

Structural use of timber —

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

Section 7.5 Domestic rafters

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- Building Woodworking Federation
- Building Employers' Confederation
- Chartered Institute of Building
- Department of the Environment (Building Research Establishment, Princes Risborough Laboratory)
- Department of the Environment for Northern Ireland
- Department of the Environment (Housing and Construction Industries)
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- Health and Safety Executive
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- Institution of Structural Engineers
- International Truss Plate Association
- National House-building Council
- Royal Institute of British Architects
- Royal Institute of Chartered Surveyors
- Timber Research and Development Association
- Timber Trade Federation

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Foreword

This Section of BS 5268 has been prepared under the direction of the Civil Engineering and Building Structures Standards Policy Committee.

The general principles for the design of structural timber components are given in BS 5268-2 and using these principles it is possible for span tables to be prepared for a wide range of components.

Experience has shown that different interpretations of these principles has led to inconsistencies in span tables prepared by different compilers. It is the purpose of BS 5268-7 to eliminate these differences by recommending the design equations and the loading to be used in the preparation of span tables. Part 7 is intended to ensure that different organizations produce span tables on a consistent basis in the future, and is not necessarily intended for use by designers for individual designs carried out in their day-to-day work, where simplified procedures may produce adequate designs. This section deals with rafters.

Other Sections of BS 5268-7, published or in preparation are as follows.

- *Section 7.1: Domestic floor joists;*
- *Section 7.2: Joists for flat roofs;*
- *Section 7.3: Ceiling joists;*
- *Section 7.4: Ceiling binders;*
- *Section 7.6: Purlins supporting rafters;*
- *Section 7.7: Purlins supporting sheeting or decking.*

BS 5268-2 gives grade stresses for very many combinations of species and grade and it is considered impractical to publish in a British Standard span tables for all possible combinations of species, grades and sizes. BS 5268-7 is therefore restricted to the basis of the calculations.

The solution of the design equations for many combinations of geometry and material is most conveniently undertaken by computer. A program written by the Timber Research and Development Association (TRADA) was used to prepare Appendix A and Appendix B. For users wishing to prepare their own span tables or computer programs Appendix A gives a sample calculation. Appendix B gives span tables for three typical combinations of species and grade. Although the presentation of span tables is not covered in BS 5268-7, it is recommended that tables for predetermined rafter centres and loading follow this format.

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.

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 and ii, pages 1 to 22, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Section of BS 5268 recommends a calculation basis for the permissible clear span for rafters for roofs with a slope from 15° to 45° . The recommendations apply to rafters at a maximum spacing of 610 mm centre-to-centre, this being the maximum spacing for which the “load-sharing” assumption may be adopted as described in BS 5268-2. The method of calculation makes no allowance for any contribution of other parts of the roof to the load resistance of the rafters although it is assumed that the tiling battens are capable of providing lateral load distribution and lateral support. It does not cover the design of rafters taking account of a structural contribution by sheet material supporting the roofing where such action can be provided by adequate design of its attachments as in a stressed skin panel roof. The uniform and concentrated loads of BS 6399-1, are considered. Provision is made for a uniformly distributed snow load derived from BS 6399-3.

A typical example of roof construction is given in Figure 1 and of types of rafters in Figure 2.

This Section of BS 5268 is applicable to the species and grades of timber given in BS 5268-2.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Section of BS 5268, the definitions given in BS 6100-4.1 to BS 6100-4.4, BS 6100-2.1 and BS 5268-2 apply, together with the following.

2.1

grade stress

stress that can safely be permanently sustained by material of a specific section size and of a particular strength class or species and grade

2.2

load-sharing system

assembly of pieces or members that are constrained to act together to support a common load

2.3

permissible stress

stress that can safely be sustained by a structural material under a particular condition

NOTE For the purposes of this Section of BS 5268 it is the product of the grade stress and the appropriate modification factors for section size, service and loading.

2.4

strength class

classification of timber based on particular values of grade stress

2.5

bearing length

length at each end of the rafter in contact with the support

2.6

notional bearing length

bearing length required for the calculation of permissible clear spans

2.7

effective span

span measured on the slope from centre to centre of the minimum bearing lengths at each end

2.8

permissible effective span

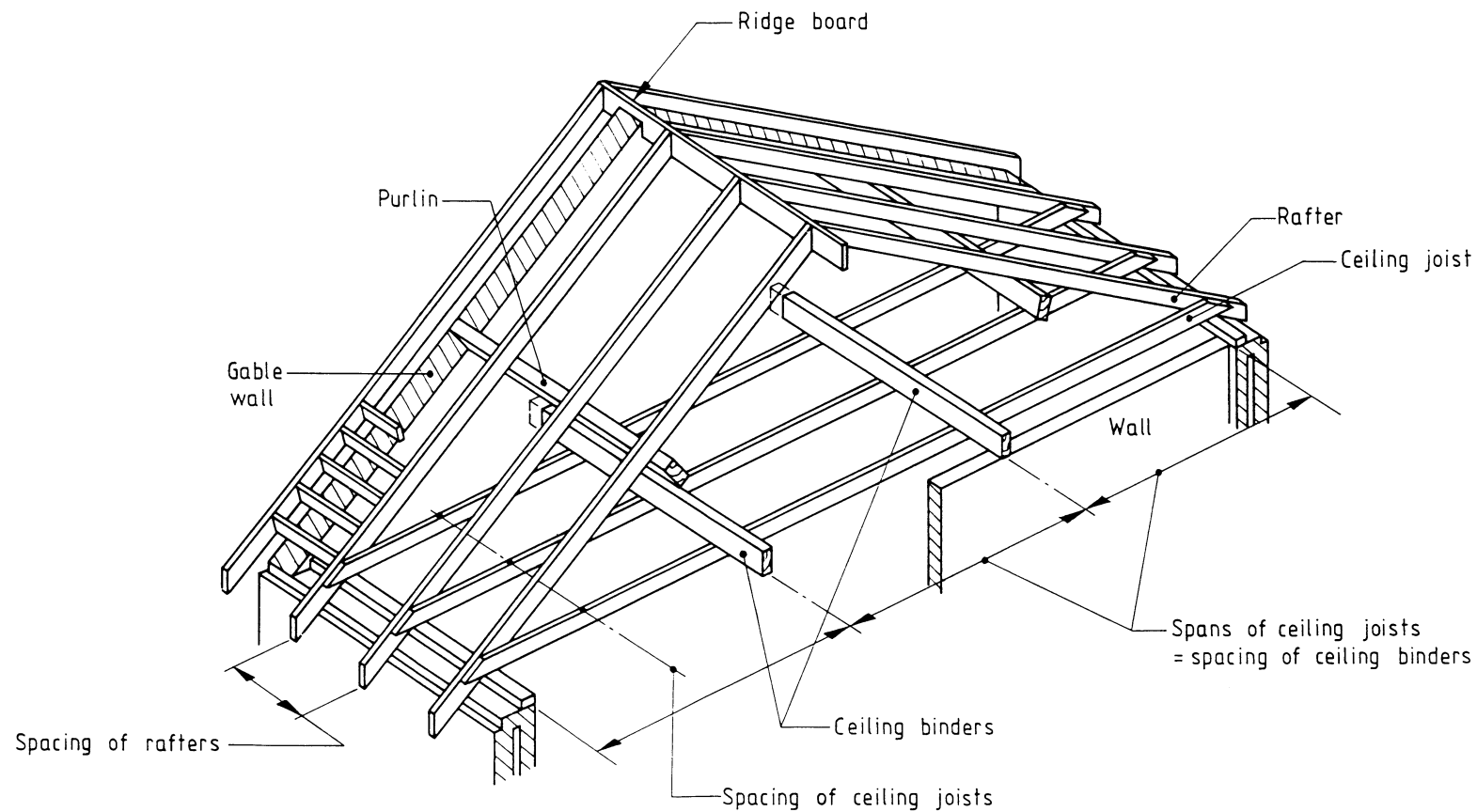
lowest value of effective span found from the calculations for bending strength, shear strength and deflection

2.9

permissible clear span

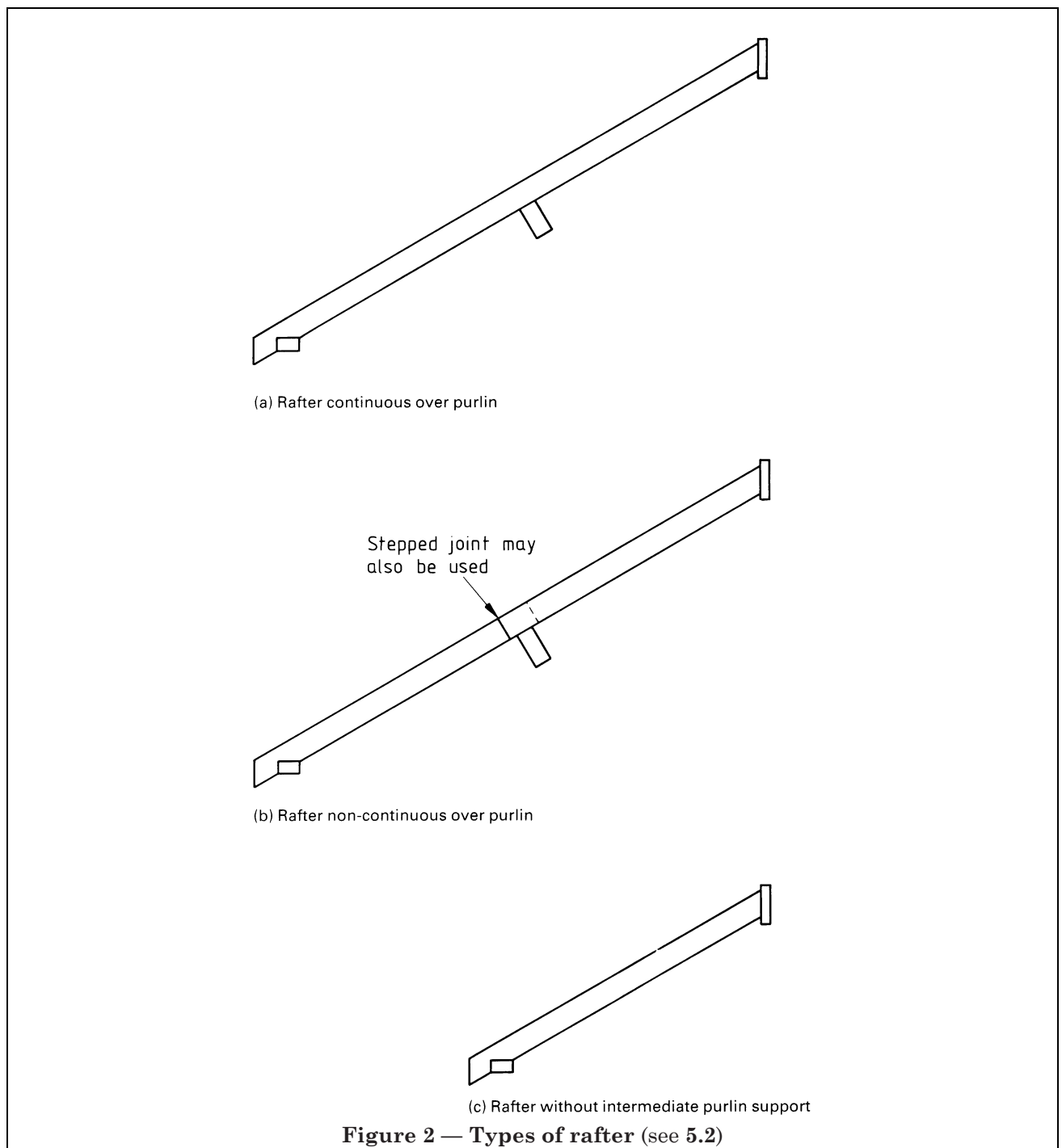
permissible unsupported span of a rafter, measured between the faces of the support at its two ends

NOTE Permissible clear span is equal to permissible effective span less the notional bearing length.



NOTE Spans of purlins and ceiling binders are not shown.

Figure 1 — Roof construction



2.10 point load

concentrated load referred to in BS 6399-1, that is regarded as acting at a point for calculation purposes

2.11 rafter

member extending the full distance from eaves to ridge

NOTE The rafter may be continuous or jointed over the purlin, i.e. non-continuous.

2.12

purlin

beam parallel to the eaves giving intermediate support to rafters

3 Symbols

For the purposes of this Section of BS 5268, the following symbols apply.

NOTE The symbols used are in accordance with ISO 3898, published by the International Organization for Standardization, supplemented by the recommendations of CIB-W18-1 “Symbols for use in structural timber design” published by the International Council for Building Research Studies and Documentation, which takes particular account of timber properties.

The symbols used are:

a	Distance (notional bearing length)
b	Breadth of rafter
E	Modulus of elasticity
F	Total load per metre length on slope, resolved perpendicular to the rafter
F_d	Dead load per square metre applied by mass of roofing materials (excluding rafter self weight), measured on slope
F_i	Imposed uniformly distributed load per square metre, measured on plan
F_j	Self weight of rafter per metre length
F_p	Point load
G	Shear modulus
h	Depth of rafter
I	Second moment of area
j	Radius of gyration
K	Modification factor (always with a subscript)
L	Effective span
L_{adm}	Permissible effective span
L_{cl}	Permissible clear span
L_e	Effective length in buckling calculations
M	Bending moment
s	Spacing of rafters, centre-to-centre
w	Deflection
Z	Section modulus
α	Roof slope (pitch)
η	Eccentricity factor (see Appendix C of BS 5268-2:1989)
ρ	Density
λ	Slenderness ratio
σ	Stress
τ	Shear stress

The following subscripts are used:

a) **Type of force, stress, etc.**

c	Compression
m	Bending

b) **Significance**

a	Applied
adm	Permissible

cl Clear
 g Grade
 max Maximum

c) Geometry

Par or $\parallel$ Parallel (to the grain)
 tra or $\perp$ Perpendicular (to the grain)

It is recommended that where more than one subscript is used, the categories should be separated by commas.

Subscripts may be omitted when the context in which the symbols are used is unambiguous except in the case of modification factor K .

4 Design considerations

4.1 General

The design calculations recommended by this Section of BS 5268 are based on engineers' bending theory and are consistent with the recommendations of BS 5268-2. The design method ensures that the permissible bending, shear and compression stresses, as given in BS 5268-2, are not exceeded and that the deflection due to bending and shear does not exceed the recommended limit of 0.003 times the effective span (see 14.7 of BS 5268-2:1988).

NOTE A sample calculation is given in Appendix A and Table 1 to Table 3 in Appendix B contain specimen span tables.

4.2 Qualifying assumptions

The calculations given in this Section of BS 5268 relate to pitched roofs having a single purlin on each side of the ridge. The rafter may be continuous or non-continuous over the purlin, which is centrally placed so that the upper and lower portions of the rafter have equal spans. The purlin is perpendicular to the rafter (see Figure 1 and Figure 2).

The calculations given in this standard apply to systems of at least four rafters at a maximum spacing of 610 mm centre-to-centre, and having tiling battens adequate to provide lateral load distribution. Because load sharing takes place the load sharing modification factor K_8 should be used and the mean modulus of elasticity is applicable in deflection calculations. The formulae derived are based on rafters having two equal spans and lateral restraint sufficient to prevent lateral buckling in accordance with 14.8 of BS 5268-2:1988. It is also assumed that ceiling joists will be used to transmit the horizontal component of thrust occurring at eaves level to complementary rafters.

The bearing length required at each end of the rafter, calculated in accordance with 5.6, may not be sufficient for practical construction purposes.

4.3 Loading

The design calculations provide for roof loads which consist of the following.

a) Imposed load

1) For a roof slope of 30° or less: a uniformly distributed snow load, e.g. 0.75 kN/m^2 , measured on plan or a 0.9 kN concentrated vertical load, whichever governs the design.

The concentrated load is assumed to act in the position which produces maximum stress or deflection. However the effect of deflection under the concentrated load need be considered only when it would affect the finishes.

2) For a roof slope greater than 30° and not exceeding 75° : an imposed load obtained by linear interpolation between the values at 30° roof slope, e.g. 0.75 kN/m^2 , and zero for a 75° roof slope. No concentrated load is applied.

The imposed distributed load should be considered as a medium term load. The imposed point load should be considered as a short term load, as given in Table 8 of BS 5268-3:1985.

b) **Dead load.** Dead load per square metre on slope F_d (in kN/m^2) to provide for the mass of roofing materials, insulation, etc. Weights of materials are given in BS 648.

c) **Self weight.** Self weight per metre length F_j (in kN/m), to provide for the mass of the rafters. The timber densities (in kg/m^3) given in Tables 9 and 92 of BS 5268-2:1988, should be used.