British Standard

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BRITISH STANDARD

BS 5268-7.5:
1990

Structural use of timber —

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

Section 7.5 Domestic rafters

UDC [624.011.1 + 674.038.5 + 69.1.11]:674.038.3.001.24

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Civil Engineering and Building Structures Standards Policy Committee (CSB/-) to Technical Committee CSB/32, upon which the following bodies were represented:

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)
Department of the Environment (Property Services Agency)
Health and Safety Executive
Incorporated Association of Architects and Surveyors
Institute of Clerks of Works of Great Britain Inc.
Institute of Wood Science
Institution of Civil Engineers
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.

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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.

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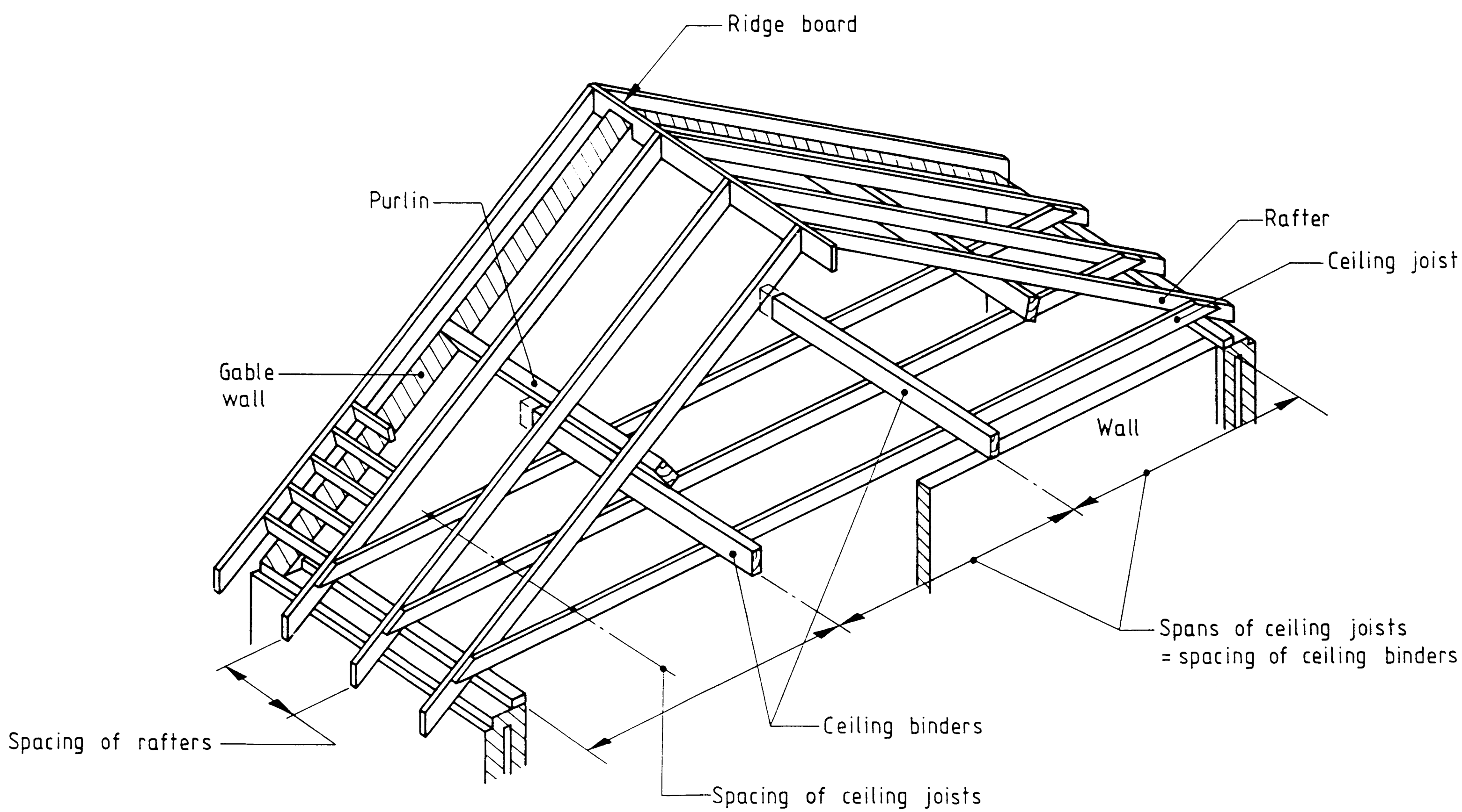

NOTE Spans of purlins and ceiling binders are not shown.

Figure 1 — Roof construction

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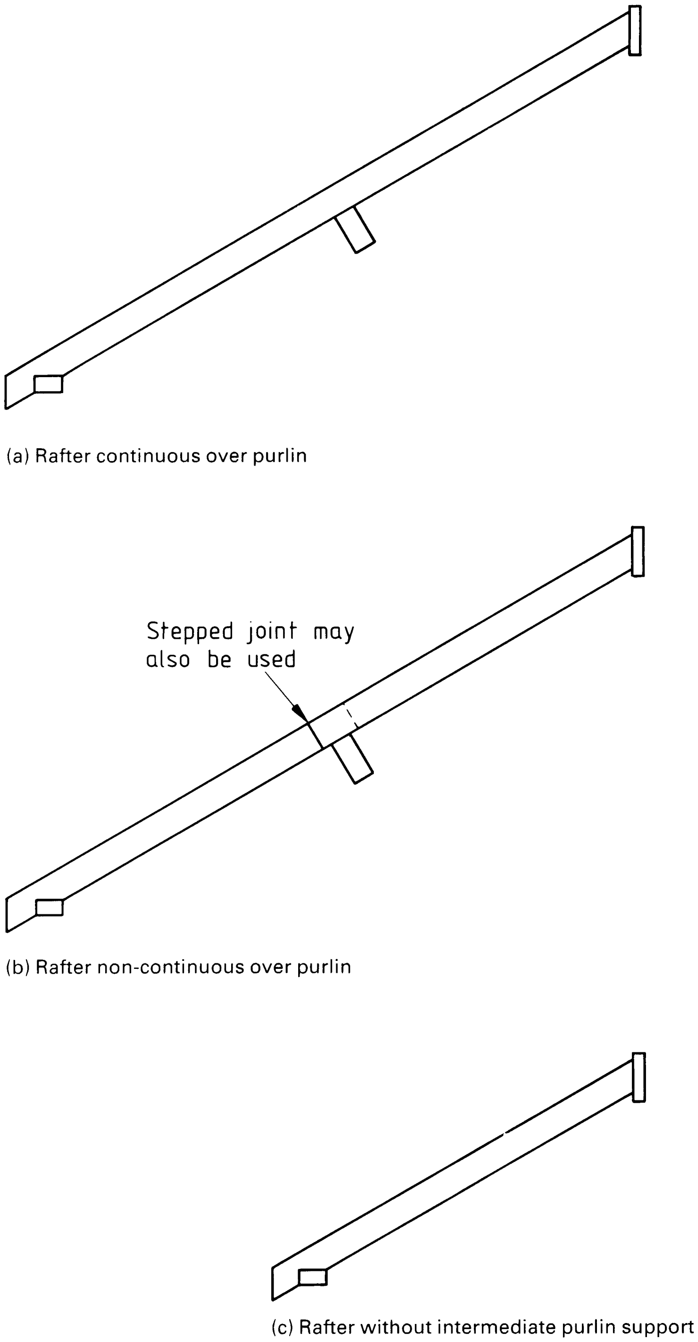

Figure 2 — Types of rafter (see **5.2**)

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.

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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

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cl Clear

g Grade

max Maximum

c) **Geometry**

Par or ∥ Parallel (to the grain)

tra or ⊥ 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.

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4.4 Design loads

Three loading conditions should be considered.

a) A uniform imposed load condition, the loading consisting of uniformly distributed imposed load, dead load and member self weight. This loading should be considered as medium term.

b) A point imposed load condition, the loading consisting of a concentrated imposed load plus uniformly distributed dead load and member self weight; this condition may be omitted for roof slopes greater than 30°. This loading should be considered as short term.

c) A long term load condition, the loading consisting of uniformly distributed dead load and member self weight with no imposed load. This loading should be considered as long term.

For the uniform imposed load condition, the total load per metre length of rafter, F (in kN/m) resolved perpendicular to the rafter is given by the equation

$$F = (F_i \cos^2 \alpha + F_d \cos \alpha) \left(\frac{s}{1000}\right) + F_j \cos \alpha \qquad (1)$$

For the point imposed load condition, the load (in kN) resolved perpendicular to the rafter is given by:

$F_p \cos \alpha = 0.9 \cos \alpha$

acting together with uniform dead load and self weight (in kN/m)

$$F_d \cos \alpha \left(\frac{s}{1000}\right) + F_j \cos \alpha \qquad (2)$$

For the long term load condition, i.e. dead load and self weight alone, F (in kN/m) resolved perpendicular to the roof slope is given by the equation

$$F = F_d \cos \alpha \left(\frac{s}{1000}\right) + F_j \cos \alpha \qquad (3)$$

where

α is the roof slope (pitch);

F_i is the imposed load (in kN/m²) measured on plan;

s is the rafter spacing (in mm);

F_d is the dead load (in kN/m²) measured on slope;

F_j is the self weight of the rafter (in kN/m).

The value of F_j (in kN/m) may be found from the equation

$$F_j = 9.80665 \times 10^{-9} \rho b h \qquad (4)$$

where

ρ is the timber density (in kg/m³);

b is the rafter breadth (in mm);

h is the rafter depth (in mm).

5 Permissible spans

5.1 General

The permissible effective span of a timber rafter subjected to the applied loads given in **4.3** should be the shortest effective span resulting from calculations for bending strength, shear strength and deflection, as given in **5.3**, **5.4** and **5.5**.

The permissible clear span should be calculated as the permissible effective span less the notional bearing length, calculated in accordance with **5.6**.

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5.2 Basis of formulae

5.2.1 *General*. The formulae given are derived for a construction incorporating a single purlin at the centre of the rafter on each side of the ridge. The purlin reaction is perpendicular to the rafter length (see Figure 1 and Figure 2). A ceiling joist transmits the horizontal thrust occurring at eaves level to the complementary rafter, and the eaves joint and ceiling tie splice must be of adequate strength to transmit this force.

5.2.2 *Non-continuous rafters*. The calculations for a non-continuous rafter assume that the rafter is jointed over the purlin in a manner allowing compressive force to be transmitted through the joint, but not bending moment. The most severe combination of compressive and bending stresses is taken as occurring at the centre of the lower portion of the rafter and the effective length used (L_e) is the full length of this portion.

In deflection and shear stress calculations, the same portion is treated as a simply-supported beam. For roof slopes not exceeding 30° a point load is applied at the centre of the lower rafter.

5.2.3 *Continuous rafters*. The calculations for a continuous rafter assume that the rafter is continuous over the purlin so that bending moment as well as compressive force may be transmitted. When there is no point load the combined stress calculation is made at the point of maximum bending moment, and also at the purlin. For pitches not exceeding 30°, the point load is applied at the centre of the lower span and the combined stress calculation is made for this point and for the point supported by the purlin. The effective length in each of the two calculations (L_e) is taken as the relevant distance between points of contraflexure.

Deflection and shear stress calculations are made in the same way as for a horizontal two-span continuous beam with simple supports at its ends. However for simplicity the maximum separate deflections due to the uniformly-distributed and point load (when applied) are added together although they do not occur at exactly the same point in the rafter length.

5.2.4 *Rafters without support from purlins*. The spans derived from the formulae for non-continuous rafters may be used conservatively for rafters without support from purlins. The derived spans may also be used for jack rafters.

5.3 Limitation of combined bending and compression parallel to the grain stresses

5.3.1 *Permissible bending and compression parallel to the grain stresses*. Provided that lateral support is given to the member in accordance with clause **14.8** of BS 5268-2:1988, then the permissible bending stress $\sigma_{m,adm}$ (in N/mm^2) is given by the equation

$$\sigma_{m,adm} = \sigma_{m,g} K_3 K_7 K_8 \qquad (5)$$

where

$\sigma_{m,g}$ is the grade bending stress (in N/mm^2) (see BS 5268-2);

K_3 is the load duration modification factor, 1.0 for long term, 1.25 for medium term or 1.5 for short term (see Table 17 of BS 5268-2:1988);

K_7 is the section depth modification factor (see **14.6** of BS 5268-2:1988);

K_8 is the load-sharing modification factor 1.1 [see clause **13** item a) of BS 5268-2:1988].

From BS 5268-2, the permissible compression parallel to the grain stress $\sigma_{c,adm}$ (in N/mm^2) is given by the equation

$$\sigma_{c,adm} = \sigma_{c,g} K_8 K_{12} \qquad (6)$$

where

$\sigma_{c,g}$ is the grade compression parallel to the grain stress (in N/mm^2) (see BS 5268-2)

K_{12} is the modification factor calculated from the equation

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$$K_{12} = \tfrac{1}{2} + \tfrac{1}{2}\left(\frac{1+\eta}{1.5}\right)\frac{\pi^2 E}{\lambda^2 \sigma_c} - \sqrt{\left[\left\{\tfrac{1}{2} + \tfrac{1}{2}\left(\frac{1+\eta}{1.5}\right)\frac{\pi^2 E}{\lambda^2 \sigma_c}\right\}^2 - \frac{\pi^2 E}{1.5\,\lambda^2 \sigma_c}\right]} \tag{7}$$

where

$$\sigma_c = \sigma_{c,g} K_3 \tag{8}$$

E is the minimum modulus of elasticity (in N/mm²);

λ is the slenderness radio L_e/i;

L_e is the effective length;

η is the eccentricity factor taken as 0.005λ in calculating spans for the specimen span tables in Appendix B.

The combination of applied bending and compression parallel to the grain stresses is limited by the equation

$$\frac{\sigma_{m,a}}{\sigma_{m,adm}\left(1 - \dfrac{1.5\sigma_{c,a}}{\sigma_e}K_{12}\right)} + \frac{\sigma_{c,a}}{\sigma_{c,adm}} \le 1 \tag{9}$$

where

$\sigma_{m,a}$ is the applied bending stress (in N/mm²);

$\sigma_{c,a}$ is the applied compression stress (in N/mm²);

σ_e is the Euler stress, $\pi^2 E/(L_e/i)^2$ (in N/mm²).

When values for $\sigma_{m,a}$ and $\sigma_{c,a}$ are inserted in equation (9), the maximum permissible span may be obtained by incrementing the span L until the left-hand side of equation (9) becomes equal to unity.

5.3.2 *Applied bending and compression parallel to the grain stresses*

Non-continuous rafters

Uniform imposed load condition

The applied bending stress is given by the equation

$$\sigma_{m,a} = \frac{FL^2}{8Z} \tag{10}$$

where L is the effective span of the lower portion of the rafter.

The applied compression parallel to the grain stress is given by the equation

$$\sigma_{c,a} = \frac{FL}{2bh}(\cot\alpha + 3\tan\alpha) \tag{11}$$

Point imposed load condition

$$\sigma_{m,a} = \frac{FL^2}{8Z} + \frac{F_p L\cos\alpha}{4Z} \tag{12}$$

$$\sigma_{c,a} = \frac{FL}{2bh}(\cot\alpha + 3\tan\alpha) + \frac{F_p \sin\alpha}{bh} \tag{13}$$

Long term load condition, i.e. dead load and self weight alone

$$\sigma_{m,a} = \frac{FL^2}{8Z} \tag{14}$$

$$\sigma_{c,a} = \frac{FL}{2bh}(\cot\alpha + 3\tan\alpha) \tag{15}$$

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Expanding equations (10) to (15) by inserting the appropriate expression for F leads to the following equations.

Uniform imposed load condition

$$\sigma_{m,a} = \frac{6L^2}{8bh^2}\left\{(F_i \cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \quad (16)$$

$$\sigma_{c,a} = \frac{L}{2bh}(\cot\alpha + 3\tan\alpha)\left\{(F_i \cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \quad (17)$$

Point imposed load condition

$$\sigma_{m,a} = \frac{6L^2}{8bh^2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha + \frac{6L}{4bh^2}\,900\cos\alpha \quad (18)$$

$$\sigma_{c,a} = \frac{L}{2bh}(\cot\alpha + 3\tan\alpha)\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha + \frac{900}{bh}\sin\alpha \quad (19)$$

Long term load condition, i.e. dead load and self weight alone

$$\sigma_{m,a} = \frac{6L^2}{8bh^2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \quad (20)$$

$$\sigma_{c,a} = \frac{L}{2bh}(\cot\alpha + 3\tan\alpha)\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \quad (21)$$

Continuous rafters

At purlin

Uniform imposed load condition

$$\sigma_{m,a} = \frac{FL^2}{8Z} \quad (22)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{FL}{bh}\left(\cot\alpha + \frac{8}{3}\tan\alpha\right) \quad (23)$$

Point imposed load condition

$$\sigma_{m,a} = \frac{FL^2}{8Z} + \frac{3}{32}\frac{F_p L\cos\alpha}{Z} \quad (24)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{FL}{bh}\left(\cot\alpha + \frac{8}{3}\tan\alpha\right) + \frac{F_p\sin\alpha}{bh} \quad (25)$$

Long term load condition, i.e. dead load and self weight alone

$$\sigma_{m,a} = \frac{FL^2}{8Z} \quad (26)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{FL}{bh}\left(\cot\alpha + \frac{8}{3}\tan\alpha\right) \quad (27)$$

In lower portion of rafter

Uniform imposed load condition

$$\sigma_{m,a} = \frac{9}{128}\frac{FL^2}{Z} \quad (28)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{FL}{bh}\left(\cot\alpha + \frac{13}{3}\tan\alpha\right) \quad (29)$$

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Point imposed load condition

$$\sigma_{m,a} = \frac{FL^2}{16Z} + \frac{13}{64}\frac{F_p\, L\cos\alpha}{Z} \qquad (30)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{FL}{bh}(\cot\alpha + 4\tan\alpha) + \frac{F_p\sin\alpha}{bh} \qquad (31)$$

Long term load condition, i.e. dead load and self weight alone

$$\sigma_{m,a} = \frac{9}{128}\frac{FL^2}{Z} \qquad (32)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{FL}{bh}\left(\cot\alpha + \frac{13}{3}\tan\alpha\right) \qquad (33)$$

Expanding equations (22) to (33) by inserting the appropriate expression for F leads to the following equations.

At purlin

Uniform imposed load condition

$$\sigma_{m,a} = \frac{6L^2}{8bh^2}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \qquad (34)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{L}{bh}\left(\cot\alpha + \frac{8}{3}\tan\alpha\right)\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \qquad (35)$$

Point imposed load condition

$$\sigma_{m,a} = \frac{6L^2}{8bh^2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha + \frac{3}{32}\frac{6L}{bh^2}\,900\cos\alpha \qquad (36)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{L}{bh}\left(\cot\alpha + \frac{8}{3}\tan\alpha\right)\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha + \frac{F_p\sin\alpha}{bh} \qquad (37)$$

Long term load condition, i.e. dead load and self weight alone

$$\sigma_{m,a} = \frac{6L^2}{8bh^2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \qquad (38)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{L}{bh}\left(\cot\alpha + \frac{8}{3}\tan\alpha\right)\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \qquad (39)$$

The effective length L_e for buckling calculations should be taken as $L/2$ for the uniform imposed load and long term load conditions, or

$$L_e = \frac{7}{8}L + \frac{25}{32}\frac{F_p\cos\alpha}{F} - \sqrt{\left\{\frac{9}{64}\left(L - \frac{19}{12}\frac{F_p\cos\alpha}{F}\right)^2 + \frac{F_p\, L\cos\alpha}{F}\right\}} \qquad (40)$$

where $F = \left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha$

for the point imposed load condition.

In lower portion of rafter

Uniform imposed load condition

$$\sigma_{m,a} = \frac{9}{128}\frac{6L^2}{bh^2}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \qquad (41)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{L}{bh}\left(\cot\alpha + \frac{13}{3}\tan\alpha\right)\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \qquad (42)$$

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Point imposed load condition

$$\sigma_{m,a} = \frac{6L^2}{16bh^2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} \cos\alpha + \frac{13}{64}\frac{6L}{bh^2} 900 \cos\alpha \quad (43)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{L}{bh}(\cot\alpha + 4\tan\alpha)\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} \cos\alpha + \frac{900}{bh} \sin\alpha \quad (44)$$

Long term load condition, i.e. dead load and self weight alone

$$\sigma_{m,a} = \frac{9}{128}\frac{6L^2}{bh^2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} \cos\alpha \quad (45)$$

$$\sigma_{c,a} = \frac{3}{8}\frac{L}{bh}\left(\cot\alpha + \frac{13}{3}\tan\alpha\right)\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} \cos\alpha \quad (46)$$

The effective length L_e for buckling calculations should be taken as $^3/_4L$ for the uniform imposed load and long term load conditions, or

$$L_e = \frac{3}{8}L - \frac{19}{32}\frac{F_p\cos\alpha}{F} + \sqrt{\left\{\frac{9}{64}\left(L - \frac{19}{12}\frac{F_p\cos\alpha}{F}\right)^2 + \frac{F_p L\cos\alpha}{F}\right\}} \quad (47)$$

where $F = \left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha$

. for the point imposed load condition

5.4 Limitation of shear stress

From BS 5268-2, the permissible shear stress τ_{adm} (in N/mm²) is given by the equation

$$\tau_{adm} = \tau_g K_3 K_8 \quad (48)$$

where

τ_g is the grade shear stress (in N/mm²) (see BS 5268-2);

K_3 is the load duration modification factor, 1.0 for long term, 1.25 for medium term or 1.5 for short term (see Table 7 of BS 5268-2:1988);

K_8 is the load sharing modification factor, 1.1 [see clause **13** item a) of BS 5268-2:1988].

Expanding the equation

$$\tau_{adm} = \frac{3}{2} \times \frac{\text{max shear force}}{bh} \quad (49)$$

leads to the following equations.

Non-continuous rafters

Uniform imposed load condition

$$\tau_g \times 1.25 \times 1.1 = \frac{3}{2}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\frac{L}{2bh} \cos\alpha \quad (50)$$

Point imposed load condition

$$\tau_g \times 1.5 \times 1.1 = \frac{3}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\frac{L}{2bh} \cos\alpha + \frac{3}{2} \times \frac{900}{bh}\cos\alpha \quad (51)$$

Long term load condition, i.e. dead load and self weight alone

$$\tau_g \times 1.0 \times 1.1 = \frac{3}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\frac{L}{2bh} \cos\alpha \quad (52)$$

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Continuous rafters

Uniform imposed load condition

$$\tau_g \times 1.25 \times 1.1 = \frac{3}{2}\left\{(F_i \cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \times \frac{5}{8}\frac{L}{bh} \quad (53)$$

Point imposed load condition

$$\tau_g \times 1.5 \times 1.1 = \frac{3}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \times \frac{5}{8}\frac{L}{bh} + \frac{3}{2} \times \frac{900\cos\alpha}{bh} \quad (54)$$

Long term load condition, i.e. dead load and self load weight alone

$$\tau_g \times 1.0 \times 1.1 = \frac{3}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \times \frac{5}{8}\frac{L}{bh} \quad (55)$$

NOTE These equations lead to the following polynomials in L.

Non-continuous rafters

Uniform imposed load condition

$$\frac{3\cos\alpha}{4bh}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}L - \tau_g \times 1.25 \times 1.1 = 0 \quad (56)$$

Point imposed load condition

$$\frac{3\cos\alpha}{4bh}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}L + \frac{1350\cos\alpha}{bh} - \tau_g \times 1.5 \times 1.1 = 0 \quad (57)$$

Long term load condition, i.e. dead load and self weight alone

$$\frac{3\cos\alpha}{4bh}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}L - \tau_g \times 1.0 \times 1.1 = 0 \quad (58)$$

Continuous rafters

Uniform imposed load condition

$$\frac{15\cos\alpha}{16bh}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}L - \tau_g \times 1.25 \times 1.1 = 0 \quad (59)$$

Point imposed load condition

Point load adjacent to central support

$$\frac{15\cos\alpha}{16bh}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}L + \frac{3}{2} \times \frac{900\cos\alpha}{bh} - \tau_g \times 1.5 \times 1.1 = 0 \quad (60)$$

Long term load condition, i.e. dead load and self weight alone

$$\frac{15\cos\alpha}{16bh}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}L - \tau_g \times 1.0 \times 1.1 = 0 \quad (61)$$

5.5 Limitation of deflection

From **14.7** of BS 5268-2:1988, the recommended deflection limitation w_{max} (in mm) is given by the equation

$$w_{max} = 0.003L \quad (62)$$

Non-continuous rafters

The design equation limiting deflection[1)] is:

Uniform imposed load condition

$$w_{max} = \frac{5}{384}\frac{FL^4}{EI} + \frac{3FL^2}{20Gbh} \quad (63)$$

Point imposed load condition

$$w_{max} = \frac{5}{384}\frac{FL^4}{EI} + \frac{3FL^2}{20Gbh} + \frac{1}{48}\frac{F_pL^3}{EI} + \frac{3}{10}\frac{F_pL}{Gbh} \quad (64)$$

where E is the mean modulus of elasticity.

1) In addition to the deflection due to bending the shear deflection may be significant and has been taken into account.

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Taking G as $\frac{E}{16}$ (see clause **11** of BS 5268-2:1988):

Uniform imposed load condition

$$w_{max} = \frac{5}{384}\frac{FL^4}{EI} + \frac{12}{5}\frac{FL^2}{Ebh} \quad (65)$$

Point imposed load condition

$$w_{max} = \frac{5}{384}\frac{FL^4}{EI} + \frac{12}{5}\frac{FL^2}{Ebh} + \frac{F_pL^3}{48EI} + \frac{24}{5}\frac{F_pL}{Ebh} \quad (66)$$

With a deflection limitation of $0.003L$:

Uniform imposed load condition

$$0.003L = \cos\alpha\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\left(\frac{5}{384}\frac{L^4}{E}\frac{12}{bh^3} + \frac{12L^2}{5Ebh}\right) \quad (67)$$

Point imposed load condition

$$0.003L = \cos\alpha\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\left(\frac{5}{384}\frac{L^4}{E}\frac{12}{bh^3} + \frac{12L^2}{5Ebh}\right) + \left\{\frac{L^3}{48EI} + \frac{24}{5}\frac{L}{Ebh}\right\}F_p\cos\alpha \quad (68)$$

Continuous rafters

The design equation limiting deflection is:

Uniform imposed load condition

$$w_{max} = \frac{FL^4}{185EI} + \frac{3}{20}\frac{FL^2}{Gbh} \quad (69)$$

Point imposed load condition

$$w_{max} = \frac{FL^4}{185EI} + \frac{3}{20}\frac{FL^2}{Gbh} + 0.015\frac{F_pL^3}{EI} + \frac{3}{10}\frac{F_pL}{Gbh} \quad (70)$$

where E is the mean modulus of elasticity.

Taking G as $\frac{E}{16}$ (see clause **11** of BS 5268-2:1988)

Uniform imposed load condition

$$w_{max} = \frac{FL^4}{185EI} + \frac{12}{5}\frac{FL^2}{Ebh} \quad (71)$$

Point imposed load condition

$$w_{max} = \frac{FL^4}{185EI} + \frac{12}{5}\frac{FL^2}{Ebh} + 0.015\frac{F_pL^3}{EI} + \frac{24}{5}\frac{F_pL}{Ebh} \quad (72)$$

With a deflection limitation of $0.003L$:

Uniform imposed load condition

$$0.003L = \cos\alpha\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\left(\frac{L^4}{185E}\frac{12}{bh^3} + \frac{12}{5}\frac{L^2}{Ebh}\right) \quad (73)$$

Point imposed load condition

$$0.003L = \cos\alpha\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\left(\frac{L^4}{185E}\frac{12}{bh^3} + \frac{12}{5}\frac{L^2}{Ebh}\right) + \left\{0.015\frac{L^3}{E}\frac{12}{bh^3} + \frac{24}{5}\frac{L}{Ebh}\right\}F_p\cos\alpha \quad (74)$$

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NOTE These equations lead to the following polynomials in L.

Non-continuous rafters

Uniform imposed load condition

$$\frac{5\cos\alpha}{32Ebh^3}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_i\right\}L^3 + \frac{12\cos\alpha}{5Ebh}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}L - 0.003 = 0 \qquad (75)$$

Point imposed load condition

$$\frac{5\cos\alpha}{32Ebh^3}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}L^3 + \frac{225\cos\alpha}{5Ebh^3}L^2 + \frac{12\cos\alpha}{5Ebh}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}L + \frac{4320\cos\alpha}{Ebh} - 0.003 = 0 \qquad (76)$$

Continuous rafters

Uniform imposed load condition

$$\frac{12\cos\alpha}{185Ebh^3}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_i\right\}L^3 + \frac{12\cos\alpha}{5Ebh}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}L - 0.003 = 0 \qquad (77)$$

Point imposed load condition

$$\frac{12\cos\alpha}{185Ebh^3}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}L^3 + \frac{162\cos\alpha}{Ebh^3}L^2 + \frac{12\cos\alpha}{5Ebh}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}L + \frac{4320\cos\alpha}{Ebh} - 0.003 = 0 \qquad (78)$$

5.6 Permissible clear spans

The calculation of clear span requires the deduction of a notional bearing length from an effective span.

The calculation of the notional bearing length to be deducted from the permissible effective span to produce the clear span is made after finding L_{adm}, the smallest of the effective spans for a given cross section, as limited by:

a) bending stress under uniform imposed load;

b) bending stress under point imposed load;

c) bending stress under long term load alone;

d) shear stress under uniform imposed load;

e) shear stress under point imposed load;

f) shear stress under long term load alone;

g) deflection under uniform imposed load;

h) deflection under point imposed load.

In the following formulae, the notional bearing length is calculated as though the rafter were supported in the manner shown in Figure 3, taking account only of the load components perpendicular to the rafter. In practical constructions, the clear span of the lower rafter portion may be taken as the distance from the birdsmouth to the nearer face of the purlin.

The upper portion of the rafter, extending from purlin to ridge, will be a conservative design because the calculations of effective span are made for the lower portion of the rafter where the thrust is greater. However, for simplicity the clear span of the upper portion of the rafter may be taken as the distance from the upper face of the purlin to the first cut made in the lower surface of the rafter adjacent to the ridge. In cases where the top end of the rafter meets a ridge board, this first cut will be the bottom end of the vertical cut at the top of the rafter.

From BS 5268-2, the permissible compression perpendicular to grain stress $\sigma_{c,\perp,adm}$ (in N/mm^2) is given by the equation

$$\sigma_{c,\perp,adm} = \sigma_{c,\perp,g}K_3K_8 \qquad (79)$$

where

$\sigma_{c,\perp,g}$ is the grade compression perpendicular to grain stress (in N/mm^2) (see BS 5268-2)[a];

K_3 is the load duration modification factor, 1.0 for long term, 1.25 for medium term or 1.5 for short term (see Table 17 of BS 5268-2:1988);

K_8 is the load sharing modification factor, 1.1 [see clause **13** item a) of BS 5268-2:1988].

[a] BS 5268-2, provides two values for the grade compression perpendicular to grain stress. When the specification specifically prohibits wane at bearing areas, the higher value may be used, otherwise the lower value applies (see footnotes to Tables 9, 10, 11, 12 and 13 of BS 5268-2:1988). The span table should indicate whether wane is permitted.

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The notional bearing length a (in mm) required at each end should be found from the following equations.

Non-continuous rafters

Uniform imposed load condition

$$\sigma_{c,\perp,g} \times 1.25 \times 1.1 \times ba = \frac{L_{adm}\cos\alpha}{2}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\} \quad (80)$$

Point imposed load condition with bending stress or deflection governing

$$\sigma_{c,\perp,g} \times 1.5 \times 1.1 \times ba = \frac{L_{adm}\cos\alpha}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} + 450\cos\alpha \quad (81)$$

Point imposed load condition with shear stress governing

$$\sigma_{c,\perp,g} \times 1.5 \times 1.1 \times ba = \frac{L_{adm}\cos\alpha}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} + 900\cos\alpha \quad (82)$$

Long term load condition, i.e. dead load and self weight alone

$$\sigma_{c,\perp,g} \times 1.0 \times 1.1 \times ba = \frac{L_{adm}\cos\alpha}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} \quad (83)$$

Continuous rafters

Uniform imposed load condition

$$\sigma_{c,\perp,g} \times 1.25 \times 1.1 \times ba = \frac{L_{adm}\cos\alpha}{2}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\} \quad (84)$$

Point imposed load condition with bending stress or deflection governing

$$\sigma_{c,\perp,g} \times 1.5 \times 1.1 \times ba = \frac{L_{adm}\cos\alpha}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} + 337.5\cos\alpha \quad (85)$$

Point imposed load condition with shear stress governing

$$\sigma_{c,\perp,g} \times 1.5 \times 1.1 \times ba = \frac{L_{adm}\cos\alpha}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} + 900\cos\alpha \quad (86)$$

Long term load condition, i.e. dead load and self weight alone

$$\sigma_{c,\perp,g} \times 1.0 \times 1.1 \times ba = \frac{L_{adm}}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} \quad (87)$$

In equations (80) to (87)

a is the notional bearing length (in mm);

b is the breadth of the rafters (in mm);

L_{adm} is the permissible effective span (in mm).

The equation corresponding to the loading condition governing the permissible effective span should be solved for a, and half the value of a should be deducted from each end of the span (total deduction a, see Figure 3) to give the permissible clear span. L_{cl} (in mm) is given by the equation

$$L_{cl} = L_{adm} - a \quad (88)$$

6 Bearing length

Although correct for the calculation of clear span the procedure given in **5.6** for the calculation of notional bearing length may not ensure that the permissible compression perpendicular to the grain stress is not exceeded for all loading cases.

The design of some members may be governed by a loading case which does not represent the greatest total load of all loading cases. For example, the governing design case may include a concentrated load, but another less critical loading case may consist of a greater load uniformly distributed along the span.

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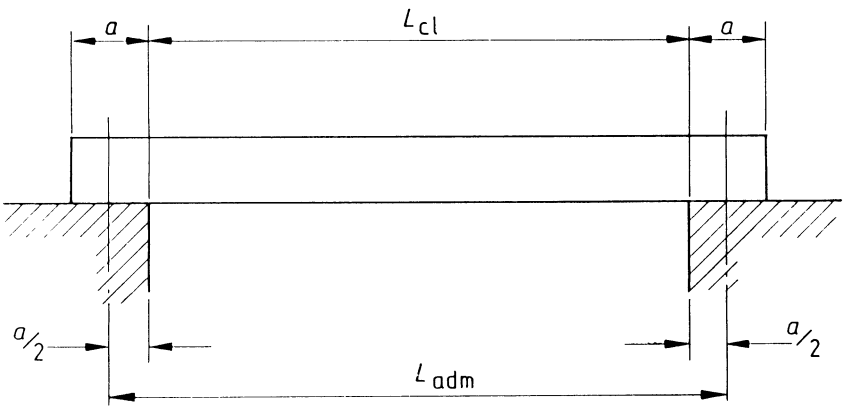

Figure 3 — Bearing length, permissible effective and permissible clear span

7 Information to be given in span tables

There are many possible formats for span tables. A typical format suitable for rafters at predetermined centres and for quoted loading is given in Appendix B.

This Section of BS 5268 does not recommend formats for different components but whatever format is used the following information should be given in the heading or in the main body or in the footnotes of the span tables, or in an introduction to the tables:

a) the loading;

b) details of the arrangement of the members;

c) the member sizes and their maximum permissible deviations and/or the standards that define these quantities;

d) the species, stress grade or strength class and/or the standards that define these properties;

e) a statement specifying any requirement additional to those given in the stress grading rules, e.g. whether wane is prohibited at bearings;

f) a statement that the spans have been calculated in accordance with the recommendations of BS 5268-2 and BS 5268-7.5;

g) a statement specifying any structural requirements that may be necessary to comply with the qualifying assumptions made in **4.2**, e.g. lateral support requirements, accommodation of lateral thrust of supports;

h) the permissible clear spans.

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Appendix A Sample calculations for a rafter

The object is to find the permissible clear span (on slope), given the following data as applicable to a particular design case.

Timber	Strength class SC3		(see Tables 3 to 7 of BS 5268-2:1988)
Rafter type	Continuous, slope 30°		
Dimensions	Rafter breadth, b	= 47 mm	
	Rafter depth, h	= 97 mm	
	Rafter spacing, s	= 600 mm	
Loading	Dead load per square metre on slope, F_d	= 0.75 kN/m²	[see **4.3** b)]
	Imposed snow load on plan	= 0.75 kN/m²	[see **4.3** a)]
		or = 0.9 kN	

The following data are given in BS 5268-2:1988.

Grade stresses and density		**BS 5268-2:1988 reference**
Grade bending stress, $\sigma_{m,g}$	= 5.3 N/mm²	Table 9
Grade compression parallel to the grain stress, $\sigma_{c,\parallel,g}$	= 6.8 N/mm²	Table 9
Grade shear stress, τ_g	= 0.67 N/mm²	Table 9
Grade mean modulus of elasticity	= 8 800 N/mm²	Table 9
Grade minimum modulus of elasticity	= 5 800 N/mm²	Table 9
Grade compression perpendicular to the grain stress (with wane permitted), $\sigma_{c,\perp,g}$	= 1.7 N/mm²	Table 9
Density, ρ	= 540 kg/m³	Table 9
Modification factors		
Uniform load, load duration, K_3	= 1.00	long term, Table 17
Uniform load, load duration, K_3	= 1.25	medium term, Table 17
Point load, load duration, K_3	= 1.5	short term, Table 17
Depth, K_7	= $(300/h)^{0.11}$	**14.6**
Load sharing, K_8	= 1.1	clause **13**

Permissible stresses and recommended deflection limitation		**BS 5268-7.5 reference**
Permissible bending stress, $\sigma_{m,adm}$ (in N/mm²)	= $\sigma_{m,g}K_3K_7K_8$	**5.3**
	= 8.251 N/mm² for uniform load (medium term)	
	or = 9.901 N/mm² for point load	
	or = 6.601 N/mm² for uniform load (long term)	
Permissible compression parallel to the grain stress, $\sigma_{c,adm}$ (in N/mm²)	= $\sigma_{c,g}K_3K_8K_{12}$	**5.3**
	= 9.35 K_{12} N/mm² for uniform load (medium term)	
	or = 11.22 K_{12} N/mm² for point load	
	or = 7.48 K_{12} N/mm² for uniform load (long term)	

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The value of σ_c adopted for calculating K_{12} [equation (7)] is: σ_c		$= \sigma_{c,g}K_3$	**5.3**
		= 8.5 N/mm² for uniform load (medium term)	
	or	= 10.2 N/mm² for point load	
	or	= 6.8 N/mm² for uniform load (long term)	
Permissible shear stress, τ_{adm} (in N/mm²)		$= \tau_g K_3 K_8$	**5.4**
		= 0.921 N/mm² for uniform load (medium term)	
	or	= 1.1055 N/mm² for point load	
	or	= 0.737 N/mm² for uniform load (long term)	
Recommended deflection limitation, w_{max} (in mm)		$= 0.003L$	**5.5**
Permissible compression perpendicular to the grain stress, $\sigma_{c,\perp,adm}$ (in N/mm²)		$= \sigma_{c,\perp,g}K_3K_8$	**5.6**
		= 2.3375 N/mm² for uniform load (medium term)	
	or	= 2.805 N/mm² for point load	
	or	= 1.87 N/mm² for uniform load (long term)	

Application of the design equations from **5.3** to **5.5** leads to the following solutions for effective span, L:

Limitation of combined bending and compression stress

At purlin

Uniform imposed load	L = 2 437 mm [equation (9)]
Point imposed load	L = 2 960 mm [equation (9)]
Long term load	L = 2 957 mm [equation (9)]

In lower portion of rafter

Uniform imposed load	L = 2 985 mm [equation (9)]
Point imposed load	L = 2 770 mm [equation (9)]
Long term load	L = 3 634 mm [equation (9)]

Limitation of shear stress

Uniform imposed load	L = 5 988 mm [equation (59)]
Point imposed load	L = 10 055 mm [equation (60)]
Long term load	L = 8 728 mm [equation (61)]

Limitation of deflection

Uniform imposed load	L = 2 817 mm [equation (77)]
Point imposed load	L = 2 309 mm [equation (78)]

The permissible effective span L_{adm} is therefore

L_{adm} = 2 309 mm

However if the effect of deflection under the concentrated load is disregarded (see **4.3**), the lowest remaining value is

L_{adm} = 2 437 mm

Using this value, the appropriate equation is selected from **5.6** to calculate the notional bearing length, a, as 8 mm.

The permissible clear span L_{cl} for the joists is then

$L_{cl} = L_{adm} - a$

L_{cl} = 2 429 mm

The point load deflection is disregarded in computing the Table 1, Table 2 and Table 3.

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Appendix B Specimen span tables for rafters

There are many possible formats for span tables and Table 1, Table 2 and Table 3 are typical examples. Whatever format is used, the information listed in clause **7** should be given.

Table 1 — Permissible clear spans for two-span continuous rafters, roof slope 30°, uniform snow load 0.75 kN/m²: SC3[a], regularized sizes[b]

Size of rafter	Dead load per square metre (in kN/m²) supported by rafter, excluding the self weight of the rafter								
	Not more than 0.50 (51 kg/m²)			More than 0.50 but not more than 0.75 (76.5 kg/m²)			More than 0.75 but not more than 1.00 (102 kg/m²)		
	Centre-to-centre spacing of rafters (in mm)								
	400	450	600	400	450	600	400	450	600
	Permissible clear span on slope								
mm	m	m	m	m	m	m	m	m	m
38 × 72	1.728	1.703	1.636	1.636	1.606	1.527	1.560	1.527	1.439
97	2.781	2.728	2.410	2.588	2.521	2.185	2.435	2.324	2.011
122	3.638	3.436	2.985	3.307	3.122	2.707	3.051	2.879	2.493
147	4.319	4.082	3.550	3.930	3.711	3.222	3.628	3.424	2.968
170	4.934	4.666	4.062	4.493	4.245	3.688	4.150	3.918	3.399
195	5.591	5.290	4.610	5.096	4.816	4.188	4.710	4.448	3.862
220	6.237	5.904	5.151	5.689	5.380	4.682	5.261	4.971	4.319
44 × 72	1.958	1.928	1.847	1.847	1.811	1.716	1.756	1.716	1.612
97	3.120	2.983	2.592	2.871	2.710	2.351	2.649	2.499	2.165
122	3.902	3.688	3.208	3.551	3.354	2.912	3.278	3.095	2.683
147	4.629	4.378	3.813	4.217	3.985	3.464	3.896	3.679	3.193
170	5.285	5.001	4.361	4.818	4.555	3.963	4.455	4.209	3.656
195	5.984	5.667	4.947	5.461	5.166	4.499	5.053	4.776	4.152
220	6.671	6.321	5.524	6.094	5.767	5.028	5.642	5.334	4.642
47 × 72	2.069	2.036	1.948	1.948	1.909	1.806	1.849	1.806	1.692
97	3.259	3.080	2.677	2.964	2.799	2.429	2.736	2.582	2.238
122	4.026	3.807	3.313	3.665	3.463	3.009	3.385	3.196	2.773
147	4.774	4.517	3.937	4.351	4.113	3.578	4.022	3.799	3.299
170	5.449	5.159	4.501	4.971	4.701	4.093	4.598	4.345	3.777
195	6.168	5.843	5.105	5.632	5.330	4.645	5.213	4.929	4.288
220	6.874	6.515	5.699	6.283	5.948	5.190	5.820	5.505	4.793
50 × 72	2.178	2.142	2.046	2.046	2.004	1.894	1.940	1.894	1.745
97	3.357	3.173	2.760	3.054	2.885	2.505	2.820	2.662	2.308
122	4.145	3.921	3.414	3.776	3.568	3.102	3.489	3.295	2.860
147	4.914	4.651	4.056	4.481	4.237	3.687	4.143	3.915	3.402
170	5.607	5.310	4.636	5.117	4.841	4.218	4.735	4.476	3.893
195	6.344	6.012	5.257	5.797	5.487	4.786	5.368	5.077	4.420
220	7.068	6.702	5.868	6.464	6.122	5.346	5.991	5.668	4.940
63 × 147	5.465	5.178	4.529	4.993	4.726	4.124	4.624	4.374	3.809
170	6.226	5.904	5.171	5.696	5.395	4.713	5.279	4.996	4.356
195	7.035	6.677	5.857	6.444	6.108	5.343	5.978	5.661	4.942
220	7.826	7.433	6.531	7.177	6.807	5.963	6.665	6.314	5.519
75 × 195	7.589	7.212	6.344	6.966	6.610	5.797	6.473	6.136	5.368
220	8.432	8.019	7.068	7.750	7.360	6.464	7.209	6.838	5.991

NOTE 1 The tables are computed on the basis that the specification does not exclude wane at bearings.

NOTE 2 The spans have been calculated in accordance with the recommendations of BS 5268-2 and BS 5268-7.5. Lateral support should be provided in accordance with **14.8** of BS 5268-2:1988.

NOTE 3 The material should be stress graded in accordance with BS 4978.

NOTE 4 The sizes and their maximum permissible deviations should be in accordance with BS 4471.

[a] For species/grade combinations in this strength class, see Tables 3 to 7 of BS 5268-2:1988.

[b] Regularized sizes are given in BS 4471.

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Table 2 — Permissible clear spans for single-span rafters, roof slope 30°, uniform snow load 0.75 kN/m²: redwood/whitewood, SS grade, basic sizes[a]

Size of rafter	Dead load per square metre (in kN/m²) supported by rafter, excluding the self weight of the rafter								
	Not more than 0.50 (51 kg/m²)			More than 0.50 but not more than 0.75 (76.5 kg/m²)			More than 0.75 but not more than 1.00 (102 kg/m²)		
	Centre-to-centre spacing of rafters (in mm)								
	400	450	600	400	450	600	400	450	600
	Permissible clear span on slope								
mm	m	m	m	m	m	m	m	m	m
38 × 75	1.922	1.883	1.722	1.781	1.737	1.611	1.671	1.624	1.507
100	2.617	2.518	2.290	2.454	2.360	2.144	2.324	2.235	2.028
125	3.260	3.138	2.855	3.058	2.942	2.675	2.898	2.787	2.531
150	3.898	3.754	3.418	3.659	3.522	3.203	3.468	3.337	3.032
175	4.532	4.366	3.979	4.257	4.098	3.730	4.036	3.884	3.532
200	5.162	4.974	4.536	4.851	4.671	4.254	4.602	4.429	4.029
225	5.787	5.579	5.091	5.441	5.242	4.777	5.164	4.972	4.525
44 × 75	2.067	1.989	1.808	1.938	1.864	1.693	1.835	1.764	1.602
100	2.745	2.642	2.404	2.575	2.477	2.252	2.439	2.346	2.131
125	3.417	3.290	2.997	3.207	3.087	2.808	3.040	2.925	2.659
150	4.084	3.934	3.586	3.836	3.693	3.362	3.638	3.501	3.184
175	4.746	4.573	4.172	4.461	4.296	3.914	4.232	4.074	3.708
200	5.402	5.208	4.755	5.081	4.895	4.463	4.823	4.645	4.229
225	6.054	5.839	5.336	5.698	5.491	5.010	5.411	5.212	4.749
47 × 75	2.112	2.032	1.848	1.980	1.905	1.731	1.876	1.804	1.638
100	2.804	2.699	2.457	2.631	2.531	2.302	2.493	2.398	2.179
125	3.489	3.361	3.062	3.277	3.154	2.870	3.107	2.989	2.718
150	4.170	4.017	3.664	3.918	3.773	3.436	3.717	3.577	3.255
175	4.844	4.669	4.262	4.555	4.388	3.999	4.323	4.162	3.790
200	5.513	5.316	4.857	5.187	4.999	4.559	4.926	4.744	4.322
225	6.177	5.959	5.448	5.816	5.606	5.117	5.525	5.323	4.852
50 × 75	2.155	2.074	1.886	2.021	1.944	1.767	1.914	1.841	1.672
100	2.860	2.754	2.507	2.684	2.583	2.350	2.544	2.448	2.225
125	3.559	3.428	3.124	3.342	3.218	2.930	3.170	3.050	2.775
150	4.251	4.097	3.738	3.996	3.848	3.506	3.791	3.650	3.322
175	4.937	4.761	4.347	4.644	4.475	4.080	4.409	4.246	3.867
200	5.618	5.419	4.953	5.288	5.097	4.651	5.023	4.839	4.410
225	6.293	6.073	5.555	5.928	5.715	5.220	5.633	5.428	4.951
63 × 150	4.565	4.403	4.024	4.297	4.141	3.779	4.081	3.931	3.584
175	5.297	5.112	4.677	4.990	4.812	4.395	4.742	4.570	4.169
200	6.021	5.814	5.325	5.677	5.477	5.007	5.399	5.205	4.752
225	6.738	6.509	5.968	6.358	6.136	5.615	6.050	5.835	5.332
75 × 200	6.335	6.122	5.618	5.981	5.775	5.288	5.694	5.493	5.023
225	7.084	6.849	6.293	6.694	6.466	5.928	6.377	6.155	5.633

NOTE 1 The tables are computed on the basis that the specification does not exclude wane at bearings.

NOTE 2 The spans have been calculated in accordance with the recommendations of BS 5268-2 and BS 5268-7.5. Lateral support should be provided in accordance with **14.8** of BS 5268-2:1988.

NOTE 3 The material should be stress graded in accordance with BS 4978.

NOTE 4 The sizes and their maximum permissible deviations should be in accordance with BS 4471.

[a] Basic sizes are given in BS 4471.

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Table 3 — Permissible clear spans for two-span continuous rafters, roof slope 30°, uniform snow load 0.75 kN/m²: spruce-pine-fir, joist and plank no. 2 grade, CLS sizes[a]

Size of rafter	Dead load per square metre (in kN/m²) supported by rafter, excluding the self weight of the rafter								
	Not more than 0.50 (51 kg/m²)			More than 0.50 but not more than 0.75 (76.5 kg/m²)			More than 0.75 but not more than 1.00 (102 kg/m²)		
	Centre-to-centre spacing of rafters (in mm)								
	400	450	600	400	450	600	400	450	600
	Permissible clear span on slope								
mm	m	m	m	m	m	m	m	m	m
38 × 140	4.260	4.024	3.495	3.872	3.655	3.169	3.572	3.370	2.918
184	5.479	5.180	4.505	4.986	4.710	4.089	4.604	4.346	3.767
235	6.850	6.482	5.648	6.243	5.901	5.131	5.771	5.450	4.731
285	8.157	7.724	6.743	7.444	7.042	6.132	6.887	6.509	5.658

NOTE 1 The tables are computed on the basis that the specification does not exclude wane at bearings.

NOTE 2 The spans have been calculated in accordance with the recommendations of BS 5268-2 and BS 5268-7.5. Lateral support should be provided in accordance with **14.8** of BS 5268-2.

NOTE 3 The material should be stress graded in accordance with NLGA rules. (The similar ALS sizes are graded in the USA to NGRDL rules).

NOTE 4 The sizes and their maximum permissible deviations should be in accordance with BS 4471.

[a] CLS sizes are given in Appendix A of BS 4471.

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Publications referred to

BS 565, *Glossary of terms relating to timber and woodwork.*
BS 648, *Schedule of weights of building materials.*
BS 4471, *Specification for dimensions for softwood.*
BS 4471-1, *Sizes of sawn and planed timber.*
BS 4978, *Timber grades for structural use.*
BS 5268, *Structural use of timber.*
BS 5268-2, *Code of practice for permissible stress design, materials and workmanship.*
BS 5268-3, *Trussed rafter roofs.*
BS 5268-7.1, *Domestic floor points*[2].
BS 5268-7.2, *Joists for flat roofs*[2].
BS 5268-7.3, *Ceiling joists*[2].
BS 5268-7.4, *Ceiling binders*[2].
BS 5268-7.6, *Purlins supporting rafters*[2].
BS 5268-7.7, *Purlins supporting sheeting or decking*[2].
BS 6100, *Glossary of building and civil engineering terms.*
BS 6100-2.1, *Structural design and elements.*
BS 6100-4.1, *Characteristics and properties of timber and wood based panel products.*
BS 6100-4.2, *Sizes and quantities.*
BS 6100-4.3, *Wood based panel products.*
BS 6100-4.4, *Carpentry and joinery.*
BS 6399, *Design loading for buildings.*
BS 6399-1, *Code of practice for dead and imposed loads.*
BS 6399-3, *Code of practice for imposed roof loads.*
ISO 3898, *Basis for design of structures — Notations — General Symbols.*
CIB-W18-1, *Symbols for use in structural timber design. International Council for Building Research Studies and Documentation, Post Box 20704, 3001 JA Rotterdam, The Netherlands.*
NLGA 1979, *The national grading rules for dimension lumber. National Lumber Grades Authority, 1450-1055 West Hastings Street, Vancouver, British Columbia, Canada V6E 2G8.*
NGRDL 1975, *The national grading rules for softwood dimension lumber (USA).*

[2] Referred to in the foreword only.

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