British Standard

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Structural use of timber —

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

Section 7.7 Purlins supporting sheeting or decking

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Committees responsible for this British Standard

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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
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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 have 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 purlins supporting sheeting or decking on pitched roofs. 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 7.5: Rafters;*

— *Section 7.6: Purlins supporting rafters.*

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 species/grade combinations. Although the presentation of span tables is not covered in BS 5268-7, it is recommended that tables for predetermined purlin 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 16, 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.

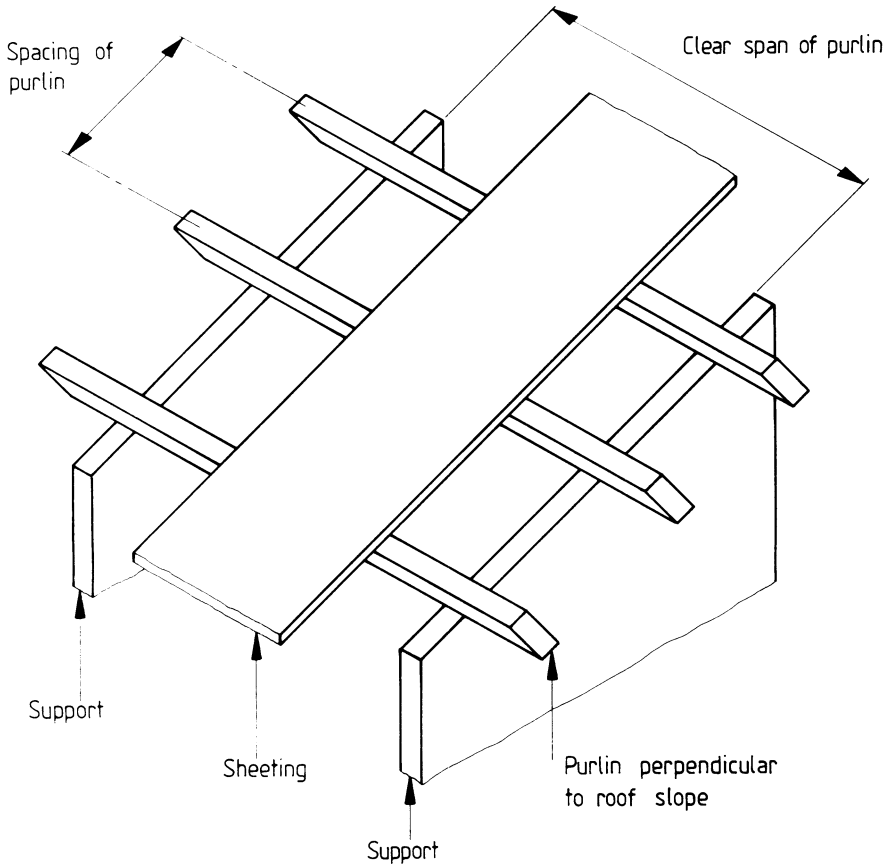

Figure 1 — Roof construction

1 Scope

This Section of BS 5268 recommends a calculation basis for the permissible clear span of purlins supporting sheeting or decking in pitched roof construction. The recommendations apply to purlins formed from solid timber and supported by external or internal walls. The major axis of the purlin is perpendicular to the roof slope (see Figure 1); other orientations of the purlin are not covered by this standard. 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.

This Section of BS 5268 is applicable to the species, stress grades or strength classes 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 Part of BS 5268 the definitions given in BS 5268-2 and BS 6100-4.1 to BS 6100-4.4 and BS 6100-2.1 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 purlin 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 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 purlin, measured between the faces of the supports at its two ends

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

2.10
point load

concentrated load required by BS 6399-1, regarded as acting at a point for calculation purposes

2.11
purlin

beam parallel to the eaves giving support to sheeting or decking on pitched roofs

3 Symbols

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

NOTE The symbols used in this standard 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 purlin
E	Modulus of elasticity
F	Total load per metre length, applied to purlin in the direction perpendicular to the roof slope
F_d	Dead load per square metre applied by mass of roofing material (excluding purlin self weight), measured on slope
F_i	Imposed uniformly distributed load per square metre, measured on plan
F_j	Self weight of purlin per metre length
F_p	Point load
G	Shear modulus

h	Depth of purlin
I	Second moment of area
K	Modification factor (always with a subscript)
L	Effective span
L_{adm}	Permissible effective span
L_{cl}	Permissible clear span
M	Bending moment
s	Spacing of purlins, centre-to-centre, measured on slope
w	Deflection
z	Section modulus
α	Roof slope (pitch)
ρ	Density
σ	Stress
τ	Shear stress

The following subscripts are used:

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

c	Compression
m	Bending

b) **Significance**

adm	Permissible
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 and shear 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 design calculations recommended in this Section of BS 5268 apply to single-span purlins supporting sheet roofing materials or timber decking. The major axis of the purlin is perpendicular to the rafter slope. The component of load in the plane of the roofing is assumed to be carried by the roof construction other than the purlins; it is essential that the type of roofing and its fixings are capable of acting in this manner.

The uniformly distributed dead and imposed loads are as given in BS 6399-1 and BS 6399-3 for pitched roofs.

The purlins are treated as solid timbers acting alone, with no provision for load sharing. In accordance with **14.7** of BS 5268-2:1988, the minimum value of modulus of elasticity is used in the calculations.

Lateral support should be provided in accordance with **14.8** of BS 5268-2:1988. Where stress reversal can occur, lateral restraint of the upper and lower edges of the purlin should be considered.

The bearing length required at each end of the purlin, calculated in accordance with **5.5**, 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.

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 at 75° roof slope. No concentrated load is applied.

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 weight of the purlin. The timber densities (in kg/m^3) given in Tables 9 and 92 of BS 5268-2:1988 should be used.

The concentrated load in accordance with BS 6399-1 is taken as a point load for calculation purposes.

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

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.

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 point 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 longer 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.

NOTE Wind uplift may be the governing design loading when the lighter types of roof cladding are to be used, and should be checked when appropriate.

For the uniform imposed load condition, the total load per metre length of purlin, F(in kN/m) resolved perpendicular to the roof slope, 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 resolved perpendicular to the roof slope from the point imposed load is given by:

$F_p \cos\alpha = 0.9 \cos\alpha$ kN, 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

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

In equations (1) to (3)

α is the roof slope (pitch);

F_i is the imposed load (in kN/m^2) measured on plan;

s is the purlin spacing (in mm) measured on slope;

F_d is the dead load (in kN/m^2) measured on slope;

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

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

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

where

ρ is the timber density (in kg/m^3);

b is the purlin breadth (in mm);

h is the purlin depth (in mm).

For the calculation of spans under loading incorporating a point load, the combined effect of uniform and point loads may be obtained using the equivalent uniformly distributed load F. F (in kN/m) is given by the following equations.

In bending strength calculations

$$F = \left\{ \frac{1000 \times 2F_p}{L} + F_d \left(\frac{s}{1000} \right) + F_j \right\} \cos \alpha \quad (5)$$

In shear strength calculations

$$F = \left\{ \frac{1000 \times 2F_p}{L} + F_d \left(\frac{s}{1000} \right) + F_j \right\} \cos \alpha \quad (6)$$

In deflection calculations:

For bending deflection

$$F = \left\{ \frac{1000 \times 1.6F_p}{L} + F_d \left(\frac{s}{1000} \right) + F_j \right\} \cos \alpha \quad (7)$$

For shear deflection

$$F = \left\{ \frac{1000 \times 2F_p}{L} + F_d \left(\frac{s}{1000} \right) + F_j \right\} \cos \alpha \quad (8)$$

In equations (5) to (8)

$F_p = 0.9$ kN;

L is the span (in mm).

5 Permissible spans

5.1 General

The permissible effective span of a timber purlin 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 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**.

5.2 Basis of formulae

The formulae given in **5.3**, **5.4** and **5.5** are derived for domestic roofs in which multiple purlins support a sheet roofing material or timber decking, with no rafters incorporated in the construction. The purlin reaction is perpendicular to the roof slope and the purlin is treated as a beam simply supported at its two ends. The component of load in the plane of the roofing is assumed to be carried by the roof construction other than the purlins.

5.2.1 *Multiple purlins*. When purlin spacing is given in computed tables, this may be taken as either the distance between the centres of adjacent purlins or the distance between the eaves and the adjacent purlin. It is assumed that purlins are installed close to the ridge on either side.

5.3 Limitation of bending stress

If lateral restraint is provided in accordance with **14.8** of BS 5268-2:1988, then from BS 5268-2, the permissible bending stress $\sigma_{m,adm}$ (in N/mm^2) is given by the equation

$$\sigma_{m,adm} = \sigma_{m,g} K_3 K_7 \qquad (9)$$

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).

Expanding the equation

$$\sigma_{m,adm} = \frac{M}{Z} \qquad (10)$$

leads to the following equations.

Uniform imposed load condition

$$\sigma_{m,g} \times 1.25 \times K_7 = \frac{6L^2}{8bh^2}\left\{ (F_1 \cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j \right\} \cos\alpha \qquad (11)$$

Point imposed load condition

$$\sigma_{m,g} \times 1.5 \times K_7 = \frac{6L^2}{8bh^2}\left\{ \frac{1800}{L} + F_d \left(\frac{s}{1000}\right) + F_j \right\} \cos\alpha \qquad (12)$$

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

$$\sigma_{m,g} \times 1.0 \times K_7 = \frac{6L^2}{8bh^2}\left\{ F_d\left(\frac{s}{1000}\right) + F_j \right\} \cos\alpha \qquad (13)$$

NOTE These equations lead to the following polynomials in L.

Uniform imposed load condition

$$\frac{3\cos\alpha}{4bh^2}\left\{ (F_j \cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j \right\} L^2 - \sigma_{m,g} \times 1.25 \times K_7 = 0 \qquad (14)$$

Point imposed load condition

$$\frac{3\cos\alpha}{4bh^2}\left\{ F_d\left(\frac{s}{1000}\right) + F_j \right\} L^2 + \frac{1350\cos\alpha}{bh^2} L - \sigma_{m,g} \times 1.5 \times K_7 = 0 \qquad (15)$$

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

$$\frac{3\cos\alpha}{4bh^2}\left\{ F_d\left(\frac{s}{1000}\right) + F_j \right\} L^2 - \sigma_{m,g} \times 1.0 \times K_7 = 0 \qquad (16)$$

5.4 Limitation of shear stress

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

$$\tau_{adm} = \tau_g K_3 \quad (17)$$

where

τ_g is the grade shear 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).

Expanding the equation

$$\tau_{adm} = \frac{3}{2}\frac{FL}{2bh} \quad (18)$$

leads to the following equations.

Uniform imposed load condition

$$\tau_g \times 1.25 = \frac{3}{2}\left\{(F_i \cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\frac{L}{2bh}\cos\alpha \quad (19)$$

Point imposed load condition

$$\tau_g \times 1.5 = \frac{3}{2}\left\{\frac{1800}{L} + F_d\left(\frac{s}{1000}\right) + F_j\right\}\frac{L}{2bh}\cos\alpha \quad (20)$$

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

$$\tau_g \times 1.0 = \frac{3}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\frac{L}{2bh}\cos\alpha \quad (21)$$

NOTE These equations lead to the following polynomials in L.

Uniform imposed load condition

$$\frac{3\cos\alpha}{4bh}\left\{(F_i \cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\} L - \tau_g \times 1.25 = 0 \quad (22)$$

Point imposed load condition

$$\frac{3\cos\alpha}{4bh}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} L + \frac{1350}{bh}\cos\alpha - \tau_g \times 1.5 = 0 \quad (23)$$

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

$$\frac{3\cos\alpha}{4bh}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\} L - \tau_g \times 1.0 = 0 \quad (24)$$

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

$$w_{max} = 0.003L \quad (25)$$

The design equation limiting deflection[1)] is:

Uniform imposed load condition

$$w_{max} = \frac{5}{384}\frac{FL^4}{EI} + \frac{3FL^2}{20Gbh} \quad (26)$$

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

Point imposed load condition

$$w_{max} = \frac{5}{384}\frac{FL^4}{EI} + \frac{3FL^2}{20Gbh} + \frac{1}{48}\frac{F_pL^3}{EI} + \frac{3}{10}\frac{F_pL}{Gbh} \quad (27)$$

where E is the minimum modulus of elasticity.
Taking G as $\frac{E}{16}$ (see clause **11** of BS 5268-2:1988):
Uniform imposed load condition

$$w_{max} = \frac{5}{384}\frac{FL^4}{EI} + \frac{12}{5}\frac{FL^2}{Ebh} \quad (28)$$

Point imposed load condition

$$w_{max} = \frac{5}{384}\frac{FL^4}{EI} + \frac{12}{5}\frac{FL^2}{Ebh} + \frac{F_pL^3}{48EI} + \frac{24}{5}\frac{F_pL}{Ebh} \quad (29)$$

or, inserting the expressions for equivalent uniformly distributed load,

$$w_{max} = \frac{5}{384}\frac{L^4}{EI}\left\{\frac{1000 \times 1.6F_p}{L} + F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha + \frac{12L^2}{5Ebh}\left\{\frac{1000 \times 2F_p}{L} + F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \quad (30)$$

With a deflection limitation of $0.003L$
Uniform imposed load condition

$$0.003L = \left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\left(\frac{5}{384}\frac{L^4}{E}\frac{12}{bh^3} + \frac{12L^2}{5Ebh}\right)\cos\alpha \quad (31)$$

Point imposed load condition

$$0.003L = \frac{5}{384}\frac{L^4}{E}\frac{12}{bh^3}\left\{\frac{1440}{L} + F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha + \frac{12L^2}{5Ebh}\left\{\frac{1800}{L} + F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \quad (32)$$

NOTE These equations lead to the following polynomials in L.
Uniform imposed load condition

$$\frac{5\cos\alpha}{32Ebh^3}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}L^3 + \frac{12\cos\alpha}{5Ebh}\left\{(F_i\cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}L - 0.003 = 0 \quad (33)$$

Point imposed load condition

$$\frac{5\cos\alpha}{32Ebh^3}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}L^3 + \frac{225\cos\alpha}{Ebh^3}L^2 + \frac{12\cos\alpha}{5Ebh}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}L + \frac{4320}{Ebh}\cos\alpha - 0.003 = 0 \quad (34)$$

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.

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

$$\sigma_{c,\perp,adm} = \sigma_{c,\perp,g} K_3 \quad (35)$$

where

$\sigma_{c,\perp,g}$ is the grade compression perpendicular to the 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).

[a] BS 5268-2 provides two values for the grade compression perpendicular to the 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 in BS 5268-2:1988.) The span table should indicate whether wane is permitted.

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

Uniform imposed load condition

$$\sigma_{c,\perp,g} \times 1.25 \times ba = \frac{L_{adm}}{2}\left\{(F_i \cos\alpha + F_d)\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \quad (36)$$

Point imposed load condition with bending stress or deflection governing

$$\sigma_{c,\perp,g} \times 1.5 \times ba = \frac{L_{adm}}{2}\left\{\frac{900}{L_{adm}} + F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \quad (37)$$

Point imposed load condition with shear stress governing

$$\sigma_{c,\perp,g} \times 1.5 \times ba = \frac{L_{adm}}{2}\left\{\frac{1800}{L_{adm}} + F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \quad (38)$$

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

$$\sigma_{c,\perp,g} \times 1.0 \times ba = \frac{L_{adm}}{2}\left\{F_d\left(\frac{s}{1000}\right) + F_j\right\}\cos\alpha \quad (39)$$

In equations (36) to (39)

a is the notional bearing length (in mm);

b is the breadth of the purlin (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 2) to give the permissible clear span. L_{cl} (in mm) is given by the equation

$$L_{cl} = L_{adm} - a \quad (40)$$

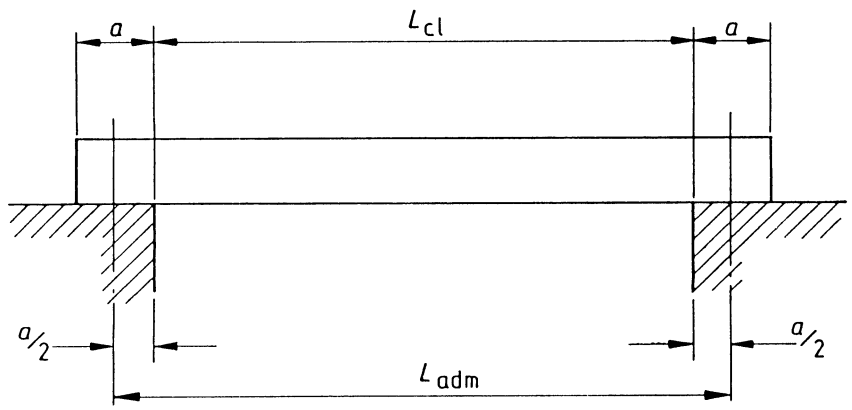

Figure 2 — Bearing length, permissible effective and permissible clear span

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 total load uniformly distributed along the span.

7 Information to be given in span tables

There are many possible formats for span tables. A typical format suitable for purlins 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, e.g. roof slope, purlin spacing;

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 requirements 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 5268-7.7;

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 at supports;

h) the permissible clear spans.

Appendix A Sample calculations for a purlin supporting sheeting or decking

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

Timber	Strength class SC3		(See Tables 3 to 6 of BS 5268-2:1988)
Dimensions	Purlin breadth, b	= 47 mm	
	Purlin depth, h	= 195 mm	
	Purlin spacing, s	= 1 800 mm	
	Roof slope, α	= 30°	
Loading	Dead load per square metre on slope, F_d	= 0.50 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 shear stress, τ_g	= 0.67 N/mm²	Table 9
Grade minimum modulus of elasticity, E	= 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**

Permissible stresses and recommended deflection limitation		**BS 5268-7.7 reference**
Permissible bending stress, $\sigma_{m,adm}$ (in N/mm²)	$= \sigma_{m,g}K_3K_7$	**5.3**
	= 6.946 N/mm² for uniform load (medium term)	
	or = 8.336 N/mm² for point load	
	or = 5.557 N/mm² for uniform load (long term)	
Permissible shear stress, τ_{adm} (in N/mm²)	$= \tau_g K_3$	**5.4**
	= 0.8375 N/mm² for uniform load (medium term)	
	or = 1.005 N/mm² for point load	
	or = 0.67 N/mm² for uniform load (long term)	
Recommended deflection limitation w_{max} (in mm)	= 0.003 L	**5.5**
Permissible compression perpendicular to the grain stress $\sigma_{c,\perp,adm}$ (in N/mm²)	$= \sigma_{c,\perp,g}K_3$	**5.6**
	= 2.125 N/mm² for uniform load (medium term)	
	or = 2.55 N/mm² for point load	
	or = 1.70 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:

a) limitation of bending stress, uniform imposed load — L = 3 004 mm (equation 14);
b) limitation of bending stress, point imposed load — L = 4 059 mm (equation 15);
c) limitation of bending stress, long term load alone — L = 4 015 mm (equation 16);
d) limitation of shear stress, uniform imposed load — L = 5 580 mm (equation 22);
e) limitation of shear stress, point imposed load — L = 13 053 mm (equation 23);
f) limitation of shear stress, long term load alone — L = 9 967 mm (equation 24);
g) limitation of deflection, uniform imposed load — L = 2 696 mm (equation 33);
h) limitation of deflection, point imposed load — L = 3 099 mm (equation 34);

The permissible effective span L_{adm} is therefore

L_{adm} = 2 696 mm

The appropriate equation is selected from **5.6** to calculate the notional bearing length, a, as 25 mm.

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

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

L_{cl} = 2 671 mm

Appendix B Specimen span tables for purlins supporting sheeting or decking

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 purlins supporting sheeting or decking, roof slope 30°, uniform snow load 0.75 kN/m²: SC 3[a], regularized sizes[b]

Size of purlin	Dead load (in kN/m²) supported by roof, excluding the self weight of the purlins																	
	Not more than 0.25 (25.5 kg/m²)						More than 0.25 but not more than 0.5 (51 kg/m²)						More than 0.5 but not more than 0.75 (76.5 kg/m²)					
	Centre-to-centre spacing of purlins (in m)																	
	0.90	1.20	1.50	1.80	2.10	2.40	0.90	1.20	1.50	1.80	2.10	2.40	0.90	1.20	1.50	1.80	2.10	2.40
	Permissible clear span																	
mm	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
38 × 72	0.990	0.968	0.949	0.931	0.914	0.899	0.931	0.899	0.871	0.846	0.824	0.804	0.884	0.846	0.814	0.786	0.761	0.739
97	1.503	1.465	1.426	1.350	1.277	1.217	1.392	1.333	1.283	1.239	1.169	1.113	1.307	1.239	1.184	1.137	1.087	1.034
122	2.059	1.953	1.808	1.696	1.605	1.530	1.873	1.782	1.658	1.554	1.469	1.399	1.742	1.642	1.545	1.446	1.366	1.300
147	2.591	2.350	2.176	2.041	1.932	1.842	2.366	2.159	1.996	1.870	1.769	1.684	2.185	2.015	1.861	1.741	1.645	1.565
170	2.991	2.714	2.513	2.358	2.233	2.128	2.753	2.494	2.306	2.161	2.044	1.947	2.574	2.328	2.150	2.013	1.902	1.809
195	3.423	3.108	2.879	2.702	2.559	2.439	3.153	2.857	2.643	2.477	2.343	2.231	2.948	2.667	2.464	2.307	2.180	2.074
220	3.854	3.501	3.244	3.045	2.884	2.750	3.551	3.219	2.978	2.792	2.641	2.516	3.321	3.006	2.778	2.601	2.458	2.339
44 × 72	1.066	1.042	1.020	1.000	0.982	0.954	1.000	0.965	0.934	0.907	0.883	0.861	0.949	0.907	0.872	0.841	0.815	0.791
97	1.617	1.569	1.515	1.421	1.346	1.283	1.489	1.424	1.370	1.303	1.233	1.175	1.396	1.323	1.263	1.213	1.148	1.092
122	2.201	2.054	1.902	1.785	1.691	1.613	1.998	1.888	1.746	1.637	1.549	1.476	1.856	1.748	1.629	1.526	1.442	1.373
147	2.721	2.470	2.289	2.149	2.035	1.941	2.506	2.272	2.102	1.971	1.865	1.777	2.322	2.121	1.961	1.837	1.737	1.653
170	3.140	2.852	2.643	2.482	2.352	2.243	2.893	2.623	2.428	2.277	2.155	2.054	2.706	2.451	2.266	2.122	2.007	1.911
195	3.594	3.266	3.028	2.843	2.695	2.570	3.313	3.005	2.782	2.609	2.470	2.354	3.100	2.808	2.596	2.433	2.301	2.190
220	4.045	3.678	3.411	3.204	3.037	2.897	3.730	3.385	3.135	2.941	2.784	2.654	3.491	3.164	2.926	2.742	2.594	2.470
47 × 72	1.102	1.077	1.054	1.033	1.013	0.976	1.033	0.996	0.964	0.935	0.910	0.888	0.979	0.935	0.899	0.867	0.840	0.815
97	1.668	1.618	1.550	1.455	1.378	1.314	1.535	1.467	1.410	1.334	1.263	1.203	1.437	1.361	1.300	1.248	1.176	1.119
122	2.267	2.101	1.946	1.827	1.731	1.651	2.055	1.932	1.787	1.676	1.587	1.512	1.908	1.797	1.668	1.562	1.478	1.407
147	2.782	2.526	2.341	2.199	2.083	1.987	2.563	2.324	2.151	2.018	1.910	1.820	2.386	2.171	2.007	1.881	1.779	1.694
170	3.209	2.916	2.704	2.539	2.407	2.296	2.958	2.683	2.485	2.331	2.207	2.103	2.768	2.507	2.319	2.173	2.056	1.958
195	3.672	3.339	3.097	2.909	2.757	2.631	3.386	3.073	2.846	2.671	2.529	2.411	3.170	2.873	2.657	2.491	2.356	2.244
220	4.132	3.760	3.488	3.278	3.107	2.966	3.813	3.462	3.207	3.010	2.851	2.718	3.570	3.237	2.995	2.808	2.656	2.530
50 × 72	1.136	1.110	1.086	1.064	1.044	0.998	1.064	1.025	0.992	0.962	0.936	0.913	1.008	0.962	0.924	0.892	0.863	0.838
97	1.717	1.665	1.583	1.486	1.408	1.343	1.578	1.508	1.449	1.364	1.291	1.230	1.477	1.399	1.335	1.271	1.202	1.145
122	2.330	2.145	1.988	1.867	1.769	1.688	2.110	1.973	1.826	1.713	1.622	1.546	1.959	1.844	1.705	1.597	1.511	1.439
147	2.839	2.580	2.392	2.246	2.129	2.031	2.617	2.374	2.198	2.062	1.953	1.861	2.446	2.218	2.052	1.923	1.819	1.733
170	3.275	2.978	2.761	2.594	2.459	2.347	3.020	2.741	2.539	2.382	2.256	2.151	2.827	2.562	2.370	2.222	2.102	2.003
195	3.747	3.408	3.162	2.972	2.818	2.689	3.457	3.139	2.908	2.729	2.585	2.465	3.237	2.935	2.716	2.546	2.410	2.296
220	4.216	3.838	3.562	3.348	3.175	3.031	3.892	3.535	3.276	3.076	2.914	2.779	3.645	3.306	3.060	2.870	2.716	2.588
63 × 147	3.062	2.787	2.586	2.432	2.307	2.203	2.826	2.567	2.380	2.235	2.118	2.021	2.647	2.402	2.224	2.087	1.976	1.884
170	3.530	3.215	2.985	2.808	2.664	2.544	3.260	2.963	2.748	2.582	2.447	2.335	3.055	2.773	2.569	2.411	2.284	2.178
195	4.036	3.678	3.417	3.215	3.051	2.914	3.730	3.392	3.147	2.957	2.804	2.676	3.496	3.175	2.943	2.762	2.617	2.496
220	4.539	4.140	3.848	3.621	3.437	3.284	4.197	3.820	3.545	3.332	3.159	3.016	3.936	3.577	3.315	3.113	2.949	2.813
75 × 195	4.265	3.892	3.620	3.408	3.237	3.094	3.946	3.594	3.338	3.139	2.978	2.844	3.703	3.367	3.123	2.935	2.782	2.655
220	4.793	4.378	4.074	3.838	3.645	3.485	4.438	4.045	3.758	3.535	3.355	3.204	4.167	3.791	3.518	3.306	3.135	2.992

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 5268-7.7. 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.

Table 2 — Permissible clear spans for purlins supporting sheeting or decking, roof slope 30°, uniform snow load 0.75 kN/m²: redwood/whitewood, SS grade, basic sizes[a]

Size of purlin	Dead load (in kN/m²) supported by roof, excluding the self weight of the purlins																	
	Not more than 0.25 (25.5 kg/m²)						More than 0.25 but not more than 0.5 (51 kg/m²)						More than 0.5 but not more than 0.75 (76.5 kg/m²)					
	Centre-to-centre spacing of purlins (in m)																	
	0.90	1.20	1.50	1.80	2.10	2.40	0.90	1.20	1.50	1.80	2.10	2.40	0.90	1.20	1.50	1.80	2.10	2.40
	Permissible clear span																	
mm	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
38 × 75	1.155	1.127	1.102	1.080	1.059	1.009	1.080	1.040	1.006	0.975	0.949	0.925	1.022	0.975	0.936	0.903	0.874	0.848
100	1.722	1.669	1.586	1.488	1.409	1.344	1.581	1.510	1.451	1.365	1.291	1.230	1.479	1.400	1.335	1.271	1.202	1.144
125	2.321	2.138	1.980	1.858	1.760	1.679	2.101	1.965	1.818	1.704	1.613	1.537	1.948	1.833	1.695	1.588	1.502	1.430
150	2.822	2.561	2.373	2.227	2.110	2.013	2.598	2.355	2.179	2.043	1.934	1.843	2.424	2.199	2.033	1.904	1.801	1.715
175	3.286	2.983	2.765	2.596	2.460	2.346	3.027	2.744	2.540	2.382	2.254	2.149	2.831	2.563	2.370	2.220	2.100	1.999
200	3.747	3.404	3.156	2.963	2.808	2.679	3.453	3.132	2.899	2.720	2.575	2.454	3.231	2.926	2.706	2.536	2.398	2.284
225	4.207	3.824	3.546	3.330	3.156	3.012	3.879	3.519	3.258	3.057	2.894	2.759	3.630	3.288	3.041	2.851	2.696	2.568
44 × 75	1.241	1.210	1.183	1.158	1.114	1.063	1.158	1.114	1.076	1.043	1.014	0.974	1.094	1.043	1.000	0.964	0.933	0.905
100	1.843	1.785	1.668	1.566	1.484	1.416	1.688	1.611	1.532	1.437	1.361	1.297	1.577	1.491	1.422	1.340	1.268	1.208
125	2.477	2.247	2.083	1.956	1.853	1.768	2.236	2.067	1.913	1.795	1.700	1.620	2.072	1.931	1.786	1.674	1.584	1.509
150	2.963	2.692	2.495	2.344	2.222	2.120	2.730	2.477	2.293	2.152	2.038	1.943	2.555	2.314	2.141	2.007	1.899	1.810
175	3.449	3.135	2.907	2.731	2.589	2.471	3.179	2.885	2.672	2.508	2.375	2.265	2.976	2.697	2.495	2.340	2.214	2.110
200	3.932	3.576	3.317	3.117	2.956	2.821	3.627	3.293	3.051	2.863	2.712	2.587	3.395	3.078	2.849	2.672	2.529	2.410
225	4.413	4.016	3.727	3.503	3.322	3.171	4.072	3.699	3.428	3.218	3.049	2.908	3.814	3.459	3.202	3.003	2.843	2.709
47 × 75	1.281	1.249	1.220	1.194	1.141	1.088	1.194	1.148	1.109	1.074	1.044	0.997	1.127	1.074	1.030	0.993	0.960	0.931
100	1.900	1.839	1.707	1.603	1.519	1.449	1.738	1.657	1.568	1.471	1.393	1.328	1.623	1.534	1.462	1.372	1.299	1.237
125	2.530	2.298	2.130	2.001	1.897	1.810	2.299	2.114	1.958	1.837	1.740	1.659	2.129	1.976	1.828	1.714	1.622	1.546
150	3.028	2.752	2.552	2.398	2.273	2.170	2.791	2.533	2.346	2.202	2.086	1.989	2.612	2.368	2.191	2.055	1.945	1.853
175	3.524	3.204	2.973	2.794	2.649	2.529	3.250	2.951	2.734	2.566	2.431	2.319	3.043	2.759	2.554	2.395	2.267	2.161
200	4.017	3.655	3.392	3.189	3.024	2.887	3.707	3.367	3.121	2.930	2.776	2.648	3.472	3.149	2.915	2.735	2.589	2.468
225	4.508	4.104	3.810	3.582	3.398	3.245	4.162	3.782	3.506	3.293	3.120	2.977	3.899	3.538	3.276	3.074	2.911	2.775
50 × 75	1.320	1.286	1.256	1.229	1.166	1.112	1.229	1.181	1.140	1.104	1.069	1.019	1.159	1.104	1.059	1.020	0.986	0.950
100	1.954	1.881	1.743	1.637	1.552	1.481	1.786	1.702	1.602	1.503	1.424	1.358	1.666	1.574	1.496	1.403	1.328	1.265
125	2.582	2.346	2.176	2.044	1.938	1.850	2.360	2.159	2.000	1.877	1.778	1.696	2.184	2.018	1.868	1.752	1.658	1.581
150	3.090	2.810	2.606	2.449	2.323	2.217	2.850	2.587	2.397	2.250	2.132	2.034	2.668	2.419	2.239	2.100	1.988	1.895
175	3.596	3.271	3.036	2.853	2.706	2.584	3.318	3.013	2.793	2.622	2.485	2.371	3.107	2.818	2.609	2.448	2.318	2.210
200	4.099	3.731	3.464	3.257	3.089	2.950	3.784	3.438	3.187	2.994	2.837	2.707	3.544	3.216	2.979	2.795	2.647	2.524
225	4.599	4.189	3.890	3.659	3.471	3.315	4.248	3.861	3.581	3.364	3.189	3.043	3.980	3.613	3.347	3.142	2.975	2.837
63 × 150	3.332	3.033	2.817	2.650	2.515	2.402	3.076	2.796	2.594	2.437	2.311	2.206	2.882	2.617	2.425	2.277	2.158	2.059
175	3.874	3.530	3.280	3.086	2.929	2.799	3.579	3.256	3.021	2.840	2.693	2.571	3.355	3.048	2.826	2.654	2.515	2.400
200	4.413	4.024	3.741	3.521	3.343	3.194	4.080	3.714	3.447	3.241	3.074	2.935	3.826	3.478	3.225	3.029	2.871	2.740
225	4.949	4.516	4.200	3.954	3.755	3.589	4.578	4.169	3.872	3.641	3.454	3.299	4.295	3.906	3.623	3.404	3.227	3.080
75 × 200	4.661	4.257	3.961	3.731	3.545	3.389	4.315	3.932	3.654	3.438	3.263	3.118	4.050	3.686	3.421	3.216	3.051	2.913
225	5.224	4.775	4.445	4.189	3.981	3.807	4.839	4.414	4.103	3.861	3.666	3.503	4.545	4.139	3.843	3.613	3.428	3.273

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 5268-7.7. 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.

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

Size of purlin	Dead load (in kN/m²) supported by roof, excluding the self weight of the purlins																	
	Not more than 0.25 (25.5 kg/m²)						More than 0.25 but not more than 0.5 (51 kg/m²)						More than 0.5 but not more than 0.75 (76.5 kg/m²)					
	Centre-to-centre spacing of purlins (in m)																	
	0.90	1.20	1.50	1.80	2.10	2.40	0.90	1.20	1.50	1.80	2.10	2.40	0.90	1.20	1.50	1.80	2.10	2.40
	Permissible clear span																	
mm	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
38 × 140	2.502	2.268	2.099	1.968	1.863	1.776	2.264	2.083	1.925	1.803	1.705	1.623	2.093	1.943	1.794	1.679	1.586	1.508
184	3.279	2.974	2.753	2.583	2.446	2.331	3.017	2.732	2.526	2.367	2.239	2.132	2.820	2.550	2.355	2.204	2.082	1.981
235	4.173	3.788	3.509	3.293	3.118	2.973	3.843	3.482	3.221	3.019	2.855	2.719	3.593	3.251	3.003	2.811	2.656	2.527
285	5.043	4.582	4.246	3.986	3.776	3.600	4.648	4.214	3.899	3.656	3.458	3.294	4.348	3.935	3.637	3.405	3.218	3.062

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 5268-7.7. 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 NLGA rules. (The similar ALS sizes are graded in the USA in accordance with NGRDL rules).

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

[a] CLS sizes are given in BS 4471.

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Publications referred to

BS 648, *Schedule of weights of building materials.*
BS 4471, *Specification for sizes of sawn and processed softwood.*
BS 4978, *Specification for softwood 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, *Code of practice for trussed rafter roofs.*
BS 5268-7.1, *Domestic floor joists*[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 5268-7.5, *Rafters*[2)].
BS 5268-7.6, *Purlins supporting rafters*[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 of solid timber.*
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, *Bases for design of structures — Notations — General symbols.*
CIB-W18-1, *Symbols for use in structural timber design*[3)].
NLGA 1979, *The national grading rules for dimension lumber*[4)].
NGRDL 1975, *The national grading rules for softwood dimension lumber (USA).*

[2)] Referred to in the foreword only.

[3)] Available from the International Council for Building Research studies and Documentation, Post Box 20704, 3001 JA Rotterdam, The Netherlands.

[4)] Available from the National Lumber Grades Authority, 1450-1055 West Hastings Street, Vancouver, British Colombia, Canada V6E 2GS.

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