

Structural use of timber —

Part 3: Code of practice for trussed rafter roofs

ICS 91.060.20; 91.080.20

Committees responsible for this British Standard

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- 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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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 It supersedes BS 5268-3:1998, which is withdrawn.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 14545¹⁾).
- 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)	Europe
Redwood (imported)	
Hem-fir Douglas fir-larch Spruce-pine-fir	Canada
Southern pine Hem-fir Douglas fir-larch	
Scots pine Corsican pine	
Radiata pine	New Zealand 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.
 - 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:

- the efficiency rating recommended in BS 5268-2 for timber of the strength grade specified in the trussed rafter design; or
- 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	All other finger profiles
	Length 15 mm	
	Pitch 3.8 mm	
	Tip width 0.5 mm	
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/mm² 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 mm	Maximum length ^a (measured on plan between node points)			
	35 mm thick		47 mm thick	
	Rafter m	Ceiling tie m	Rafter m	Ceiling tie 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 14545²⁾). 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 <i>d</i>
Edge distance perpendicular to grain	5 <i>d</i>
Distance between lines of nails, perpendicular to grain	7 <i>d</i>
Distance between adjacent nails in any one line, parallel to grain	10 <i>d</i>

^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	<i>Dead</i> See 6.4.1	Full length	Long-term
2	<i>Imposed</i> 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 $\geq 600 \text{ mm}$ (see 6.4.2)	Short-term
4	<i>Wind</i> 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 fastening loads.			

Table 7 — Summary of ceiling tie loads

Type	Load	Position on ceiling tie	Duration
5	<i>Dead</i> See 6.4.1 plus	Full length	Long-term
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 plus Plant and special services	At two nodes nearest water tank As appropriate	Long-term Long-term
7	<i>Imposed</i> 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/m² 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.

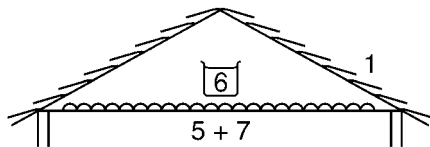
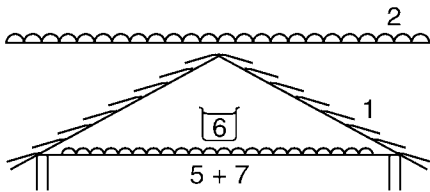
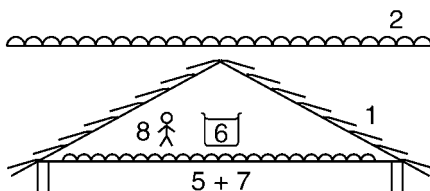
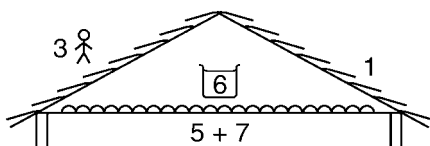
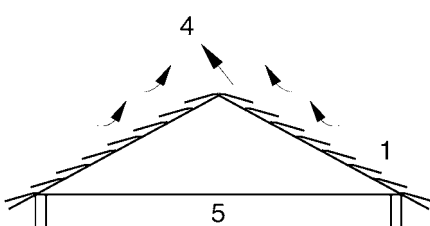
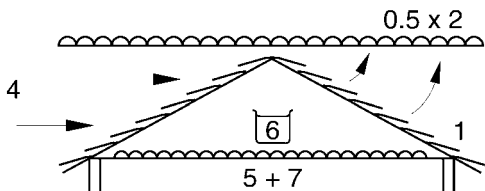
6.4.4 Load combinations

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:

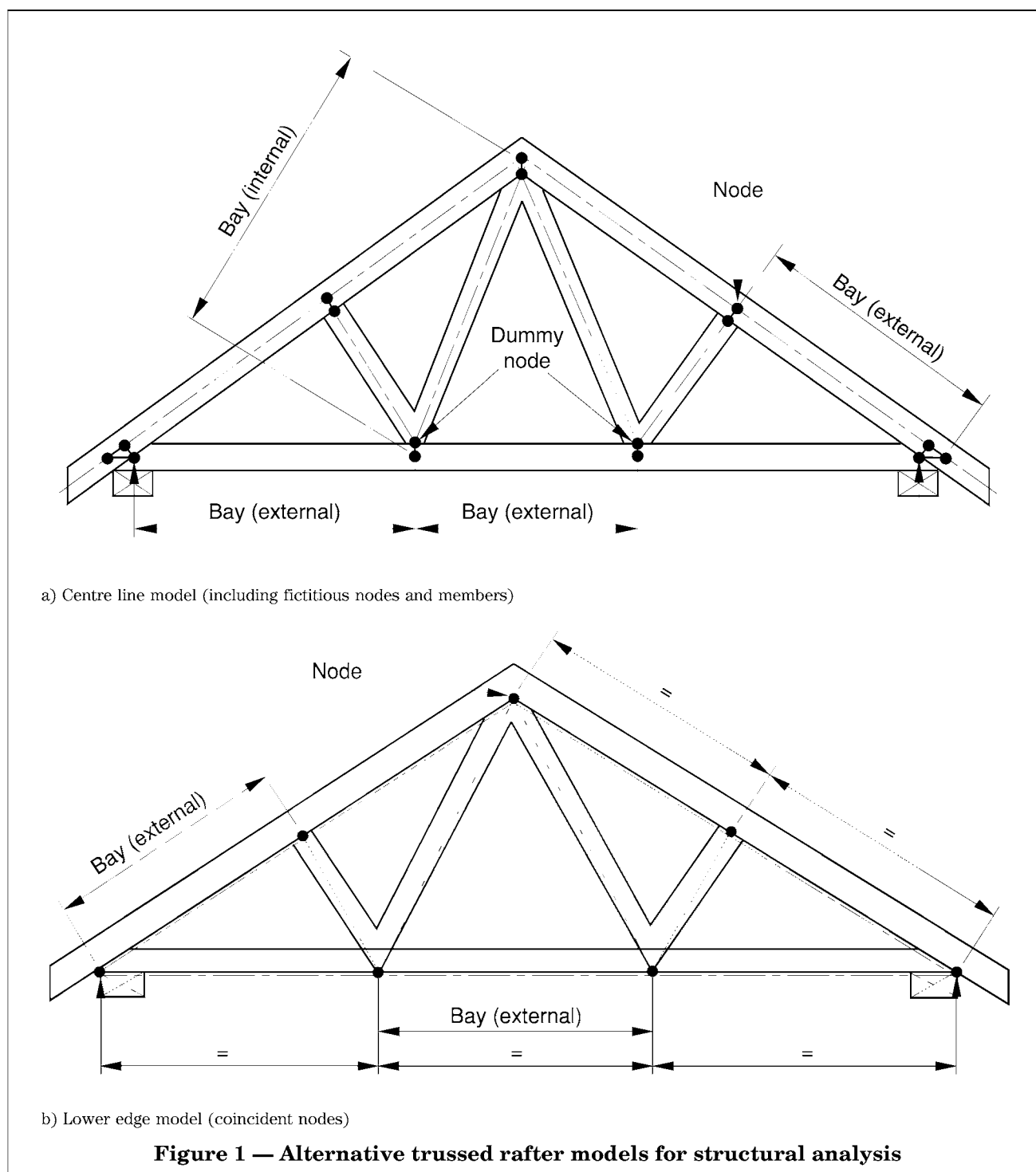
- the trussed rafter supports are level and connected with a continuous horizontal ceiling tie;
- the trussed rafter is supported in accordance with Figure 3, with a value of S_2 no greater than $S_1/3$ or 50 mm whichever is the greater;
- the height of the trussed rafter measured at the centre of the 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.



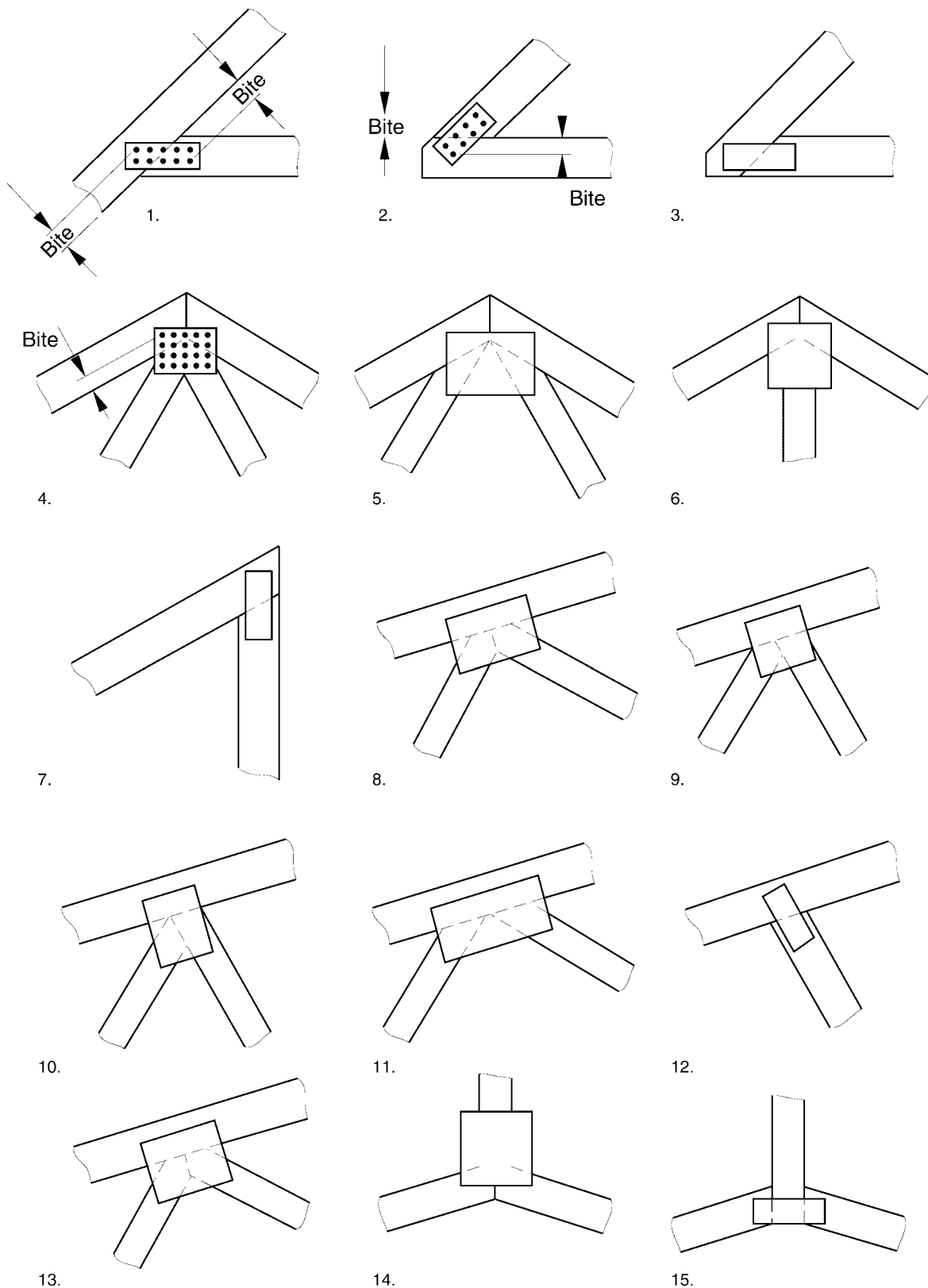


Figure 2 — Examples of joints

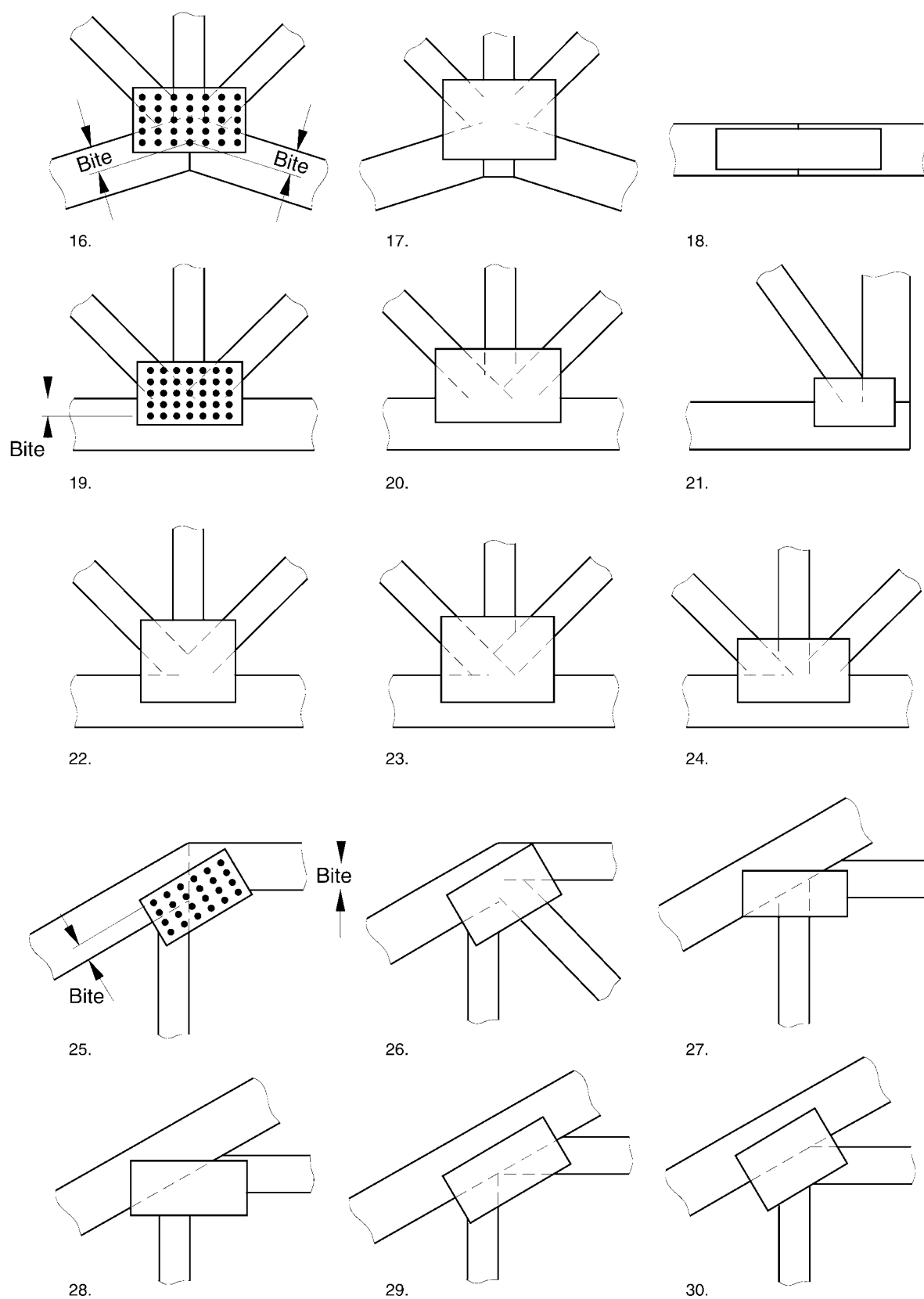
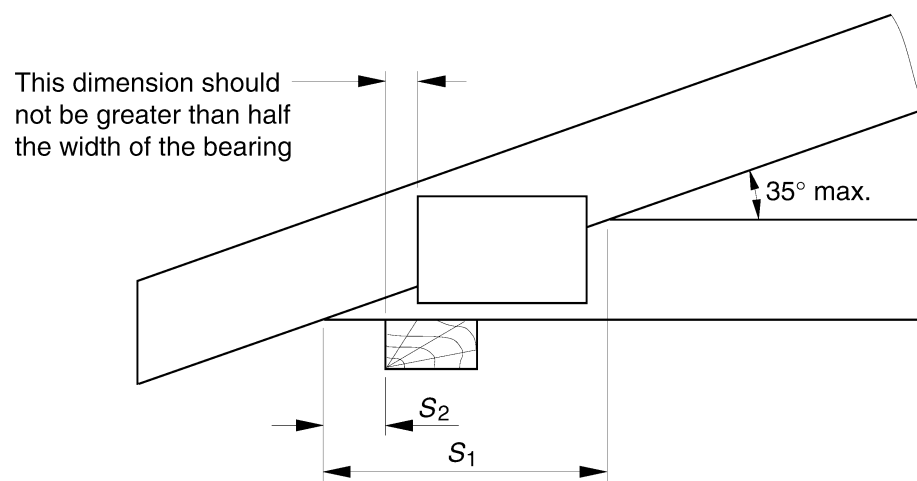
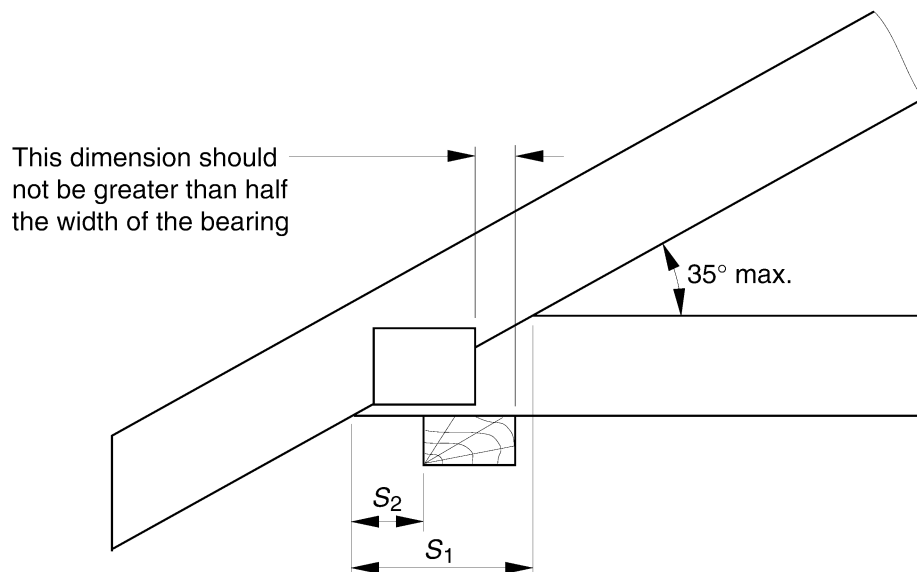


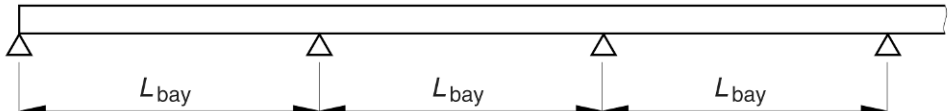
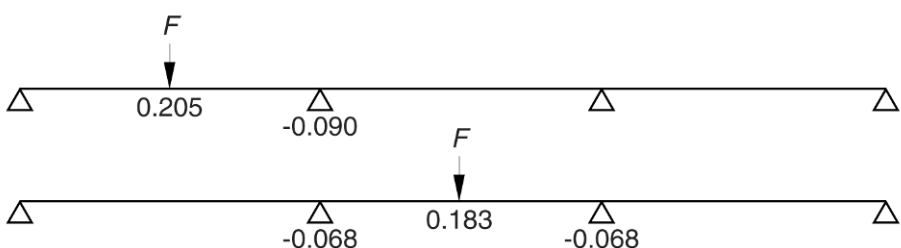
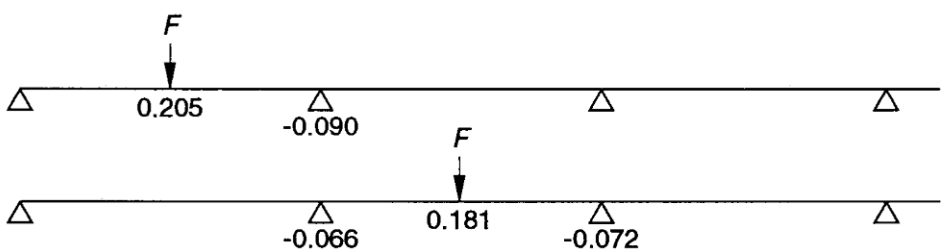
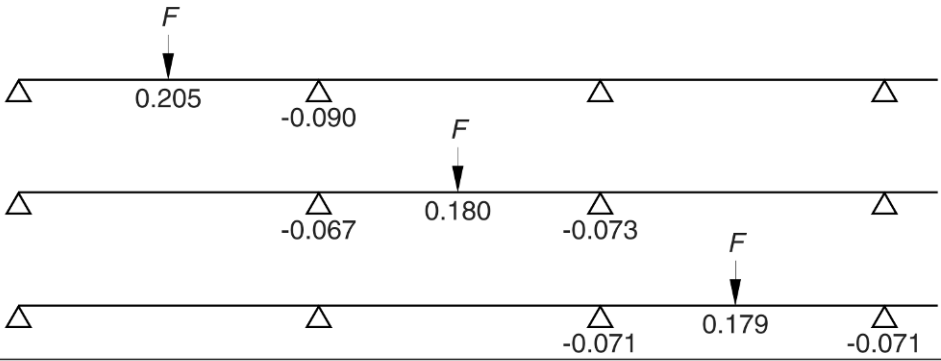
Figure 2 — Examples of joints (continued)



$$S_2 \leq \max. \begin{cases} 50 \text{ mm} \\ \text{or} \\ S_1/3 \end{cases}$$

Figure 3 — Wall plate location for simplified analysis

Table 9 — Bending moment coefficients (K_m)

Number of bays	K_m					
	<i>Uniformly distributed load</i> Bending moment (M) = $K_m w L_{bay}^2$ 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	
2	<i>Concentrated load</i> Bending moment (M) = $K_m F L_{bay}$ Load F is located midway between supports					
						
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.						