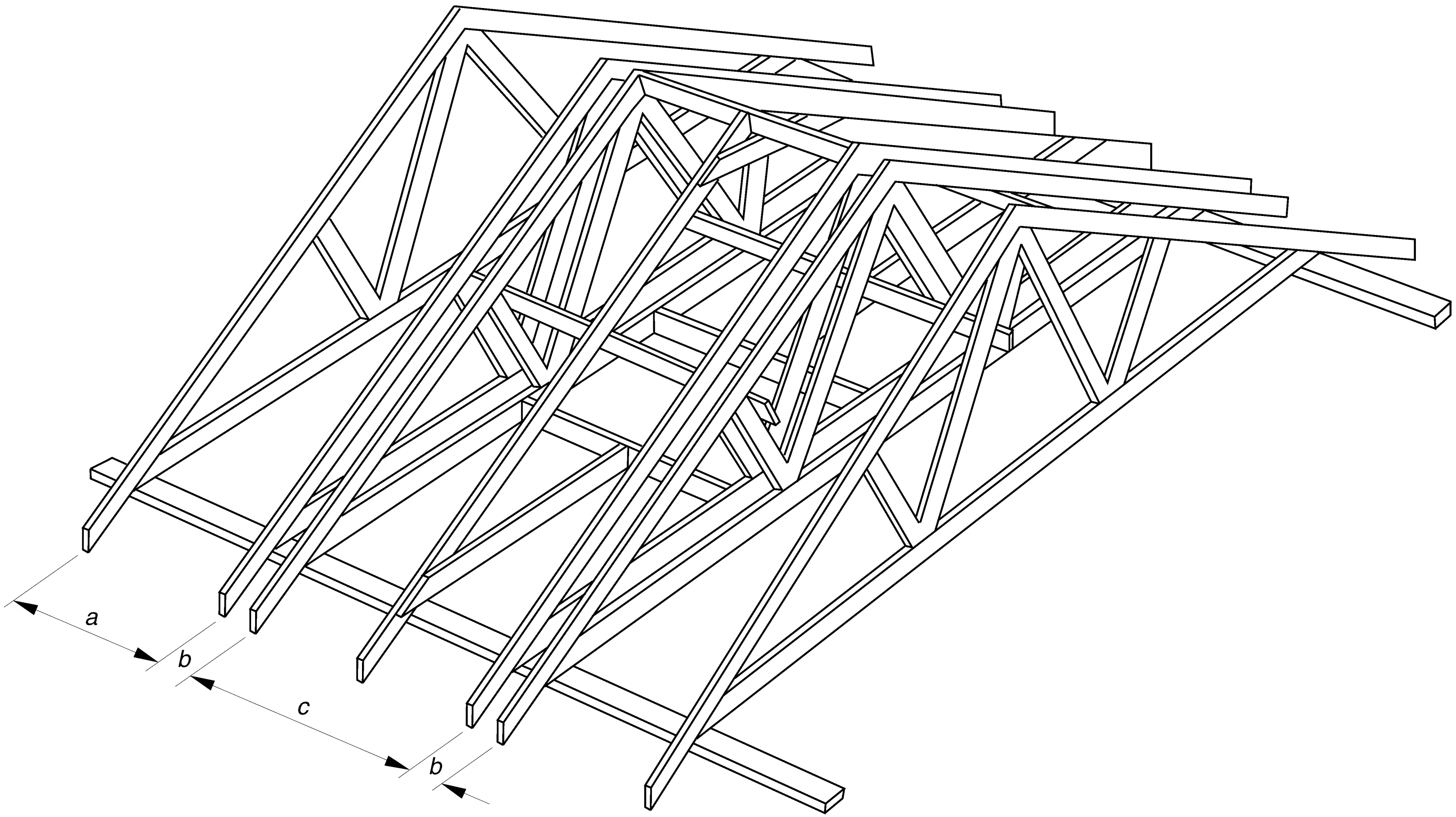



**Figure 10 — Hatch opening**

# 8 Fabrication

NOTE This section applies to trussed rafters manufactured with plywood gussets or nailed metal plate fasteners with pre-formed holes. For trussed rafters manufactured with metal plate fasteners with integral teeth the requirements of BS EN 14250 apply.

## 8.1 General

### 8.1.1 *Staff and premises*

Staff should have the skills necessary for the selection of timber and the production of trussed rafters. Individual responsibilities for production and quality control should be clearly defined. The fabricator's premises should use covered storage to minimize changes in the moisture content of cut timber components due to weather, prior to assembly. Covered storage should be used for metal products required for the production of trussed rafters.

### 8.1.2 *Equipment*

Suitable equipment for handling materials and completed trussed rafters should be available.

Equipment used for the cutting of timber components should be capable of producing accurate and consistent angles and lengths. Such equipment should be regularly calibrated and maintained in this condition. Assembly should be carried out with jigs and other equipment appropriate to the particular jointing device being used. Measuring equipment for production and verification purposes should be available in the production area

### 8.1.3 *Information required by the trussed rafter fabricator prior to assembly*

Adequate detailed drawings, specifications and cutting lists should be available prior to fabrication giving the information specified below.

a) *Timber*. Strength class or alternatively grade and species, sizes, lengths and required cut dimensions.

b) *Connection devices*. Type, size, location details, permissible tolerances on fastener location and corrosion preventative treatment.

c) *Dimensions*. Span, pitch, camber, eaves overhang and splice locations.

d) *Treatment*. Details of required preservative treatment.

e) *Fixing*. Details of fixing of multiple trussed rafters or reinforcing timbers (see **6.5.5**). Where this is not carried out by the trussed rafter fabricator the information should be issued to site in the form of clearly detailed drawings and specifications, sufficient to enable the components to be correctly assembled on site.

## 8.2 Assembly

### 8.2.1 *General*

The moisture content of the timber at the time of fabrication should not exceed 22%. All members should be cut to enable the required tolerances for overall dimensions and joints to be fulfilled. Cuts should be clean without undue tearing of the timber members. Wane should not occur on the top edges of the rafter, the bottom edges of the ceiling tie or within bearing areas. Wane should not occur within the area of the jointing device.

Fastener mispositioning during assembly should be within the limits assumed in design. Unless greater allowance has been made, fastener misplacement should be no more than 5 mm in any direction. The lower edge of any fastening device intended to be located over a point of support should be at least 3 mm from the lower edge of the member in contact with the support. Within the area of the fastener, the average gap between two adjacent members should not exceed 1.5 mm unless specifically allowed for in the design of the joint or justified by test.

Where a camber is specified it should be measured at the ceiling tie node nearest mid-span with the trussed rafter unloaded and laid on its side. Camber should be taken as the distance from the bottom edge of the ceiling tie at the node to a straight line joining the centres of the bearings normally supported on the wall plates.

The overall horizontal and vertical dimensions of the trussed rafter should not deviate from the specified dimensions by more than the following tolerances:

— up to 10 m: ±10 mm;

— more than 10 m: 1 mm for each metre.

The overall dimensions on a batch of trussed rafters should not differ by more than 10 mm.

**8.2.2** ***Joints formed with glued plywood gussets***

Surfaces to be bonded should be prepared in accordance with the requirements of BS 6446.

Members may be square cut if it can be shown that the plywood gussets alone are capable of sustaining all of the member forces at the joint. The difference in thickness between adjacent members should not exceed 0.5 mm. Special precautions may be necessary when gluing timber treated with a wood preservative or flame retardant. The species of timber, adhesive and wood preservative or flame retardant should be compatible.

Throughout the adhesive setting period, the plywood gussets should be held in position and sufficient pressure should be applied to ensure that the timber and plywood surfaces make continuous firm contact with the adhesive. Pressure should be applied using cramps, screws, nails or staples of a size and frequency approved by the adhesive manufacturer and in accordance with the requirements of BS 6446. The written instructions from the adhesive manufacturer should be followed, particularly with respect to mixing, spreading, open and closed assembly times and the time and temperature required for setting.

Adhesive spreaders, mixing equipment, containers and other equipment should be kept clean and free from traces of old adhesive and other contaminating substances at all times. Plywood gussets should not project beyond the outer edges of the trussed rafter.

Sufficient production control tests involving strength tests on sample joints, should be made on specimens representative of each day's production, to provide evidence of the soundness of the bonded joints.

**8.2.3** ***Joints formed with metal plate fasteners or nailed plywood gussets***

Where nailed metal plates require cutting, the equipment used should ensure that the resultant plate is not deformed.

Live knots are permitted within the area covered by fasteners, provided that the fasteners can be satisfactorily fixed without distortion of the nails or splitting of the timber. Where a dead knot, knot hole, or fissure occurs within the area covered by a nailed metal plate fastener or plywood gusset, the number of effective nails should be verified disregarding those in the dead knot, knot hole or on the line of the fissure. When necessary a larger plate or gusset should be used to provide the minimum number of effective nails specified in the design.

NOTE Hairline fissures which do not extend more than 50 mm from the nail which apparently caused them may be disregarded.

Nailed metal plate fasteners or plywood gussets which project beyond the edges of the trussed rafter members should have their protruding areas removed, or be masked with suitably sized timber packs. Alternatively, nailed metal plate fasteners may be folded over once fully fixed. Particular attention in this regard should be paid to fasteners which protrude into walk spaces or other places permitting access.

Any gap between the timber and the underside of a nailed metal plate fastener or nailed plywood gusset should not exceed 1 mm and should not occur over more than 25% of the contact area of any member.

Joints fabricated with improperly positioned fasteners may be repaired by removing the affected fasteners and re-fixing with a nailed metal plate or gusset of a larger size. Where defective joints are to be repaired in this way only 50% of the nails present in the area previously covered by the plate or gusset should be counted as effective. No such repairs to trussed rafters should be undertaken without prior approval from the trussed rafter designer

NOTE Care should be taken to ensure that undue distress does not occur to the timber when defective plates or gussets are removed.

## 8.3 Marking

Every trussed rafter should be clearly marked to enable identification of the producer, the materials used and the standard to which it was produced. This marking should be placed on the face of the timber near the apex. Due to manufacturing tolerances, when symmetrical trussed rafters are produced they should be clearly marked to indicate a common production end.

# 9 Handling, storage and erection

## 9.1 Handling and transportation

Trussed rafters should be handled in a manner that will ensure that no significant damage to the product occurs.

Trussed rafters are normally designed to be used in a vertical position and should, if possible, be moved and handled in such a manner. Where strapping is used, care should be taken to avoid damage by badly positioned or excessively tight banding. Undue sagging or flexing of single units or bundles should be avoided and particular care should be taken when using mechanical handling equipment to avoid damage by impact or rough operation.

## 9.2 Storage

### 9.2.1 *General*

The fabrication of trussed rafters should be organized to minimize storage time both at the manufacturer's premises and on site.

Trussed rafters should at all times be stored on raised bearers to avoid contact with the ground and vegetation and should be suitably supported so as to prevent any distortion.

Consideration should be given to the provision of a suitable weatherproof covering where open storage is likely to lead to undue degradation.

### 9.2.2 *Vertical storage*

When trussed rafters are stored vertically they should be placed against a firm and safe support with suitable props to maintain them in a vertical position.

### 9.2.3 *Horizontal storage*

When trussed rafters are stacked horizontally bearers should be provided to give level support at close centres. If subsequent bearers are placed at different heights they should be vertically in line with those underneath. The height of stacks should be limited to that which can be safely sustained by the trussed rafters below and which will remain stable during the storage period.

## 9.3 Erection

### 9.3.1 *Verticality, straightness and spacing*

The general guidance on workmanship and maintenance of timber structures given in BS 5268-2 is applicable to trussed rafter roofs. Trussed rafters should be erected with a common production end positioned at the same support, and in such a manner that no damage occurs and the design requirements are conformed to. This may include the provision of temporary bracing, rigging and specialized equipment. Erection procedures should include a method by which the first trussed rafter on each roof may be erected and rigidly braced in the correct vertical position with all members straight, in order that it may provide a rigid datum from which all subsequent trussed rafters in the roof may be set out. The temporary erection bracing should not be removed before the permanent bracing has been installed.

Bracing should be installed in accordance with the building designer's details. Where internal members subject to axial compression require intermediate lateral restraint, these restraints should be diagonally braced to a suitable anchor point.

After the fixing of permanent bracing and tiling battens or sarking, all trussed rafters should be checked for straightness and vertical alignment. Whilst every effort should be taken to erect trussed rafters as near to vertical as possible, the following deviation from the vertical may be permitted:

$$D = \text{min.} \begin{cases} 10 + 5(H - 1)\ \text{mm} \\ \text{or} \\ 25\ \text{mm} \end{cases}$$

where

- $D$ is the maximum permitted deviation from vertical in millimetres (mm);
- $H$ is the height of the trussed rafter in metres (m).

When trussed rafters are fabricated, the members should be within the limits of distortion given in **5.1.2**. However, if members which have distorted during the period between fabrication and erection can be straightened without damage to the timber or the joints, the trussed rafter may be considered satisfactory for use. After erection, a maximum bow in any chord or web member of 0.003 of member length or 20 mm may be permitted whichever is the lesser provided it is adequately secured in the complete roof structure to prevent the bow from increasing.

Except in the special situations described in **7.6**, trussed rafters should be accurately positioned in accordance with the location drawing and spaced at intervals not exceeding the design centres. Where trusses are supported in metal hangers they should be fully seated in these supports. Because of the need to resist torsion induced by eccentric loading, any gap between the back of the metal hanger and the supported member should be packed and under no circumstances should the gap exceed 10 mm prior to packing.

### 9.3.2 *Tiling battens and boarding*

Tiling battens and boarding should be in accordance with the recommendations of BS 5534.

Battens should be not less than 1.2 m in length and should generally be continuous over at least two spans. They should be fixed to every rafter member which they cross, or on which they are jointed, with nails of the appropriate size and type in accordance with BS 5534. Where principal trussed rafters (e.g. girder trusses) are used, the tiling battens or boarding should be fixed to each of the outer plies.

The end of battens should be cut square and butt jointed centrally on a rafter member so that adequate bearing and nailing can be provided for each end of each batten. Butt joints in battens should be arranged so that not more than one batten in four is jointed on any one rafter member. Cantilevering or splicing of battens between rafters should not be permitted.

To reduce hogging, the tops of intermediate separating walls should be finished 25 mm below the underside of the tiling battens or boarding. Where necessary, to conform to fire regulations, the space between the top of the wall and the underside of the battens and felt should be filled with a compressible non-combustible material.

In situations where combustible tiling battens are required to be discontinued at separating walls, the continuity of the lateral support provided by the battens may have to be maintained by metal straps or a suitable alternative, adequately protected against corrosion, with a minimum cross-sectional area of 50 $mm^2$. Straps should be spaced at not more than 1.5 m centres, fixed to two rafter members on each side of the separating wall by 3.35 mm diameter nails, with a minimum penetration into the timber of 32 mm.

## 9.4 Modification and repairs

In no circumstances should any member in a trussed rafter be cut, trimmed, notched or repaired without reference to, and specific approval from, the trussed rafter designer. In cases where this is not possible, such approval should be sought from a chartered civil or structural engineer, or other suitably qualified person experienced in timber engineering. Any such modification or repair should be carried out under competent supervision.

Trussed rafters should not be birdsmouthed or otherwise cut unless this is specifically provided for in the design. Any measures to remedy defects which are discovered after erection should be in accordance with the provisions of this part of BS 5268.

# 10 Load testing

## 10.1 General

To establish the adequacy of a trussed rafter design, a full scale load test may be conducted which is an equally acceptable alternative to theoretical analysis. It may also be necessary to test trussed rafters where:

a) calculations are deemed impractical because of the complexity of the design;

b) there is doubt or disagreement as to whether the trussed rafter or some part of it conforms to the design requirements or whether the quality of the material is of the required standard.

When trussed rafters have been designed and fabricated in accordance with BS 5268-2 and this part of BS 5268, load testing is unnecessary.

NOTE The general principles for testing timber structures and components are given in BS EN 380.

Testing of trussed rafters should be carried out and reported upon in accordance with BS EN 595 and the results should be analysed in accordance with the requirements of that standard.

Whenever possible more than one trussed rafter of the same design should be tested to enable an assessment to be made of the likely variability in performance.

## 10.2 Testing authority

The tests should be formulated, supervised and certificated by an authority competent in structural testing and timber engineering.

## 10.3 Information required by the testing authority

A copy of the detailed drawings and specification for the trussed rafters to be tested, together with details of the loads and conditions of exposure or moisture content for which they have been designed and any other relevant information, including fixing and bracing details and the positions and method of support, should be deposited with the testing authority prior to testing. The tests should not commence until all the relevant information has been received and assessed.

## 10.4 Quality and fabrication of trussed rafters for test

The materials and assembly of the trussed rafters to be tested should conform to the design specifications in every respect and the method of assembly should simulate as closely as possible the method which would be used in production.

The materials, including the timber, metal plates, nails, plywood and glue, from which the trussed rafters are assembled, together with the associated workmanship, should be, as far as practicable, of the minimum quality and dimensions permitted by the specifications and likely to arise in practice. The testing authority may require the trussed rafters to be replaced or modified if the authority considers them to be unrepresentative of the specification requirements.

## 10.5 Tests on similar configurations

When more than one trussed rafter of identical construction is tested, only one needs to be subjected to the deformation test in BS EN 595. All trussed rafters should be given initial loading and strength tests.

## 10.6 Acceptance

### 10.6.1 *Performance*

The structural performance of a trussed rafter should only be considered satisfactory if the deformation and strength criteria given in **10.6.2** and **10.6.3** can be met.

NOTE Additional performance requirements may be appropriate in the case of eccentrically loaded components.

**10.6.2** ***Deformation criteria***

The maximum deformation of any node point during the deformation test, when the trussed rafter is supporting the dead loads only (load types 1, 5 and 6, as detailed in Table 6 and Table 7), should not exceed 0.8 times the amount specified in **6.5.7**.

The maximum deformation of an uncambered trussed rafter during the 24 h deformation test should not exceed 0.0024 times the span. For trussed rafters which are cambered to counteract dead load deformation, the maximum deformation (including that due to dead loads) during the 24 h deformation test should not exceed:

$$0.0024 \times \text{span} \times (G_2 + Q)/Q$$

where

$G_2$ is the dead load on the trussed rafter, generally taken as consisting of load types 1, 5 and 6 in Table 6 and Table 7;

$Q$ is the imposed load on the trussed rafter, generally taken as consisting of load types 2 and 7 in Table 6 and Table 7.

The rate of increase in deformation during the 24 h deformation test should decrease to a minimum at the end of the test.

**10.6.3** ***Strength***

The minimum failure load obtained for any trussed rafter should satisfy the following condition:

$$F_{max} \geq K_t (G_2 + Q)$$

where

$F_{max}$ is the maximum load that can be sustained by the trussed rafter irrespective of any serviceability criteria, characterized by:

- — fracture of a truss member; or
- — failure of a joint; or
- — deformation continuing without a further increase in load;

$K_t$ is the modification factor given in Table 12 depending on the number of trussed rafters tested of identical construction and the duration of loading for the load combination under consideration.

**Table 12 — Modification factor ($K_t$) for strength tests on trussed rafters**

| Number of trussed rafters tested | Duration of loading | | | |
|---|---|---|---|---|
| | Long-term | Medium-term | Short-term | Very short-term |
| 1 | 2.85 | 2.28 | 1.90 | 1.63 |
| 2 | 2.62 | 2.09 | 1.75 | 1.50 |
| 3 | 2.46 | 1.97 | 1.64 | 1.40 |
| 4 | 2.35 | 1.87 | 1.57 | 1.34 |
| 5 or more | 2.28 | 1.82 | 1.52 | 1.30 |

**10.7 Use of tested trussed rafters**

A trussed rafter which has been subjected to the strength test should not be used in construction. A trussed rafter which has been subjected to the initial loading and deformation tests only and has satisfied the deformation criteria given in **10.6.2** may be used for construction subject to agreement by the testing authority and the client.

## 11 Exchange of information

### 11.1 Information required by the trussed rafter designer from the building designer

The following information should be provided by the building designer:

a) the height, ground roughness and location of the building with reference to any unusual wind conditions;

b) the profile of the trussed rafter including any camber requirements;

c) the span of the trussed rafter ($L_s$ in Figure 11[3]);

d) the pitch or pitches of the roof or its overall height ($\alpha$ or $h$ in Figure 11);

e) the method of support and position of load bearing supports ($L_p$ and $L_i$, where applicable, in Figure 11);

f) the type or weights of roof tiles or covering, including sarking, insulation and ceiling materials;

g) the size and position of all water tanks or other ancillary equipment or loads to be supported on the trussed rafters;

h) the overhang of rafters at eaves ($L_o$ in Figure 11) and other eaves details;

i) the positions and dimensions of hatches, chimneys and other openings;

j) the service use of the building with reference to any unusual environmental conditions and the type of preservative treatment where required;

k) the spacing of trussed rafters and special timber sizes where these are required to match existing construction;

l) the site snow load, or the basic snow load and site altitude, or the Ordnance Survey (OS) grid reference for the site;

m) the position, dimensions and shape of any adjacent structures higher than the new roof and closer than 1.5 m;

n) any special requirement for minimum member thickness (e.g. for the purposes of fixing ceiling boards or sarking).

### 11.2 Information to be provided by the trussed rafter designer to the building designer

The trussed rafter designer should provide the building designer with the following information, on suitably detailed drawings, to enable a check to be made that the trussed rafters supplied are suitable for their intended use:

a) sizes, species, strength grades or strength classes of members;

b) the type, sizes and positions of all jointing devices with tolerances or the number of effective teeth or nails required in each member at each joint;

c) the positions and sizes of all bearings;

d) loadings and other conditions for which the trussed rafters are designed;

e) the position and spacing of trussed rafters;

f) the positions, fixings and sizes of any lateral supports necessary to prevent buckling of compression members such as rafters and struts[4];

g) the location and method of support for tanks and ancillary equipment or loads together with the capacity or magnitude of additional load assumed;

h) the range of reactions to be accommodated at the support positions including those required to resist wind uplift forces;

i) the basis of the design;

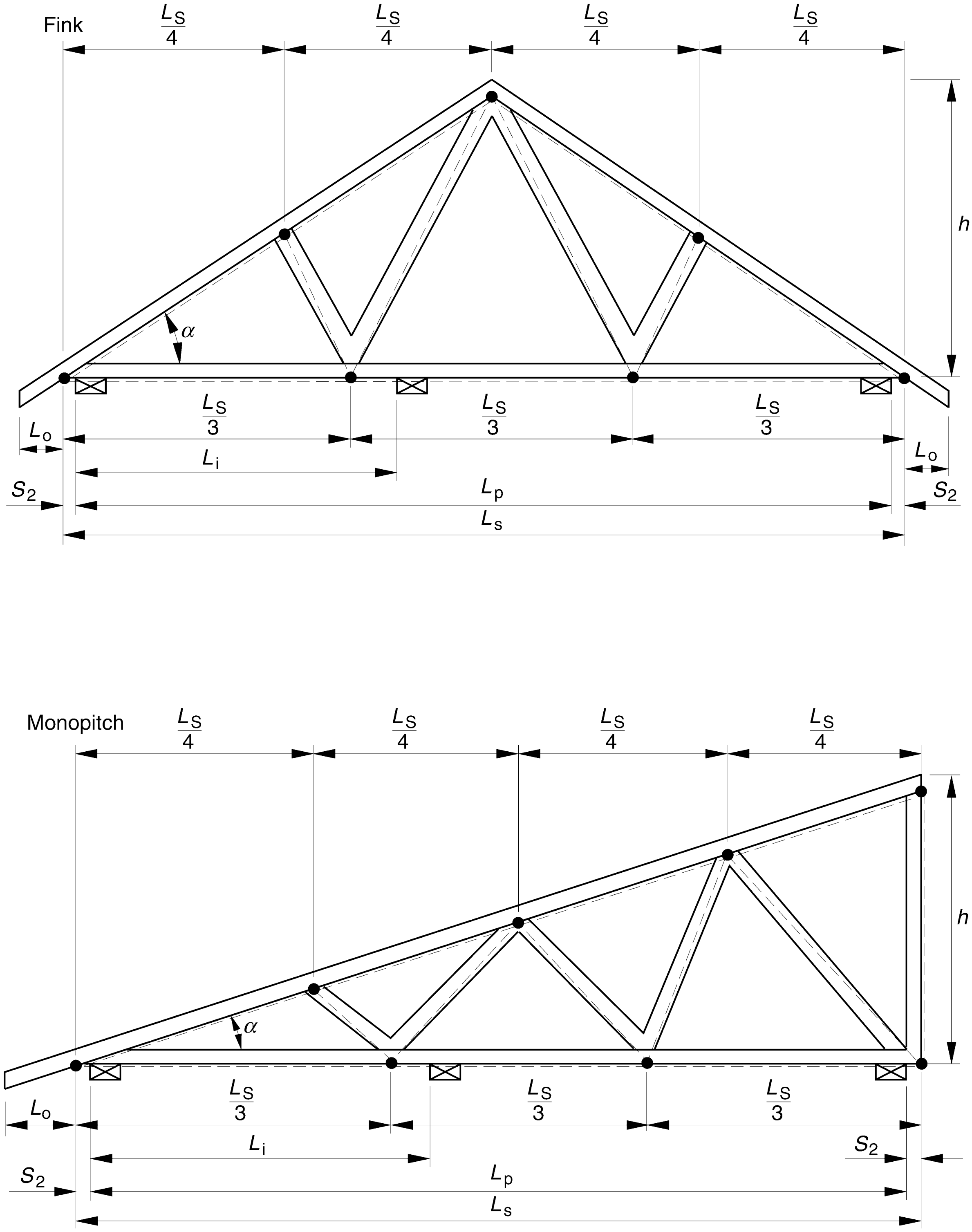
[3] When specifying the span of a trussed rafter, consideration should be given to the effect of small inaccuracies in the positioning of the wall plates. To ensure adequate clearance between the outer edge of the wall plate and the rafter member, it may be expedient to assume a minimum value, e.g. 10 mm, for dimension $S_2$ in Figure 11.

[4] Details of the permanent bracing necessary to ensure the overall stability of the complete roof structure and supporting walls should be provided by the building designer (see **7.1** and **7.2**).

j) details of any changes in spacing to accommodate chimneys or openings;

k) any special precautions for handling, storage and erection, in addition to those covered by this part of BS 5268;

l) The number, type, size and position of all fasteners required to join principal trussed rafters (e.g. girder trusses) together.




NOTE For dimensions $S_2$ [see **11.1**c)], it may be expedient to assume a specified minimum value, e.g. 10 mm.

**Figure 11 — Trussed rafter specification**

# Annex A (normative)
# Roof bracing

## A.1 General

From experience in the use of trussed rafters for domestic scale roofs, a standard method for providing roof and wall stability has been evolved for spans up to 17 m.

The flow diagrams in Figure A.1 and Figure A.2 illustrate how standard bracing arrangements might be selected at both rafter and ceiling level.

Figure A.1 enables the selection of suitable bracing details at rafter level to ensure adequate roof stability at this level.

Figure A.2 enables the plasterboard diaphragm at ceiling level to be appraised as a suitable means of ensuring wall stability at this level.

In addition to the bracing at rafter and ceiling level defined in this annex, additional bracing may be required to stabilize the gable walls at intermediate levels. The building designer is responsible for designing this additional bracing and verifying the overall stability of the masonry wall.

When properly followed, the standard bracing details derived in this manner may be used without further calculation. If no standard bracing solution is available, then a specific bracing system should be designed by the building designer following the principles laid down in **A.3**.

Hipped ends on a trussed rafter roof will provide a satisfactory alternative to the bracing shown in Figure A.3 for the area contained by the hip end. If the length of roof between the hip ends exceeds 1.8 m, this section should be braced as shown in Figure A.3.

## A.2 Sarking materials

For the purposes of this annex, sarking is defined as structural boarding used for the purposes of bracing the roof.

Where certain sarking materials are directly fixed to the top face of the rafter members, it is permissible to omit the rafter diagonal bracing, chevron bracing and longitudinal bracing at rafter level. This omission is acceptable where the solid sarking material is moisture resistant and provides an equivalent level of restraint to out-of-plane instability and wind forces.

Minimum thicknesses of some sarking materials required to meet the bracing requirements only are given in Table A.1. Greater thicknesses may be necessary to meet imposed loading and durability requirements. Sarking materials should be nailed to the rafters with due allowance being made for moisture related movement between boards. Joints between square-edged boards should be supported on timber noggings. Cantilevering or splicing of boards between rafters is not recommended.

Extra care should be taken during erection to ensure that the stability, verticality and straightness is maintained throughout the period of fixing of the solid sarking material.

**Table A.1 — Thickness and fixing of sarking materials**

| Material | Minimum thickness | Fixing |
|---|---|---|
| Plywood<br>Oriented strand board (OSB)<br>Chipboard | 9 mm[a]<br>9 mm[a]<br>12 mm[a] | 3.0 mm diameter times 50 mm long galvanized round wire nails fixed at 200 mm centres to every trussed rafter |
| Timber boarding (no more than one board in four may be joined on any one rafter member). | 16 mm | Two 3.0 mm diameter 50 mm long galvanized round wire nails per board fixed to every trussed rafter |

[a] Suitable only where roof coverings (e.g. slates and tiles) are independently supported on battens, secured to counter battens. In all other cases, roof coverings may be attached directly to the board.

### A.3 Non-standard roof bracing

Where no standard bracing solution is available a bracing system should be designed which performs the functions given in **7.2.1**. The bracing system, which may consist of a suitable combination of elements such as those given in this annex or other suitable structural systems, should be capable of restraining all out-of-plane forces on the roof without excessive deflection (whether they be induced by external wind forces acting on the walls or by internal compression instability forces in the truss members themselves).

The bracing forces should be determined on the basis of the most unfavourable combinations of geometrical/structural imperfections and induced deflections under load.

In the absence of any other guidance, where trussed rafters are erected within the tolerances in **9.3.1**, the compression induced out-of-plane instability force per unit length that needs to be restrained may be calculated as follows for the purposes of designing roof stability bracing:

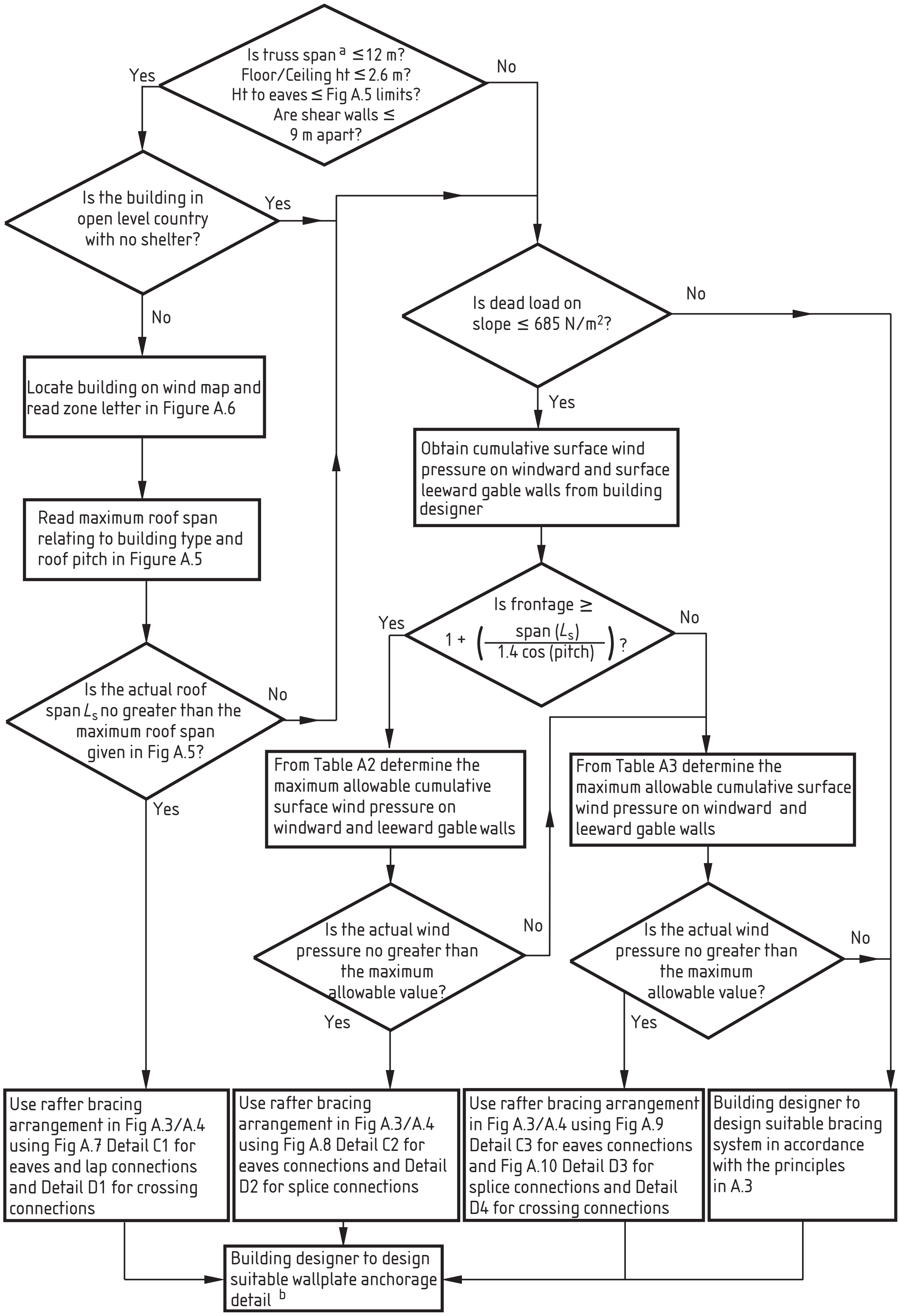
$$q = \frac{n^{0.75} N_d}{40L}$$

where

- $q$ is the compression induced out-of-plane instability force per unit length along the rafter in newtons per metre (N/m);
- $n$ is the number of trussed rafters being restrained by the bracing system;
- $N_d$ is the mean axial compression force in the rafter in newtons (N);
- $L$ is the length of the rafter member being considered in metres (m).

Where the bracing system is also required to serve the purpose of wall stability, out-of-plane wind forces need to be combined with the appropriate compression induced instability force.

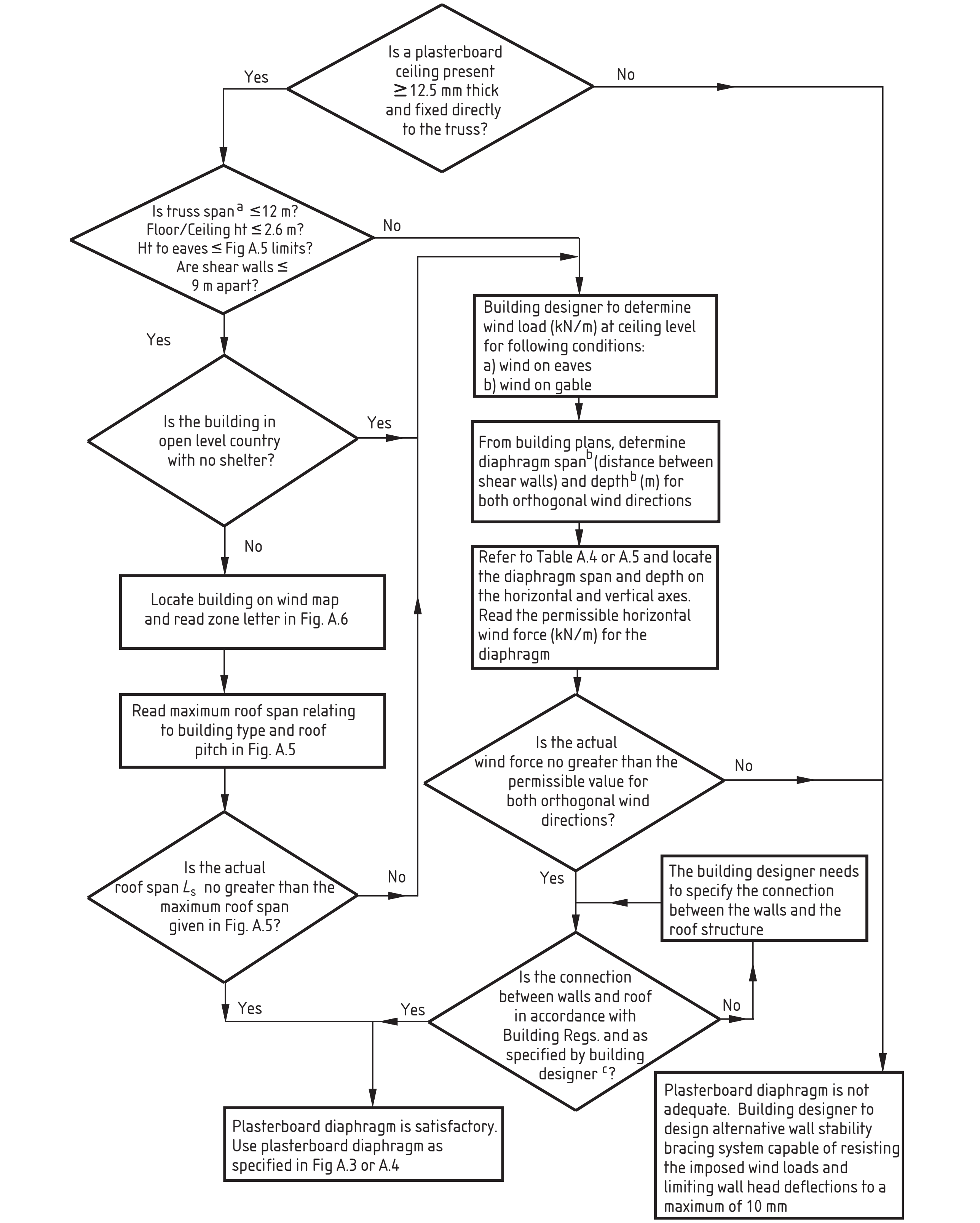
Whether the bracing system is either a purpose designed bracing system at rafter or ceiling level, a prefabricated wind girder or ring beam, the bracing system chosen should be capable of resisting the imposed loads (wind and/or instability) and of limiting the horizontal deflection due to these loads to 10 mm or span/700, whichever is the lesser, unless an alternative deflection limit has been set by the building designer.




[a] For monopitch roofs, for purposes of this annex, use a span which is twice the actual span $L_s$ (see Figure 11).

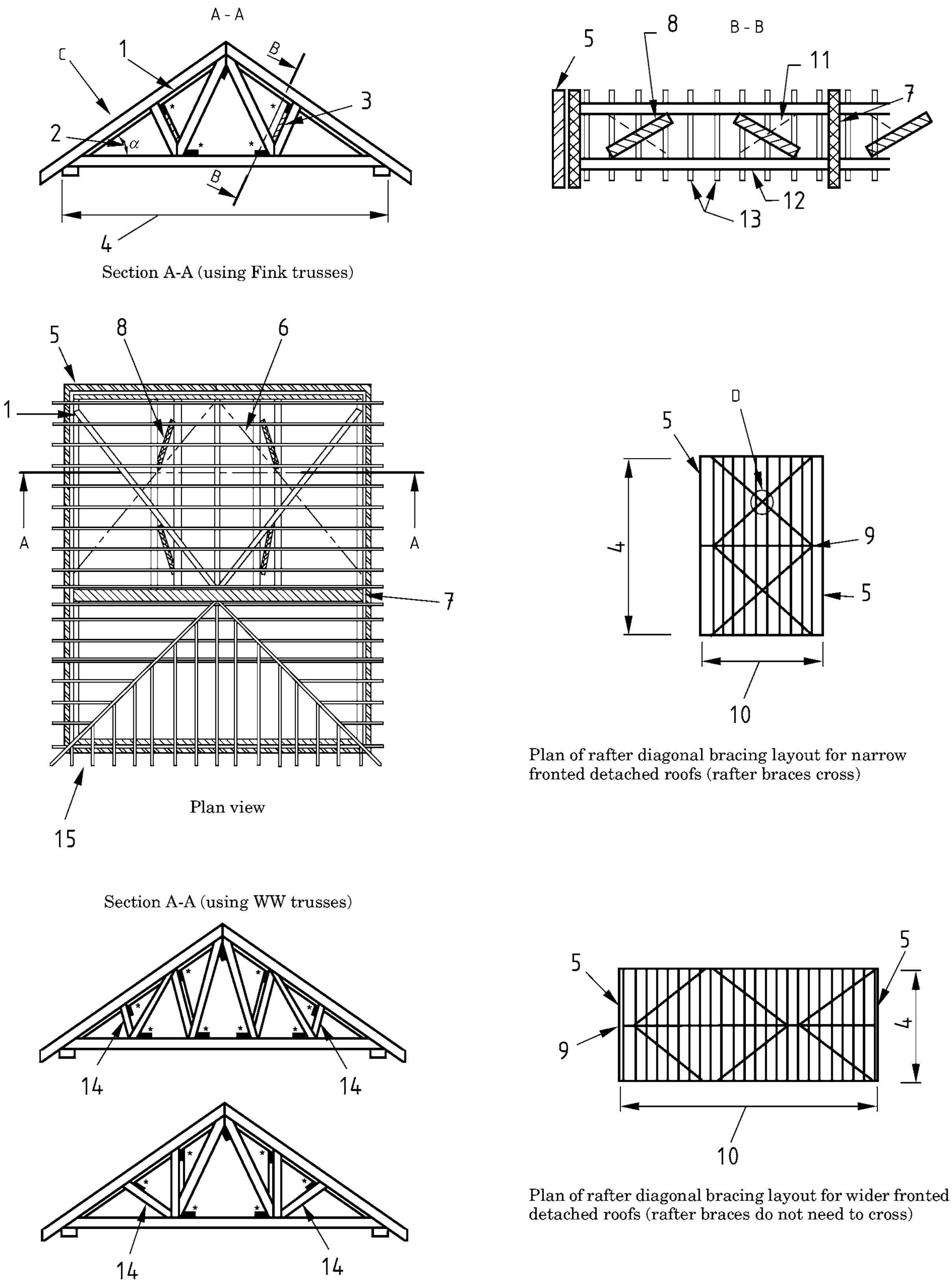
[b] The wallplate anchorage detail should be designed to transfer the forces stated for the rafter diagonal braces in Figures A.7, A.8 or A.9 into the supporting structure.

**Figure A.1 — Procedure for the design of roof bracing at rafter level**




[a] For monopitch roofs, for purposes of this annex, use a span which is twice the actual span $L_s$ (see Figure 11).
[b] For the purposes of this annex, the diaphragm span and depth should be defined from any unbroken area of plasterboard bounded on each edge by timber wallplates, head plates or trusses which can be deemed to act as flanges to the diaphragm.
[c] The wallplate anchorage detail should be designed to transfer the forces stated for the rafter diagonal braces in Figures A.7, A.8

**Figure A.2 — Procedure for the design of roof bracing at ceiling level**




Section A-A (using Fink trusses)

Plan of rafter diagonal bracing layout for narrow fronted detached roofs (rafter braces cross)

Section A-A (using WW trusses)

Plan of rafter diagonal bracing layout for wider fronted detached roofs (rafter braces do not need to cross)

Section A-A (using Fan trusses)

**Figure A.3 — Standard bracing for rafter and web members of duopitch trussed rafters**

**Specification notes to Figure A.3**

a) The maximum trussed rafter spacing is 600 mm.

b) Horizontal lateral connections between masonry walls and the roof structure are in accordance with the recommendations given in BS 8103-1 and fixed at both rafter and ceiling tie level.

c) The ceiling is of plasterboard throughout (plasterboard which conforms to BS 1230-1 and which is of a minimum thickness of 12.5 mm and installed in accordance with BS 8212), or of similar rigid material fixed either directly to the bottom chords of the trussed rafters or to continuous counter battens which are fixed directly to the bottom chords of the trussed rafters. Where the ceiling is less rigid than plasterboard or is omitted, extra bracing will normally be required at ceiling level.

d) All bracing members are nailed to every trussed rafter they cross with two 3.35 mm diameter galvanized wire nails with a minimum length equal to the bracing thickness plus 32 mm. In all details 3.1 × 90 mm long mechanically driven gun nails may be substituted for 3.35 × 65 mm long wire nails.

e) At least four rafter diagonal braces as shown in Figure A.3 (lap jointed, as required) are fixed to the undersides of the rafter members ideally at 45° to the rafters but not less than 35° or greater than 55° measured normal to the roof slope.

f) Longitudinal bracing members (lap jointed, if required) extend over the whole length of the roof and tightly abut the face of every gable and party wall.

g) A longitudinal bracing member is located at the apex and either:

1) a longitudinal bracing member is located at all other nodes (excluding support points); or

2) where intermediate longitudinal bracing members are omitted, the resultant spacing between longitudinal braced nodes does not exceed 4.2 m measured along each rafter and 3.7 m measured along each ceiling tie, and temporary battens are installed to assist in the correct erection and alignment of the trussed rafters.

h) Internal compression members are provided with lateral restraint where required by the trussed rafter designer.

i) On trussed rafter roofs with spans in excess of 8 m for duopitch roofs, chevron bracing as shown in Figure A.3 is required. For spans in excess of 11 m additional chevron bracing is required.

j) Rafter diagonal bracing and chevron bracing members extend over the whole length of the roof except that this bracing may be omitted from no more than two trussed rafters between sets of bracing and single trussed rafters adjacent to the faces of gable and party walls.

NOTE 1 Chevron bracing shown is not required on internal members of trusses with spans of 8 m or less.

NOTE 2 * denotes longitudinal bracing not required when the criteria described in Figure A.3g(2) are met.

NOTE 3 For the purposes of this annex, a building may be defined as narrow fronted when the frontage $F < 1 + \left(\frac{L_s}{1.4\cos\alpha}\right)$

**Key to Figure A.3**

1) Rafter diagonal bracing nailed to wall plate

2) Roof pitch, α

3) Chevron bracing to webs

4) Span of trussed rafter, $L_s$ (see Figure 11)

5) Gable end

6) Alternative direction of rafter diagonal bracing

7) Party wall

8) Chevron brace to be at approx 45° and nailed to at least 3 trusses

9) Ridge

10) Frontage F

11) Alternative direction of chevron brace

12) Longitudinal brace

13) Maximum of 2 trusses between chevron braces

14) For spans in excess of 11 m additional chevron bracing is required

15) Hipped end (Note: Longitudinal bracing not shown in hip area)

C) For details on Arrow C see Figures A.7, A.8 and A.9

D) For details on Detail D see Figures A.8, A.9 and A.10

**Figure A.3 — Standard bracing for rafter and web members of duopitch trussed rafters** (*continued*)

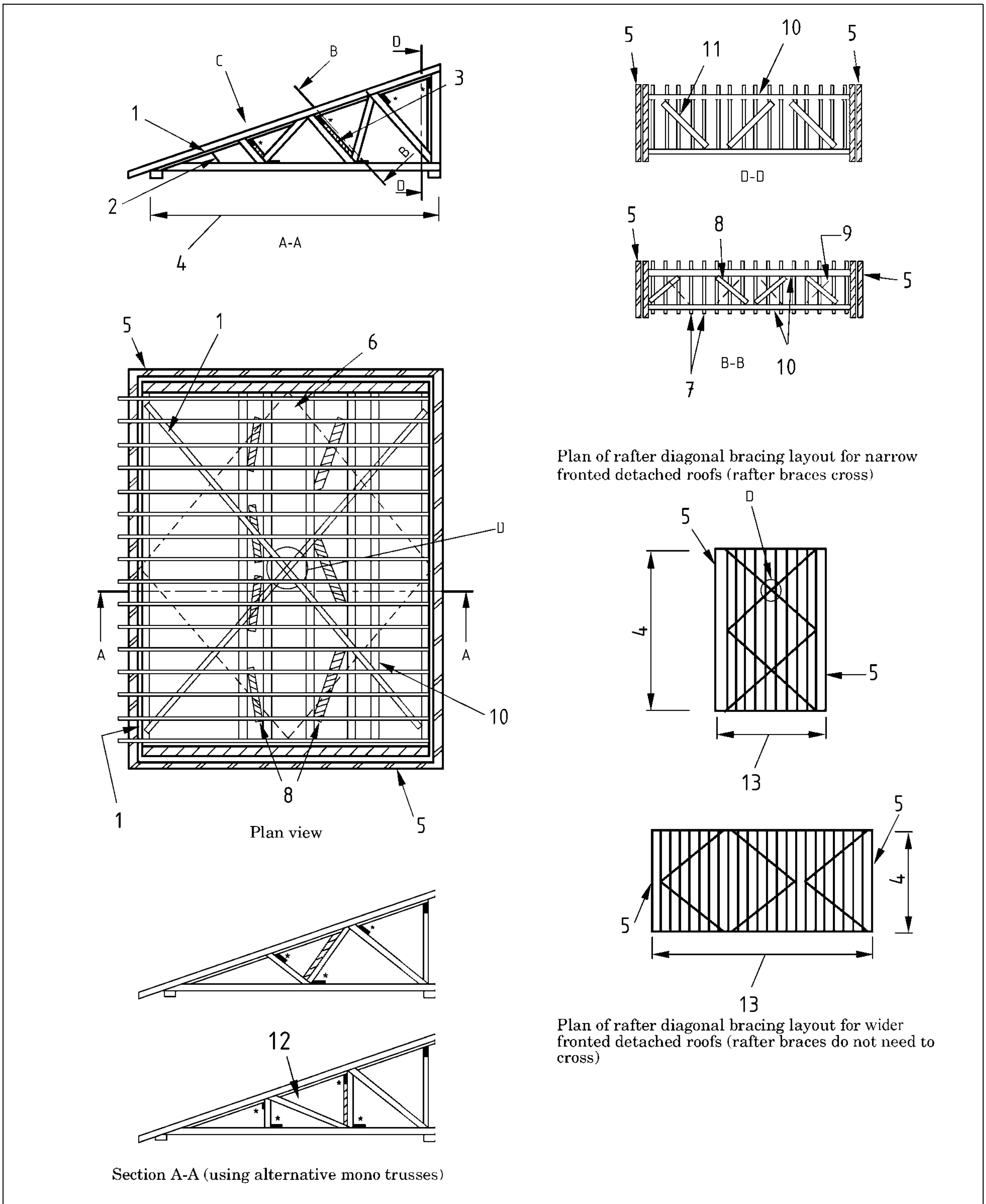



**Figure A.4 — Standard bracing for rafter and web members of monopitch trussed rafters**

**Specification notes to Figure A.4**

a) The maximum trussed rafter spacing is 600 mm.

b) Horizontal lateral connections between masonry walls and the roof structure are in accordance with the recommendations given in BS 8103-1 and fixed at both rafter and ceiling tie level.

c) The ceiling is of plasterboard throughout (plasterboard which conforms to BS 1230-1 and which is of a minimum thickness of 12.5 mm and installed in accordance with BS 8212), or of similar rigid material fixed either directly to the bottom chords of the trussed rafters or to continuous counter battens which are fixed directly to the bottom chords of the trussed rafters. Where the ceiling is less rigid than plasterboard or is omitted, extra bracing will normally be required at ceiling level.

d) All bracing members are nailed to every trussed rafter they cross with two 3.35 mm diameter galvanized wire nails with a minimum length equal to the bracing thickness plus 32 mm. In all details 3.1 × 90 mm long mechanically driven gun nails may be substituted for 3.35 × 65 mm long wire nails.

e) At least two rafter diagonal braces as shown in Figure A.4 (lap jointed, as required) are fixed to the undersides of the rafter members ideally at 45° to the rafters but not less than 35° or greater than 55° measured normal to the roof slope.

f) Longitudinal bracing members (lap jointed, if required) extend over the whole length of the roof and tightly abut the face of every gable and party wall.

g) A longitudinal bracing member is located at the apex and either:

1) a longitudinal bracing member is located at all other nodes (excluding support points); or

2) where intermediate longitudinal bracing members are omitted, the resultant spacing between longitudinal braced nodes does not exceed 4.2 m measured along each rafter and 3.7 m measured along each ceiling tie, and temporary battens are installed to assist in the correct erection and alignment of the trussed rafters.

h) Internal compression members are provided with lateral restraint where required by the trussed rafter designer.

i) On trussed rafter roofs with spans in excess of 5 m for monopitch roofs, chevron bracing as shown in Figure A.4 is required. For spans in excess of 8 m additional chevron bracing is required.

j) Rafter diagonal bracing and chevron bracing members extend over the whole length of the roof except that this bracing may be omitted from no more than two trussed rafters between sets of bracing and single trussed rafters adjacent to the faces of gable and party walls.

k) Monopitch trussed rafters also require diagonal bracing fixed to the inside face of the end vertical if this member is not laterally restrained at its top by connection to a masonry wall or by being clad in plywood or similar rigid sheet material adequately fixed to the truss.

NOTE 1 Chevron bracing shown is not required on internal members of truss spans of 5 m or less.

NOTE 2 * denotes longitudinal binders not required when the criteria described in Figure A.4g)2 are met.

NOTE 3 For the purposes of this annex, a building may be defined as narrow fronted when the frontage $F < 1 + \left(\frac{L_s}{1.4\cos\alpha}\right)$

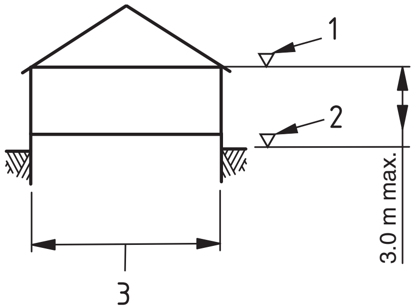
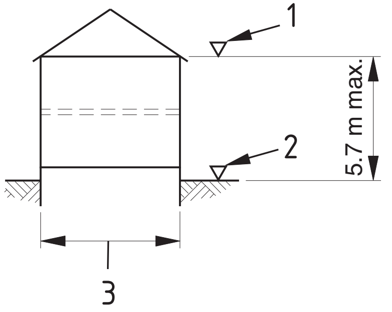
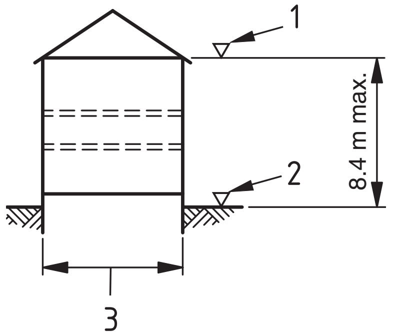
**Key to Figure A.4**

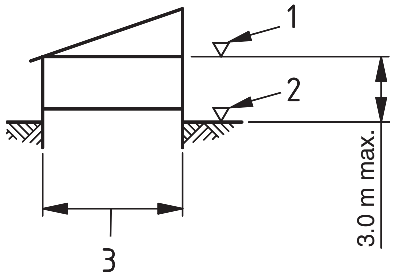
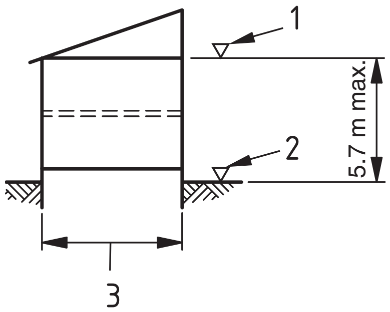
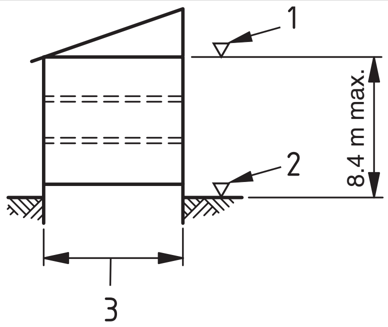
1) Rafter diagonal bracing nailed to wall plate
2) Roof pitch, α
3) Chevron bracing to webs
4) Span of trussed rafter, $L_s$ (see Figure 11)
5) Gable end
6) Alternative direction of rafter diagonal bracing
7) Maximum of two trusses between chevron bracing
8) Chevron brace to be approx. 45° and nailed to at least 3 trusses
9) Alternative direction of chevron bracing
10) Longitudinal bracing
11) Web diagonal bracing
12) For spans in excess of 8.0 m additional chevron bracing will be required
13) Frontage F

C) For details on Arrow C see Figures A.7, A.8 and A.9

D) For details on Detail D see Figures A.8, A.9 and A.10

**Figure A.4 — Standard bracing for rafter and web members of monopitch trussed rafters** (*continued*)

| Building profile | Maximum truss span ($L_s$) | | | | |
|---|---|---|---|---|---|
| | Roof pitch<br>° | Zone A[a]<br>m | Zone B[a]<br>m | Zone C[a]<br>m | Zone D[a]<br>m |
|  | ≤ 22.5 | 12.0 | 12.0 | 12.0 | 12.0 |
| | 25.0 | 12.0 | 12.0 | 12.0 | 12.0 |
| | 27.5 | 12.0 | 12.0 | 12.0 | 11.5 |
| | 30.0 | 12.0 | 12.0 | 11.6 | 10.2 |
| | 32.5 | 12.0 | 11.8 | 10.4 | 9.0 |
| | 35.0 | 12.0 | 10.6 | 9.8 | 8.6 |
| | 37.5 | 11,5 | 10.0 | 8.7 | 7.5 |
| | 40.0 | 10.3 | 8.9 | 7.6 | 7.1 |
| | 42.5 | 9.1 | 8.5 | 7.3 | 6.1 |
| | 45.0 | 8.7 | 7.4 | 6.3 | 5.9 |
|  | ≤ 22.5 | 12.0 | 12.0 | 12.0 | 12.0 |
| | 25.0 | 12.0 | 12.0 | 12.0 | 10.5 |
| | 27.5 | 12.0 | 12.0 | 10.6 | 9.9 |
| | 30.0 | 12.0 | 11.5 | 10.0 | 8.7 |
| | 32.5 | 11.8 | 10.2 | 8.9 | 7.6 |
| | 35.0 | 10.5 | 9.1 | 7.7 | 7.2 |
| | 37.5 | 10.0 | 8.6 | 7.4 | 6.2 |
| | 40.0 | 8.9 | 7.5 | 6.3 | 5.9 |
| | 42.5 | 8.4 | 7.2 | 6.0 | 4.9 |
| | 45.0 | 7.4 | 6.2 | 5.8 | 4.7 |
|  | ≤ 22.5 | 12.0 | 12.0 | 12.0 | 10.4 |
| | 25.0 | 12.0 | 12.0 | 10.5 | 9.1 |
| | 27.5 | 12.0 | 11.5 | 10.0 | 8.6 |
| | 30.0 | 11.8 | 10.2 | 8.8 | 7.5 |
| | 32.5 | 10.5 | 9.0 | 7.6 | 7.1 |
| | 35.0 | 10.0 | 8.5 | 7.2 | 6.0 |
| | 37.5 | 8.9 | 7.5 | 6.2 | 5.8 |
| | 40.0 | 7.7 | 7.1 | 5.9 | 4.8 |
| | 42.5 | 7.4 | 6.1 | 4.9 | 4.6 |
| | 45.0 | 6.3 | 5.8 | 4.7 | 4.4 |

| Building profile | Maximum truss span ($L_s$) | | | | |
|---|---|---|---|---|---|
| | Roof pitch<br>° | Zone A[a]<br>m | Zone B[a]<br>m | Zone C[a]<br>m | Zone D[a]<br>m |
|  | ≤ 22.5 | 10.8 | 9.4 | 8.1 | 7.3 |
| | 25.0 | 9.5 | 8.1 | 7.3 | 6.5 |
| | 27.5 | 8.6 | 7.3 | 6.5 | 5.8 |
| | 30.0 | 7.8 | 6.6 | 5.8 | 5.1 |
| | 32.5 | 7.1 | 5.9 | 5.2 | 4.5 |
| | 35.0 | 6.4 | 5.6 | 4.9 | 4.3 |
| | 37.5 | 5.8 | 5.0 | 4.4 | 3.8 |
| | 40.0 | 5.2 | 4.5 | 3.8 | 3.6 |
| | 42.5 | 4.9 | 4.3 | 3.6 | 3.1 |
| | 45.0 | 4.4 | 3.7 | 3.1 | 3.0 |
|  | ≤ 22.5 | 9.3 | 8.0 | 7.1 | 6.3 |
| | 25.0 | 8.1 | 7.2 | 6.4 | 5.6 |
| | 27.5 | 7.3 | 6.4 | 5.7 | 5.0 |
| | 30.0 | 6.6 | 5.8 | 5.0 | 4.4 |
| | 32.5 | 5.9 | 5.1 | 4.5 | 3.8 |
| | 35.0 | 5.6 | 4.5 | 4.2 | 3.6 |
| | 37.5 | 5.0 | 4.3 | 3.7 | 3.1 |
| | 40.0 | 4.4 | 3.8 | 3.5 | 3.0 |
| | 42.5 | 4.2 | 3.6 | 3.0 | 3.0 |
| | 45.0 | 3.7 | 3.1 | 3.0 | 3.0 |
|  | ≤ 22.5 | 8.5 | 7.2 | 6.3 | 5.2 |
| | 25.0 | 7.4 | 6.4 | 5.6 | 4.5 |
| | 27.5 | 6.6 | 5.7 | 5.0 | 4.3 |
| | 30.0 | 5.9 | 5.1 | 4.4 | 3.7 |
| | 32.5 | 5.6 | 4.5 | 3.8 | 3.5 |
| | 35.0 | 5.0 | 4.3 | 3.6 | 3.0 |
| | 37.5 | 4.4 | 3.7 | 3.1 | 3.0 |
| | 40.0 | 4.2 | 3.6 | 3.0 | 3.0 |
| | 42.5 | 3.7 | 3.0 | 3.0 | 3.0 |
| | 46.0 | 3.5 | 3.0 | 3.0 | 3.0 |

[a] Wind zones are shown in Figure A.6.

**Key**

1) Underside of ceiling tie    2) Ground level    3) Truss span, $L_s$ (see Figure 11)

**Figure A.5 — Limiting spans for standard bracing of trussed rafter roofs**

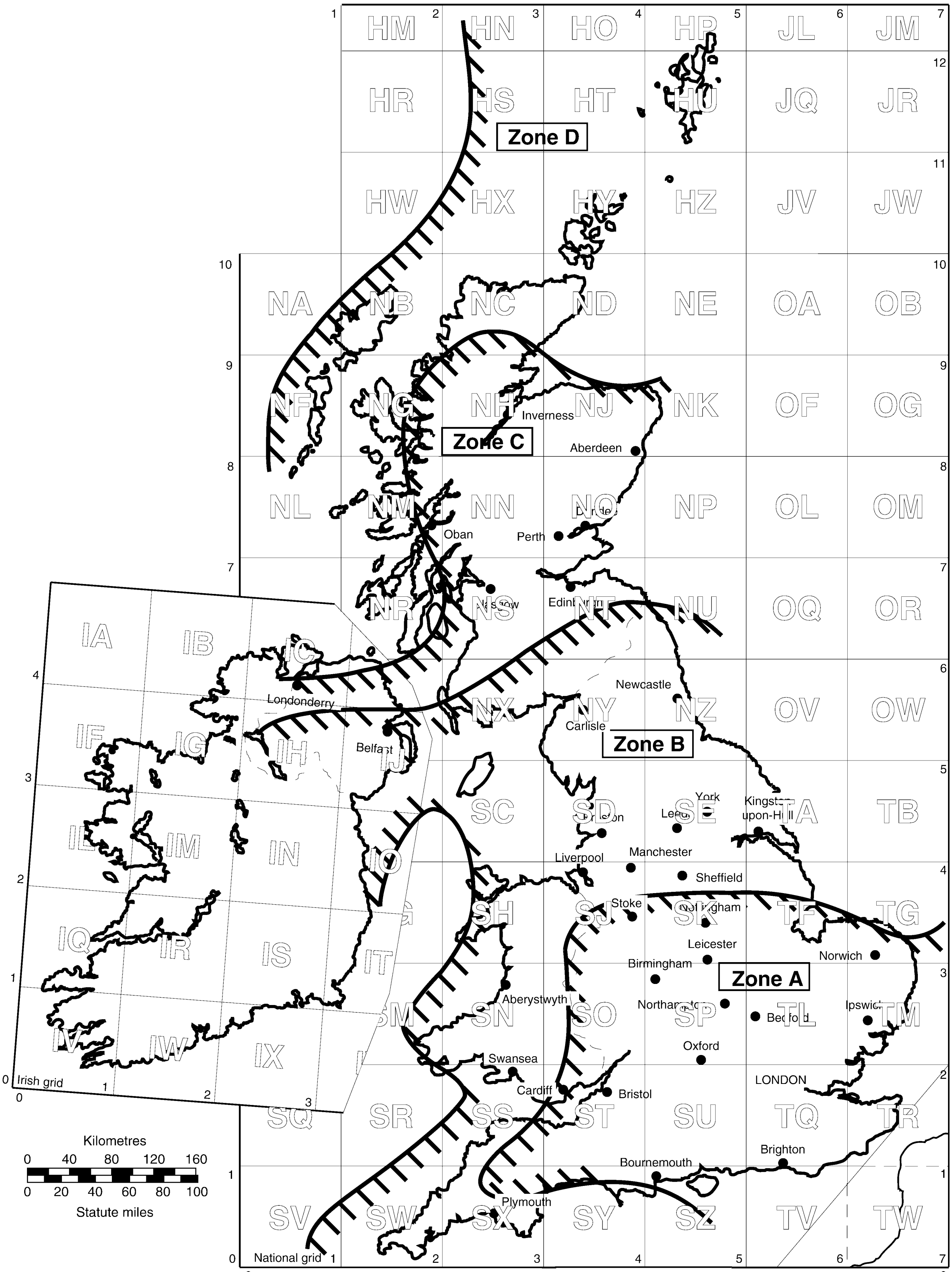



**Figure A.6 — Basic wind zones** (for use with Figure A.5)

**Table A.2 — Maximum allowable cumulative surface wind pressures (kN/m²) on windward and leeward gable walls for roofs constructed using the details of Figure A.8**

| Roof pitch | Roof span ($L_s$) m | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| **22.5** | Minimum standard bracing[a] | Minimum standard bracing[a] | Minimum standard bracing[a] | 1.95 | 1.57 | 1.28 | 1.04 | 0.85 |
| **25** | Minimum standard bracing[a] | Minimum standard bracing[a] | 2.10 | 1.77 | 1.43 | 1.16 | 0.96 | 0.79 |
| **27.5** | Minimum standard bracing[a] | 2.10 | 2.01 | 1.61 | 1.30 | 1.06 | 0.88 | 0.72 |
| **30** | 2.10 | 2.10 | 1.83 | 1.46 | 1.19 | 0.98 | 0.80 | 0.67 |
| **32.5** | 2.10 | 2.10 | 1.66 | 1.34 | 1.09 | 0.89 | 0.74 | 0.61 |
| **35** | 2.10 | 1.92 | 1.52 | 1.23 | 0.99 | 0.82 | 0.68 | 0.57 |
| **37.5** | 2.10 | 1.76 | 1.39 | 1.12 | 0.91 | 0.75 | 0.62 | 0.52 |
| **40** | 2.09 | 1.62 | 1.28 | 1.02 | 0.83 | 0.68 | 0.57 | — |
| **42.5** | 1.92 | 1.48 | 1.16 | 0.94 | 0.76 | 0.63 | — | — |
| **45** | 1.75 | 1.35 | 1.07 | 0.86 | 0.69 | — | — | — |

NOTE Intermediate values may be obtained by linear interpolation.

[a] See Figure A.3 or A.4 together with Figure A.7.

**Table A.3 — Maximum allowable cumulative surface wind pressures (kN/m²) on windward and leeward gable walls for roofs constructed using the details of Figure A.9 and Figure A.10**

| Roof pitch | Roof span ($L_s$) m | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| **22.5** | Minimum standard bracing[a] | 2.10 | 2.10 | 2.06 | 1.71 | 1.44 | 1.22 | 1.04 |
| **25** | 2.10 | 2.10 | 2.10 | 1.85 | 1.56 | 1.32 | 1.11 | 0.95 |
| **27.5** | 2.10 | 2.10 | 2.03 | 1.69 | 1.42 | 1.19 | 1.02 | 0.87 |
| **30** | 2.10 | 2.10 | 1.85 | 1.54 | 1.29 | 1.09 | 0.94 | 0.80 |
| **32.5** | 2.10 | 2.05 | 1.69 | 1.40 | 1.18 | 1.00 | 0.85 | 0.73 |
| **35** | 2.10 | 1.87 | 1.54 | 1.28 | 1.08 | 0.92 | 0.78 | 0.67 |
| **37.5** | 2.10 | 1.71 | 1.40 | 1.17 | 0.98 | 0.84 | — | — |
| **40** | 1.93 | 1.56 | 1.29 | 1.07 | 0.90 | — | — | — |
| **42.5** | 1.76 | 1.43 | 1.18 | 0.98 | — | — | — | — |
| **45** | 1.62 | 1.31 | 1.07 | — | — | — | — | — |

NOTE Intermediate values may be obtained by linear interpolation.

[a] See Figure A.3 or Figure A.4 together with Figure A.7.

**Table A.4 — Permissible horizontal wind force (kN/m) at bottom chord level on 12.5 mm thick plasterboard ceiling diaphragms**

| Diaphragm depth m | Diaphragm span m[a] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** |
| **6** | 1.77 | 1.59 | 1.45 | 1.33 | 1.22 | 1.14 | 1.06 | 0.99 | 0.93 |
| **7** | 2.06 | 1.86 | 1.69 | 1.55 | 1.43 | 1.33 | 1.24 | 1.16 | 1.09 |
| **8** | 2.36 | 2.12 | 1.93 | 1.77 | 1.63 | 1.52 | 1.41 | 1.33 | 1.25 |
| **9** | 2.66 | 2.39 | 2.17 | 1.99 | 1.84 | 1.71 | 1.59 | 1.49 | 1.40 |
| **10** | 2.95 | 2.66 | 2.41 | 2.21 | 2.04 | 1.90 | 1.77 | 1.66 | 1.56 |
| **11** | 3.25 | 2.92 | 2.66 | 2.43 | 2.25 | 2.09 | 1.95 | 1.82 | 1.72 |
| **12** | 3.54 | 3.19 | 2.90 | 2.66 | 2.45 | 2.28 | 2.12 | 1.99 | 1.87 |
| **13** | 3.84 | 3.45 | 3.14 | 2.88 | 2.66 | 2.47 | 2.30 | 2.16 | 2.03 |
| **14** | 4.13 | 3.72 | 3.38 | 3.10 | 2.86 | 2.66 | 2.48 | 2.32 | 2.19 |
| **15** | 4.43 | 3.99 | 3.62 | 3.32 | 3.06 | 2.85 | 2.66 | 2.49 | 2.34 |
| **16** | 4.72 | 4.25 | 3.86 | 3.54 | 3.27 | 3.04 | 2.83 | 2.66 | 2.50 |
| **17** | 5.02 | 4.52 | 4.11 | 3.76 | 3.47 | 3.23 | 3.01 | 2.82 | 2.66 |

[a] Intermediate values may be obtained by linear interpolation.

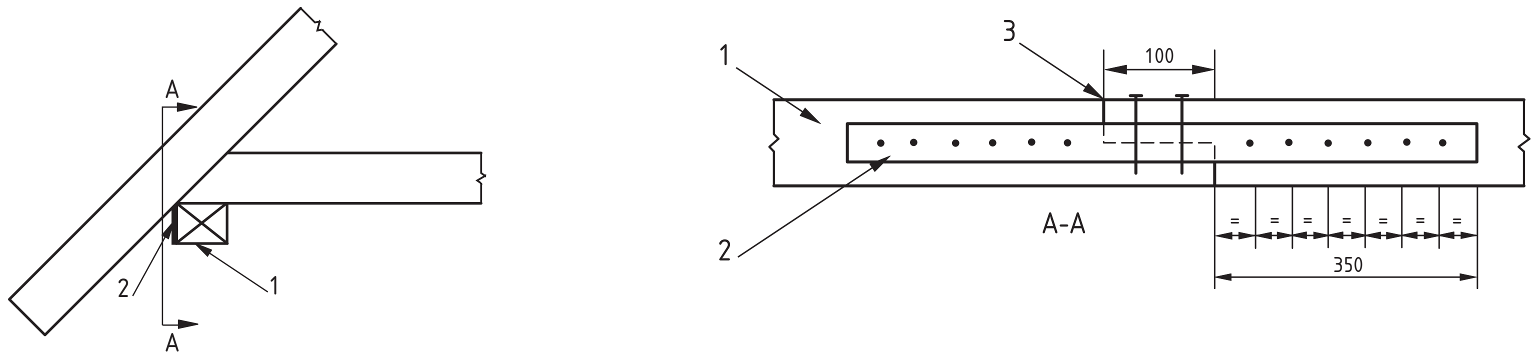
For plasterboard ceiling diaphragms greater than 9 m span, wallplates should be spliced in accordance with the detail provided below or using an alternative spliced detail capable of resisting a short-term axial load of 3.3 kN.

**Table A.5 — Permissible horizontal wind force (kN/m) at bottom chord level on 15 mm thick plasterboard ceiling diaphragms**

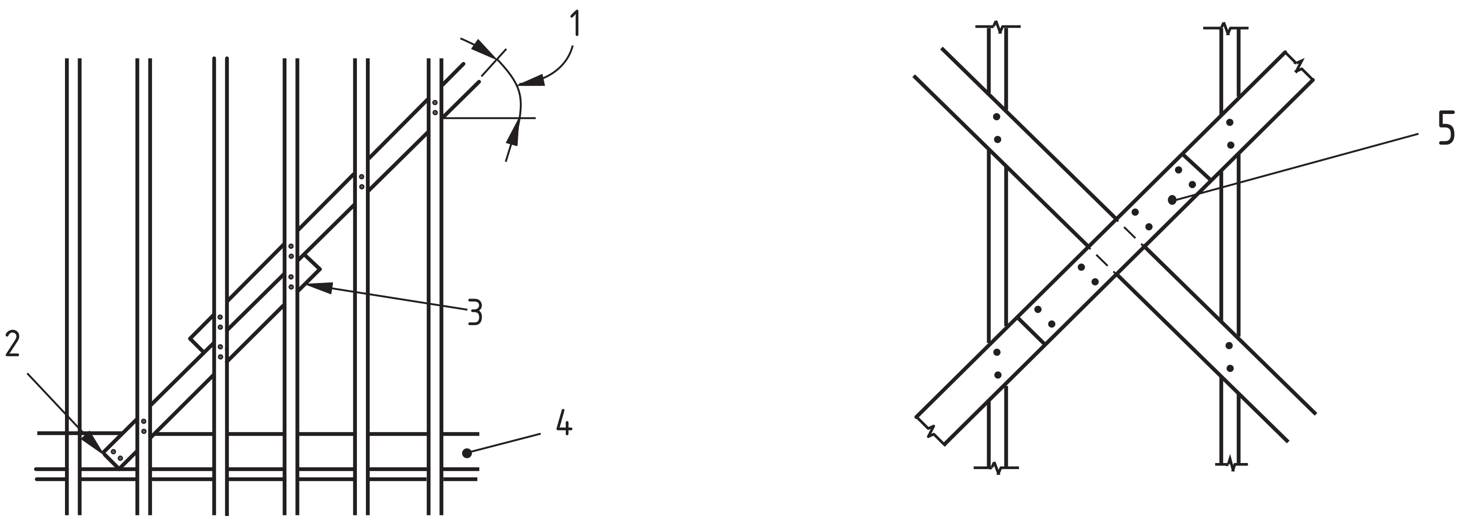
| Diaphragm depth m | Diaphragm span m[a] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** |
| **6** | 1.98 | 1.78 | 1.62 | 1.49 | 1.37 | 1.27 | 1.19 | 1.11 | 1.05 |
| **7** | 2.31 | 2.08 | 1.89 | 1.73 | 1.60 | 1.49 | 1.39 | 1.30 | 1.22 |
| **8** | 2.65 | 2.38 | 2.16 | 1.98 | 1.83 | 1.70 | 1.59 | 1.49 | 1.40 |
| **9** | 2.98 | 2.68 | 2.44 | 2.23 | 2.06 | 1.91 | 1.78 | 1.67 | 1.57 |
| **10** | 3.31 | 2.98 | 2.71 | 2.48 | 2.29 | 2.13 | 1.98 | 1.86 | 1.75 |
| **11** | 3.64 | 3.28 | 2.98 | 2.73 | 2.52 | 2.34 | 2.18 | 2.05 | 1.93 |
| **12** | 3.97 | 3.57 | 3.25 | 2.98 | 2.75 | 2.55 | 2.38 | 2.23 | 2.10 |
| **13** | 4.30 | 3.87 | 3.52 | 3.23 | 2.98 | 2.76 | 2.58 | 2.42 | 2.28 |
| **14** | 4.63 | 4.17 | 3.79 | 3.47 | 3.21 | 2.98 | 2.78 | 2.60 | 2.45 |
| **15** | 4.97 | 4.47 | 4.06 | 3.72 | 3.44 | 3.19 | 2.98 | 2.79 | 2.63 |
| **16** | 5.30 | 4.77 | 4.33 | 3.97 | 3.67 | 3.40 | 3.18 | 2.98 | 2.80 |
| **17** | 5.63 | 5.06 | 4.60 | 4.22 | 3.90 | 3.62 | 3.38 | 3.16 | 2.98 |

[a] Intermediate values may be obtained by linear interpolation.

For plasterboard ceiling diaphragms greater than 9 m span, wallplates should be spliced in accordance with the detail provided below or using an alternative spliced detail capable of resisting a short-term axial load of 3.3 kN.




**Key**
1) Wallplate
2) Steel strap fixed using 6 no. 3.75 × 30 mm square twist nails into each member
3) 100 mm long half lap joint with 2 no. nail fixings




Detail C1 — Eaves and lap connection: view on slope on topside of rafters (arrow C on Figure A.3 or Figure A.4)

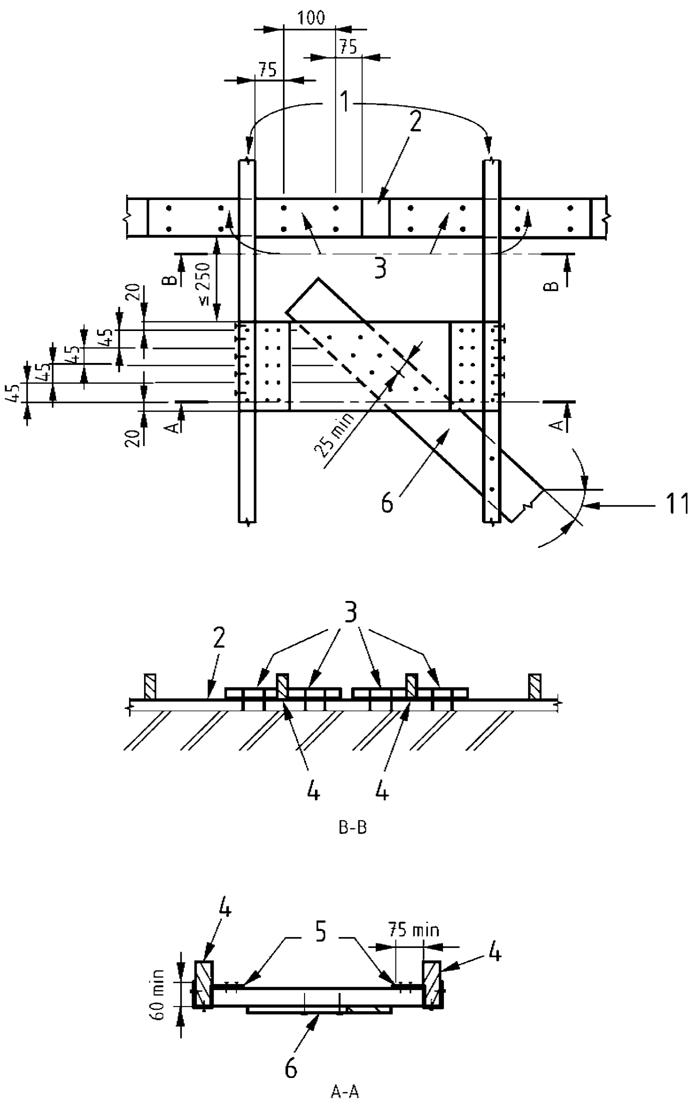
Detail D1 — Crossing connection for narrow fronted buildings (see Detail D Figure A.3 or Figure A4)

**Figure A.7 — Standard bracing for rafter members: detail C1 and D1**

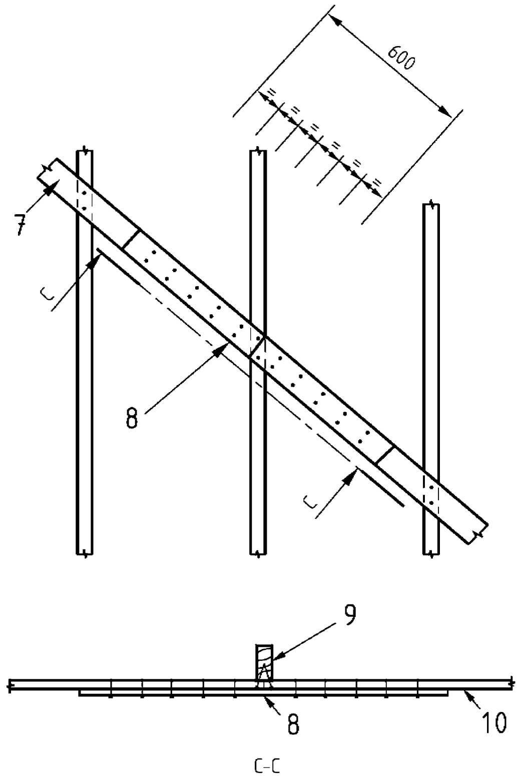
**Key**
1) Ideally 45º but not less than 35º or greater than 55º
2) Nail to wall plate
3) Rafter diagonal brace lap jointed if required
4) Wall plate
5) 600 mm long timber splice plate the same size as bracing timbers. Fix using minimum of 4 no 3.35 diameter galvanized nails each side × minimum nail length equal to bracing thickness + 32 mm

**Specification notes to Figure A.7**
a) All bracing members are of minimum width 89 mm and minimum depth 22 mm, of a species listed in Table 1 and free from major strength reducing defects. Additionally the cross-sectional area should not be less than 2 134 $mm^2$. Provided these conditions are met, no further strength grading is necessary for bracing members.
b) All bracing members are nailed to every trussed rafter they cross with two 3.35 mm diameter wire nails with a minimum length equal to the bracing thickness plus 32 mm.
c) In all details 3.1 × 90 mm long mechanically driven gun nails may be substituted for 3.35 × 65 mm long wire nails.
d) Where bracing members are provided in two pieces, they are lap jointed over at least two trussed rafters and are nailed as described in b) or c).
e) Where nails exceed the thickness of bracing members they should either be clenched or a packing piece added behind the joint.
f) For the purposes of designing a suitable wallplate anchorage detail a short-term axial load of 3.3 kN should be assumed to exist in the rafter diagonal braces.

**Figure A.7 — Standard bracing for rafter members: detail C1 and D1** (*continued*)




Detail C2 — Eaves connection: view on slope on topside of rafters (arrow C Figure A.3 or Figure A.4)




Detail D2 — Splice connection: view on slope on underside of rafters

NOTE Cross-over of diagonal rafter braces in the slope of the roof is not permitted. The bracing system described in Figure A.8 being only applicable to wide-fronted buildings.

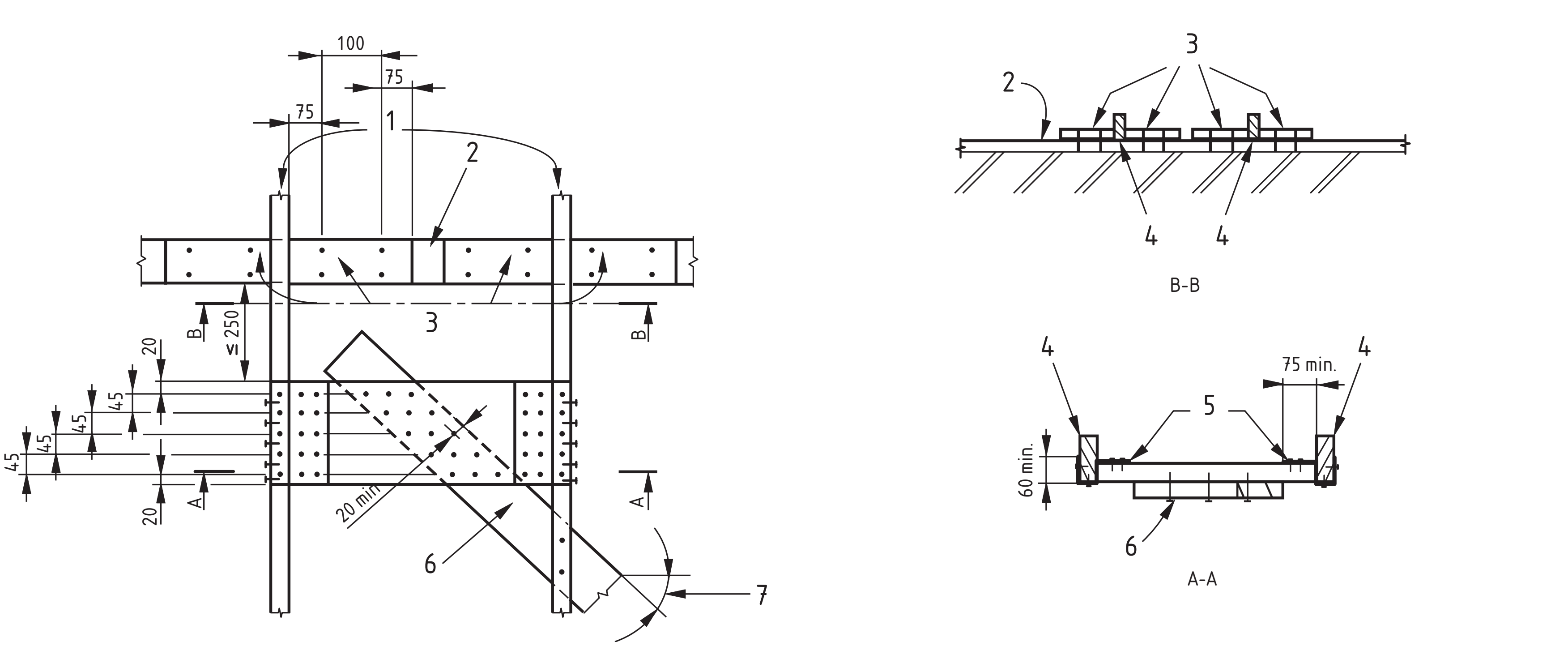
**Figure A.8 — Standard bracing for rafter members: detail C2 and D2**

**Key**
1) Trussed rafters at 600 mm centres
2) Wallplate
3) 47 × 100 × 250 long timber blocks to be fixed hard against each side of truss and nailed to wallplate using 4 no. 4 diameter × 90 long nails
4) Trusses supporting rafter brace timber shelf
5) 1 mm thick steel bracket fixed to both rafter and timber shelf using minimum of 10 no. 3.35 diameter × 30 long square twist nails
6) 22 × 97 diagonal rafter brace fixed to 47 × 220 timber shelf (minimum grade C16) using 8 no. 3.35 diameter × 65 long nails
7) 22 × 97 rafter brace
8) Timber splice plate (22 × 97 × 1 200) fixed to each diagonal rafter brace using 10 no. 3.35 diameter × 65 long nails
9) Rafter
10) Rafter braces butt-jointed over a truss
11) Ideally 45° but not less than 35° or greater than 55°

**Specification notes to Figure A.8**

a) All bracing members are nailed to every trussed rafter they cross with two 3.35 mm diameter wire nails with a minimum length equal to the bracing thickness plus 32 mm
b) In all details 3.1 × 90 mm long mechanically driven gun nails may be substituted for 3.35 × 65 mm long wire nails.
c) Where nails exceed the thickness of bracing members they should either be clenched or a packing piece added behind the joint.
d) Other connection details may be used as alternatives to those shown provided they are designed to provide equivalent stiffness and can resist a short-term axial load in the rafter brace of 5.2 kN in the case of details shown in Figure A.8.

**Figure A.8 — Standard bracing for rafter members: detail C2 and D2** (*continued*)




Detail C3 — Eaves connection: view on slope on topside of rafters (arrow C Figure A.3 or Figure A.4)

**Figure A.9 — Standard bracing for rafter members: detail C3**

**Key**
1) Trussed rafters at 600 mm centres
2) Wall plate
3) 47 × 100 × 250 long timber blocks to be fixed hard against each side of truss and nailed to wallplate using 4 no. 4 diameter × 90 long nails
4) Trusses supporting rafter brace timber shelf
5) 1 mm thick steel bracket fixed to both rafter and timber shelf using minimum of 10 no. 3.35 diameter × 30 long square twist nails
6) 35 × 120 diagonal rafter brace (minimum grade C16) fixed to 47 × 220 timber shelf (minimum grade C16) using 15-no 3.35 diameter × 75 long nails
7) Ideally 45° but not less than 35° or greater than 55°

**Specification notes to Figure A.9**

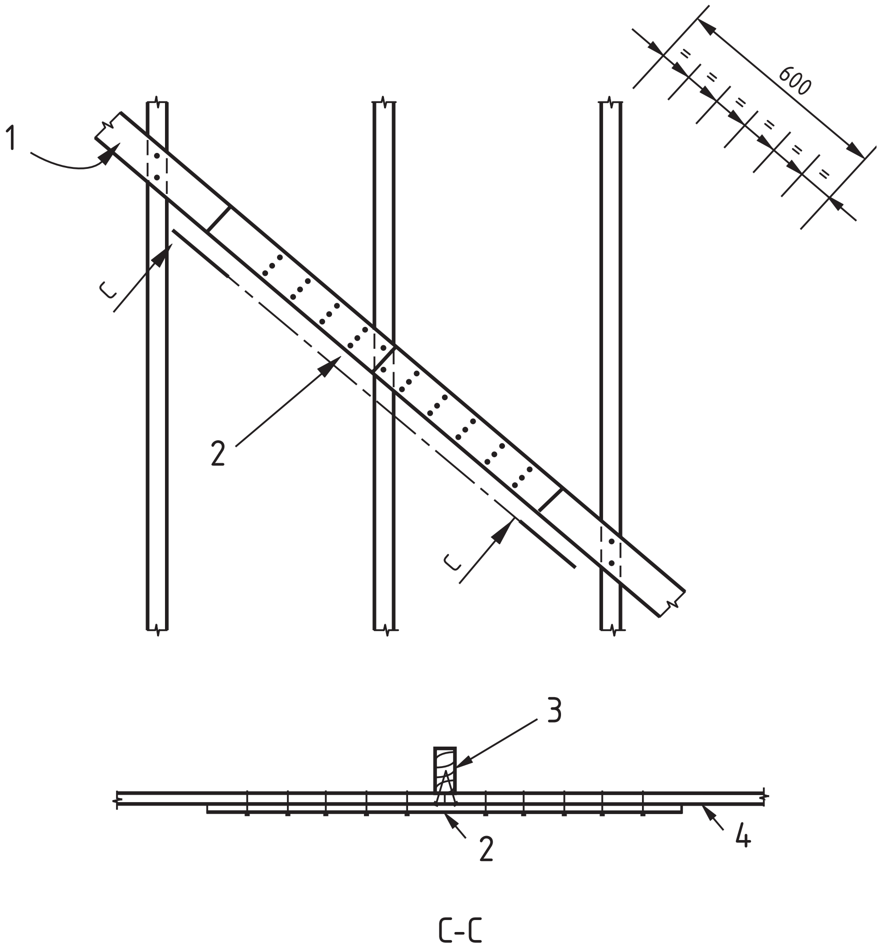
a) All bracing members are nailed to every trussed rafter they cross with two 3.35 mm diameter wire nails with a minimum length equal to the bracing thickness plus 32 mm.

b) In all details 3.1 × 90 mm long mechanically driven gun nails may be substituted for 3.35 × 65 mm long wire nails.

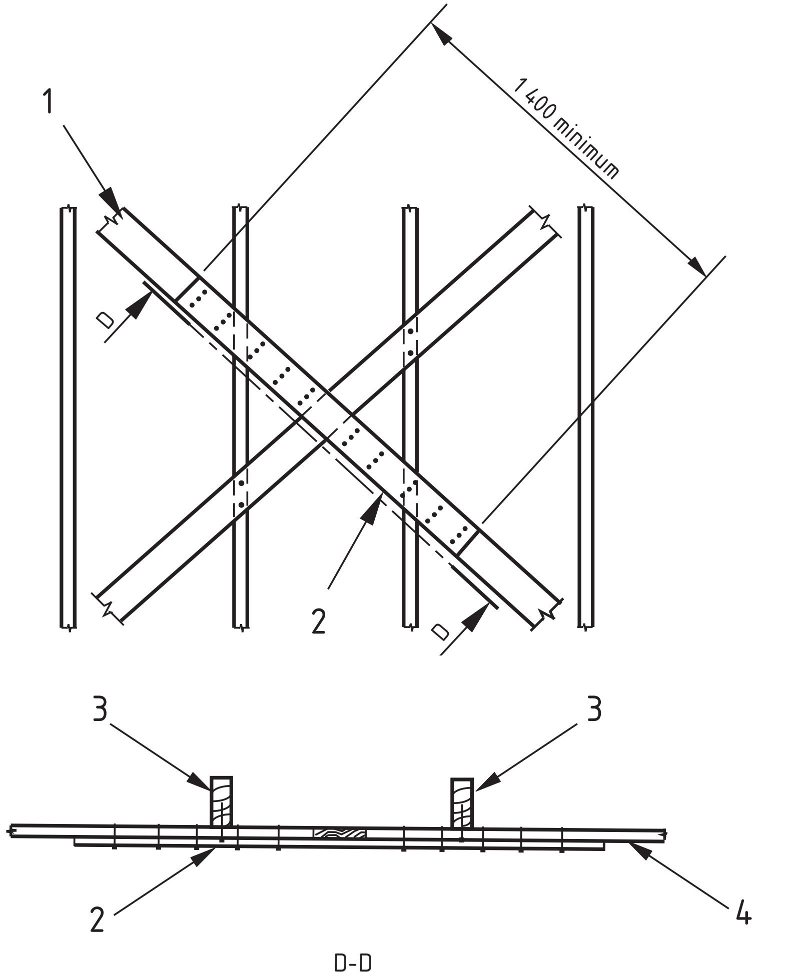
c) Where nails exceed the thickness of bracing members they should either be clenched or a packing piece added behind the joint.

d) Other connection details may be used as alternatives to those shown provided they are designed to provide equivalent stiffness and can resist a short-term axial load in the rafter of 9.7 kN in the case of details shown in Figure A.9.

**Figure A.9 — Standard bracing for rafter members: detail C3** (*continued*)




Detail D3 — Splice connection: view on slope on underside of rafters




Detail D4 — Crossing connection for narrow fronted buildings (see detail D Figure A.3 or Figure A.4)

**Figure. A.10 — Standard bracing for rafter members: detail D3 splice connection and D4 crossing connection**

**Key**
1) 35 × 120 rafter brace
2) Timber splice plate (35 × 120) fixed to each diagonal rafter brace using 15 no 3.35 diameter × 75 mm long nails
3) Rafter
4) Rafter braces butt-jointed over a truss

**Specification notes to Figure A.10**

a) All bracing members are nailed to every trussed rafter they cross with two 3.35 mm diameter wire nails with a minimum length equal to the bracing thickness plus 32 mm.

b) In all details 3.1 × 90 mm long mechanically driven gun nails may be substituted for 3.35 × 65 mm long wire nails.

c) Where nails exceed the thickness of bracing members they should either be clenched or a packing piece added behind the joint.

d) Other connection details may be used as alternatives to those shown provided they are designed to provide equivalent stiffness and can resist a short-term axial load in the rafter brace of 9.7 kN in the case of details shown in Figure A.10.

**Figure A.10 — Standard bracing for rafter members: detail D3 splice connection and D4 crossing connection** (*continued*)

# Annex B (normative) Permissible spans

## B.1 General

From experience in the use of trussed rafters, together with analyses of test results, maximum spans have been established for the rafter and ceiling tie members of the two configurations shown in Figure 11. The maximum permissible spans for these members are given in Table B.1 and Table B.2 for a range of member sizes and roof pitches in selected strength classes of timber. Span, which is defined as the dimension $L_s$ in Figure 11, may be interpolated linearly with respect to pitch and timber size. The tables are limited to spans up to 12.00 m since this covers the range normally required for domestic roofs from which most experience has been gained. The spans may be used without further tests or calculations provided the following conditions are satisfied.

a) The dead load on the rafter members does not exceed 0.41 kN/m measured along the slope. For lightweight roofs subject to wind uplift, checks should be made for possible stress reversal in members, the effects of such reversals on joint design, and the need to provide additional lateral restraint to members normally in tension. The adequacy of the holding down restraints should also be checked in accordance with **7.2.3**.
b) The dead load on the ceiling tie does not exceed 0.15 kN/m.
c) The method of support and capacity of any water tank carried by the trussed rafters is in accordance with the details given in Figure 7.
d) The trussed rafters do not support any other plant or equipment.
e) The imposed loads do not exceed those recommended in **6.4.2**, with the exception of snow loading, which should not exceed 0.75 kN/m$^2$
f) Each trussed rafter supports load from a section of roof not more than 0.6 m wide and the spacing between centres of trussed rafters is not more than 0.6 m, except where it is necessary to accommodate chimneys and other openings as described in **7.6**.
g) The joints between members have adequate strength in service and can resist normal handling forces without damage (see **6.5.6**).
h) The cross-section dimensions, tolerances, moisture content and fabrication are in accordance with the recommendations of this part of BS 5268.
i) The trussed rafter members are of one or more of the species listed in Table 1 and strength graded in accordance with **5.1.2**.
j) The strength class of timber used is not inferior to that recommended in Table B.1 or Table B.2, and within each trussed rafter the rafter and ceiling tie members are of the same strength grade or strength class.
k) The roof pitch is no greater than 35° and the supports are located in accordance with Figure 3, so that not less than half the width of each bearing is vertically below the eaves joint fastener and the distance $S_2$ is no greater than $S_1/3$ or 50 mm, whichever is the greater.
l) Any overhang of the rafter at the eaves (dimension $L_o$ in Figure 11) does not exceed 0.6 mm unless justified by calculation.
m) Proper consideration is given to the stability of both the complete roof and the individual trussed rafters in accordance with Clause **7**.

## B.2 Internal members

The internal members used for Fink trussed rafters in accordance with Table B.1 and Table B.2 should be of the same size and strength class as the smaller of either the rafter members or the ceiling tie. Smaller sizes and other strength classes may be used where they can be justified by test or calculation. In no case however should the internal members be less than 60 mm in depth (see **5.1.3**).

For monopitch trussed rafters, the internal members and the vertical end member should be justified by test or calculation, but in no case should the depth be less than 60 mm (see **5.1.3**) and the length should not exceed the appropriate value given in Table 4.

### B.3 Span limitations

The maximum spans given in Table B.1 and Table B.2 for configurations shown in Figure 11 for the specified timber sizes, strength classes and loadings should not be exceeded even where larger spans can be justified by structural calculations.

### B.4 Modification to Fink configurations

Where a Fink trussed rafter is truncated as shown in Figure B.1, (for example when framing around chimney openings), Table B.1 and Table B.2 may be used to determine the maximum span, $L_s$, for the truncated configuration, provided the following conditions, in addition to those in **B.1**, are satisfied.

a) Additional members are incorporated as shown in Figure B.1.

b) Individual members can be shown to be subject to combined bending and axial stresses which are not greater than those in the corresponding Fink trussed rafter.

c) Any member which, as a result of the modification, suffers a reversal of stress or is otherwise changed in its function can be verified by test or calculation.

d) The maximum deflection between the rafter nodes is as **6.5.7**.

e) The adequacy of the additional members can be justified by test or calculation.

f) The modified trussed rafter design is checked by a suitably qualified person experienced in timber engineering.

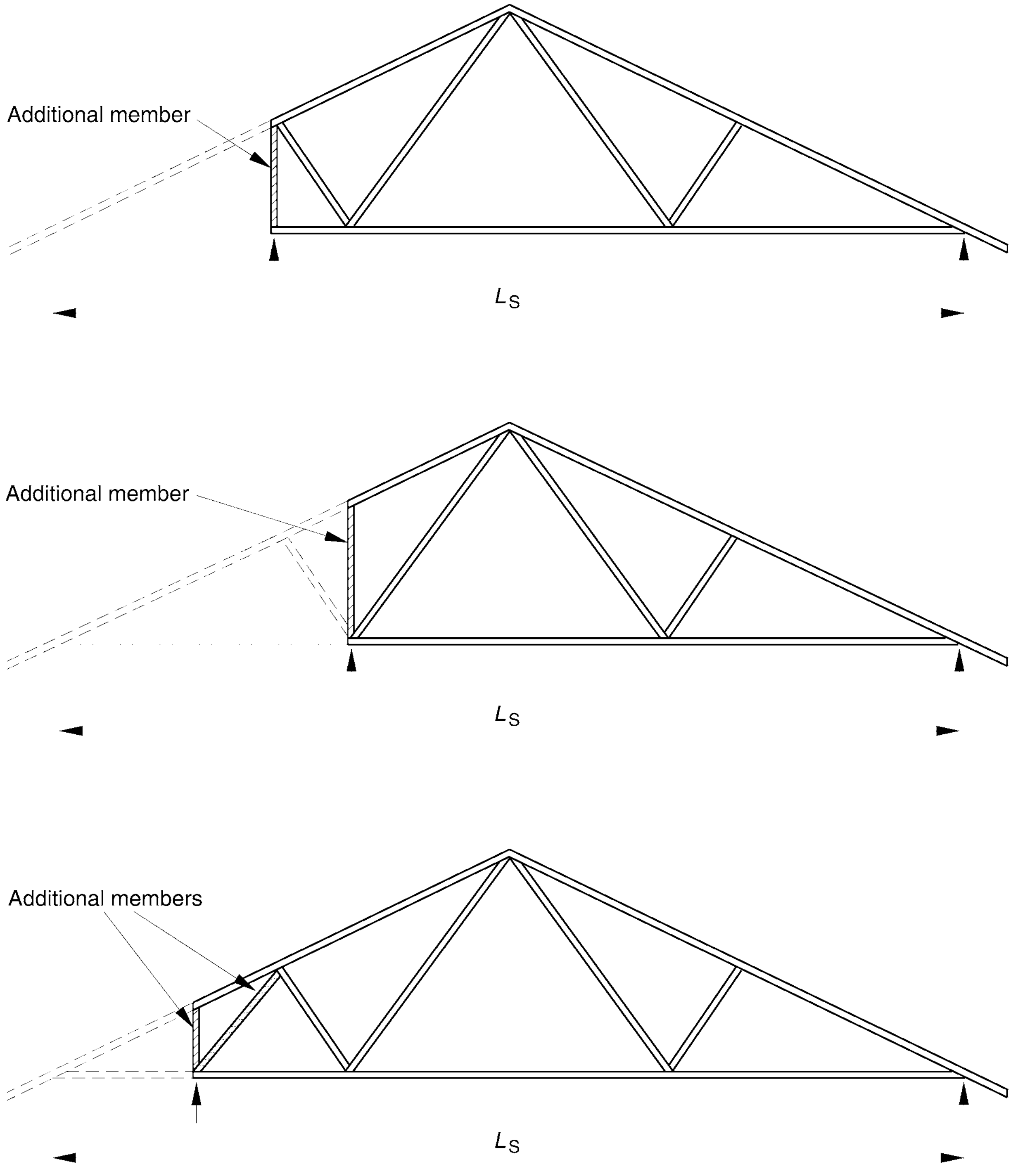



**Figure B.1 — Truncated Fink trussed rafters**

**Table B.1 — Maximum permissible spans[a] for rafter members shown in Figure 11**

| Strength class of timber[b] | Finished size[c] | Pitch | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 15° | 17½° | 20° | 22½° | 25° | 27½° | 30° | 32½° | 35° |
| | mm | m | m | m | m | m | m | m | m | m |
| | 35 × 72 | 5.06 | 5.20 | 5.34 | 5.49 | 5.63 | 5.77 | 5.91 | 6.06 | 6.21 |
| | 35 × 97 | 6.35 | 6.53 | 6.70 | 6.87 | 7.05 | 7.22 | 7.40 | 7.57 | 7.75 |
| | 35 × 120 | 7.55 | 7.75 | 7.94 | 8.15 | 8.36 | 8.54 | 8.74 | 8.94 | 9.14 |
| | 35 × 145 | 8.83 | 9.07 | 9.29 | 9.53 | 9.74 | 9.97 | 10.21 | 10.43 | 10.67 |
| C16 | | | | | | | | | | |
| | 38 × 72 | 5.25 | 5.40 | 5.54 | 5.68 | 5.82 | 5.97 | 6.11 | 6.26 | 6.41 |
| | 38 × 89 | 6.16 | 6.33 | 6.50 | 6.66 | 6.83 | 7.00 | 7.16 | 7.33 | 7.50 |
| | 38 × 114 | 7.48 | 7.53 | 7.87 | 8.07 | 8.28 | 8.47 | 8.67 | 8.81 | 9.07 |
| | 38 × 140 | 8.73 | 8.98 | 9.25 | 9.49 | 9.71 | 9.95 | 10.18 | 10.41 | 10.65 |
| | 47 × 72 | 5.83 | 5.98 | 6.12 | 6.26 | 6.41 | 6.56 | 6.70 | 6.85 | 7.00 |
| | 47 × 97 | 7.32 | 7.50 | 7.69 | 7.88 | 8.06 | 8.25 | 8.44 | 8.63 | 8.81 |
| | 47 × 120 | 8.51 | 8.73 | 8.96 | 9.19 | 9.41 | 9.64 | 9.87 | 10.10 | 10.32 |
| | 47 × 145 | 9.63 | 9.90 | 10.16 | 10.43 | 10.71 | 10.99 | 11.25 | 11.53 | 11.79 |
| | 35 × 72 | 5.60 | 5.76 | 5.92 | 6.09 | 6.25 | 6.41 | 6.57 | 6.74 | 6.90 |
| | 35 × 97 | 7.03 | 7.23 | 7.42 | 7.62 | 7.82 | 8.02 | 8.22 | 8.41 | 8.61 |
| C22 | 35 × 120 | 8.35 | 8.58 | 8.80 | 9.03 | 9.26 | 9.48 | 9.71 | 9.93 | 10.15 |
| | 35 × 145 | 9.76 | 10.04 | 10.29 | 10.56 | 10.80 | 11.00 | 11.00 | 11.00 | 11.00 |
| | 47 × 72 | 6.46 | 6.63 | 6.79 | 6.95 | 7.12 | 7.29 | 7.45 | 7.62 | 7.78 |
| | 47 × 97 | 8.10 | 8.31 | 8.53 | 8.74 | 8.95 | 9.16 | 9.38 | 9.59 | 9.80 |
| | 47 × 120 | 9.41 | 9.67 | 9.93 | 10.19 | 10.45 | 10.70 | 10.96 | 11.22 | 11.47 |
| | 47 × 145 | 10.65 | 10.96 | 11.26 | 11.57 | 11.88 | 12.00 | 12.00 | 12.00 | 12.00 |
| | 35 × 72 | 5.96 | 6.12 | 6.30 | 6.46 | 6.63 | 6.80 | 6.96 | 7.13 | 7.25 |
| | 35 × 97 | 7.50 | 7.71 | 7.92 | 8.12 | 8.33 | 8.54 | 8.74 | 8.94 | 9.00 |
| | 35 × 120 | 8.71 | 8.95 | 9.20 | 9.42 | 9.66 | 9.89 | 10.12 | 10.15 | 10.15 |
| | 35 × 145 | 10.25 | 10.54 | 10.80 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 |
| C24 | | | | | | | | | | |
| | 38 × 72 | 6.19 | 6.34 | 6.51 | 6.66 | 6.83 | 6.99 | 7.14 | 7.30 | 7.43 |
| | 38 × 89 | 7.27 | 7.46 | 7.65 | 7.83 | 8.02 | 8.21 | 8.39 | 8.57 | 8.74 |
| | 38 × 114 | 8.66 | 8.90 | 9.14 | 9.36 | 9.59 | 9.82 | 10.06 | 10.15 | 10.21 |
| | 38 × 140 | 10.16 | 10.45 | 10.72 | 10.99 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 |
| | 47 × 72 | 6.87 | 7.01 | 7.14 | 7.28 | 7.42 | 7.55 | 7.69 | 7.82 | 7.96 |
| | 47 × 97 | 8.64 | 8.81 | 8.99 | 9.17 | 9.35 | 9.52 | 9.70 | 9.87 | 10.05 |
| | 47 × 120 | 9.81 | 10.07 | 10.32 | 10.58 | 10.83 | 11.10 | 11.34 | 11.60 | 11.85 |
| | 47 × 145 | 11.10 | 11.41 | 11.73 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 |

[a] These maximum permissible spans are suitable for trussed rafters fabricated and used in accordance with the conditions given in Annex B.

[b] Subject to the visual grading criteria in **5.1.2**.

[c] Measured at a moisture content of 20% and subject to the manufacturing tolerance in **5.1.3**.

**Table B.1 — Maximum permissible spans[a] for rafter members shown in Figure 11** (*continued*)

| Strength class of timber[b] | Finished size[c] | Pitch | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 15° | 17½° | 20° | 22½° | 25° | 27½° | 30° | 32½° | 35° |
| | mm | m | m | m | m | m | m | m | m | m |
| TR26 or C27 | 35 × 72 | 6.90 | 6.98 | 7.07 | 7.16 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 |
| | 35 × 97 | 8.30 | 8.44 | 8.58 | 8.71 | 8.85 | 8.98 | 9.00 | 9.00 | 9.00 |
| | 35 × 120 | 9.55 | 9.74 | 9.93 | 10.11 | 10.15 | 10.15 | 10.15 | 10.15 | 10.15 |
| | 35 × 145 | 10.92 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 |
| | 38 × 72 | 7.07 | 7.15 | 7.23 | 7.32 | 7.41 | 7.47 | 7.55 | 7.61 | 7.68 |
| | 38 × 89 | 8.06 | 8.18 | 8.30 | 8.42 | 8.54 | 8.65 | 8.77 | 8.89 | 8.98 |
| | 38 × 114 | 9.50 | 9.68 | 9.86 | 10.02 | 10.20 | 10.38 | 10.58 | 10.73 | 10.90 |
| | 38 × 140 | 11.01 | 11.24 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 |
| | 47 × 72 | 7.57 | 7.65 | 7.73 | 7.80 | 7.88 | 7.96 | 8.04 | 8.12 | 8.20 |
| | 47 × 97 | 9.20 | 9.35 | 9.49 | 9.64 | 9.78 | 9.92 | 10.07 | 10.21 | 10.35 |
| | 47 × 120 | 10.75 | 10.94 | 11.13 | 11.31 | 11.50 | 11.69 | 11.88 | 12.00 | 12.00 |
| | 47 × 145 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 |

[a] These maximum permissible spans are suitable for trussed rafters fabricated and used in accordance with the conditions given in Annex B.
[b] Subject to the visual grading criteria in **5.1.2**.
[c] Measured at a moisture content of 20% and subject to the manufacturing tolerance in **5.1.3**.

**Table B.2 — Maximum permissible spans[a] for ceiling ties shown in Figure 11**

| Strength class of timber[b] | Finished size[c] | Pitch | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 15° | 17½° | 20° | 22½° | 25° | 27½° | 30° | 32½° | 35° |
| | mm | m | m | m | m | m | m | m | m | m |
| C16 | 35 × 72 | 3.70 | 3.97 | 4.24 | 4.50 | 4.77 | 5.02 | 5.29 | 5.55 | 5.82 |
| | 35 × 97 | 5.13 | 5.51 | 5.90 | 6.28 | 6.65 | 7.03 | 7.41 | 7.78 | 8.15 |
| | 35 × 120 | 6.29 | 6.79 | 7.29 | 7.78 | 8.24 | 8.72 | 9.20 | 9.69 | 10.14 |
| | 35 × 145 | 7.36 | 8.04 | 8.71 | 9.38 | 10.05 | 10.73 | 11.00 | 11.00 | 11.00 |
| | 38 × 72 | 3.85 | 4.14 | 4.42 | 4.69 | 4.97 | 5.24 | 5.52 | 5.79 | 6.07 |
| | 38 × 89 | 4.84 | 5.20 | 5.56 | 5.89 | 6.27 | 6.63 | 6.98 | 7.33 | 7.68 |
| | 38 × 114 | 6.15 | 6.64 | 7.13 | 7.60 | 8.07 | 8.55 | 9.02 | 9.49 | 9.95 |
| | 38 × 140 | 7.27 | 7.94 | 8.59 | 9.25 | 9.91 | 10.57 | 11.23 | 11.25 | 11.25 |
| | 47 × 72 | 4.31 | 4.63 | 4.95 | 5.26 | 5.58 | 5.89 | 6.20 | 6.51 | 6.82 |
| | 47 × 97 | 5.81 | 5.26 | 6.70 | 7.14 | 7.57 | 8.01 | 8.45 | 8.88 | 9.31 |
| | 47 × 120 | 6.91 | 7.50 | 8.09 | 8.67 | 9.25 | 9.82 | 10.37 | 10.94 | 11.50 |
| | 47 × 145 | 7.77 | 8.59 | 9.33 | 10.11 | 10.88 | 11.66 | 12.00 | 12.00 | 12.00 |

[a] These maximum permissible spans are suitable for trussed rafters fabricated and used in accordance with the conditions given in Annex B.
[b] Subject to the visual grading criteria in **5.1.2**.
[c] Measured at a moisture content of 20% and subject to the manufacturing tolerance in **5.1.3**.

**Table B.2 — Maximum permissible spans[a] for ceiling ties shown in Figure 11** (*continued*)

| Strength class of timber[b] | Finished size[c] | Pitch | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 15° | 17½° | 20° | 22½° | 25° | 27½° | 30° | 32½° | 35° |
| | mm | m | m | m | m | m | m | m | m | m |
| C22 | 35 × 72 | 4.40 | 4.68 | 4.97 | 5.25 | 5.54 | 5.82 | 6.11 | 6.39 | 6.67 |
| | 35 × 97 | 6.05 | 6.46 | 6.87 | 7.28 | 7.69 | 8.10 | 8.51 | 8.92 | 9.00 |
| | 36 × 120 | 7.40 | 7.93 | 8.47 | 9.00 | 9.50 | 10.02 | 10.15 | 10.15 | 10.15 |
| | 36 × 145 | 8.65 | 9.38 | 10.10 | 10.83 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 |
| | 47 × 72 | 5.09 | 5.43 | 5.77 | 6.11 | 6.45 | 6.79 | 7.13 | 7.47 | 7.81 |
| | 47 × 97 | 6.82 | 7.30 | 7.77 | 8.25 | 8.72 | 9.20 | 9.68 | 10.15 | 10.62 |
| | 47 × 120 | 8.10 | 8.73 | 9.37 | 10.00 | 10.63 | 11.25 | 11.85 | 12.00 | 12.00 |
| | 47 × 145 | 9.11 | 10.00 | 10.80 | 11.65 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 |
| C24 | 35 × 72 | 4.76 | 5.05 | 5.35 | 5.64 | 5.94 | 6.23 | 6.52 | 6.81 | 7.10 |
| | 35 × 97 | 6.49 | 6.90 | 7.33 | 7.76 | 8.18 | 8.62 | 9.00 | 9.00 | 9.00 |
| | 35 × 120 | 7.95 | 8.50 | 9.05 | 9.61 | 10.15 | 10.15 | 10.15 | 10.15 | 10.15 |
| | 35 × 145 | 9.28 | 10.02 | 10.79 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 |
| | 38 × 72 | 4.95 | 5.25 | 5.56 | 5.86 | 6.17 | 6.48 | 6.78 | 7.08 | 7.39 |
| | 38 × 89 | 6.15 | 6.47 | 6.93 | 7.33 | 7.72 | 8.13 | 8.59 | 8.92 | 9.32 |
| | 38 × 114 | 7.76 | 8.27 | 8.82 | 9.38 | 9.91 | 10.45 | 10.99 | 11.25 | 11.25 |
| | 38 × 140 | 9.14 | 9.87 | 10.72 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 |
| | 47 × 72 | 5.51 | 5.85 | 6.20 | 6.54 | 6.88 | 7.22 | 7.57 | 7.91 | 8.25 |
| | 47 × 97 | 7.36 | 7.84 | 8.31 | 8.79 | 9.26 | 9.74 | 10.21 | 10.69 | 11.16 |
| | 47 × 120 | 8.59 | 9.22 | 9.85 | 10.49 | 11.12 | 11.75 | 12.00 | 12.00 | 12.00 |
| | 47 × 145 | 9.77 | 10.60 | 11.43 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 |
| TR26 or C27 | 35 × 72 | 5.65 | 5.88 | 6.11 | 6.34 | 6.58 | 6.81 | 7.04 | 7.25 | 7.25 |
| | 35 × 97 | 7.92 | 8.24 | 8.55 | 8.87 | 9.00 | 9.00 | 9.00 | 9.00 | 9.00 |
| | 35 × 120 | 9.68 | 10.11 | 10.15 | 10.15 | 10.15 | 10.15 | 10.15 | 10.15 | 10.15 |
| | 35 × 145 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 |
| | 38 × 72 | 5.89 | 6.14 | 6.38 | 6.62 | 6.88 | 7.12 | 7.36 | 7.61 | 7.85 |
| | 38 × 89 | 7.43 | 7.72 | 8.05 | 8.35 | 8.67 | 8.98 | 9.29 | 9.59 | 9.91 |
| | 38 × 114 | 9.46 | 9.87 | 10.27 | 10.68 | 11.09 | 11.25 | 11.25 | 11.25 | 11.25 |
| | 38 × 140 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 |
| | 47 × 72 | 6.63 | 6.91 | 7.20 | 7.48 | 7.77 | 8.05 | 8.33 | 8.62 | 8.90 |
| | 47 × 97 | 8.84 | 9.16 | 9.68 | 10.09 | 10.51 | 10.93 | 11.35 | 11.76 | 12.00 |
| | 47 × 120 | 10.57 | 10.99 | 11.41 | 11.83 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 |
| | 47 × 145 | 11.85 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 |

[a] These maximum permissible spans are suitable for trussed rafters fabricated and used in accordance with the conditions given in Annex B.

[b] Subject to the visual grading criteria in **5.1.2**.

[c] Measured at a moisture content of 20% and subject to the manufacturing tolerance in **5.1.3**.

# Bibliography


**Standards publications**

BS 5250:2002, *Code of practice for control of condensation in buildings.*

BS 8417:2003, *Preservation of timber — Recommendations.*

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prEN 14545, *Timber structures — Connectors — Requirements.*[5)]

**Other publications**

[1] GREAT BRITAIN. Building Regulations 1991. London: The Stationery Office.

[2] GREAT BRITAIN. Building Standards Scotland. Edinburgh: The Stationery Office.

[3] NORTHERN IRELAND. Building Regulations (Northern Ireland). Belfast: The Stationery Office.


5) Currently still a draft European Standard. To be published by CEN as EN 14545 and adopted in the UK as BS EN 14545.

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