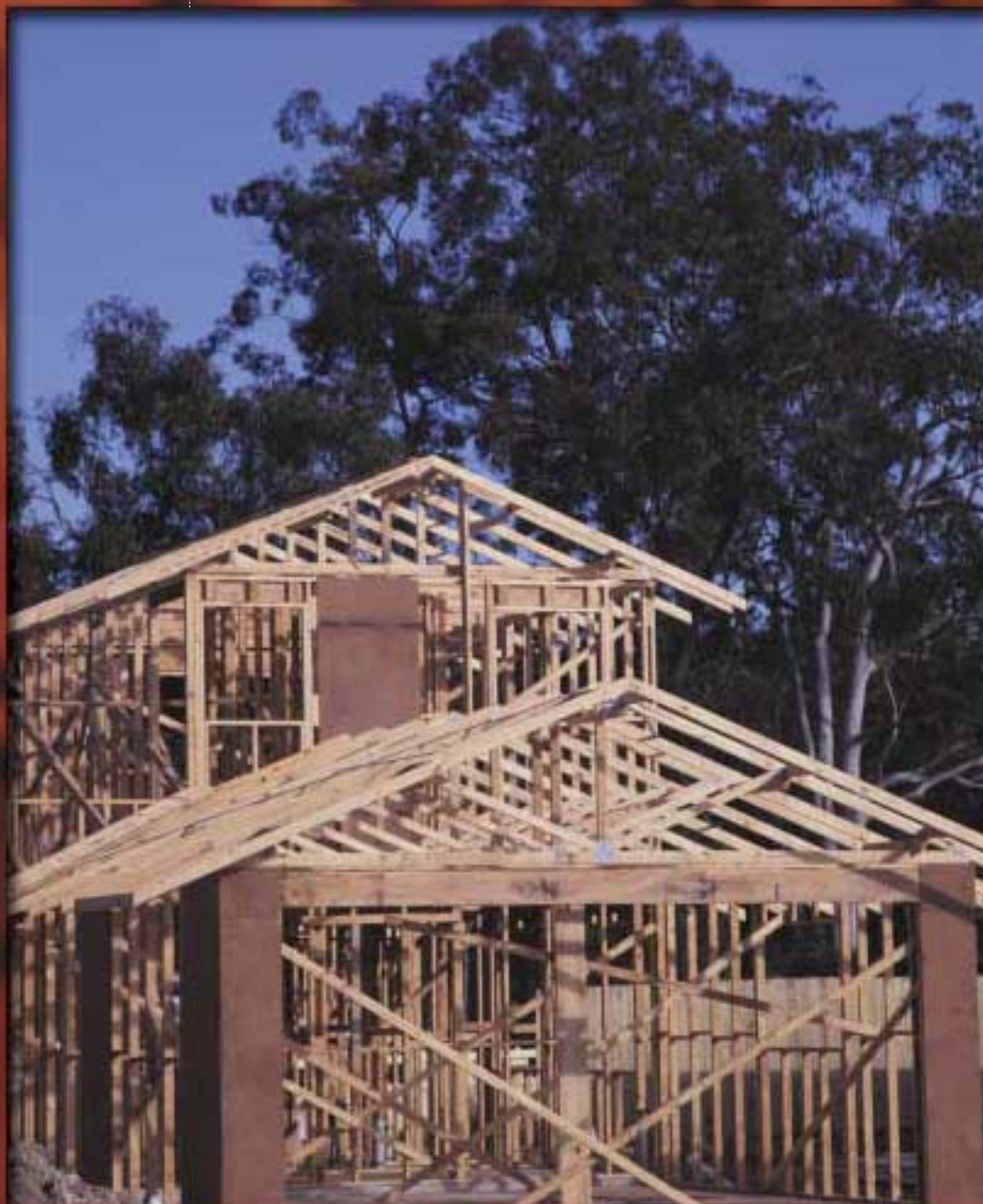


AS 1684.1—1999 *Residential timber-framed construction*



Part 1

Design criteria

(Incorporating Amendment No.1)



Standards Australia



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Australian Standard™

Residential timber-framed construction
Part 1: Design criteria

First published as AS 1684.1—1999.
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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee TM/1, Timber Structures.

This Standard incorporates Amendment No. 1 (February 2002). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure, or part thereof affected.

This Standard is the result of a consensus of representatives on the Joint Committee that it be produced as an Australian Standard.

The objective of this Standard is to provide users with the design methods, assumptions and other design criteria, which have been used in the preparation of the Span Tables, uplift forces and racking pressures contained within AS 1684.2, AS 1684.3 and AS 1684.4.

Continued development of timber framing systems and the need to cater for a widening variety of materials and design conditions have led to a total revision of structural framing design. These developments include —

- (a) provision for limit state design methods;
- (b) revised/new structural grades for timber;
- (c) provisions catering for open plan living—larger spans, wider openings and bigger rooms, which need a more rational approach to bracing design;
- (d) special ‘engineered’ and fabricated timber products;
- (e) recognition of a wider range of high wind and cyclonic design; and
- (f) computer-aided design software for member sizes, bracing and tie-down.

This Standard is a companion publication to the following:

AS	
1684	Residential timber-framed construction
1684.2	Part 2 Non-cyclonic areas
1684.3	Part 3 Cyclonic areas
1684.4	Part 4 Simplified—Non-cyclonic areas

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies, A ‘normative’ appendix is an integral part of a Standard.

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STANDARDS AUSTRALIA

Australian Standard

Residential timber-framed construction

Part 1: Design criteria

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE AND APPLICATION

1.1.1 Scope

This Standard sets out the design methods, assumptions and other criteria used in the preparation of the Span Tables, uplift forces and racking pressures contained within AS 1684.2, AS 1684.3 and AS 1684.4.

The design criteria apply for the preparation of design data for traditional timber-framed construction where the loading and performance requirements correspond to those for Class 1 and Class 10 buildings as defined by the Building Code of Australia.

This Standard should be read in conjunction with AS 1684.2, AS 1684.3 and AS 1684.4, the AS 1170 series, and AS 1720.1.

NOTE: Whilst this Standard may be used as a reference for the design of Class 10 buildings, less conservative levels of design for this building class may be permitted by building regulations and other Australian Standards.

1.1.2 Application

The design criteria contained herein may be used as a basis for the preparation of Span Tables and design data for structural wood products, having stress grades and sizes other than those included in AS 1684.2, AS 1684.3 and AS 1684.4 where the application and performance are claimed to be consistent with AS 1684.2, AS 1684.3 and AS 1684.4.

NOTE: The use of the design criteria contained in this Standard may provide evidence of satisfactory safety and serviceability performance.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1170	Minimum design loads on structures (known as the SAA Loading Code)
1170.1	Part 1: Dead and live loads and load combinations
1170.2	Part 2: Wind loads
1170.3	Part 3: Snow loads
1170.4	Part 4: Earthquake loads
1684	Residential timber-framed construction
1684.2	Part 2: Non-cyclonic areas
1684.3	Part 3: Cyclonic areas
1684.4	Part 4: Simplified —Non-cyclonic areas
1720	Timber structures
1720.1	Part 1: Design methods

AS

4055 Wind loads for housing

CSIRO Low-rise domestic and similar framed structures
Part 1: Design criteria (revised 1978)

1.3 OTHER METHODS

This Standard does not preclude the use of other methods of design, other assumptions or criteria for design or any other means of demonstrating satisfactory safety and serviceability performance.

1.4 BASIS FOR DESIGN

1.4.1 General

The design criteria contained in this Standard are an interpretation of the AS 1170 series, and AS 1720.1. The criteria have been formulated for the preparation of generalized design data for houses constructed using the traditionally evolved timber framing system as described in AS 1684.2, AS 1684.3 and AS 1684.4. The design criteria are based upon the assumptions described in Clauses 1.4.2 to 1.4.11 below.

1.4.2 Geometric limitations

The following geometric limitations for houses have been assumed:

- (a) The overall width at any section, excluding eaves and lean-to verandahs but including verandahs under the main roof, does not exceed 16.0 m.
- (b) The roof pitch does not exceed 35°.
- (c) Roof shapes may be skillion or gable, hip or gable ended or any combination of these.
- (d) The number of trafficable floors supported by timber framing does not exceed two.
- (e) Wall height, measured from floor to ceiling, does not exceed 3.0 m.

NOTE: For further definitions of these limitations refer to AS 1684.2, AS 1684.3 and AS 1684.4.

1.4.3 Design methods

The design methods used are based upon analytical and engineering principles and comply with the requirements of AS 1720.1.

1.4.4 System-based assumptions

The design criteria include many system-based assumptions, which recognize the interactions between structural elements and other elements of the overall construction system. These assumptions are based upon the methods of assembly and materials given in AS 1684.2, AS 1684.3 and AS 1684.4.

NOTE: Changes in materials (both structural and non-structural) and the use of installation methods other than those given in AS 1684.2, AS 1684.3 and AS 1684.4, may invalidate the system-based assumptions contained in this Standard.

1.4.5 Durability

The structural design criteria have been developed on the assumption that materials used and their installation and maintenance ensure that components will fulfil their intended structural function for the intended life of the structure.

NOTE: In the selection of materials, specific consideration should be given to the risk of and resistance to biological attack and corrosion, long-term durability of adhesives and the long-term strength and rigidity of materials taking into account the short-term and long-term conditions of exposure.

1.4.6 Structural timber

Member design for Span Tables in AS 1684.2, AS 1684.3 and AS 1684.4, is based upon the use of generic stress grades of scantling timber.

NOTE: For other materials, the design procedures and assumptions may require modification in accordance with the requirements of AS 1720.1.

1.4.7 Design properties

The design properties given in AS 1720.1 for stress grades and strength groups have been used for design, except for F-grades the characteristic beam shear strengths given in Appendix A have been used.

1.4.8 Effect of temperature on strength

The modification factor for the effect of temperature on strength (k_6) has been taken as unity regardless of location.

1.4.9 Design loads

1.4.9.1 Dead loads

Dead loads are based upon standardized allowances for the mass of roof, wall and floor constructions.

NOTE: Where mass allowances different from those referred in the Standard are used, then such variation should be noted in any published data.

1.4.9.2 Live loads

Generally, the live loads used for design correspond to those given in AS 1170.1. The following departures and interpretations have been used:

- (a) The partial-area live load for floor areas less than 10 m² is not considered.
- (b) The permanent component of floor live load is taken as 0.5 kPa.
- (c) To allow for balconies or decks 1 m or more above the ground, the cantilevered portion of floor joists and bearers and the main spans of floor joists and bearers for decks are designed for 3.0 kPa floor live load for the strength limit states and 1.5 kPa for the serviceability limit state.
- (d) The area used to calculate the distributed roof live load resultant from stacked materials or equipment used in repair or maintenance is taken as the area supported in the plane of the roof and not the plan projected area.
- (e) The occasional loading on roof and ceiling members is taken as 1.1 kN.

NOTE: Live loads specific to construction, for example, loads resulting from the use of fall protection devices or scaffolding attached to the structure, are not considered.

1.4.9.3 Wind loads

The free stream dynamic pressures for the strength limit state and the serviceability limit state are derived using AS 1170.2 for design wind speeds corresponding to wind classifications N1 to N4 and C1 to C3 as specified in Appendix B.

1.4.9.4 Snow loads

Snow loads, determined in accordance with AS 1170.3, up to 0.2 kPa have been considered and determined as not critical. For this reason, snow loading is not included in the load combinations given for member design in this Standard.

1.4.9.5 Earthquake loads

Earthquake loads for earthquake load categories H1 and H2, that is for domestic structures, have been determined in accordance with AS 1170.4 and found not critical for design. For this reason, earthquake loads are not included in the load combinations given for member design or for the methods of determination of racking loads in AS 1684.2 and AS 1684.3.

1.4.9.6 Load combinations

Load combinations included for the determination of the strength limit states and the serviceability limit states for each member are those determined appropriate in accordance with AS 1170.1.

1.4.10 Strength limit states

For each member, all strength limit states have been considered; however, only those strength limit states deemed as potentially critical are included in the design criteria.

NOTE: For other timber-based products, design may require consideration of strength limit states other than those included in this Standard.

1.4.11 Serviceability limit states

The serviceability limit states used for the design have been determined on the basis of experience with the known serviceability performance of individual member types in typical applications. Serviceability limits used are intended to provide satisfactory rigidity for average situations.

NOTES:

- 1 For installations where greater than usual rigidity may be required, then it is anticipated that larger sizes and or materials with higher or more uniform modulus of elasticity will be used (see AS 1720.1).
- 2 The limits on deflection used as part of the definition of the serviceability limit states are limits intended for comparison with calculated deflections only. Actual or measured deflections may differ from calculated deflections due to any or all of the following factors:
 - (a) Differences between actual loads and design loads used for serviceability calculations.
 - (b) Differences between the actual modulus of elasticity of components and the average value used for design.
 - (c) Differences between the structural behaviour of the system and the structural models used for design.

1.5 DEFINITIONS

For the purpose of this Standard, the following definitions apply.

1.5.1 Balcony

An external trafficable floor area of a house including a deck that is 1 m or more above ground level.

1.5.2 Birdsmouth

A triangular notch cut into the underside of a sloping beam (e.g. rafter) to permit seating on the supporting member.

1.5.3 Bracing

An assembly intended to resist racking forces including diagonal members, shear panels, diaphragms, cantilevered columns or portal (rigid) frames.

1.5.4 Cladding

Material used for the external surface of walls or roofs.

1.5.5 Flooring or decking

Boards or sheets overlying floor joists intended to support floor loads. Flooring is usually tongue and groove jointed along the edges whereas decking is not.

1.5.6 Generic stress grades

Stress grades for which properties are included in AS 1720.1.

1.5.7 Lining

The materials used for the internal faces of walls or ceilings.

1.5.8 Loadbearing walls

Walls required to support vertical loads from roofs and/or floors.

NOTE: This definition differs from that given in the Building Code of Australia.

1.5.9 Nogging

A horizontal member fitted between studs in a wall frame which restrains the studs against buckling in the plane of the wall. Noggings may also be used for attachment of cladding or lining or as part of a bracing system.

1.5.10 Non-loadbearing walls

Partition walls not supporting roofs or floors. Non-loadbearing walls may support ceilings.

NOTE: This definition differs from that given in the Building Code of Australia.

1.5.11 Sheet roofing

Includes sheet metal tile panels and other metal deck roofing of mass up to 10 kg/m^2 .

1.5.12 Span

The face to face distance between supports of a structural member measured along the axis of the member.

NOTES:

- 1 This definition differs from that given in AS 1720.1
- 2 Truss spans have traditionally been measured from outside to outside of pitching plates.

1.5.13 Standard roof truss

An engineered, triangulated framework installed at similar centres to rafters and designed to transfer roof and ceiling loads, usually, to external walls.

1.5.14 Tie-down

The connections or fixings designed to resist uplift forces due to wind.

1.5.15 Tiled roofing

Includes slate, terracotta and concrete tiles of mass up to 60 kg/m^2 .

1.5.16 Wall/brick tie

A bracket connecting brick cladding to a timber wall frame.

1.6 NOTATION

Generally, the notation used in AS 1720.1 and the AS 1170 series is used also in this Standard. Notation specific to each clause is defined in that clause. Some general notation symbols used in this Standard are as follows:

b = breadth of member

CLW = ceiling load width

d	=	depth of member
FLW	=	floor load width
K_c	=	pressure combination factor (see Section 6)
L	=	general symbol used for span
L_o	=	horizontal span for rafter overhang
P	=	general symbol for concentrated load
RLW	=	roof load width
S	=	general symbol used for spacing
w	=	general symbol for distributed load

SECTION 2 DESIGN OF ROOF MEMBERS

2.1 ROOF BATTENS

2.1.1 Description

A roof batten is a rectangular section used on its flat to provide direct support for sheet or tile roofing. Spans for roof battens are limited to 1200 mm. For tile roofs a standard spacing of 330 mm is considered whereas for sheet roofs, spacings up to 1200 mm are included.

Battens are assumed to span continuously over rafters (or trusses) for at least two spans (see Figure 2.1).

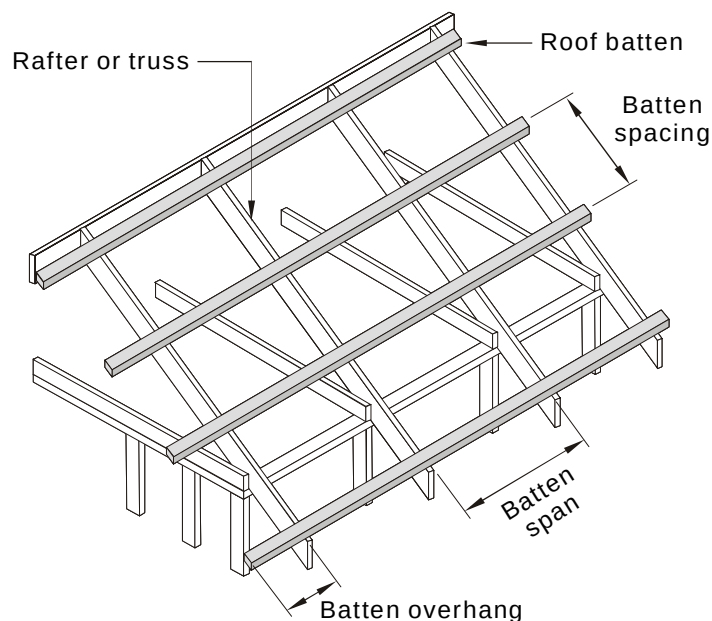


FIGURE 2.1 ROOF BATTENS

2.1.2 Design for Safety

2.1.2.1 General consideration

Design for safety includes consideration of the strength limit states for bending about the minor axis only and shear.

NOTE: Battens are assumed to be prevented from bending in the plane of the roof by the attached cladding.

2.1.2.2 Loads

The loads used for the determination of the design action effects are determined as follows:

- (a) *Dead loads (G)* Dead loads, corresponding to the typical roof constructions, are determined as in Table 2.1.1.

TABLE 2.1.1
DEAD LOAD FOR ROOF BATTENS

Roof type	Dead load, G (kN/m)
Sheet roof	$0.1S + \text{self weight}$
Tile roof	$0.6S + \text{self weight}$

NOTE: S = spacing of roof battens, in metres.

- (b) *Live loads* The uniformly distributed live load, Q_1 (in kN/m), and concentrated live loads, Q_2 and Q_3 (both in kN), used for design are obtained as follows:

$$(i) \quad Q_1 = g_{44} \times (0.9/L + 0.12S) \quad \dots 2.1.2(1)$$

$$(ii) \quad Q_2 = g_{44} \times 1.1 \quad \dots 2.1.2(2)$$

$$(iii) \quad Q_3 = g_{45} \times 1.1 \quad \dots 2.1.2(3)$$

where

g_{44} = the lesser of 1.33S and 1.0

L = span of roof battens, in metres

S = spacing of roof battens, in metres

and

g_{45} is calculated in accordance with Paragraph B3, Appendix B, assuming a bargeboard of rigidity $E_f I_f = 18 \times 10^9 \text{ Nmm}^2$ is attached to the ends of the parallel overhanging battens, and $g_{47} = 1.0$ (i.e. no birdsmouth notch).

NOTES:

- 1 The formula for distributed live load is derived from the formula for roof live load given in AS 1170.1, where the plan area is taken as $2LS$ and is always less than 14 m^2 for the spans and spacings considered.
- 2 The load distribution factor g_{44} is taken from CSIRO, *Low-rise domestic and similar framed structures* (see Clause 1.2). The use of this load distribution factor is based upon construction workers following the traditional practice of not treading at or near midspan of closely spaced battens prior to the installation of roof claddings.

- (c) *Wind load* The wind load, W_u (in kN/m), applicable for the strength limit state, is calculated as follows:

$$W_u = q_u C_{pt} S \quad \dots 2.1.2(4)$$

where

q_u = free stream dynamic gust pressure, in kPa, for the ultimate limit state; values of q_u are given in Table B2, Appendix B, for each wind classification

C_{pt} = net pressure coefficients given in Table 2.1.2

S = spacing of roof battens, in metres

TABLE 2.1.2
NET PRESSURE COEFFICIENTS FOR ROOF BATTENS

Wind classification	C_{pt}	
	General areas	Areas within 1.2 m of an edge
N1 to N4	+0.7, -1.1	-2.0
C1 to C3		

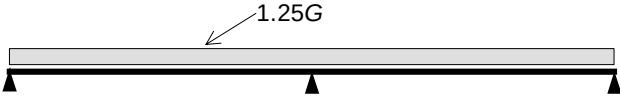
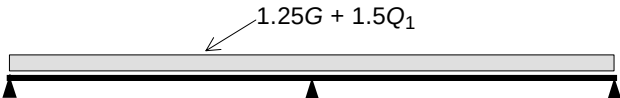
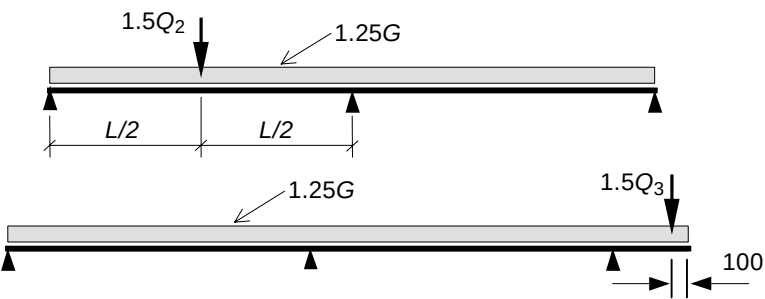
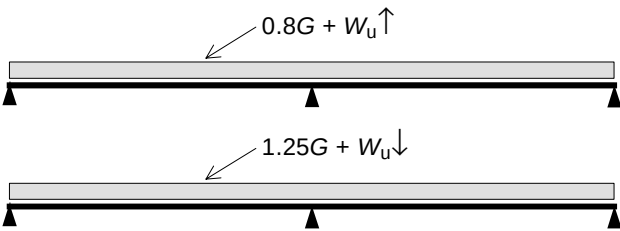
NOTES:

- 1 Local pressure effects are catered for in AS 1684.2, AS 1684.3 and AS 1684.4 by notes attached to Span Tables specifying reductions in batten spacing near edges, as appropriate.
- 2 Values given in this Table are based on the assumption that a separate ceiling is provided and a maximum internal pressure coefficient (C_{pi}) in the roof cavity of +0.2 for both cyclonic and non-cyclonic regions.

2.1.2.3 Structural models and load categories for strength design

The structural models used to calculate the member design action effects are given in Table 2.1.3. Load combinations shown in Table 2.1.3 are divided into load categories that are used for the determination of member design capacity as specified in Clause 2.1.2.4.

TABLE 2.1.3
STRUCTURAL MODELS AND LOAD CATEGORIES — STRENGTH

Load category	Structural model
1	
2	
3	
4	

2.1.2.4 Member design capacity

The requirements of AS 1720.1 are applied to determine member design capacities in bending and shear. The following assumptions and modification factors are used:

- (a) *Load duration factor* The member design capacity includes the modification factor for load duration (k_1). Values of k_1 appropriate for each load category are given in Table 2.1.4.

TABLE 2.1.4
LOAD DURATION FACTORS FOR STRENGTH

Load category	Load duration factor (k_1)
1	0.57
2	0.94
3	1.00
4	1.15

- (b) *Moisture content of timber:*
- (i) *Unseasoned timber*—for load category 3 given in Table 2.1.3, values of k_4 appropriate for thickness as specified in AS 1720.1 are used. For load categories 1 and 2, $k_4 = 1.0$.
 - (ii) *Seasoned timber*— $k_4 = 1.0$ for all load categories.
- (c) *Member restraint* For battens, breadth is greater than or equal to depth and, hence, the lateral stability factor $k_{12} = 1.0$.

2.1.3 Design for serviceability

2.1.3.1 Loads

The loads used for the serviceability limit states are given as follows:

- (a) *Dead load (G)* Dead loads corresponding to various typical roof constructions are determined as in Table 2.1.1.
- (b) *Wind load* The uniformly distributed wind load, W_s (in kN/m), applicable for the serviceability limit state is calculated as follows:

$$W_s = q_s C_{pt} S \quad \dots 2.1.3$$

where

q_s = free stream dynamic gust pressure, in kPa, for the serviceability limit state; values of q_s are given in Table B2, Appendix B, for each wind classification

C_{pt} = net pressure coefficients given in Table 2.1.2

S = spacing of roof battens, in metres

2.1.3.2 Structural models and load categories for serviceability design

The structural models for which deflections are calculated are given in Table 2.1.5. Load cases included in Table 2.1.5 are divided into load categories for the purpose of allowing for the effect of duration of load on stiffness as specified in Clause 2.1.3.3.

TABLE 2.1.5
STRUCTURAL MODELS AND LOAD CATEGORIES — SERVICEABILITY

Load category	Structural models
1	
2	

2.1.3.3 Calculation of deflection

The requirements of AS 1720.1 for the calculation of deformation are applied using the duration of load factor for creep deformation as given in Table 2.1.6.

TABLE 2.1.6
LOAD DURATION FACTORS FOR DEFORMATION

Moisture content	Load duration factor (j_2)	
	Load category 1 (permanent loads)	Load category 2 (transient loads)
Seasoned	2.0	1.0
Unseasoned	3.0	1.0

2.1.3.4 Serviceability limits

The limits on deflection defining the serviceability limit state are given in Table 2.1.7.

TABLE 2.1.7
LIMITS ON DEFLECTION

Load category	Deflection limits	
	Midspan	End of overhang
1	Span/300	Overhang/150* or 4 mm whichever is greater
2	Span/150	No limitation

* Ignore limit for upwards deflection

2.2 RAFTERS

2.2.1 Description

Rafters are roof members which run parallel to the fall of the roof and support roof battens or purlins. They may also support ceilings, either directly or via ceiling battens or joists.

Rafters may be either single span or continuous span and may be cantilevered to form an eaves overhang either with or without a birdsmouth notch at the overhang support. Continuous span rafters are assumed not notched at intermediate supports.

For the determination of the maximum overhang the ends of rafters are assumed rigidly connected to a fascia which acts to share any concentrated or partial area loads to adjacent members (see Figure 2.2).

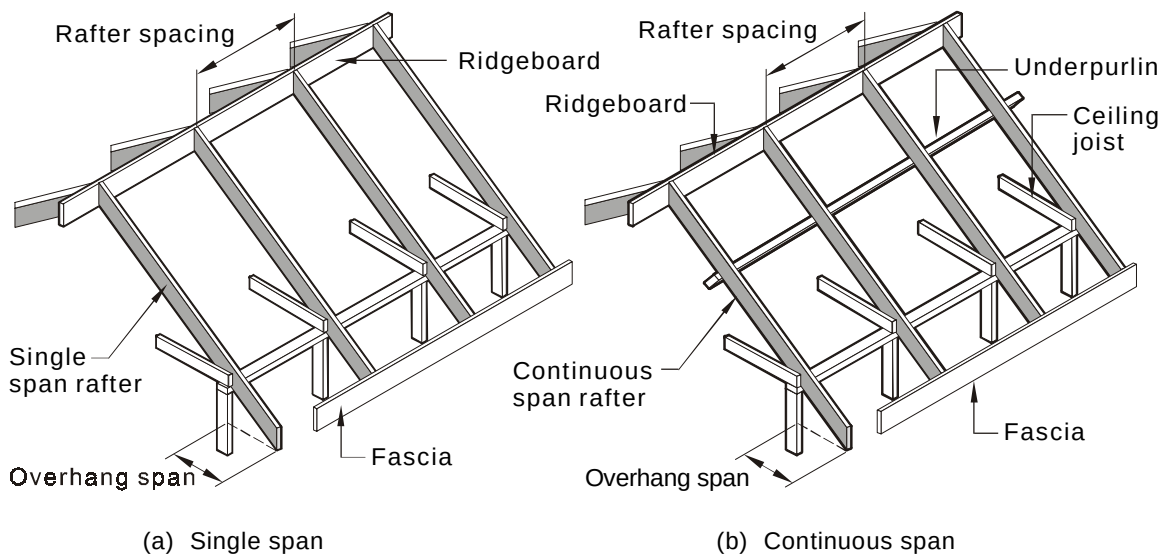


FIGURE 2.2 RAFTERS

2.2.2 Design for safety

2.2.2.1 General consideration

Design for safety includes consideration of the strength limit states for bending and shear. In addition, for birdsmouth notches associated with overhangs, the interaction of bending and shear is also considered.

2.2.2.2 Loads

The loads used for the determination of the design action effects are determined as follows:

- (a) *Dead loads (G)* Dead loads, corresponding to various typical roof constructions, are determined as in Table 2.2.1.

TABLE 2.2.1
DEAD LOAD

Roof type	Dead load, G (kN/m)
Sheet roof only	$0.1S + \text{self weight}$ $0.2S + \text{self weight}$
Sheet roof and ceiling	$0.4S + \text{self weight}$
Tile roof only	$0.6S + \text{self weight}$
Tile roof and ceiling	$0.9S + \text{self weight}$

NOTE: S = spacing of rafters, in metres.

- (b) *Live loads* The distributed live loads, Q_1 , Q_2 and Q_3 (in kN/m), and concentrated live loads Q_4 and Q_5 (in kN), are determined as follows:

$$(i) \quad Q_1 = g_{43} \left(\frac{1.8}{L} + 0.12S \right) \text{ or } 0.25S, \text{ whichever is greater} \quad \dots 2.2.2(1)$$

$$(ii) \quad Q_2 = g_{43} \left(\frac{0.9}{L} + 0.12S \right) \text{ or } 0.25S, \text{ whichever is greater} \quad \dots 2.2.2(2)$$

$$(iii) \quad Q_3 = g_{45} \left(\frac{1.8}{L_o} + 0.12S \right) \text{ or } 0.25S, \text{ whichever is greater} \quad \dots 2.2.2(3)$$

$$(iv) \quad Q_4 = g_{42} \times 1.1 \quad \dots 2.2.2(4)$$

$$(v) \quad Q_5 = g_{45} \times 1.1 \quad \dots 2.2.2(5)$$

where,

L = span of rafters, in metres

S = spacing of rafters, in metres

L_o = horizontal span of rafter overhang, in metres

g_{45} = load distribution factor for parallel rafter overhangs, calculated as detailed in Appendix C for the case where the depth of the birdsmouth notch is one third of the rafter depth and a fascia of minimum rigidity $86 \times 10^9 \text{ Nmm}^2$ is attached to the end of each rafter

g_{42}, g_{43} = are the load distribution factors for concentrated load and partial area load, respectively, applied to a grid system, calculated in accordance with AS 1720.1, assuming the crossing members are battens with rigidity and spacing as follows:

(1) *Sheet roofs*: $E_c I_c = 2.7 \times 10^9 \text{ Nmm}^2$, and spacing = 1200 mm.

(2) *Tile roofs*: $E_c I_c = 380 \times 10^6 \text{ Nmm}^2$, and spacing = 330 mm.

- (c) *Wind loads* The wind load, W_u (in kN/m), applicable for the strength limit state is calculated as follows:

$$W_u = q_u C_{pt} S \quad \dots 2.2.2(6)$$

where

q_u = free stream dynamic gust pressure, in kPa, for the ultimate limit state; values of q_u are given in Table B2, Appendix B, for each wind classification

C_{pt} = net pressure coefficients given in Table 2.2.2

S = spacing of rafters, in metres

TABLE 2.2.2
NET PRESSURE COEFFICIENTS FOR RAFTERS—STRENGTH

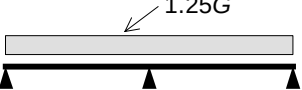
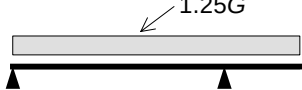
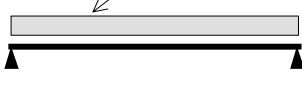
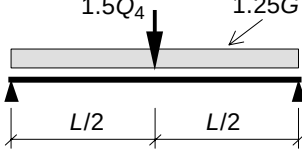
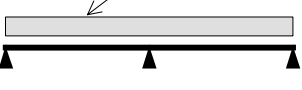
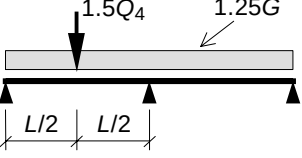
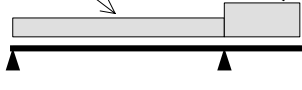
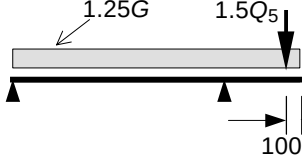
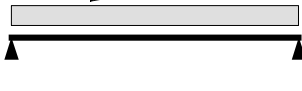
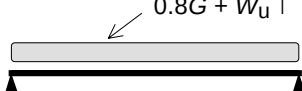
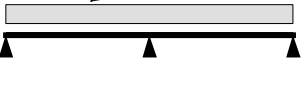
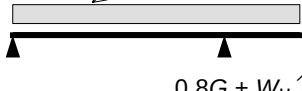
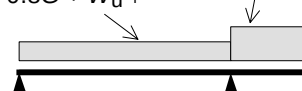
Wind classification	C_{pt}	
	Main spans	Overhang
N1 to N4	+0.56 or -1.1	+0.56 or -1.6
C1 to C3	+0.72 or -1.6	+0.72 or -1.6

NOTE: The positive net pressure coefficients include the pressure combination factor $K_c = 0.8$, which allows for the combined effect of positive wind pressure on the roof and negative internal pressure.

2.2.2.3 Structural models and load categories for strength design

The structural models used to calculate the member design action effects are given in Table 2.2.3. Load combinations shown in Table 2.2.3 are divided into load categories that are used for the determination of member design capacity as specified in Clause 2.2.2.4.

TABLE 2.2.3
STRUCTURAL MODELS AND LOAD CATEGORIES — STRENGTH

Load category	Structural model		
	Single span	Continuous span	Overhang
1			
2	 	 	 
3	 	 	 

2.2.2.4 Member design capacity

The requirements of AS 1720.1 are applied to determine member design capacities in bending and shear. In addition, for birdsmouth notches associated with rafter overhangs, the procedures given in Appendix C are applied, assuming the notch depth is one third of the rafter depth. The following assumptions and modification factors are used:

- (a) *Load duration factor* The member design capacity includes the modification factor for load duration (k_1). Values of k_1 appropriate for each load category, as defined in Table 2.2.3, are given in Table 2.2.4.

TABLE 2.2.4
LOAD DURATION FACTORS FOR STRENGTH

Load category	Load duration factor (k_1)
1	0.57
2	0.94
3	1.15

- (b) *Moisture content of timber:*
- (i) *Unseasoned timber*—for load category 3 given in Table 2.2.3, values of k_4 appropriate for thickness as specified in AS 1720.1 are used. For load categories 1 and 2, $k_4 = 1.0$.
 - (ii) *Seasoned timber*— $k_4 = 1.0$ for all load categories.
- (c) *Strength sharing* For scantling timber, the strength sharing factor (k_9) has been determined as follows:
- (i) For the determination of the maximum main spans, k_9 has been determined in accordance with AS 1720.1, assuming $n_{\text{mem}} = 5$ and $n_{\text{com}} = 1$ (for single members).
 - (ii) For the determination of maximum overhangs and for negative moment only, in accordance with Appendix C—

$$k_9 = 1.24 - 0.24 (S/L_o), \text{ but not less than } 1.0 \quad \dots 2.2.2(7)$$
 where

$$S = \text{spacing of rafters}$$

$$L_o = \text{horizontal span of the overhang}$$
- (d) *Member restraint* For the determination of bending capacity the following assumptions related to lateral restraint are used:
- (i) *At supports*—rafters are assumed torsionally restrained at their supports.
 - (ii) *Between supports*—
 - (A) the top edges of rafters are assumed laterally restrained by battens or purlins at 330 mm centres for tile roofs and 1200 mm centres for sheet roofs; and
 - (B) *in addition*, continuous span rafters are assumed restrained against torsional buckling at the points of contraflexure taken as one quarter of the span from the intermediate support.

2.2.3 Design for serviceability

2.2.3.1 Loads

The loads used for the purpose of assessing the serviceability limit states are given as follows:

- (a) *Dead loads and live loads* Dead loads and live loads are determined as described in Clause 2.2.2.2.
- (b) *Wind loads* The uniformly distributed wind load, W_s (in kN/m), applicable for the serviceability limit state is calculated as follows:

$$W_s = q_s C_{\text{pt}} S \quad \dots 2.2.3$$

where

q_s = free stream dynamic gust pressure, in kPa, for the serviceability limit state; values of q_s are given in Table B2, Appendix B, for each wind classification

C_{pt} = net pressure coefficients given in Table 2.2.5

S = spacing of rafters, in metres

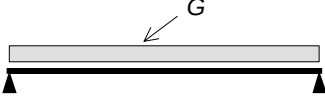
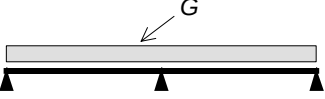
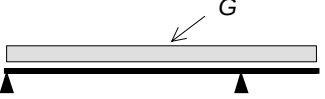
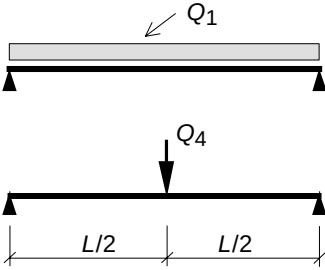
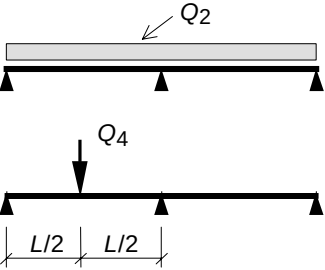
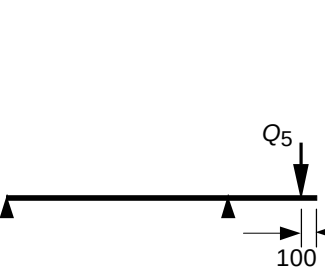
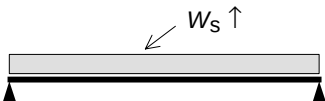
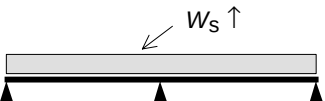
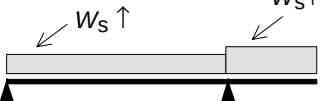
TABLE 2.2.5
NET PRESSURE COEFFICIENTS FOR RAFTERS—SERVICEABILITY

Wind classification	C_{pt}	
	Main spans	Overhangs
N1 to N4 and C1 to C3	−1.1	−1.6

2.2.3.2 Structural models and load categories for serviceability design

The structural models for which deflections are calculated are given in Table 2.2.6. Load cases included in Table 2.2.6 are divided into load categories for the purpose of allowing for the effect of duration of load on stiffness, as specified in Clause 2.2.3.3.

TABLE 2.2.6
STRUCTURAL MODELS AND LOAD CATEGORIES—SERVICEABILITY

Load category	Structural model		
	Single span	Continuous span	Overhang (cantilevered)
1			
2			
3			

2.2.3.3 Calculation of deflection

The requirements of AS 1720.1 for the calculation of deflection are applied using the duration of load factor for creep deformation as given in Table 2.2.7. In addition, the deflection at the ends of overhangs for birdsmouth-notched rafters is determined using the modified rafter rigidity given in Appendix C.

2.2.3.4 Serviceability limits

The limits on deflection, defining the serviceability limit state, are given in Table 2.2.8.

TABLE 2.2.7
LOAD DURATION FACTORS FOR DEFORMATION

Moisture content	Load duration factor (j_2)	
	Load category 1	Load category 2 or 3
Seasoned	2.0	1.0
Unseasoned	3.0	1.0

TABLE 2.2.8
LIMITS ON DEFLECTION

Load category	Deflection limits	
	Midspan	End of overhang
1	Span/300	10 mm
2	Span/250	10 mm
3	Span/150	10 mm

2.3 ROOF BEAMS—RIDGE OR INTERMEDIATE BEAMS

2.3.1 Description

Ridge or intermediate beams are roof beams that support rafters, which in turn support roof or roof and ceiling loads. Roof beams run perpendicular to the slope of the roof, either single or continuous span and may cantilever to support a verge overhang. Overhang spans are determined assuming roof beams are not notched at the overhang support.

For the purpose of determining lateral stability, roof beams are assumed to be laterally restrained by rafters fixed to their top edge (see Figure 2.3).

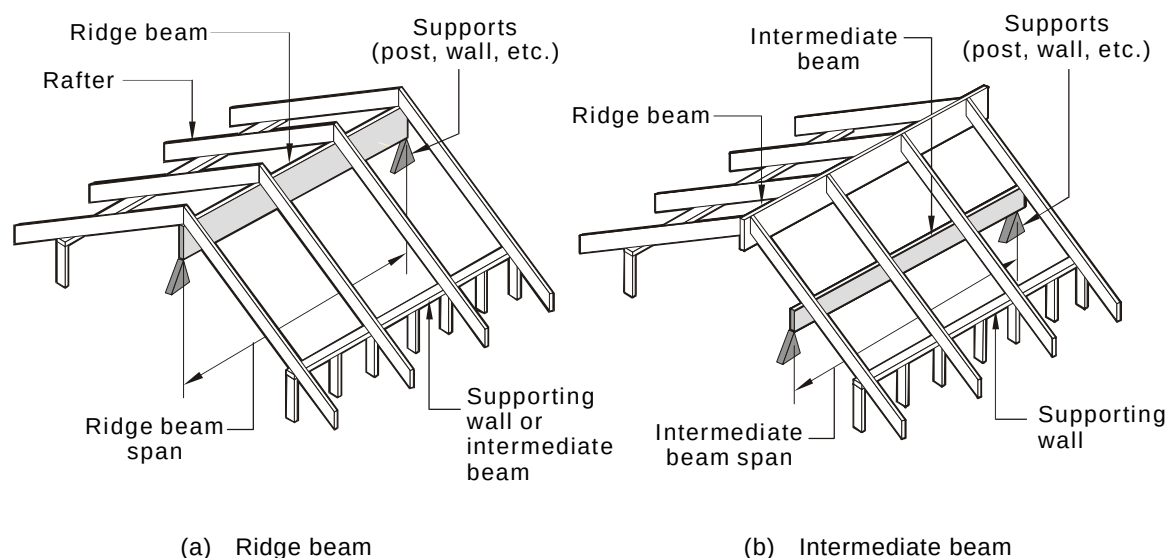


FIGURE 2.3 ROOF BEAMS—RIDGE OR INTERMEDIATE BEAM

2.3.2 Design for safety

2.3.2.1 General consideration

Roof beam design for safety includes consideration of the strength limit state for bending, shear and bearing.

2.3.2.2 Loads

The loads used for the determination of the design action effects are determined as follows:

- (a) *Dead loads* The uniformly distributed dead load, G (in kN/m), corresponding to various typical roof constructions with additional allowance for the weight of the rafters, are determined as follows:

$$G = 0.01(RM)(RLW) + 0.02(RLW)^2 + \text{self weight} \quad \dots 2.3.2(1)$$

where

RM = standardized roof mass, i.e. 10, 20, 40, 60 or 90 kg/m²

RLW = roof load width for the roof beam, in metres

- (b) *Live loads* The distributed live loads, Q_1 and Q_2 (in kN/m), and concentrated live load, Q_3 (in kN), are determined as follows:

$$(i) \quad Q_1 = \left(\frac{1.8}{L} + 0.12(RLW) \right) \text{ or } 0.25(RLW), \text{ whichever is greater} \quad \dots 2.3.2(2)$$

$$(ii) \quad Q_2 = \left(\frac{0.9}{L} + 0.12(RLW) \right) \text{ or } 0.25(RLW), \text{ whichever is greater} \quad \dots 2.3.2(3)$$

$$(iii) \quad Q_3 = 1.1 \quad \dots 2.3.2(4)$$

where

L = span of roof beam, in metres

RLW = roof load width for the roof beam, in metres

- (c) *Wind loads* The uniformly distributed wind load, W_u (in kN/m), applicable for the strength limit state is calculated as follows:

$$W_u = q_u C_{pt}(RLW) \quad \dots 2.3.2(5)$$

where

q_u = free stream dynamic gust pressure, in kPa, for the ultimate limit state; values of q_u are given in Table B2, Appendix B, for each wind classification

C_{pt} = net pressure coefficients given in Table 2.3.1

RLW = roof load width for roof beam, in metres

TABLE 2.3.1

NET PRESSURE COEFFICIENTS FOR ROOF BEAMS—STRENGTH

Wind classification	C_{pt}	
	Main spans	Overhang
N1 to N4	+0.56 or −1.1	+0.56 or −1.6
C1 to C3	+0.72 or −1.6	+0.72 or −1.6

NOTE: The positive net pressure coefficients include the pressure combination factor $K_c = 0.8$, which allows for the combined effect of positive wind pressure on the roof and negative internal pressure.

2.3.2.3 Structural models and load categories for strength design

The structural models used to calculate the member design action effects are given in Table 2.3.2. Load combinations shown in Table 2.3.2 are divided into load categories that are used for the determination of member design capacity as specified in Clause 2.3.2.4.

2.3.2.4 Member design capacity

The requirements of AS 1720.1 are applied to determine member design capacities in bending, shear and bearing. The following assumptions and modification factors are used:

- (a) *Load duration factor* The member design capacity includes the modification factor for load duration (k_1). Values of k_1 appropriate for each load category, as defined in Table 2.3.2, are given in Table 2.3.3.

(b) *Moisture content of timber:*

- (i) *Unseasoned timber* — for load categories 2 and 3 given in Table 2.3.2, values of k_4 appropriate for thickness as given in AS 1720.1 are used. For load category 1, $k_4 = 1.0$.
- (ii) *Seasoned timber* — $k_4 = 1.0$ for all load categories.

TABLE 2.3.2
STRUCTURAL MODELS AND LOAD CATEGORIES —STRENGTH

Load category	Structural model		
	Single span	Continuous span	Overhang
1			
2			
3			

TABLE 2.3.3
LOAD DURATION FACTORS FOR STRENGTH

Load category	Load duration factor (k_1)
1	0.57
2	0.94
3	1.15

- (c) *Strength sharing* Where multiple sections of scantling timber are nail-laminated, the strength sharing factor (k_9) is applied for the combined member, assuming $n_{\text{mem}} = 1$ and $n_{\text{com}} = \text{number of combined sections}$.
- (d) *Member restraint* For the determination of bending capacity, the following assumptions relating to lateral restraint are used:
- (i) *At supports* — roof beams are assumed torsionally restrained at their supports.
- (ii) *Between supports:*
- (A) The top edges of roof beams are assumed restrained at 1200 mm centres.
- (B) Continuous span roof beams are assumed restrained against buckling at the points of contraflexure.

NOTE: Where nail-laminated members are used, the breadth of member used to derive the slenderness coefficient (S_1) is taken as the breadth of an individual lamination.

2.3.3 Design for serviceability

2.3.3.1 Loads

The loads used for the serviceability limit state are given as follows:

- (a) *Dead loads and live loads* Dead loads and live loads are determined as described in Clause 2.3.2.2.
- (b) *Wind loads* The uniformly distributed wind load, W_s (in kN/m), applicable for the serviceability limit state, is calculated as follows:

$$W_s = q_s C_{pt} (RLW) \quad \dots 2.3.3$$

where

q_s = free stream dynamic gust pressure, in kPa, for the serviceability limit state; values of q_s are given in Table B2, Appendix B, for each wind classification

C_{pt} = net pressure coefficients given in Table 2.3.4

RLW = roof load width for roof beam, in metres

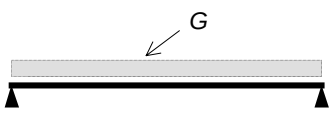
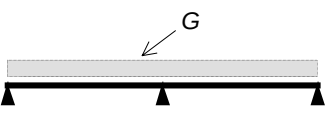
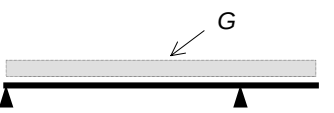
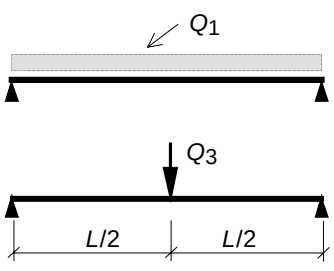
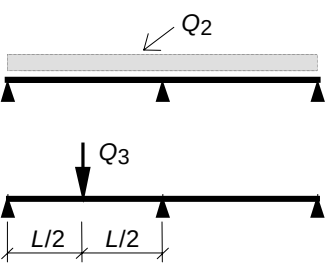
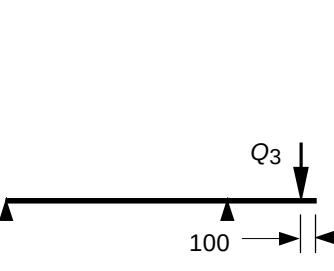
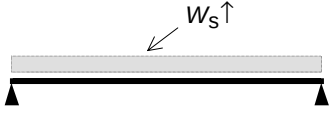
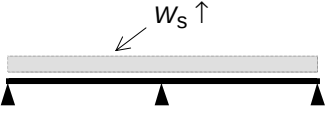
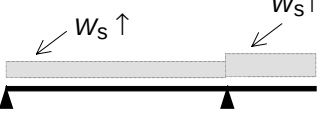
TABLE 2.3.4
NET PRESSURE COEFFICIENTS FOR RAFTERS—SERVICEABILITY

Wind classification	C_{pt}	
	Main spans	Overhangs
N1 to N4 and C1 to C3	−1.1	−1.6

2.3.3.2 Structural models and load categories for serviceability design

The structural models for which deflections are calculated are given in Table 2.3.5. Load cases included in Table 2.3.5 are divided into load categories for the purpose of allowing for the effect of duration of load on stiffness, as specified in Clause 2.3.3.3.

TABLE 2.3.5
STRUCTURAL MODELS AND LOAD CATEGORIES—SERVICEABILITY

Load category	Structural model		
	Single span	Continuous span	Overhang (cantilevered)
1			
2			
3			

2.3.3.3 Calculation of deflection

The requirements of AS 1720.1 for the calculation of deflection are applied using the duration of load factor for creep deformation as given in Table 2.3.6.

TABLE 2.3.6
LOAD DURATION FACTORS FOR DEFORMATION

Moisture content	Load duration factor (j_2)	
	Load category 1	Load category 2 or 3
Seasoned	2.0	1.0
Unseasoned	3.0	1.0

2.3.3.4 Serviceability limits

The limits on deflection used to define the serviceability limit states are given in Table 2.3.7.

TABLE 2.3.7
LIMITS ON DEFLECTION

Load category	Deflection limits	
	Midspan	End of overhang
1	Span/300	10 mm
2	Span/250	10 mm
3	Span/150	10 mm

2.4 UNDERPURLINS

2.4.1 Description

Underpurlins provide intermediate support for rafters in coupled roof construction. They are orientated as shown in Figure 2.4 and primarily support roof loads normal to the plane of the roof over the middle part of the rafter length.

Sections with depth to overall breadth ratios greater than four are not considered for application as underpurlins. Further, where the depth to overall breadth ratio exceeds two, underpurlins are assumed torsionally braced at supports and fly-braced back to rafters at intervals not exceeding 1200 mm along their span. These requirements are intended to minimize weak axis sag which may reduce support to rafters and/or induce buckling, particularly for more steeply pitched roofs.

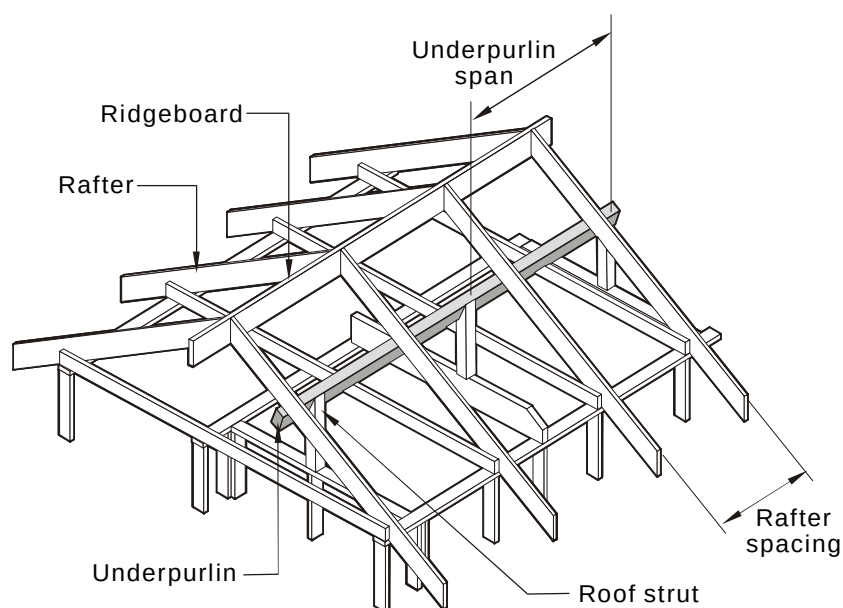


FIGURE 2.4 UNDERPURLINS

2.4.2 Design for safety

2.4.2.1 General consideration

Design for safety includes consideration of the strength limit states in bending and shear.

2.4.2.2 Loads

The loads used for determination of the design actions effects are determined as follows:

- (a) *Dead loads* Dead loads include the self weight of the underpurlin (G_1) and concentrated loads (G_2) imposed by the rafters. G_2 (in kN) is determined as follows:

$$G_2 = 1.25 (0.01RM) S_R (RLW) \quad \dots 2.4.2(1)$$

where

RM = standardized roof mass, i.e. 10, 20 or 60 kg/m²

S_R = spacing of rafters, i.e. 0.6 m or 1.2 m

RLW = roof load width for underpurlin, in metres

NOTE: The 1.25 factor in Equation 2.4.2(1) provides an allowance for the weight of supported rafters and the effect of their continuity.

- (b) *Live loads* Live loads imposed via rafters are considered as concentrated loads, Q_1 (in kN), and are determined as follows:

$$Q_1 = \frac{1.8}{N} + 0.12 S_R (RLW) \text{ or } 0.25 S_R (RLW), \text{ whichever is greater} \quad \dots 2.4.2(2)$$

where

N = number of rafters supported—over one span for the single span case, or over two spans for the continuous span case

S_R = spacing of rafters, i.e. 0.6 m or 1.2 m

RLW = roof load width for underpurlins, in metres

- (c) *Wind loads* Wind loads are considered as concentrated loads (W_u), imposed via the rafters. Concentrated loads, W_u (in kN), are calculated as follows:

$$W_u = q_u C_{pt} S_R (RLW) \quad \dots 2.4.2(3)$$

where

q_u = free stream dynamic gust pressure, in kPa, for the ultimate limit state; values of q_u are given in Table B2, Appendix B, for each wind classification

C_{pt} = net pressure coefficients given in Table 2.4.1

S_R = spacing of rafters, i.e. 0.6 m or 1.2 m

RLW = roof load width for underpurlin, in metres

TABLE 2.4.1

NET PRESSURE COEFFICIENTS FOR UNDERPURLINS

Wind classification	C_{pt}
N1 to N4 or C1 to C3	+0.7 or -1.1

2.4.2.3 Structural models and load categories used for strength design

The structural models used to determine the member design action effects are given in Table 2.4.2. Load combinations shown in Table 2.4.2 are divided into load categories that are used for the determination of member design capacity as specified in Clause 2.4.2.4.

2.4.2.4 Member design capacity

The requirements of AS 1720.1 are applied to determine member design capacities in bending and shear. The following assumptions and modification factors are used:

- (a) *Load duration factor* The member design capacity includes the modification factor for load duration (k_1). Values of k_1 appropriate for each load category defined in Table 2.4.2 are given in Table 2.4.3.
- (b) *Moisture content of timber:*
- Unseasoned timber*—for load categories 2 and 3, values of k_4 appropriate for member thickness as given in AS 1720.1 are used. For load category 1, $k_4 = 1.0$.
 - Seasoned timber*— $k_4 = 1.0$ for all load categories.
- (c) *Strength sharing* Where multiple sections of scantling timber are nail-laminated, the strength sharing factor (k_9) is applied for the combined member, assuming $n_{\text{mem}} = 1$ and $n_{\text{com}} =$ number of combined sections.

- (d) *Member restraint* For the determination of bending capacity, the following assumptions related to lateral restraint are used:
- (i) *At supports*—underpurlins are considered torsionally restrained at their supports.
 - (ii) *Between supports*:
 - (A) The top edges of underpurlins are assumed restrained by rafters at 600 mm or 1200 mm centres, as appropriate.
 - (B) Underpurlins with a depth to overall breadth ratio greater than two are assumed torsionally restrained at 1200 mm centres.
 - (C) Continuous span underpurlins are assumed restrained against buckling at the points of contraflexure.

NOTE: Where nail-laminated members are used, the breadth of member used to derive the slenderness coefficient (S_1) is taken as the breadth of an individual lamination and not the overall breadth.

TABLE 2.4.2
STRUCTURAL MODELS AND LOAD CATEGORIES—STRENGTH

Design action effect	Structural models	
	Single span	Continuous span
In bending		
In shear		
Load category	Design loads	
1	$w = 1.25G_1$ and $P = 1.25G_2$	
2	$w = 1.25G_1$ and $P = (1.25G_2 + 1.5Q_1)$	
3	$w = 1.25G_1$ and $P = (1.25G_2 + W_u \downarrow)$ $w = 0.80G_1$ and $P = (0.8G_2 + W_u \uparrow)$	

NOTES:

- 1 S_R is rafter spacing, either 0.6 m or 1.2 m.
- 2 The number of concentrated loads considered will vary according to span, rafter spacing and locations of concentrated loads.
- 3 Loads within $1.5d$ of supports are ignored in the determination of the design action effect in shear.

TABLE 2.4.3
LOAD DURATION FACTORS FOR STRENGTH

Load category	Load duration factor (k_1)
1	0.57
2	0.94
3	1.15

2.4.3 Design for serviceability

2.4.3.1 Loads

The loads used for the serviceability limit states are given as follows:

- (a) *Dead loads* Dead loads are determined as described in Clause 2.4.2.2.
- (b) *Live Loads* Concentrated live loads, Q_1 (in kN), are determined as follows:

$$Q_1 = 0.7 \left[\frac{1.8}{N} + 0.12 S_R (RLW) \right] \text{ or } 0.25 S_R (RLW), \text{ whichever is greater}$$

... 2.4.3

where

N = number of rafters supported over one span for both the single and continuous span cases

S_R = spacing of rafters, i.e. 0.6 m or 1.2 m

RLW = roof load width for underpurlin, in metres

2.4.3.2 Structural models and load categories for serviceability design

The structural models for which deflections are calculated are given in Table 2.4.4. Load cases given in Table 2.4.4 are divided into load categories for the purpose of allowing for duration of load on stiffness as specified in Clause 2.4.3.3.

TABLE 2.4.4
STRUCTURAL MODELS AND LOAD CATEGORIES — SERVICEABILITY

Load category	Structural models	
	Single span	Continuous span
1		
2		

NOTE: S_R = rafter spacing

2.4.3.3 Calculation of deflection

The requirements of AS 1720.1 for the calculation of deflection are applied using the duration of load factor for creep deformation as given in Table 2.4.5.

TABLE 2.4.5
LOAD DURATION FACTORS FOR DEFORMATION

Moisture content	Load duration factor (j_2)	
	Load category 1	Load category 2
Seasoned	2.0	1.0
Unseasoned	3.0	1.0

2.4.3.4 Serviceability limits

The limits on deflection used to define the serviceability limit states are given in Table 2.4.6.

TABLE 2.4.6
LIMITS ON DEFLECTION

Load category	Deflection limits
1	Span/300
2	Span/250

2.5 STRUTTING BEAMS

2.5.1 Description

Strutting beams are near horizontal, single span beams installed within the roof space, clear of ceilings, which provide support to underpurlins via struts.

Whilst strutting beams may be loaded by one or more struts located anywhere within the span, the design procedures given conservatively assume all roof load is applied via a single strut.

Strutting beams are assumed torsionally braced at supports and at midspan (see Figure 2.5).

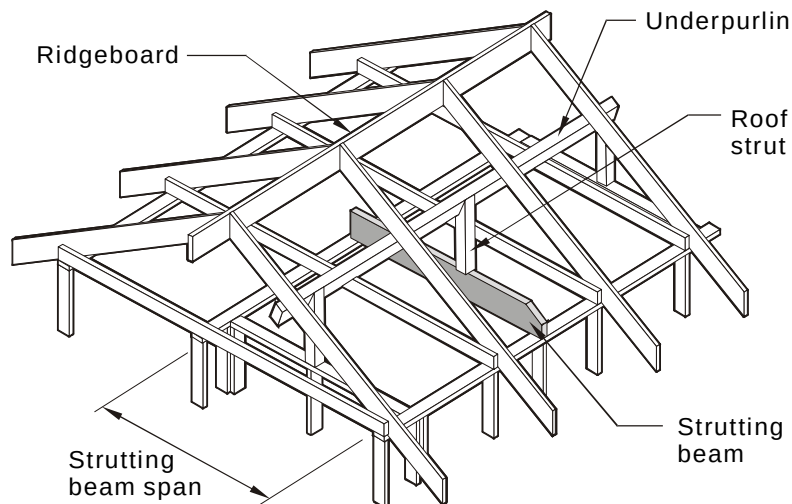


FIGURE 2.5 STRUTTING BEAMS

2.5.2 Design for safety

2.5.2.1 General consideration

Design for safety includes consideration of the strength limit states for bending and shear.

2.5.2.2 Loads

Roof loads applied to strutting beams are calculated on the basis of roof area supported. Design loads are calculated as follows:

- (a) **Dead loads** Dead loads for strutting beams include the self weight of the strutting beam, G_1 (in kN/m), and the roof dead load as a concentrated load, G_2 (in kN), calculated as follows:

$$G_2 = 0.01 (RM + 10) A \quad \dots 2.5.2(1)$$

where

RM = standardized roof mass allowance, i.e. 20 kg/m² for sheet roofs and 60 kg/m² for tile roofs

A = area of roof supported by the strutting beam, in square metres

- (b) **Live loads** Roof live load is considered applied as a concentrated load, Q_1 (in kN), calculated as follows:

$$Q_1 = (1.8 + 0.12A) \text{ or } 0.25A, \text{ whichever is greater} \quad \dots 2.5.2(2)$$

where

A = area of roof supported by strutting beam in square metres

- (c) *Wind loads* Wind load applicable for the strength limit state is considered applied as a concentrated load W_u (in kN), calculated as follows:

$$W_u = q_u C_{pt} A \quad \dots 2.5.2(3)$$

where

q_u = free stream dynamic gust pressure, in kPa, for the ultimate limit state; values of q_u are given in Table B2, Appendix B, for each wind classification

C_{pt} = net pressure coefficients given in Table 2.5.1

A = area of roof supported by the strutting beam, in square metres

TABLE 2.5.1
NET PRESSURE COEFFICIENTS FOR STRUTTING BEAMS

Wind classification	C_{pt}
N1 to N4	+0.7 or -1.1
C1 to C3	

2.5.2.3 Structural models and load categories for strength design

The structural models used to calculate the member design action effect are given in Table 2.5.2. Load combinations shown in Table 2.5.2 are divided into load categories that are used for the determination of member design capacity as specified in Clause 2.5.2.4.

2.5.2.4 Member design capacity

The requirements of AS 1720.1 are applied to determine member design capacities in bending and shear. The following assumptions and modification factors are used:

- (a) *Load duration factor* The member design capacity includes the modification factor for load duration (k_1). Values of k_1 appropriate for each load category, as defined in Table 2.5.2, are given in Table 2.5.3.
- (b) *Moisture content of timber:*
 - (i) *Unseasoned timber*—for load categories 2 and 3 given in Table 2.5.2, values of k_4 appropriate for thickness as given in AS 1720.1 are used. For load category 1, $k_4 = 1.0$.
 - (ii) *Seasoned timber*— $k_4 = 1.0$ for all load categories.
- (c) *Strength sharing* Where multiple sections of scantling timber are nail-laminated, the strength sharing factor (k_9) is applied for the combined member, assuming $n_{mem} = 1.0$ and n_{com} = number of combined sections.
- (d) *Member restraint* For the determination of bending capacity the following assumptions relating to lateral restraint are used:
 - (i) *At supports*—strutting beams are assumed torsionally restrained at their supports.
 - (ii) *Between supports*—strutting beams having a depth to breadth ratio greater than three are assumed torsionally restrained at midspan (the assumed load point).

NOTE: Where nail-laminated members are used, the breadth of member used to derive the slenderness coefficient (S_1) is taken as the breadth of an individual lamination.

TABLE 2.5.2
STRUCTURAL MODELS AND LOAD CATEGORIES — STRENGTH

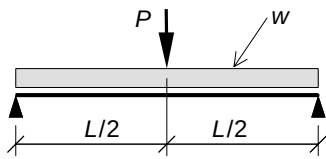
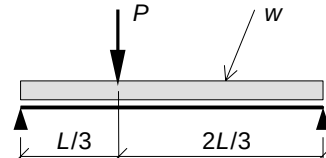
Design action effect	Structural models
In bending	
In shear	
Load category	Design loads
1	$w = 1.25G_1$ and $P = 1.25G_2$
2	$w = 1.25G_1$ and $P = 1.25G_2 + 1.5Q_1$
3	$w = 1.25G_1$ and $P = 1.25G_2 + W_u \downarrow$ $w = 0.8 G_1$ and $P = 0.8G_2 + W_u \uparrow$

TABLE 2.5.3
LOAD DURATION FACTORS FOR STRENGTH

Load category	Load duration factor (k_1)
1	0.57
2	0.94
3	1.15

2.5.3 Design for serviceability

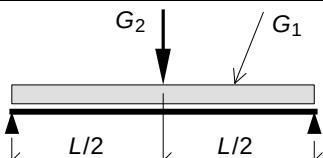
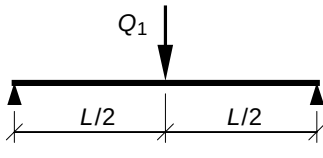
2.5.3.1 Loads

The dead loads and live loads used for the serviceability limit states are determined as specified in Clause 2.5.2.2.

2.5.3.2 Structural models and load categories for serviceability design

The structural models for which deflections are calculated are given in Table 2.5.4. Load cases given in Table 2.5.4 are divided into load categories for the purpose of allowing for duration of load on stiffness as specified in Clause 2.5.3.3.

TABLE 2.5.4
STRUCTURAL MODELS AND LOAD CATEGORIES — SERVICEABILITY

Load category	Structural models
1	
2	

2.5.3.3 Calculation of deflection

The requirements of AS 1720.1 for the calculation of deflection are applied using the duration of load factor for creep deformation as given in Table 2.5.5.

TABLE 2.5.5
LOAD DURATION FACTORS FOR DEFORMATION

Moisture content	Load duration factor (j_2)	
	Load category 1	Load category 2
Seasoned	2.0	1.0
Unseasoned	3.0	1.0

2.5.3.4 Serviceability limits

The limits on deflection used to define the serviceability limit states are given in Table 2.5.6.

TABLE 2.5.6
LIMITS ON DEFLECTION

Load category	Deflection limits
1	Span/300 or 20 mm max.
2	Span/250 or 20 mm max.

2.6 COUNTER STRUTTING BEAMS

2.6.1 Description

Counter strutting beams support roof loads from struts and ceiling loads from hanging beams.

For design, loading from both roof and ceiling is considered concentrated at midspan.

Counter strutting beams are assumed torsionally braced at their supports and at midspan by the attachment of the hanging beams (see Figure 2.6).

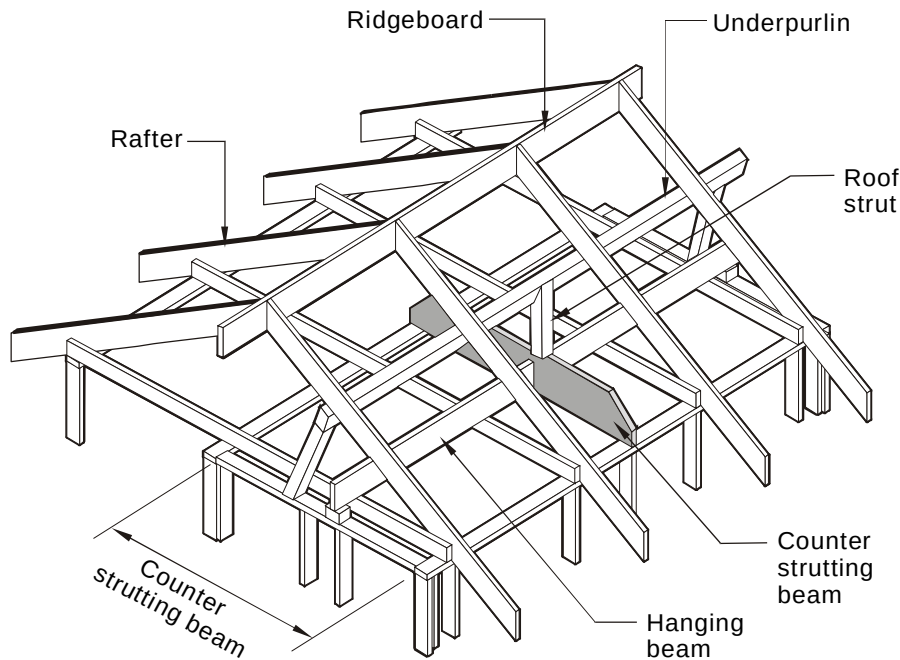


FIGURE 2.6 COUNTER STRUTTING BEAM

2.6.2 Design for safety

2.6.2.1 General consideration

Design for safety includes consideration of the strength limit states in bending and shear.

2.6.2.2 Loads

The loads used for the determination of the design action effects are determined as follows:

- (a) *Dead loads* Dead loads include the self weight of the counter strutting beam (G_1) and the concentrated load due to the roof and ceiling loads, G_2 (in kN), which is calculated as follows:

$$G_2 = 0.01(RM + 10) A + (0.06L + 0.005L^2) (CLW) \quad \dots 2.6.2(1)$$

where

RM = standardized roof mass allowance, i.e. 20 kg/m² for sheet roofs and 60 kg/m² for tile roofs

A = area of roof supported by the counter strutting beam, in square metres

L = span of the counter strutting beam, in metres

CLW = ceiling load width for the counter strutting beam, in metres