

AS 1684.4:2024



STANDARDS
Australia



Residential timber-framed construction

Part 4: Simplified — Non-Cyclonic Areas



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AS 1684.4:2024

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- Australian Institute of Building Surveyors
- Australian Timber Flooring Association
- Engineers Australia
- Engineered Wood Products Association of Australasia
- Forest Industries Federation (WA)
- Forest and Wood Products Australia
- Frame & Truss Manufacturers Association Australia
- Glued Laminated Timber Association of Australia
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- Housing Industry Association
- Housing SA
- Institution of Fire Engineers
- James Cook University
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Residential timber-framed construction

Part 4: Simplified — Non-Cyclonic Areas

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Preface

This Standard was prepared by the Australian members of the Joint Standards Australian/Standards New Zealand Committee TM-010, Timber Structures and Framing, to supersede AS 1684.4:2010.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this document as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this document is to provide the building industry with procedures that can be used to determine building practice, to design or check construction details, and to determine member sizes, and bracing and fixing requirements for timber-framed construction in non-cyclonic wind classifications N1 and N2.

The major changes in this edition are to —

- (a) include editorial amendments and some technical changes to correct mistakes, clarify interpretation and enhance the application of the document;
- (b) amend Section 5 to remove ambiguities and to reflect current research and experience which is able to provide for a quieter and more robust floor;
- (c) adjust the number of required Type A bracing units to represent JD5 joint group capacities,
- (d) amend Clause 9.6 to represent JD5 specific fixing joint group capacities; and
- (e) relaxing the notching requirements for non-loadbearing walls.

Prior to using this document, it is necessary to establish the design gust wind speed and wind classification (see Clause 1.4.2).

This document is a companion publication to the following:

AS 1684.1, *Residential timber-framed construction, Part 1: Design criteria*

AS 1684.2, *Residential timber-framed construction, Part 2: Non-cyclonic areas*

AS 1684.3, *Residential timber-framed construction, Part 3: Cyclonic areas*

This document has been derived from AS 1684.2 to provide a simpler design procedure for lower wind classification areas where details of bracing and tie-downs are simplified. It should be noted that this document differs from AS 1684.2 in a number of areas in order to achieve the simplification. Some of the differences are as follows:

- (i) Input to the Span Tables requiring references to span and spacing.
- (ii) The geometric limits of the house are more restricted, e.g. 12.0 m maximum width and 30° maximum roof pitch.
- (iii) Span Tables are provided for a more limited range of stress grades.
- (iv) Design of bracing is simplified.
- (v) Where required, design of tie-down is simplified.

Alternatively, for wind classifications N1 and N2, more economical design may be obtained by following the design procedures given in AS 1684.2. For wind classifications N3 and N4 for non-cyclonic areas, see AS 1684.2.

This document does not preclude the use of framing, fastening or bracing methods or materials other than those specified. Alternatives may be used, provided they satisfy the requirements of the Building Code of Australia.

The terms “normative” and “informative” are used in Standards to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance.

Statements expressed in mandatory terms in Notes to the Span Tables in Appendix A are deemed to be requirements of this document.

Contents

Preface	ii
Section 1 Scope and general	1
1.1 Scope	1
1.2 Normative references	1
1.3 Terms and definitions	2
1.4 Limitations	6
1.4.1 General	6
1.4.2 Wind classification	6
1.4.3 Plan	6
1.4.4 Number of storeys of timber framing	6
1.4.5 Width	7
1.4.6 Wall height	8
1.4.7 Rafter overhang	8
1.4.8 Roof pitch	8
1.4.9 Spacing	8
1.4.10 Roof types	8
1.4.11 Building masses	8
1.5 Design criteria	10
1.6 Load paths — Offsets and cantilevers	10
1.7 Durability	11
1.8 Dimensions	11
1.9 Bearing	12
1.10 Timber	12
1.11 Engineered timber products and engineered wood products (EWPs)	13
1.12 Size tolerances	13
1.13 Alternative timber dimensions	14
1.14 Steel grade and corrosion protection	14
Section 2 Terminology and definitions	15
2.1 General	15
2.2 Terminology of framing members	15
2.3 Vertical nail lamination	18
2.4 Stud lamination	19
2.5 Horizontal nail lamination — Wall plates only	20
Section 3 Substructure	21
3.1 General	21
3.2 Site preparation and drainage	21
3.3 Ground clearance and subfloor ventilation	21
3.4 Termite management	21
3.5 Substructure bracing	21
3.6 Subfloor supports	21
3.6.1 General	21
3.6.2 Footing classification	21
3.6.3 Stumps or posts	22
3.6.4 Footing type support limitations	23
Section 4 Floor framing	26
4.1 General	26
4.1.1 Application	26
4.1.2 Materials	26
4.1.3 Framing configurations	26
4.1.4 Weatherproofing	26
4.1.5 Shrinkage	26
4.1.6 Cuts, holes and notches in bearers and joists	26
4.2 Building practice	28

4.2.1	Bearers.....	28
4.2.2	Joists.....	29
4.3	Member sizes.....	31
4.3.1	General.....	31
4.3.2	Bearers.....	31
4.3.3	Floor joists.....	32
Section 5	Flooring and decking.....	35
5.1	General.....	35
5.2	Platform floors.....	35
5.3	Fitted strip floors (cut-in floors) direct to joists.....	35
5.4	Expansion joints in strip floors direct to joists.....	35
5.5	Laying and fixing strip and sheet flooring direct to joists.....	36
5.5.1	Structural strip flooring — laying.....	36
5.5.2	Structural strip flooring — cramping and fixing.....	36
5.5.3	Structural plywood flooring — laying and fixing.....	37
5.5.4	Structural Particleboard flooring — laying and fixing.....	38
5.6	Joist spacing — Flooring.....	39
5.7	Decking.....	40
Section 6	Wall framing.....	42
6.1	General.....	42
6.1.1	Application.....	42
6.1.2	Bracing.....	42
6.2	Building practice.....	42
6.2.1	Studs.....	42
6.2.2	Wall plates.....	46
6.2.3	Openings.....	47
6.2.4	Framing around chimneys and flues.....	49
6.2.5	Lateral support for non-loadbearing walls.....	49
6.3	Member sizes.....	50
6.3.1	General.....	50
6.3.2	Wall studs.....	51
6.3.3	Bottom plates.....	54
6.3.4	Top plates.....	54
6.3.5	Studs, plates and noggings in non-loadbearing internal walls.....	55
6.3.6	Lintels.....	55
6.3.7	Verandah beams (plates).....	56
6.3.8	Verandah posts supporting roof loads.....	56
Section 7	Roof framing.....	57
7.1	General.....	57
7.1.1	Application.....	57
7.1.2	Types of roofs and limitations.....	57
7.2	Building practice.....	58
7.2.1	Ceilings.....	58
7.2.2	Construction loads on ceiling framing.....	58
7.2.3	Ceiling battens.....	58
7.2.4	Ceiling joists.....	58
7.2.5	Hanging beams.....	59
7.2.6	Counter beams.....	60
7.2.7	combined strutting/hanging beams.....	60
7.2.8	Combined strutting/counter beams.....	61
7.2.9	Strutting beams.....	61
7.2.10	Underpurlins.....	62
7.2.11	Rafters.....	63
7.2.12	Ridgeboards.....	63
7.2.13	Hip and valley rafters.....	64
7.2.14	Scotch valleys.....	64
7.2.15	Roof strutting.....	64

7.2.16	Collar ties.....	67
7.2.17	Hip ends.....	68
7.2.18	Alternative support systems.....	68
7.2.19	Non-coupled roofs.....	68
7.2.20	Roof battens.....	69
7.2.21	Trussed roofs.....	69
7.2.22	Bracing for raftered and trussed roofs.....	70
7.2.23	Fixing of ceiling framing to internal bracing walls.....	70
7.2.24	Eaves construction.....	70
7.2.25	Gable or verge construction.....	71
7.2.26	Lateral restraint of hanging, strutting, strutting/hanging beams, and similar members.....	72
7.2.27	Framing around chimneys and flues.....	73
7.3	Member sizes.....	73
7.3.1	General.....	73
7.3.2	Ceiling battens.....	73
7.3.3	Ceiling lining and non-trafficable roof decking.....	74
7.3.4	Loads on ceilings.....	75
7.3.5	Binders.....	75
7.3.6	Ceiling joists.....	75
7.3.7	Hanging beams.....	75
7.3.8	Counter beams.....	76
7.3.9	Combined strutting/hanging beams.....	76
7.3.10	Combined strutting/counter beams.....	76
7.3.11	Strutting beams.....	76
7.3.12	Underpurlins.....	76
7.3.13	Rafters and purlins.....	76
7.3.14	Ridge or intermediate beams—Cathedral, skillion roofs, or similar roofs.....	78
7.3.15	Roof battens.....	78
7.3.16	Cantilevered gable ends.....	78
7.3.17	Other members/components.....	79
Section 8	Bracing.....	81
8.1	General.....	81
8.2	Temporary bracing.....	81
8.3	Permanent bracing.....	82
8.3.1	Subfloor bracing.....	82
8.3.2	Wall bracing.....	83
8.3.3	Roof bracing.....	96
Section 9	Fixings and tie-down design.....	99
9.1	General.....	99
9.2	General connection requirements.....	100
9.2.1	General.....	100
9.2.2	Straps, bolts, screws, coach screws and framing anchors.....	100
9.2.3	Steel washers.....	100
9.2.4	Drilling for bolts.....	100
9.2.5	Drilling for coach screws.....	101
9.2.6	Screw and coach screw penetration.....	101
9.2.7	Framing anchor and strap nails.....	101
9.2.8	Joining of top plates.....	101
9.3	Procedure for determining fixing and tie-down requirements.....	101
9.4	Nominal and specific fixing requirements.....	101
9.5	Nominal fixings (minimum fixings).....	102
9.6	Specific fixing (tie-down).....	104
9.6.1	General.....	104
9.6.2	Rafter to ridge connection for sheet roof.....	110
9.6.3	Ridge tied-down connection for sheet roof.....	111

Appendix B (informative) Moisture content and shrinkage	241
Appendix C (informative) Example of even distribution of bracing	247
Appendix D (normative) Collar ties with multiple rows of underpurlins	248
Bibliography	249

NOTES

Australian Standard®

Residential timber-framed construction

Part 4: Simplified — Non-Cyclonic Areas

Section 1 Scope and general

1.1 Scope

This document specifies requirements for building practice and for the selection, placement and fixing of the various structural elements used in the construction of timber-framed Class 1 and Class 10 Buildings as defined by the Building Code of Australia and within the limitations given in Clause 1.4. The provisions of the document also apply to alterations and additions to these buildings.

This document also provides building practice and procedures that assist in the correct specification and determination of timber members, bracing and connections, thereby minimizing the risk of creating an environment that may adversely affect the ultimate performance of the structure.

This document may also be applicable to the design and construction of other classes of buildings where the design criteria, loadings and other parameters applicable to those classes of building are within the limitations of this document.

NOTE 1 See AS 1684.1 for details of design criteria, loadings and other parameters.

NOTE 2 While this document may be used to design Class 10 buildings, less conservative levels of design for this building class may be permitted by building regulations and other Australian Standards.

NOTE 3 Advisory information for the construction and specifications of timber stairs, handrails and balustrades, is provided in the FWPA's publication (see the Bibliography).

Member Span Tables are given in Appendix A.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1170.4, *Structural design actions, Part 4: Earthquake actions in Australia*

AS 1397, *Continuous hot-dip metallic coated steel sheet and strip — Coatings of zinc and zinc alloyed with aluminium and magnesium*

AS 1684.1, *Residential timber-framed construction, Part 1: Design criteria*

AS 1684.2, *Residential timber-framed construction, Part 2: Non-cyclonic areas*

AS 1691, *Domestic oil-fired appliances—Installation*

AS 1720.1, *Timber structures, Part 1: Design methods*

AS 1810, *Timber—Seasoned cypress pine—Milled products*

AS 1860.2, *Particleboard flooring, Part 2: Installation*

AS 2082, *Timber—Hardwood —Visually stress-graded for structural purposes*

AS 2796.1, *Timber—Hardwood—Sawn and milled products, 1: Product specification*

AS 2858, *Timber—Softwood—Visually stress-graded for structural purposes*

AS 2870, *Residential slabs and footings—Construction*

AS 3519, *Timber—Machine proof grading*

AS 3818.3, *Timber—Heavy structural products—Visually graded, Part 3: Piles*

AS 3818.11, *Timber—Heavy structural products—Visually graded, Part 11: Utility poles*

AS 4055, *Wind loads for housing*

AS 4440, *Installation of nailplated timber trusses*

AS 4785.1, *Timber—Seasoned softwood—Sawn and milled products, Part 1: Product specification*

AS 5604, *Timber — Natural durability ratings*

AS/NZS 1170.1, *Structural design actions, Part 1: Permanent, imposed and other actions*

AS/NZS 1170.2, *Structural design actions, Part 2: Wind actions*

AS/NZS 1214, *Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series) (ISO 10684:2004, MOD)*

AS/NZS 1328.1, *Glue laminated structural timber, Part 1: Performance requirements and minimum production requirements*

AS/NZS 1604, *Preservative-treated wood-based products (all Parts)*

AS/NZS 1748.1, *Timber—Solid—Stress-graded for structural timber purposes, Part 1 General requirements*

AS/NZS 1859.4, *Reconstituted wood-based panels—Specifications, Part 4: Wet process fibreboard*

AS/NZS 1860.1, *Particleboard flooring, Part 1: Specifications*

AS/NZS 2269.0, *Plywood—Structural, Part 0: Specifications*

AS/NZS 2918, *Domestic solid fuel burning appliances—Installation*

AS/NZS 4357.0, *Structural laminated veneer lumber, Part 0: Specifications*

AS/NZS 4534, *Zinc and zinc/aluminium-alloy coatings on steel wire*

AS/NZS 4791, *Hot-dip galvanized (zinc) coatings on ferrous open sections, applied by an in-line process*

ISO 22389-1, *Timber structures—Bending strength of I-beams—Part 1: Testing, evaluation and characterization*

ABCBCA. *Building Code of Australia*

1.3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

1.3.1

engineered wood products

EWPs

range of wood products which are manufactured by binding or fixing the strands, particles, fibres, or veneers or boards of wood, together with adhesives, or other methods of fixation to form composite material where the wood fibre is the primary material

Note 1 to entry: This document is not applicable to wood -plastic composites where wood fibre is not the primary material.

1.3.2**loadbearing wall**

wall that supports roof or floor loads, or both roof and floor loads

1.3.3**may**

indicates the existence of an option

1.3.4**non-loadbearing walls****1.3.4.1****non-loadbearing wall, external**

wall that supports neither roof nor floor loads but may support ceiling loads and act as a bracing wall, and may support lateral wind loads

Note 1 to entry: Examples include gable and skillion end walls.

1.3.4.2**non-loadbearing wall, internal**

non-loadbearing internal wall supports neither roof nor floor loads but may support ceiling loads and act as a bracing wall

1.3.5**relevant authority**

an agency authorized by legislation or regulation to issue determinations, orders, or other instructions in respect of any subject covered by this Standard

Note 1 to entry: In the context of this Standard, the relevant authority may include local council building surveyors, private building surveyors or other persons nominated by the relevant State or Territory building legislation as having the legal responsibility for approving the use of structural timber products.

1.3.6**rim board**

member at right angles to and fixed to the end of deep joists (including I-joists) that provides restraint to the joists

1.3.7**roof****1.3.7.1****coupled roof**

pitched roof construction system with a roof slope of not less than 10 degrees where horizontal members (ceiling joists and collar ties) combine with opposing rafter pairs to create a triangulation of the roof structure

Note 1 to entry: A coupled roof system includes collar ties fixed to all opposing rafter pairs as specified in Clause 7.1.2.2, and rafters and ceiling joists securely fixed to the same top plate or to each other if they align, see Table 9.3. It may also include some area where it is not possible to fix ceiling joists or collar ties to all rafters, e.g. hip ends or parts of a T- or L-shaped house.

Note 2 to entry: In a coupled roof both gravity and wind forces can be resisted by axial forces in rafters, collar ties and ceiling joists, see Figure 7.1.

1.3.7.2**non-coupled roof**

pitched or flat roof that is not a coupled roof and does not incorporate triangulation

Note 1 to entry: This includes cathedral roofs and roofs constructed using ridge and intermediate beams.

Note 2 to entry: In a non-coupled roof both gravity and wind forces can only be resisted by bending in the rafters, see Figure 2.5.

1.3.7.3**pitched roof**

roof where members are cut to suit, and which is erected on site

1.3.7.4**trussed roof**

engineered roof frame system designed to carry the roof or roof and ceiling, usually without the support of internal walls

1.3.8**shall**

indicates that a statement is mandatory

1.3.9**should**

indicates a recommendation

1.3.10**spacing and span****1.3.10.1****spacing**

centre-to-centre distance between structural members, unless otherwise indicated

Note 1 to entry: Figure 1.1 illustrates the terms “spacing”, “span”, “single span” and “continuous span”.

1.3.10.2**span**

face-to-face distance between points capable of giving full support to structural members or assemblies

Note 1 to entry: In particular, rafter spans are measured as the distance between points of support along the length of the rafter and not as the horizontal projection of this distance.

1.3.10.3**single span**

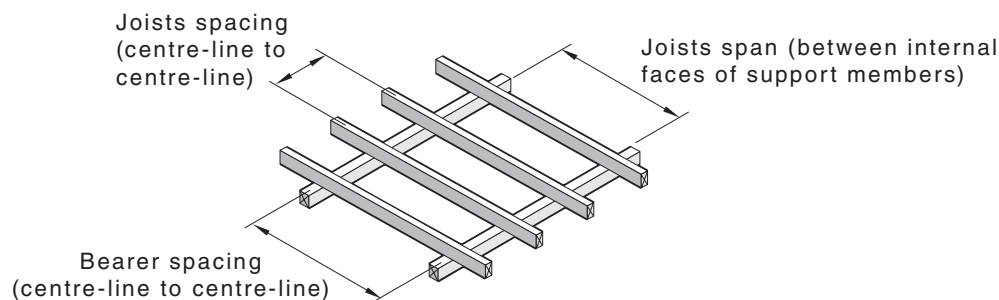
span of a member supported at or near both ends with no immediate supports

Note 1 to entry: This includes the case where members are partially cut through over intermediate supports to remove spring, see Figures 1.1(c) and 1.1(d).

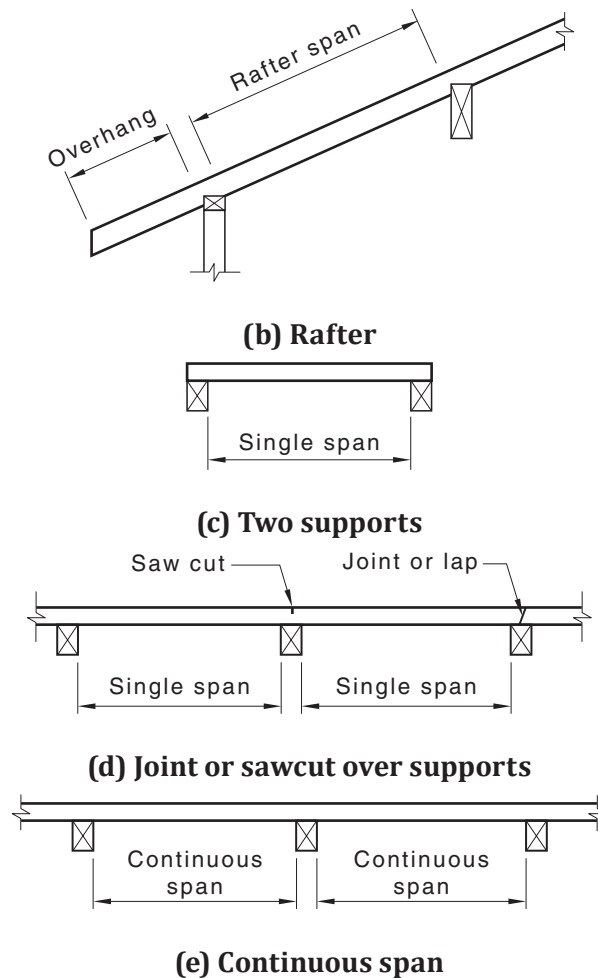
1.3.10.4**continuous span**

span of a member supported at or near both ends and at one or more intermediate points such that no span is greater than twice another

Note 1 to entry: See Figure 1.1(e) for an illustration.



(a) Bearers and joists



NOTE The design span is the average span unless one span is more than 10 % longer than another, in which case the design span is the longest span.

Figure 1.1 — Spacing and span

1.3.11

stress grade

classification of timber to indicate, for the purposes of design, a set of structural design properties in accordance with AS 1720.1

1.3.12

stud height

distance from top of bottom plate to underside of top plate or the distance between points of lateral restraint provided to both the breadth and depth of the stud

1.3.13

two storey

in any section through the house, construction that includes not more than two levels of timber-framed trafficable floor

Note 1 to entry: Trafficable floors in attics and lofts are included in the number of storeys.

Note 2 to entry: In the subfloor of a two storey construction, the maximum distance from the ground to the underside of the lower floor bearer is 1 800 mm.

Note 3 to entry: This terminology does not preclude the application of this Standard to up to a two storey timber-framed construction supported —

- (a) by a bearer and joist substructure designed in accordance with this Standard; or
- (b) by lower levels of timber wall framing or other support systems designed in accordance with engineering principles and approved by a relevant authority.

1.4 Limitations

1.4.1 General

The criteria specified in this document are specifically for conventional timber-framed buildings and applicable to single- and two-storey constructions built within the limits or parameters given in Clauses 1.4.2 to 1.4.11 and Figure 1.2.

1.4.2 Wind classification

For wind loads, the simplified wind classifications for non-cyclonic areas N1 and N2, as described by AS 4055, shall be used with the corresponding maximum design gust wind speeds given in Table 1.1.

Either AS 4055 or AS/NZS 1170.2 shall be used to determine the wind classification necessary for the use of this document.

The maximum wind classification shall be N2, which is determined as follows:

- (a) Where the wind classification is determined from AS 4055, the maximum building height limitation of 8.5 m, as given in AS 4055, shall apply to this document. The maximum building width is specified in Clause 1.4.5.
- (b) Where AS/NZS 1170.2 is used to determine the maximum design gust wind speed, a wind classification shall be adopted in accordance with Table 1.1. The ultimate limit state design gust wind speed determined from AS/NZS 1170.2 shall be not more than the ultimate limit state wind speed given in Table 1.1 for the corresponding wind classification adopted.

NOTE 1 The determination of the design gust wind speed and wind classification should take into account building height, terrain category, topographic classification, and shielding classification given in AS/NZS 1170.2 or AS 4055.

NOTE 2 Some regulatory authorities provide wind classification maps or wind classifications for designated sites within their jurisdiction.

Table 1.1 — Maximum design gust wind speed

Wind classification	Maximum design gust wind speed, m/s		
Regions A and B	Permissible stress method (V_p)	Serviceability limit state (V_s)	Ultimate limit state (V_u)
N1	28 (W28N)	26	34
N2	33 (W33N)	26	40

1.4.3 Plan

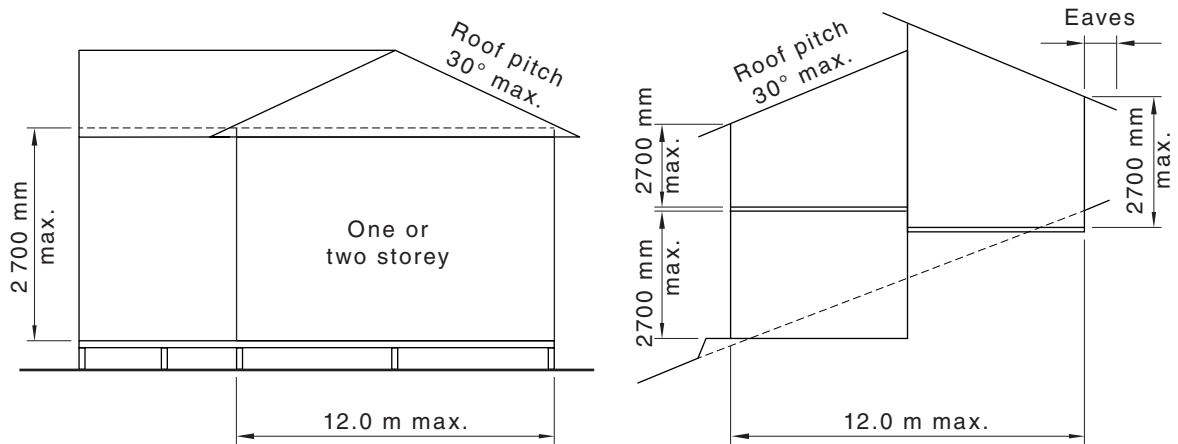
Building shapes shall be essentially rectangular, square, L-shaped or a combination of rectangular elements including played-end and boomerang-shaped buildings.

1.4.4 Number of storeys of timber framing

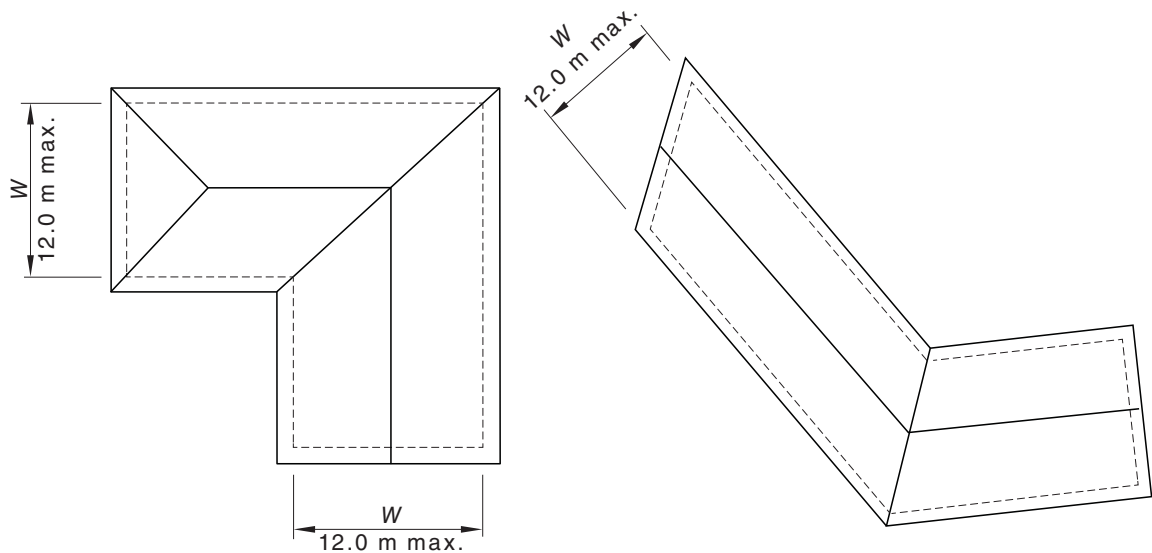
The maximum number of storeys of timber framing shall not exceed two (see Section 2).

1.4.5 Width

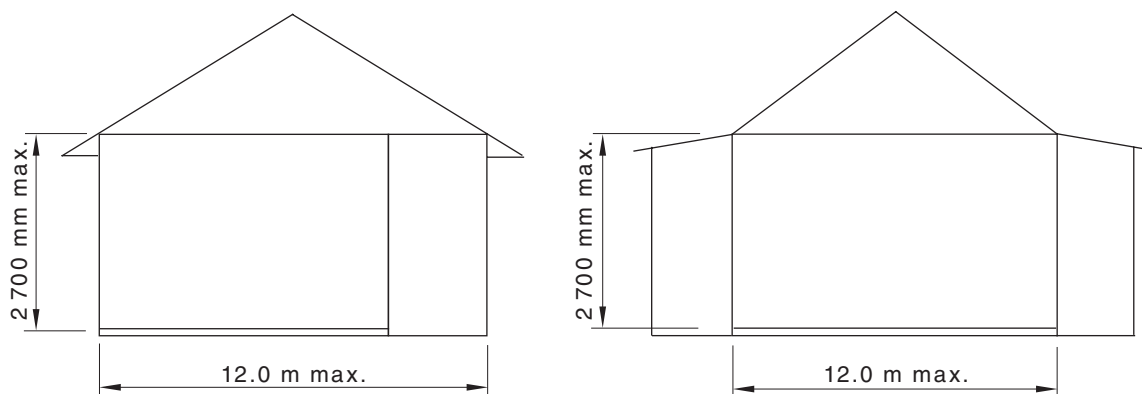
The maximum width of a building shall be 12 000 mm, excluding eaves (see Figure 1.2).



(a) Sections



(b) Plan

**(c) Verandahs**

NOTE Building height limitations apply where wind classification is determined using AS 4055. See Clause 1.4.2 and 1.4.4.

Figure 1.2 — Geometric building parameters

1.4.6 Wall height

The maximum wall height shall be 2 700 mm, floor to ceiling, as measured at external walls (see Figure 1.2).

1.4.7 Rafter overhang

The maximum rafter overhang shall be 750 mm.

1.4.8 Roof pitch

The maximum roof pitch shall be 30° (58:100).

1.4.9 Spacing

1.4.9.1 Rafters or trusses

The maximum spacing of rafters or trusses shall be 900 mm for tile roof and 1 200 mm for sheet roof.

1.4.9.2 Bracing

The spacing of bracing elements, measured at right angles to elements, shall not exceed 9 000 mm (see Section 8).

1.4.10 Roof types

Roof construction shall be hip, gable, skillion, cathedral, trussed or pitched or in any combination of these (see Figures 2.2 to 2.7).

1.4.11 Building masses

The maximum building masses (dead loads) specified in Tables 1.2 to 1.4 shall apply to the use of the Span Tables given in Appendix A. Reference shall also be made to the Notes given under each Span Table in Appendix A.

Table 1.2 — Maximum building masses — Floor framing

Description	Max. building mass kg/m ²
Joists and bearers supporting floor loads only	40
Bearers supporting loadbearing walls:	
(a) Floor loads	40
(b) Roof and ceiling loads:	
(i) Sheet roof	40
(ii) Tile roof	90
NOTE 1 An allowance has also been included for the mass of sheeted walls.	
NOTE 2 The above loads are applicable to upper-, single-, and lower-storey bearers.	

Table 1.3 — Maximum building masses — Wall framing

Description	Max. building mass kg/m ²
Studs, plates, lintels, and similar members, supporting single- or upper-storey loadbearing walls:	
(a) Sheet roof	40
(b) Tile roof	90
Studs, plates, lintel, and similar members, supporting lower-storey loadbearing walls:	
(a) Sheet roof	40 (see Note 2)
(b) Tile roof	90
NOTE 1 Where appropriate, an allowance has also been included for the mass of the walls.	
NOTE 2 An allowance of 40 kg/m ² for the mass of the floor supported has been included.	

Table 1.4 — Maximum building masses — Roof framing

Description	Max. building mass kg/m ²
Ceiling joists, hanging beams and counter beams — Ceiling lining (including battens)	12
Combined strutting/hanging and combined counter/strutting beams:	
(a) Sheet roofing plus ceiling lining (including battens)	32
(b) Tile roofing plus ceiling lining (including battens)	72
Strutting beams and underpurlins:	
(a) Sheet roof	20
(b) Tile roof	60
Rafters supporting roof loads only:	
(a) Sheet roof	20
(b) Tile roof	60
Rafters supporting roof and ceiling loads:	
(a) Sheet roof	40
(b) Tile roof	90
Ridge and intermediate beams:	

Table 1.4 (continued)

Description	Max. building mass kg/m ²
(a) Sheet roof	40
(b) Tile roof	90
Roof battens:	
(a) Sheet roof	10
(b) Tile roof	60

1.5 Design criteria

The design criteria that have been used in the preparation of this document are the following:

- (a) The bases of the design used in the preparation of this document are AS 1684.1 and AS 1720.1.
- (b) The design dead, live, and wind loadings recommended in AS/NZS 1170.1, AS/NZS 1170.2 and AS 4055, were taken into account in the member computations, with appropriate allowances for the distribution of concentrated or localized loads over a number of members where relevant (see Clause 1.4.2).

NOTE 1 Construction supporting vehicle loads is outside the scope of this document.

- (c) All pressures, loads, forces and capacities given in this document are based on limit state design.
- (d) The member sizes, bracing and connection details are suitable for construction (including timber-framed brick veneer) of domestic structures not greater than 8.5 m in height at any section through the structure and a $k_p Z$ not greater than 0.11 in accordance with AS 1170.4.

NOTE 2 Typical unreinforced masonry may include masonry bases for timber-framed houses.

- (e) The effects of snow loads up to 0.2 kPa on member sizes, bracing and connection details have been accommodated in the design.
- (f) The minimum racking capacity of Type A and Type B bracing units shall be 2.6 kN and 5.2 kN, respectively (limit state design).

1.6 Load paths — Offsets and cantilevers

Roof loads shall be transferred through the timber frame to the footings by the most direct route possible. For floor framing, the limitations imposed regarding the support of point loads and the use of offsets and cantilevers are specified in Section 4.

NOTE 1 This load path in many cases cannot be maintained in a completely vertical path, relying on structural members that transfer loads horizontally. Offset or cantilevered floor framing supporting loadbearing walls may also be used (see Figures 1.3 and 1.4).

NOTE 2 Floor members designed as “supporting floor load only” may support a loadbearing wall (walls supporting roof loads) where the loadbearing wall occurs directly over a support or is at or within 1.5 times the depth of the floor member from the support (see Clause 4.3.2.2 and Clause 4.3.3.3).

NOTE 3 Other members supporting roof or floor loads where the load occurs directly over the support or is at or within 1.5 times the depth of the member from the support do not require to be designed for that load. For the measurement of offset, see Figure 1.4.

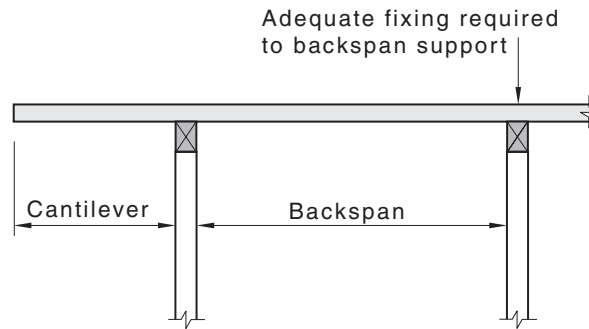


Figure 1.3 — Cantilever

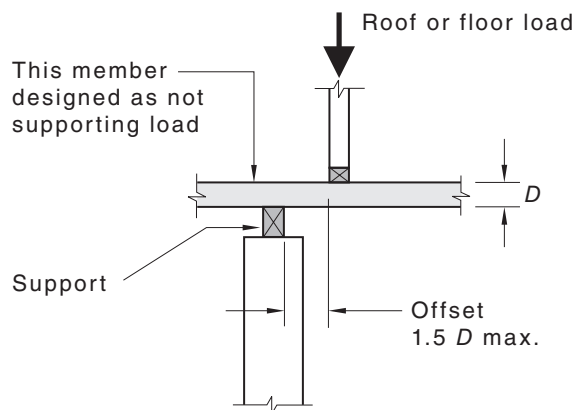


Figure 1.4 — Offset

1.7 Durability

Structural timber used in accordance with this document shall have the level of durability appropriate for the relevant climate and expected service life and conditions, including exposure to insect attack or to moisture, which could cause decay.

Structural timber members that are in ground contact or that are not protected from weather exposure and associated moisture ingress shall be of in-ground durability class 1 or 2 as appropriate (refer to AS 5604), or shall be adequately treated with preservative in accordance with the AS/NZS 1604 series, unless the ground contact or exposure is of a temporary nature.

1.8 Dimensions

Timber dimensions throughout this document are stated by nominating the depth of the member first, followed by its breadth (see Figure 1.5); e.g. 90 × 35 mm (studs, joists, etc.), 45 × 70 (wall plates, battens, etc.).

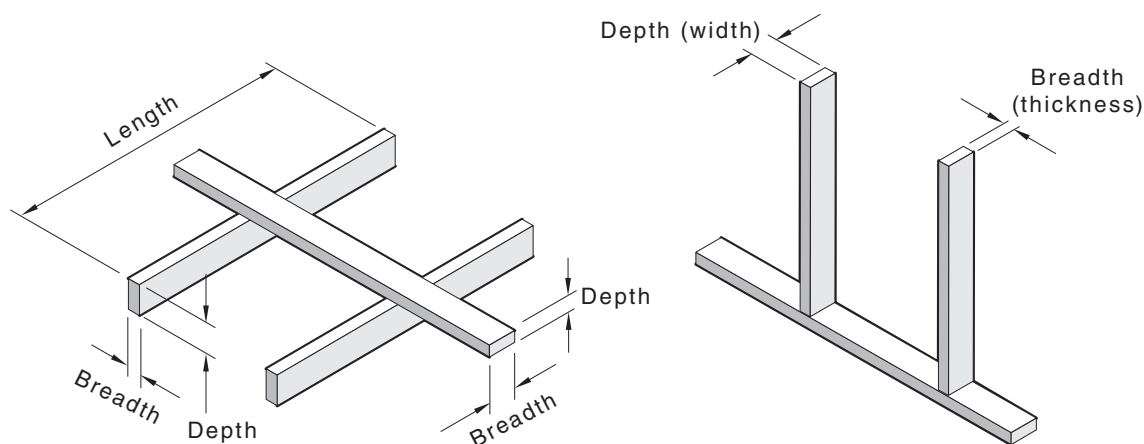


Figure 1.5 — Dimensions

1.9 Bearing

The minimum bearing for specific framing members (bearers, lintels, hanging beams, strutting beams, combined strutting/hanging beams, counter beams, combined counter and strutting beams, and verandah beams) shall be as given in the Notes to the Span Tables of Appendix A, as appropriate.

In all other cases, framing members shall bear on their supporting element, a minimum of 30 mm at their ends or 60 mm at the continuous part of the member, by their full breadth (thickness). Reduced bearing area shall only be used where additional fixings are provided to give equivalent support to the members.

Where the bearing area is achieved using a non-rectangular area such as a splayed joint, the equivalent bearing area shall not be less than that required above.

1.10 Timber

All timber used in accordance with this document shall conform to the requirements as follows:

- (a) Visually graded sawn timber shall conform to the requirements of AS 2082 or AS 2858.
- (b) Mechanically graded timber shall conform to the requirements of AS/NZS 1748.1.
- (c) Proof-graded timber shall conform to the requirements of AS 3519.
- (d) Structural plywood shall conform to the requirements of AS/NZS 2269.0.
- (e) Structural laminated veneer lumber shall conform to the requirements of AS/NZS 4357.0.
- (f) Glued laminated timber shall conform to the requirements of AS/NZS 1328.1.
- (g) Round timber shall conform to the requirements of AS 3818.3 or AS 3818.11, as appropriate.
- (h) Timber I-joists shall conform to the requirements of ISO 22389-1.
- (i) Timber products or grades not listed in this document may have properties established by testing and evaluation methods consistent with those described in the AS/NZS 4063 series. In addition, for other timber-based products, modification factors for duration of load effect for strength and stiffness shall be determined based on authoritative research. Consideration shall also be given to the determination of the structural durability of adhesives used for manufacture.

Stress Grades for visually, mechanically and proof graded timber covered by the span tables in the supplements to this document are given in Table 1.5.

Table 1.5 — Stress grades

Species or species group	Stress grade
Cypress (unseasoned)	F5, F7
Hardwood (unseasoned)	F8, F11, F14
Hardwood (seasoned)	F17, (F27 joists and beams only)
Seasoned Softwood (Radiata, slash, hoop, Caribbean, pinaster pines etc.)	F5, F8 (studs and plates only), MGP10, MGP12
Douglas Fir (Oregon) (unseasoned)	F5, F7
Spruce Pine Fir (SPF) (seasoned)	F5
Hemfir (seasoned)	F5
NOTE 1 Timber that has been visually, mechanically or proof stress-graded may be used in accordance with this document at the stress grade branded thereon.	
NOTE 2 Check timber suppliers or contact local timber advisory services to confirm availability of timber stress grades.	

1.11 Engineered timber products and engineered wood products (EWPs)

Fabricated components (e.g. roof trusses and nailplate-joined timber) may be used where their design is in accordance with AS 1720.1 and AS 1720.5. Manufactured products (e.g. glued- laminated timber members, I-beams, laminated veneer lumber, laminated strand lumber, or other glued product) may be used where their design is in accordance with AS 1720.1 and their manufacture and use conforms to Clause 1.10.

NOTE 1 AS 1684.2:2021 Appendix J provides guidance on building practices that are common to the use of EWPs from different manufacturers.

NOTE 2 In some situations, there are no relevant Australian Standards applicable to the design, manufacture or use of engineered timber products. In such cases, the use of these products in accordance with this document is subject to the approval of the regulatory authority and the recommendations of the specific manufacturer who may require provisions additional to those contained in this document. These may include, but are not restricted to, additional support, lateral restraint, blocking and similar provisions.

1.12 Size tolerances

When using the Span Tables given in Appendix A, the following maximum undersize tolerances on timber sizes shall be permitted:

(a) *Unseasoned timber:*

- | | |
|-----------------------------------|------|
| (i) <i>Up to and including F7</i> | 4 mm |
| (ii) <i>F8 and above</i> | 3 mm |

(b) *Seasoned timber — All stress grades* 0 mm

NOTE When checking unseasoned timber dimensions onsite, allowance should be made for shrinkage, which may have occurred since milling.

1.13 Alternative timber dimensions

The alternative timber dimensions given by this clause shall not apply to the Span Tables given in Appendix A.

Where a timber dimension is stated in the Clauses of this document, it refers to the usual minimum dimensions of seasoned timber. Alternative nominal dimensions for unseasoned timber shall be in accordance with Table 1.6.

The size tolerances given in Clause 1.12 are also applicable to these dimensions.

Table 1.6 — Alternative timber dimensions

Minimum seasoned timber dimension mm	Allowable dimension nominal unseasoned timber dimensions mm
19	25
32	38
35	38
42	50
45	50
70	75
90	100
120	125
140	150
170	175
190	200
240	250
290	300

1.14 Steel grade and corrosion protection

All metal used in structural timber connections shall be provided with corrosion protection appropriate for the particular conditions of use.

Where corrosion protection of steel is required it shall be in accordance with AS/NZS 4791, AS/NZS 4534, AS 1397 and AS/NZS 1214. The level of corrosion protection provided shall take into consideration weather exposure, timber treatment, moisture and presence of salt.

The minimum corrosion protection that shall be applied to metal straps, framing anchors and similar structural connections shall be Z 275. The minimum thickness of metal strap shall be 0.8 mm and the minimum net cross-section area shall be 21 mm², unless noted otherwise.

Where other types of corrosion protection are provided, they shall satisfy the requirements of the relevant authority.

The min. steel grade for metal strap, framing anchors and similar structural connection shall be G 300. The grade of all other metal components shall be in accordance with the relevant Australian Standards.

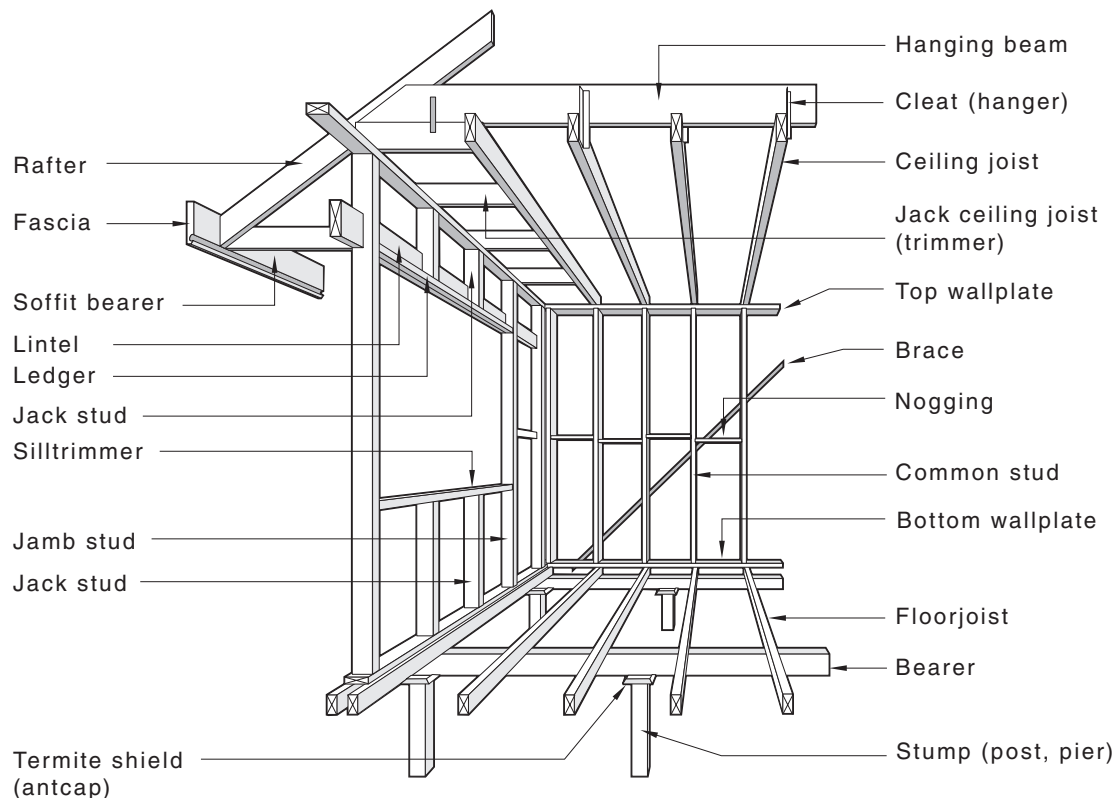
Section 2 Terminology and definitions

2.1 General

The terminology and definitions given in this section shall be used in conjunction with the requirements of this document.

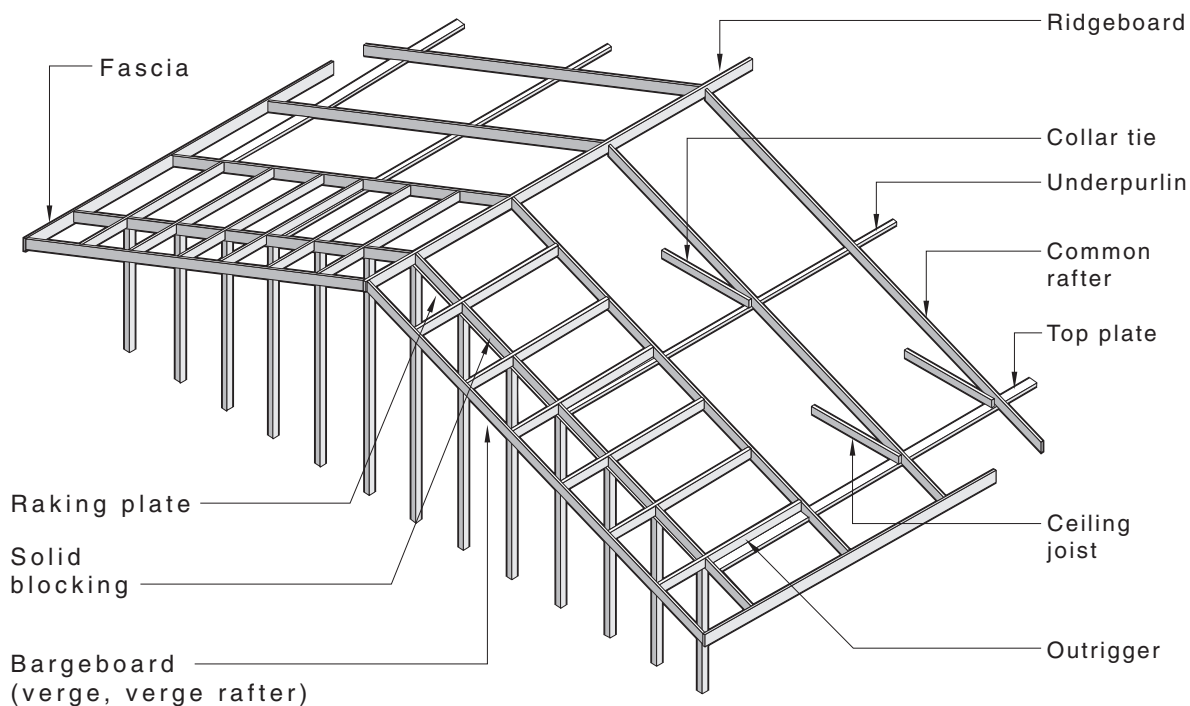
2.2 Terminology of framing members

Figure 2.1 details floor, wall and ceiling framing members in general. Figures 2.2 to 2.7 apply to roof framing.



NOTE The ceiling and floor joists are shown parallel to the external loadbearing wall for clarity. In practice, the more usual case is for the joists to be located perpendicular to the external wall. Lintel location may also vary (see Figure 6.8).

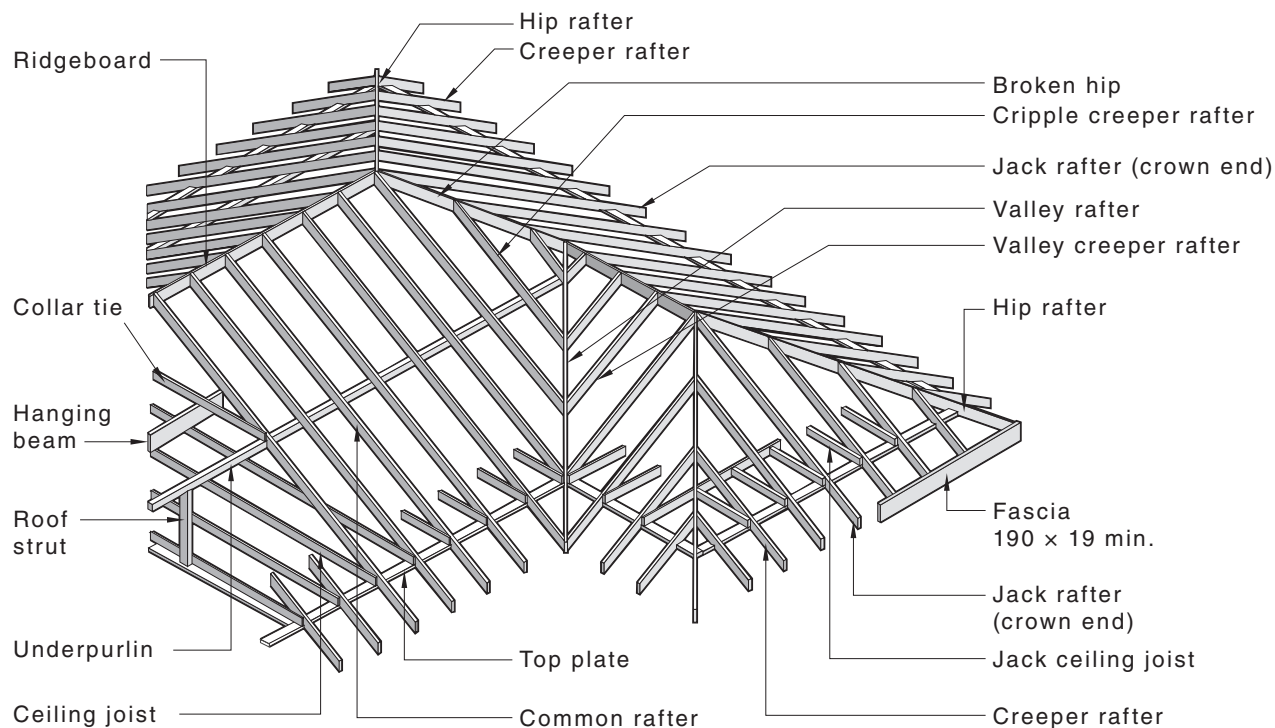
Figure 2.1 — Framing members — Floor, wall and ceiling



NOTE Some members have been omitted for clarity.

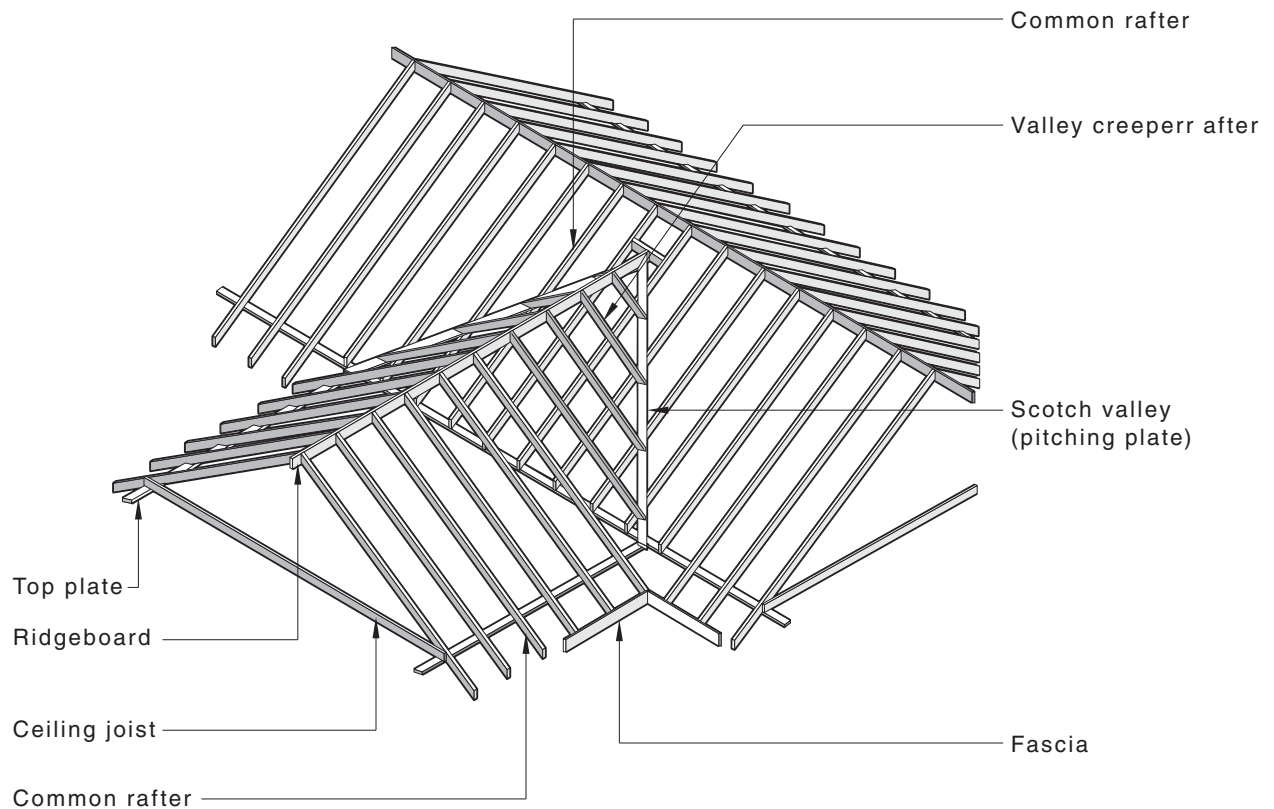
Figure 2.2 — Framing members — Gable roof construction

Dimensions in millimetres



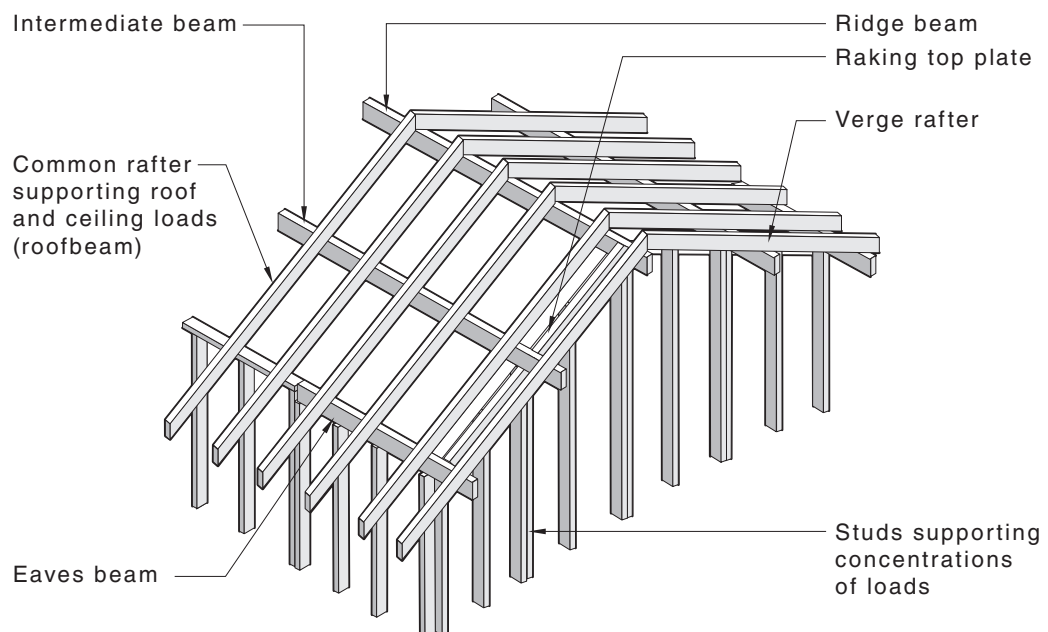
NOTE Some members have been omitted for clarity.

Figure 2.3 — Framing members — Hip and valley roof construction



NOTE Some members have been omitted for clarity.

Figure 2.4 — Framing members — Scotch valley construction



NOTE Some members have been omitted for clarity.

Figure 2.5 — Framing members — Cathedral roof construction

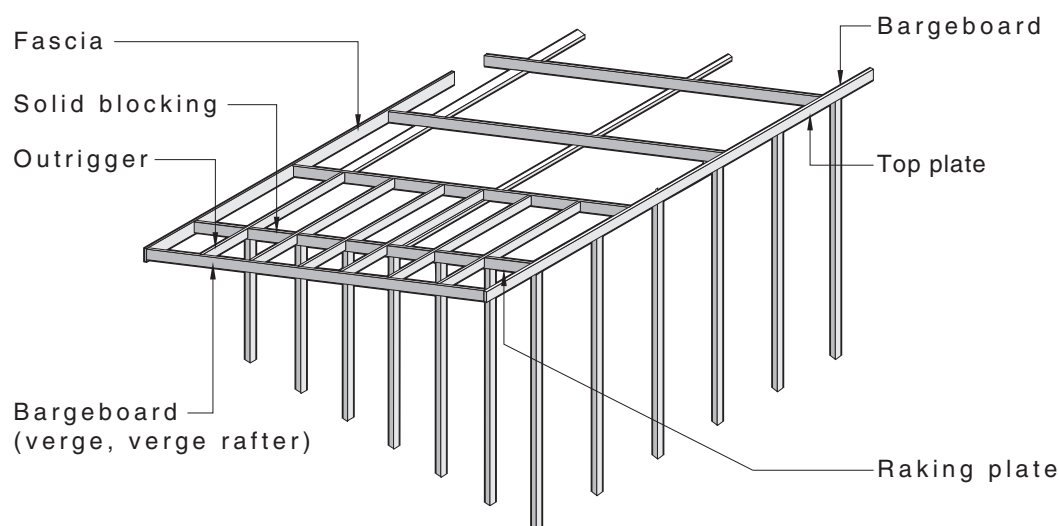
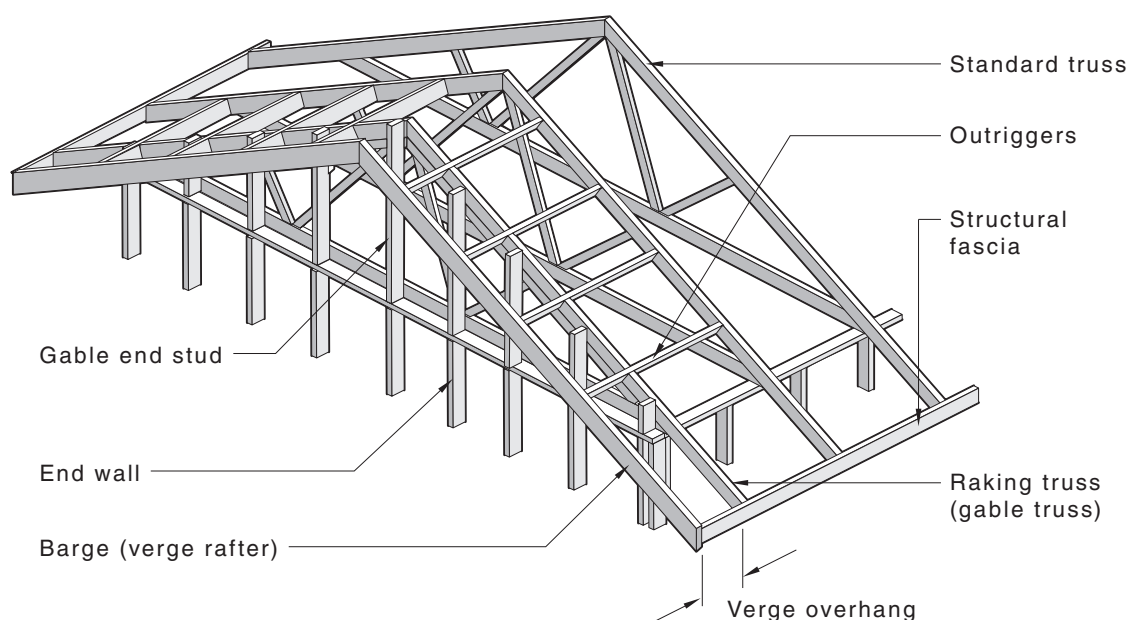


Figure 2.6 — Skillion roof



NOTE This diagram applies to verge overhangs greater than 300 mm from the raking or gable truss (see AS 4440).

Figure 2.7 — Gable end — Trussed roof

2.3 Vertical nail lamination

Vertical nail lamination shall be permitted to achieve the required breadth for the larger section sizes given in the Span Tables in Appendix A using thinner and more readily obtainable sections. This is only permissible using seasoned timber laminations of the same timber type and stress grade. Laminations shall be unjoined in their length. Nails shall be a minimum of 2.8 mm in diameter and shall be staggered as shown in Figure 2.8. They shall be through-nailed and clinched, or nailed from both sides.

Where screws are used in lieu of nails, they shall be minimum No. 10 screws. They may be at the same spacing and pattern, provided they penetrate a minimum of 75 % into the thickness of the final receiving member.

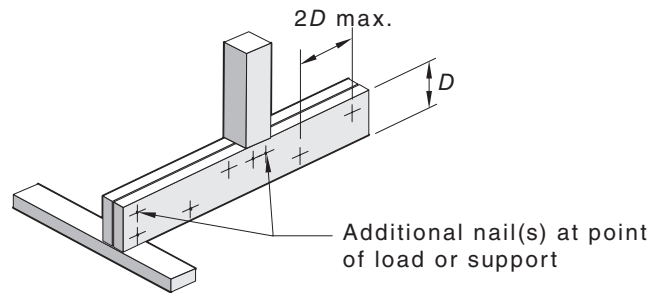


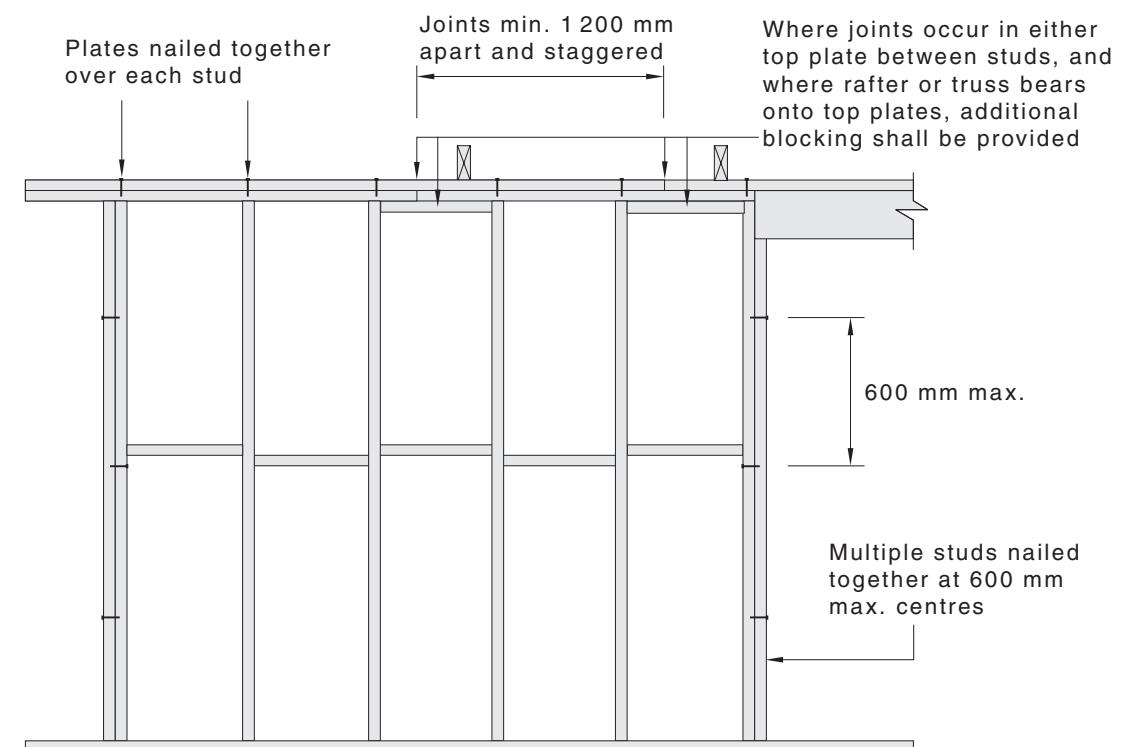
Figure 2.8 — Vertical nail lamination (Strutting beams shown)

2.4 Stud lamination

The required size may be built up by using two or more laminations of the same timber type, stress grade and moisture content condition, provided the achieved width is at least that of the nominated size. Studs up to 38 mm thick shall be nailed together with one 75 mm nail at maximum 600 mm centres. Studs over 38 mm but not exceeding 50 mm thick shall be nailed with one 90 mm nail at maximum 600 mm centres (see Figure 2.9).

Where screws are used in lieu of nails, they shall be minimum No. 10 screws. They may be at the same spacing and pattern, provided they penetrate a minimum of 75 % into the thickness of the final receiving member.

Posts shall not be nail-laminated.



NOTE Refer to Section 9 for other nominal fixing requirements including plates to studs.

Figure 2.9 — Stud or plate lamination

2.5 Horizontal nail lamination — Wall plates only

Wall plates that are made up of more than one section (e.g. $2/35 \times 70$) shall be horizontally nail-laminated in accordance with Figure 2.9, using —

- (a) two 75 mm long nails for plates up to 38 mm deep; or
- (b) two 90 mm long nails for plates up to 50 mm deep (see also Clause 9.2.8).

A minimum of two nails shall be installed at not greater than 600 mm centres along the plate. Where more than two plates are used, the nailing requirement applies to each lamination

All joints in multiple bottom plates shall occur over solid supports such as floor joists, solid blocking between bottom plate and bearer or concrete slab.

Section 3 Substructure

3.1 General

This section sets out the requirements for site preparation, subfloor supports and the determination of footing sizes that are suitable to support timber-framed houses.

3.2 Site preparation and drainage

The clearing and drainage of the site, on which the building is to be erected, shall be adequate to ensure protection of any timber framing or components from the effects of prolonged dampness or insect attack.

3.3 Ground clearance and subfloor ventilation

Ground clearance and subfloor ventilation shall be provided.

NOTE Refer to the National Construction Code for requirements related to ground clearance and subfloor ventilation.

3.4 Termite management

Protection against termites shall be provided.

NOTE Refer to the National Construction Code for requirements related to protection against termites.

3.5 Substructure bracing

The substructure shall be adequately braced (see Section 8).

3.6 Subfloor supports

3.6.1 General

This clause sets out the requirements for the selection of stumps or posts and pad footings or soleplates required to transfer roof, wall and floor loads to the soil foundation.

NOTE 1 The bracing requirements of Section 8 may necessitate the use of alternative footing or post/stump details to those given in this Section.

NOTE 2 For other roof spans, bearer spans, and wind classifications greater than N2, see AS 1684.2.

3.6.2 Footing classification

For the purposes of this clause, footings for stumps or posts are classified as types 1 to 5, as given in Table 3.1. Footing types 1 to 4 are for use in areas where the allowable foundation bearing pressure is at least 100 kPa. Type 5 footings are only suitable where the allowable foundation bearing pressure equals or exceeds 125 kPa.

When measured across the grain, timber soleplates shall not project from the face of the stump or post they support by a distance greater than their own thickness. The maximum projection from the face of the stump along the grain, which could be considered as effective, shall be three times the thickness of the soleplate.

Footings shall be proportioned to evenly distribute vertical and lateral loads from the building to the foundation material such that significant settlement or other movement is prevented. Further provisions, including minimum depth requirements, are given in AS 2870.

Table 3.1 — Footing classification

Footing type	Minimum bearing area m²	Minimum size of unreinforced concrete pad footing mm	Minimum size of timber sole plates mm
1	0.045	230 × 230 × 100 deep <i>or</i> 250 dia. × 100 deep	200 × 225 × 38 thick
2	0.090	300 × 300 × 150 deep <i>or</i> 350 dia. × 150 deep	250 × 360 × 75 thick
3	0.120	350 × 350 × 200 deep <i>or</i> 400 dia. × 200 deep	300 × 400 × 75 thick
4	0.180	430 × 430 × 250 deep <i>or</i> 500 dia. × 200 deep	300 × 600 × 100 thick
5	0.180	430 × 430 × 250 deep <i>or</i> 500 dia. × 200 deep	300 × 600 × 100 thick

3.6.3 Stumps or posts

3.6.3.1 Sizes

Stump or post sizes shall be appropriate to the footing type used, as given in Table 3.2.

The use of stumps or posts in material other than timber shall be subject to the requirements of the relevant authority.

Timber durability and/or preservative treatment shall be appropriate for the expected service conditions.

NOTE Specifications for stumps or posts in material other than timber are given in the BCA.

Table 3.2 — Stump/post sizes

Footing type (see Table 3.1)	Stress grade					
	F4	F5	F7	F8	F11	F14
	Minimum timber stump/post size, mm					
1	100 × 100 <i>or</i> 110 dia.	100 × 100 <i>or</i> 110 dia.	100 × 100 <i>or</i> 110 dia.	100 × 100 <i>or</i> 110 dia.	100 × 100 <i>or</i> 110 dia.	100 × 100 <i>or</i> 110 dia.
2	125 × 125 <i>or</i> 125 dia.	125 × 125 <i>or</i> 120 dia.	100 × 100 <i>or</i> 115 dia.	100 × 100 <i>or</i> 110 dia.	100 × 100 <i>or</i> 110 dia.	100 × 100 <i>or</i> 110 dia.
3	125 × 125 <i>or</i> 135 dia.	125 × 125 <i>or</i> 130 dia.	125 × 125 <i>or</i> 120 dia.	100 × 100 <i>or</i> 115 dia.	100 × 100 <i>or</i> 110 dia.	100 × 100 <i>or</i> 110 dia.
4	150 × 150 <i>or</i> 150 dia.	125 × 125 <i>or</i> 145 dia.	125 × 125 <i>or</i> 135 dia.	125 × 125 <i>or</i> 125 dia.	125 × 125 <i>or</i> 120 dia.	100 × 100 <i>or</i> 115 dia.
5	As approved					

NOTE 1 Stump or post size is also dependent upon height above ground (see Clause 3.6.3.2).

NOTE 2 For termite management, refer to the Building Code of Australia.

Table 3.2 (continued)

Footing type (see Table 3.1)	Stress grade					
	F4	F5	F7	F8	F11	F14
	Minimum timber stump/post size, mm					
NOTE 3 Clause 1.13 is not applicable to this table.						

3.6.3.2 Height

The above-ground height of any stump or post determined by using Table 3.2 shall not exceed 15 times the required minimum face width or diameter.

NOTE Where posts or stumps are designed in accordance with engineering principles, the height limitation may be increased.

3.6.3.3 Embedment

Stump or post embedment in the foundation material shall be at least 0.3 times the stump height above ground level or 450 mm, whichever is the greater.

3.6.4 Footing type support limitations

Tables 3.3, 3.4 and 3.5 give maximum permissible bearer spans for each footing type, based on footing capacity. The Span Tables in Appendix A give maximum bearer spans based on the capacity of the relevant timber cross-section. Both of these requirements shall be satisfied.

Table 3.3 — Bearer spans for footing types 1 to 2 — Bearers supporting floor loads only

Footing type	Bearer spacing, mm		
	1 500	1 800	2 100
	Maximum permissible bearer span, mm		
1	1 900	1 600	1 400
2	3 900	3 300	2 800
NOTE Maximum permissible bearer span is for each footing type. Bearer size is determined from the relevant Span Tables given in Appendix A.			

Table 3.4 — Bearer spans for footing types 1 to 5 — Bearers supporting single storey loadbearing walls

Footing type	Roofing type	Rafter or truss span, mm			
		3 000	6 000	9 000	12 000
		Maximum permissible bearer span, mm			
Bearer spacing up to 1 500 mm					
1	Sheet	1 300	1 100	1 000	NS
2		2 700	2 200	1 900	1 700
3		3 600	3 000	2 500	2 200
4		5 400	4 400	3 800	3 300
5		6 700	5 600	4 800	4 200
1	Tile	1 000	NS	NS	NS
2		1 900	1 500	1 200	1 000
3		2 600	1 900	1 600	1 300
4		3 900	2 900	2 300	1 900
5		4 800	3 600	2 900	2 400

Table 3.4 *(continued)*

Footing type	Roofing type	Rafter or truss span, mm			
		3 000	6 000	9 000	12 000
		Maximum permissible bearer span, mm			
Bearer spacing 1500 to 2100 mm					
1	Sheet	1 000	NS	NS	NS
2		2 100	1 800	1 600	1 400
3		2 800	2 400	2 100	1 900
4		4 200	3 600	3 200	2 800
5		5 200	4 500	4 000	3 600
1	Tile	NS	NS	NS	NS
2		1 600	1 300	1 000	NS
3		2 200	1 700	1 400	1 200
4		3 200	2 500	2 100	1 800
5		4 000	3 200	2 600	2 200
NOTE 1 NS = not suitable.					
NOTE 2 Maximum permissible bearer span is for each footing type. Bearer size is determined from the relevant member Span Tables given in Appendix A.					

Table 3.5 — Bearer spans for footing types 1 to 5 — Bearers supporting two-storey loadbearing walls

Footing type	Roofing type	Rafter or truss span, mm			
		3 000	6 000	9 000	12 000
		Maximum permissible bearer span, mm			
Upper plus lower floor joist spans up to 4 800 mm					
1	Sheet	NS	NS	NS	NS
2		1 100	1 000	NS	NS
3		1 400	1 300	1 200	1 100
4		2 100	2 000	1 800	1 700
5		2 700	2 500	2 300	2 100
1	Tile	NS	NS	NS	NS
2		NS	NS	NS	NS
3		1 200	1 000	NS	NS
4		1 800	1 600	1 400	1 300
5		2 300	2 000	1 800	1 600
Upper plus lower floor joist spans 4 800 to 7 200 mm					
1	Sheet	NS	NS	NS	NS
2		NS	NS	NS	NS
3		1 000	NS	NS	NS
4		1 500	1 400	1 300	1 300
5		1 800	1 700	1 700	1 600
1	Tile	NS	NS	NS	NS
2		NS	NS	NS	NS
3		NS	NS	NS	NS
4		1 300	1 200	1 100	1 000
5		1 700	1 500	1 400	1 200
NOTE 1 NS = not suitable.					
NOTE 2 Maximum permissible bearer span is for each footing type Bearer size is determined from the relevant member Span Tables given in Appendix A.					

Section 4 Floor framing

4.1 General

4.1.1 Application

This section sets out the requirements for the construction of timber-framed floors and shall be used in conjunction with Span Tables A.3 to A.8 and A.38 to A.39 given in Appendix A.

4.1.2 Materials

Any timber species may be used for floor framing, provided it is kept dry; that is, not exposed to weather, well ventilated, not in contact with or close to the ground (see Clause 3.3).

4.1.3 Framing configurations

Various configurations of bearers and joists may be used to support flooring at either the ground level, or at the first floor level including conventional joists over bearers and joists in line with bearers (low profile floor framing).

4.1.4 Weatherproofing

The detailing of wall cladding, flashings and damp-proof course in any construction shall be such that timber floor frame members will be protected from the weather or ground moisture rising through the substructure.

4.1.5 Shrinkage

Where large unseasoned timber members or members with different shrinkage characteristics are used, allowance shall be made for shrinkage.

NOTE Shrinkage associated with the use of small section unseasoned bearers and joists (overall depth of floor frame 200 mm or less) is usually of minimal significance for the overall performance of the structure when using low shrinkage species. Additional allowance should be made for high shrinkage species.

4.1.6 Cuts, holes and notches in bearers and joists

Cuts, holes and notches shall not exceed the sizes, nor be at closer spacing than those, given in Figure 4.1.

Unless otherwise specified, the member size shall not be reduced by any other method to a net section size less than that required to achieve the span requirements.

NOTE 1 Significant imperfections, such as knots, should be regarded as holes with respect to the hole spacing limitations given in Figure 4.1.

NOTE 2 Engineered timber products may have their own specific limitations (see Clause 1.11).

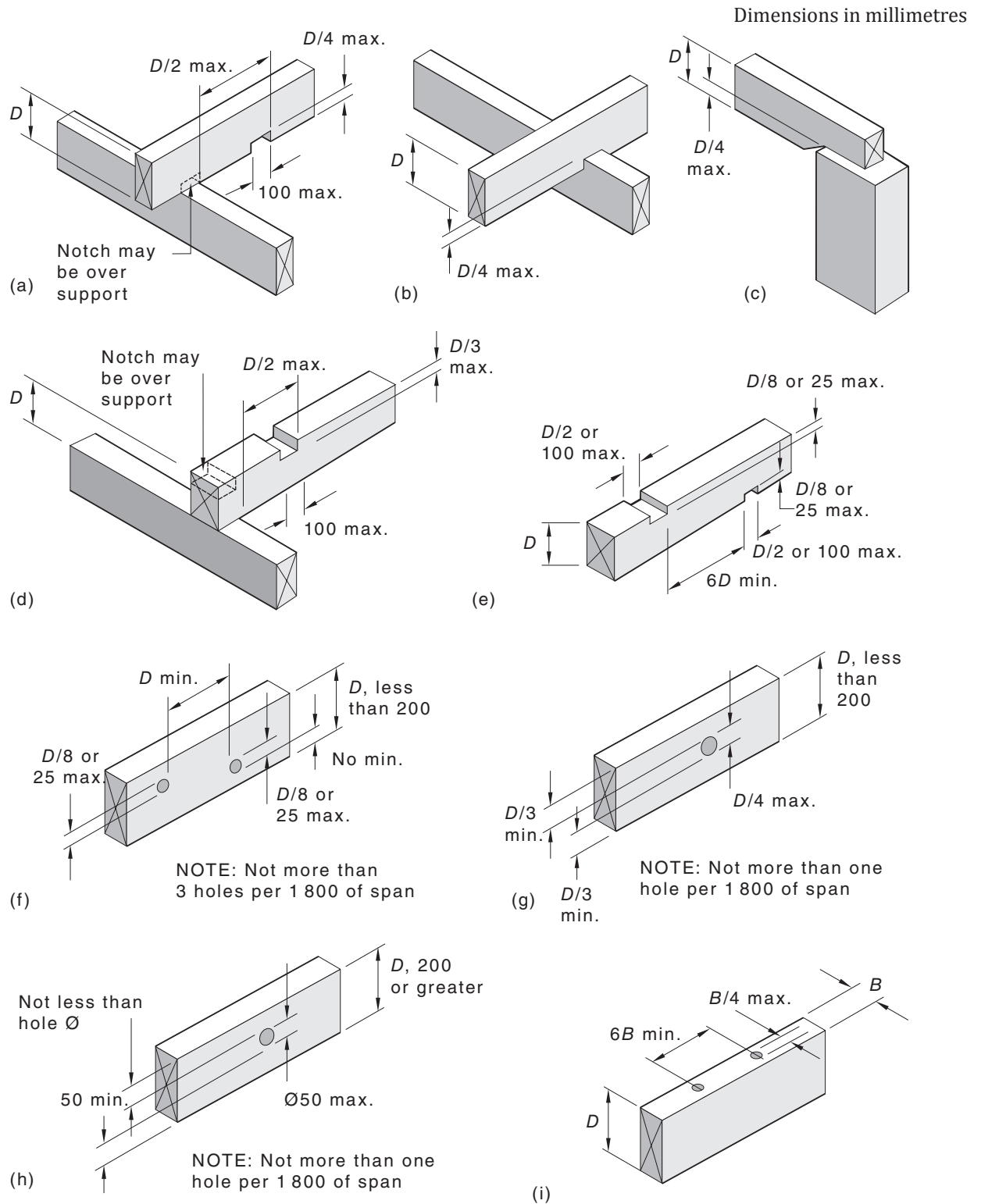


Figure 4.1 — Notches, cuts and holes in beams, bearers, joists, rafters

4.2 Building practice

4.2.1 Bearers

4.2.1.1 General

Bearers shall span between subfloor supports or walls. Bearers may either be single or continuous span over supports (see Clause 1.3.9).

Where required bearers shall be levelled, preferably by checking (notching) out the underside over supports. Packing of minor deficiencies in depth is permitted provided the packing is a corrosion-resistant, incompressible material over the full area of support.

Bearers with minor spring, within the allowable limits, shall have the spring placed to allow for straightening under loading.

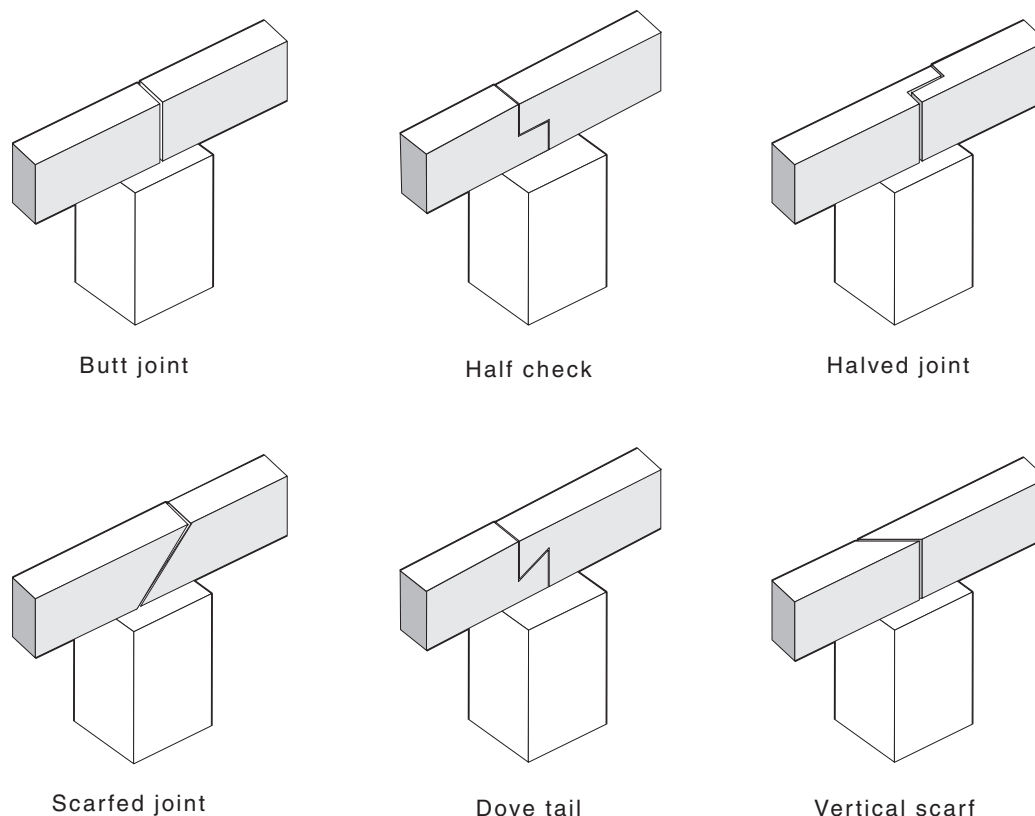
Joints in bearers shall occur only over supports, with adequate bearing for both members. Figure 4.2 shows various connection methods that may be used over supports. All cuts shall be located over the support.

Regardless of their length, if bearers are partially cut through (crippled) over supports to correct bow or spring, they shall be deemed to be supported at two points only, i.e. single span.

The minimum bearing each side of the joint shall be 50 mm.

NOTE 1 Bearers may be planed to within the allowable tolerances of the member specified.

NOTE 2 Some engineered nailplated products may permit joints to occur other than over supports (see Clause 1.11).



NOTE Bearers may also be lapped over supports.

Figure 4.2 — Bearer supports (Alternatives)

4.2.1.2 Fixing of bearers to supports

Except as permitted for masonry veneer construction, bearers shall be fixed to their supporting stumps, posts or columns in such a manner as will give adequate bearing and provide restraint against lateral movement (see Section 9 and Table 9.3).

4.2.1.3 Built-up bearers

The required breadth of larger section bearers may be obtained by vertically nail-laminating thinner sections together (see Clause 2.3).

4.2.2 Joists

4.2.2.1 General

Joists shall be laid with their top surfaces level to receive flooring. The undersides of joists having minor excesses shall be notched over bearers in order to bring them to the required level. Packing of joists having minor deficiencies in depth may be utilized, provided the packing is fixed and is of corrosion-resistant and incompressible material over the full area of contact.

Spacing of joists shall be determined by the span capacity of the flooring (see Section 5). Additional single or double joists shall be provided, where required, to support loadbearing walls parallel to joists (see Clause 4.3.3.4) or flooring (see Clause 5.2).

Joists having minor spring (within allowable limits) shall be laid such as to allow for straightening under loading. Regardless of their length, if joists are partially cut over supports to correct bow or spring they shall be deemed to be supported at two points only (single span). Where cuts are used they shall be located centrally over the support, so that each side of the cut section is adequately supported.

Joints in joists shall be as shown in Figure 4.3 and shall be made only over bearers or supports. Joists joined over bearers or supports shall have minimum 30 mm bearing for each joist. Joints in joists, which are required to be in line (e.g. supporting wall plates or fitted flooring), shall be butted or scarfed, but shall not be lapped.

The minimum length of the lap shall be 3 times the joist depth.

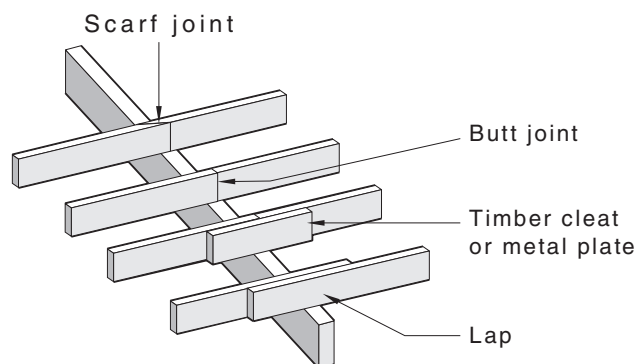


Figure 4.3 — Typical methods of joining joists

4.2.2.2 Location of joists

The following shall apply:

- (a) *Fitted flooring* — For flooring that abuts wall plates, a pair of joists shall be provided under each wall that is parallel to the direction of the joists. These joists shall be spaced to provide solid bearing and fixing for the bottom wall plate and to project not less than 12 mm to give support for fixing of the flooring (see Figure 5.1).

- (b) *Platform flooring* — Where flooring is continuous under wall plates, joists shall be provided directly under all loadbearing walls parallel to the joists (see Clause 4.3.3.4). A single joist only is required under external non-loadbearing walls.

Joists are not required under internal non-loadbearing walls except as required to support flooring.

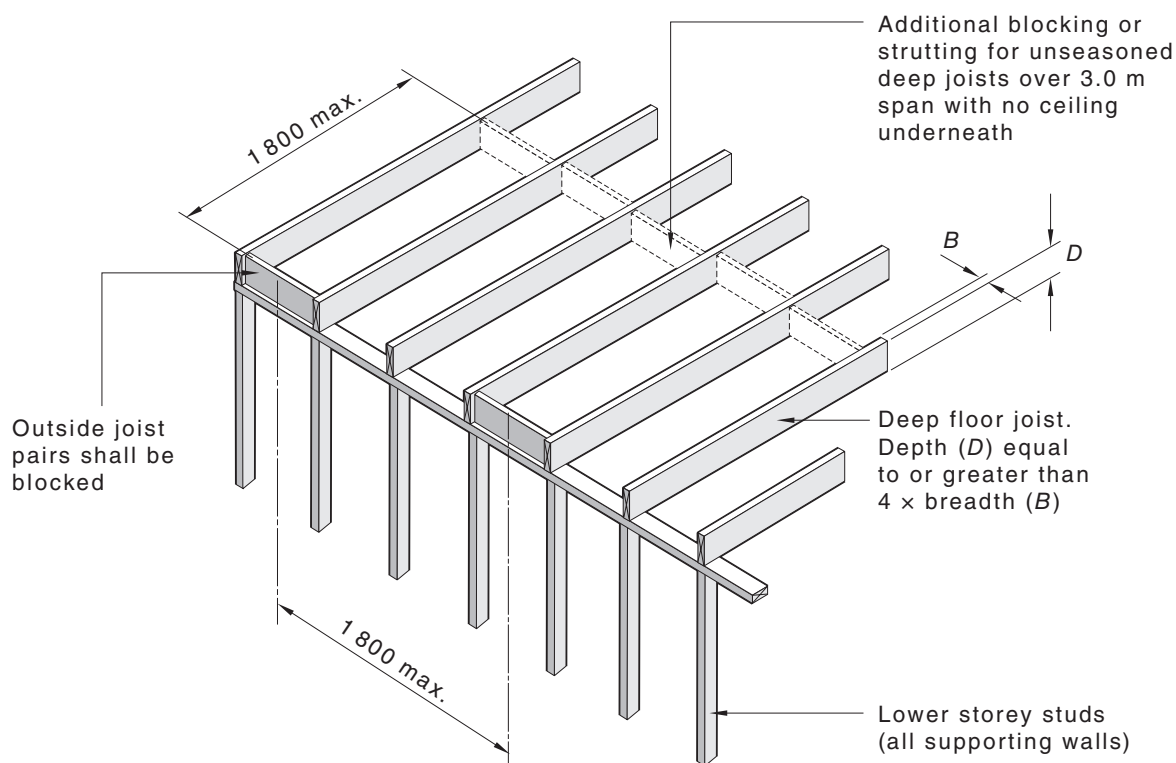
4.2.2.3 Deep joists

Where the depth of floor joists is equal to or exceeds four times the breadth (deep joists), the joists shall be restrained at their supports with either —

- (a) a continuous trimming joist provided to the ends of joists above external bearers or wall plates; or
- (b) solid blocking or herringbone strutting between the outer pairs of joists and between intermediate pairs at not more than 1.8 m centres.

Trimmers or solid blocking may be 25 mm less in depth than the joists (see Figure 4.4) and solid blocking shall be a minimum thickness of 25 mm. Trimmers or solid blocking are not required to be stress graded.

In addition, for deep joists in unseasoned timber where the span exceeds 3.0 m and there is no ceiling installed on the underside of joists, herringbone strutting or solid blocking shall be provided between all joists in evenly spaced rows not exceeding 1 800 mm centres.



NOTE 1 For engineered timber products, see Clause 1.11.

NOTE 2 A temporary batten across the tops of blocked joists, additional blocking or similar fixings, may be necessary to ensure joists do not twist or roll over during construction (prior to fixing of flooring).

Figure 4.4 — Strutting and blocking for deep joisted floors

4.2.2.4 Fixing of joists to bearers or lower wall plates

Joists shall be fixed to bearers at all points of support (see Section 9).

Where joist hangers or specialist connections are utilized, joists shall be completely seated into the hanger and fixed to maintain structural integrity.

4.2.2.5 External floors (decks, verandahs)

When constructing floors that are exposed to the weather (decks, verandahs etc.), attention shall be given to the durability of materials and detailing required to ensure an adequate service life (see Clause 1.7).

4.3 Member sizes

4.3.1 General

Clauses 4.3.2 and 4.3.3 provide details with respect to the determination of floor framing member sizes. Reference shall also be made to the notes accompanying each of the Span Tables given in Appendix A. The Span Tables for joists and bearers are also suitable for decks up to 1 m above ground. For decks over 1 m above ground (refer to AS 1684.2).

4.3.2 Bearers

4.3.2.1 Bearers supporting loadbearing walls

The size of bearers supporting single- or upper-storey loadbearing walls shall be determined from Span Tables A.3 to A.6 in Appendix A.

The size of bearers supporting the lower storey of two-storey loadbearing walls shall be determined from Span Tables A.38 to A.39 in Appendix A. These Tables are applicable to loadbearing walls parallel to the bearers where loads are distributed evenly along the bearers (see Clause 4.3.2.3). For support of other non-uniform loads, see Clause 4.3.2.4.

4.3.2.2 Bearers supporting floor loads only

The size of bearers supporting floor loads only shall be determined from Span Table A.7 in Appendix A.

4.3.2.3 Single- or upper-storey bearers supporting loadbearing walls at right angles

Where loadbearing walls are supported at or within 1.5 times the bearer depth from the bearer support, the bearer may be considered as supporting floor loads only.

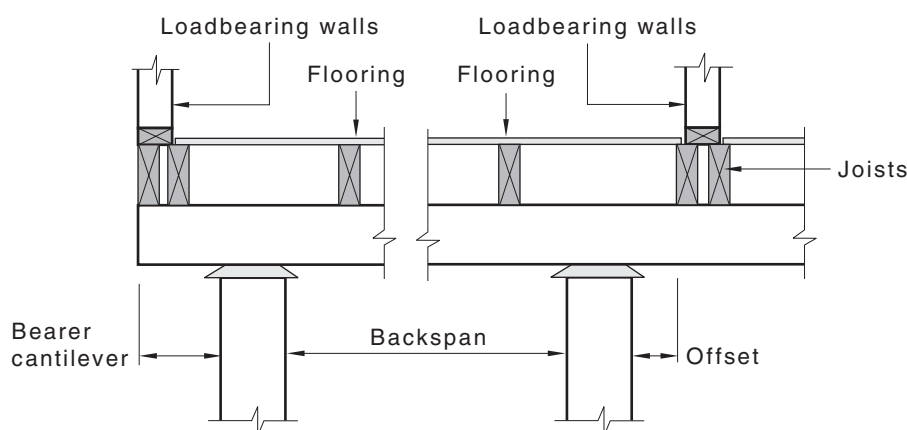
Where the loadbearing wall occurs outside 1.5 times the depth of the bearers from its support, the allowable offset or cantilever shall be determined from Table 4.1 (see Figure 4.5).

Table 4.1 — Bearers supporting loadbearing walls at right angles

Permissible cantilevers and offsets for bearers under loadbearing walls (maximum roof load width 3 600 mm)				
Depth of member mm	Maximum permissible cantilever as proportion of actual backspan %		Maximum permissible offset as proportion of allowable span %	
	Sheet roof	Tile roof	Sheet roof	Tile roof
Up to 125	11	8	22	16
126 to 200	15	10	30	20

Table 4.1 (continued)

Permissible cantilevers and offsets for bearers under loadbearing walls (maximum roof load width 3 600 mm)				
Depth of member mm	Maximum permissible cantilever as proportion of actual backspan %		Maximum permissible offset as proportion of allowable span %	
	Sheet roof	Tile roof	Sheet roof	Tile roof
201 to 275	17	12	34	24
Over 275	19	14	38	28

**Figure 4.5 — Offsets and cantilevers**

4.3.2.4 Single- or upper-storey bearers supporting roof point loads

The maximum roof area contributing to roof point loads that bearers can support are given in Table 4.2.

Table 4.2 — Area of roof point load^a

Roof type	Maximum area of roof supported m ²
Sheet	5
Tiles	2.5

^a Load from a roof strut, strutting beam, girder truss, lintel, and similar members, delivered through studs supporting concentrations of load and studs at sides of openings.

4.3.3 Floor joists

4.3.3.1 General

The size of floor joists shall be determined from Span Table A.8 in Appendix A

Floor joists supporting floor loads only may cantilever up to 25 % of their allowable span provided the minimum backspan is at least twice the cantilever distance.

4.3.3.2 Floor joists supporting non-loadbearing gable or skillion end walls

The size of joists supporting non-loadbearing gable or skillion end walls shall be the same as the adjacent floor joists. Where required for the support of flooring, a single joist shall be used.

4.3.3.3 Floor joists with loadbearing walls at right angles to joists

Where loadbearing walls are offset up to 1.5 times the joist depth from the supporting bearer or wall, the joist may be considered as supporting floor loads only (see Figure 4.6).

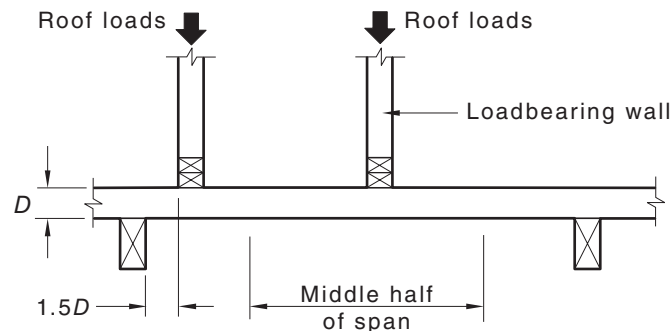


Figure 4.6 — Loadbearing wall offset

4.3.3.4 Single- or upper-storey floor joists supporting roof point loads or loadbearing walls parallel to joists

Floor joist sizes determined from Table A.8 in Appendix A may support roof point loads or loadbearing walls parallel to joists in accordance with Table 4.3. Where multiple joists are used, the maximum rafter span or point load area may be increased in proportion to the number of additional joists.

For rafter spans greater than those given in Table 4.3, the joists may be considered as for bearers in accordance with the bearer Span Tables in Appendix A and an equivalent joist size provided.

Table 4.3 — Joists supporting uniform parallel loads or roof point loads

Roof type	Uniform load parallel to joists	Point load ^a
	Maximum rafter span + overhang mm	Maximum area of roof supported m ²
Sheet	3 600	5
Tile	2 100	2.5

^a Load from a roof strut, strutting beam, girder truss, lintel, and similar members, delivered through studs supporting concentrations of load and studs at sides of openings.

4.3.3.5 Openings in floors

Trimming joists and trimmers supporting curtailed joists shall be of the same size, and shall be not less in size than the associated floor joists.

Trimmers between 1 000 mm and 3 000 mm in length shall have their breadth, including the breadth of trimming joist, increased by at least 20 % more than the common joist breadth for each 300 mm in length, or part thereof, greater than 1 000 mm. Trimmers exceeding 3 000 mm in length shall be designed as bearers.

Trimmers and curtailed joists greater than 1 000 mm in length shall not rely solely on the strength of nails into end grain and shall be suitably connected (e.g. metal nailplate connectors) (see Figure 4.7).

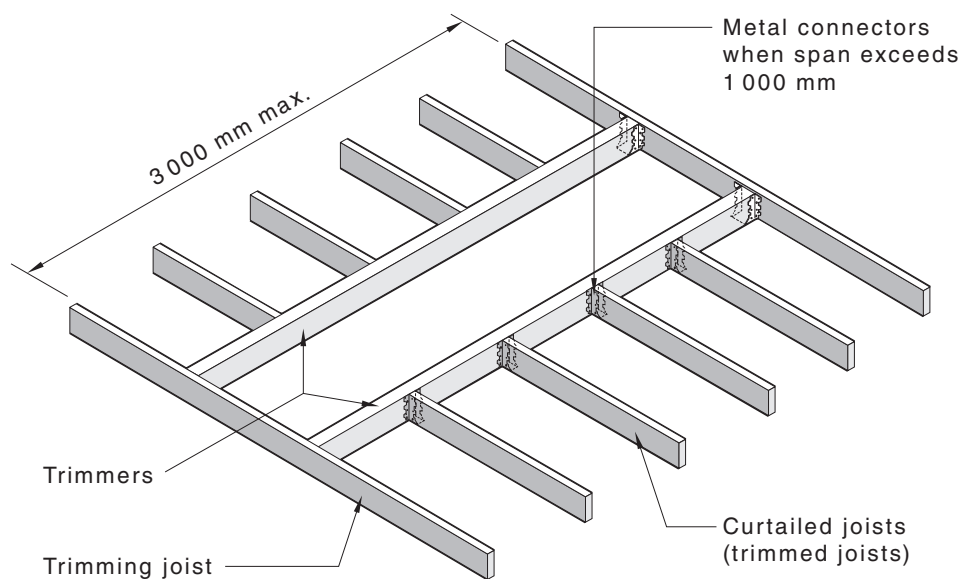


Figure 4.7 — Openings in floors

Section 5 Flooring and decking

5.1 General

This section specifies the requirements for the installation of tongued and grooved strip flooring and decking as well as plywood and particleboard sheet flooring, laid as a structural element directly to joists. It does not include timber flooring (of any thickness) that is fixed over a strip or sheet structural subfloor.

NOTE 1 Appendix E provides information on moisture content of timber flooring.

NOTE 2 Structurally graded tongued and grooved strip flooring is also laid on timber battens over concrete slabs. Span and grade requirements should be the same for floors fixed to joists, although fixings may differ.

5.2 Platform floors

Platform floors are installed continuously on top of joists before wall or roof framing is erected exposing the floor to the weather during construction.

NOTE The platform floor construction method should not be used for tongue and groove solid timber strip flooring where the platform floor is intended to be the final finished surface (polished floor).

5.3 Fitted strip floors (cut-in floors) direct to joists

Fitted tongued and grooved strip floors (cut-in floors) are installed to joists after walls have been erected, and after roofing, wall cladding, doors and windows have been installed. Where boards are laid parallel with walls, a minimum 10 mm gap shall be provided between the board adjacent to the bottom plate and the bottom plate, as shown in Figure 5.1.

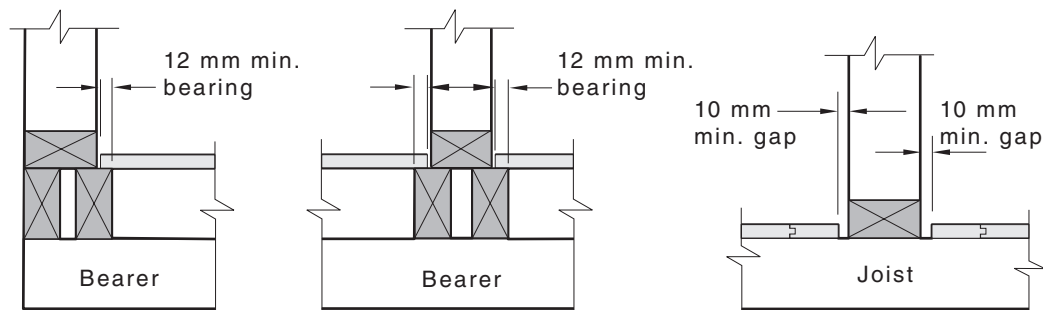


Figure 5.1 — Fitted floors

5.4 Expansion joints in strip floors direct to joists

For continuous floor widths over 6 m, measured at right angles to flooring, intermediate expansion joints shall be provided across the floor width in addition to the perimeter gaps. Each expansion joint shall be either a 12 mm wide cork-filled gap (with blocking beneath) within the floor, or of smaller gaps with closer spacings to give an equivalent space e.g. 1 mm gaps at 1 m spacing or loose cramping. A combination of cork and smaller gaps may be used.

NOTE To manage expansion in high humidity locations, a combination of acclimatization and more allowance for intermediate expansion should be considered.

5.5 Laying and fixing strip and sheet flooring direct to joists

5.5.1 Structural strip flooring — laying

End-matched flooring may be laid with end joints between joists, provided end joints are joined tightly together and well distributed and end-matched joints in adjoining boards do not fall within the same joist spacing. Board lengths shall be at least the equivalent of two joist spacings, see Figure 5.2. Finger-jointed hardwood flooring that is manufactured in accordance with AS 2796.1 shall be considered equivalent to continuous strip flooring.

Butt joints shall be cut square and butted tightly together over floor joists. Joints in adjoining boards shall be staggered, see Figure 5.2.

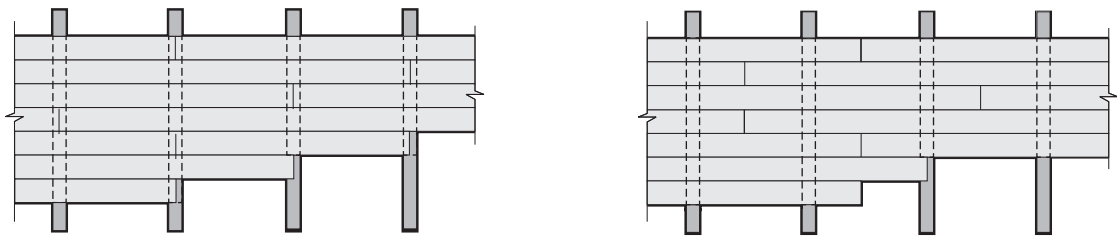


Figure 5.2 — End joints

5.5.2 Structural strip flooring — cramping and fixing

5.5.2.1 General

Tongues shall be fitted into grooves and boards cramped together, ensuring that the boards are bedded firmly on floor joists. Boards shall be in contact with the joists at the time of nailing.

5.5.2.2 Fixing

Boards up to 65 mm cover width shall be fixed by face-nailing with one nail at each joist. Boards over 65 mm and up to 85 mm wide shall be fixed by face-nailing with two nails or shall be secret-nailed with one fixing at each joist, see Figure 5.4. Boards over 85 mm cover width shall be fixed with two face-nails at each joist. Alternate nails in double-nailed boards shall be skewed slightly to the vertical, in opposing directions (see Figure 5.3). The minimum edge distance for nailing at butt joints or board ends shall be 12 mm. For boards over 85 mm cover width, the mechanical fixing shall be supplemented by a minimum 6 mm bead of polyurethane or polymer flooring adhesive to the top surface of the joist prior to board fixing.

NOTE 1 All nails, including machine-driven nails, should be punched a minimum of 3 mm below the top surface. Nail punching should allow for sanding and finishing and drawing boards tightly onto joists.

NOTE 2 Pre-drilling boards for fixings at butt ends aids in reducing splitting.

NOTE 3 For boards up to 85 mm wide, a minimum 6 mm bead of polyurethane or polymer flooring adhesive to the top surface of the joist prior to board fixing assists with board fixing and minimize squeaking.

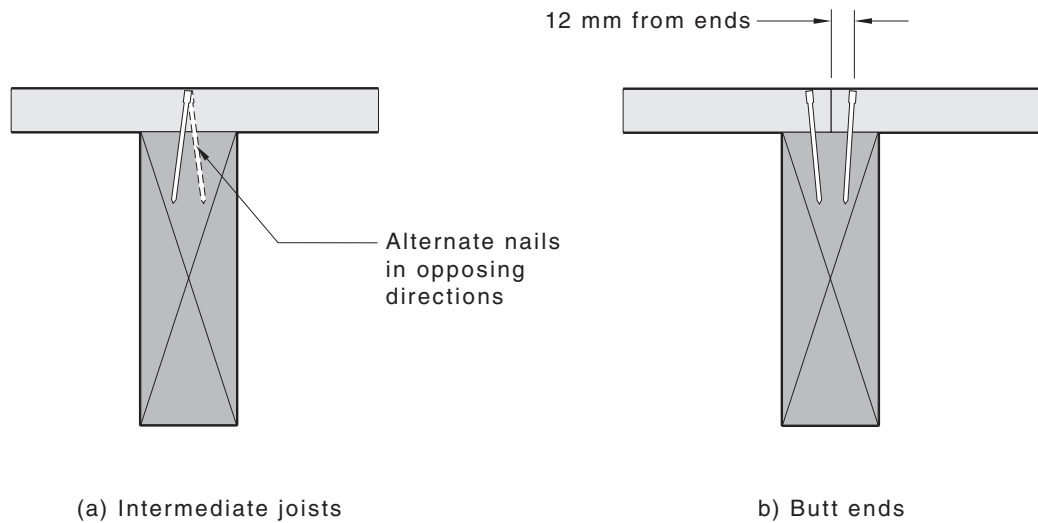
The nail sizes for face nailing flooring up to 21 mm thick shall be as given in Table 5.1.

Table 5.1 — Nail sizes for fixing tongued and grooved flooring to joists

Nailing	Hardwood, softwood, LVL and I-beam joists
Hand-driven	50 mm × 2.8 mm bullet-head
Machine-driven	50 mm × 2.5 mm
	or

Table 5.1 (continued)

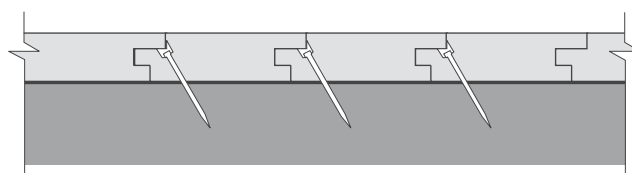
Nailing	Hardwood, softwood, LVL and I-beam joists
	50 mm × 2.2 mm with minimum 6 mm glue bead to joist

**Figure 5.3 — Face nailing**

The fixing sizes for secret nailing flooring up to 19 mm thick and 85 mm in width shall be as given in Table 5.2. The mechanical fixing shall be supplemented by a minimum 6 mm bead of polyurethane or polymer flooring adhesive to the top surface of the joist prior to board fixing.

Table 5.2 — Fixing sizes for secret fixing tongued and grooved flooring to joists

Nailing	Softwood, LVL and I-beam joists	Hardwood and cypress joists
Machine-driven	50 × 15 gauge staples or 50 × 16 gauge cleats	45 × 15 gauge staples or 45 × 16 gauge cleats

**Figure 5.4 — Secret nailing**

5.5.3 Structural plywood flooring — laying and fixing

5.5.3.1 General

Structural plywood shall be in accordance with AS/NZS 2269.0. The thickness shall be determined from Table 5.3 except that it shall be not less than 15 mm thick.

5.5.3.2 Laying

Plywood panels shall be laid with the face grain of the plies at right angles to the line of the supporting joists and shall be continuous over at least two spans. Ends of sheets shall be butted over joists and

joined over noggings between joists of a minimum size of 70 × 35 mm set flush with the top of the joists. Edge sheets, unless tongue and grooved, shall be joined over noggings between joists.

5.5.3.3 Fixing

Nails used for fixing plywood shall be either 2.8 mm diameter flat-head or bullet-head hand-driven nails or 2.5 mm diameter machine-driven nails and of a length of not less than 2.5 times the thickness of the panel. Nails shall be spaced at 150 mm centres at panel ends and at 300 mm centres at intermediate joists and along noggings. Nails shall be not less than 10 mm from edge of sheets.

Deformed shank nails shall be used where a resilient floor covering is fixed directly to the plywood.

Structural adhesive or deformed shank nails shall be used where plywood is fixed to unseasoned floor joists of depth greater than 150 mm.

Where possible, panel ends shall be staggered.

Structural plywood flooring shall not be cramped during installation.

Structural elastomeric adhesive shall be used in a designated wet area.

NOTE When overlay tongue and groove flooring with average dry densities above 750 kg/m³ are intended to be mechanically and adhesive fixed to the plywood subfloor, then screw and adhesive fixing of the plywood to the joists in accordance with the sheet manufacturer's specification should be used.

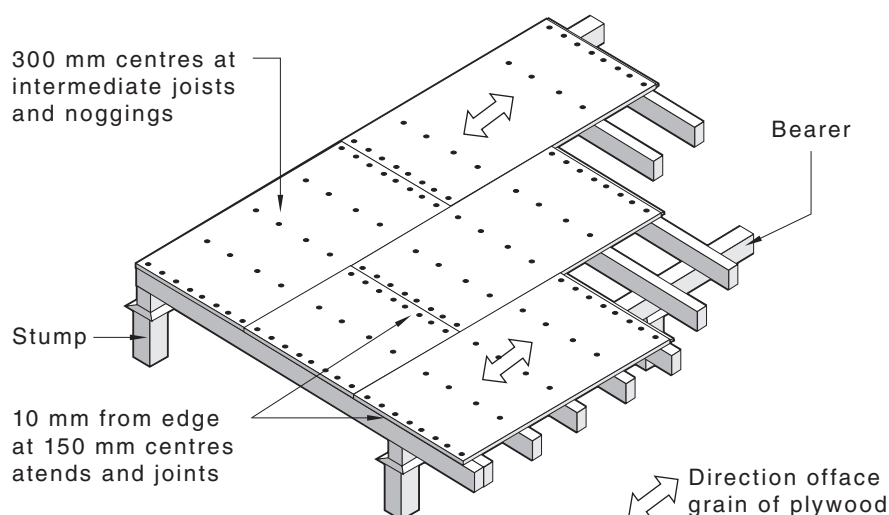


Figure 5.5 — Fixing of plywood sheet flooring

5.5.4 Structural Particleboard flooring — laying and fixing

5.5.4.1 General

Particleboard flooring shall be laid and fixed in accordance with AS 1860.2.

5.5.4.2 Laying

Sheets shall span not less than two floor joist spacings.

Square edges and ends of sheets shall be butted centrally over joists or on trimmers or blocking.

5.5.4.3 Fixing

Sheets shall be securely glued and nailed to the top edge of the joists. Nails shall be 10 mm from all edges and at 150 mm centres at ends and butt joints for square edge sheets. Nails shall be at 300 mm max. centres at intermediate joists or nogging.

NOTE When overlay tongue and groove flooring with average dry densities above 750 kg/m³ are intended to be mechanically and adhesive fixed to the particleboard subfloor, then screw and adhesive fixing of the particleboard to the joists in accordance with the sheet manufacturer's specification should be used.

5.6 Joist spacing — Flooring

The maximum allowable spacing of supports for tongued and grooved strip and sheet flooring shall be in accordance with Table 5.3.

Table 5.3 shall not be used for plywood in which the outer veneers are thinner than any or all of the inner veneers. For plywood sheets supported over one span only, the tabulated spacings shall be reduced by 25 %.

Table 5.3 — Structural flooring — Maximum allowable spacing of joists

Flooring	Standard	Grade	Thickness mm	Maximum spacing of joists mm	
				Butt joined	End matched
Strip flooring					
Australian hardwoods	AS 2796.1	Select Medium feature — Standard	19 19	680 620	520 470
Other hardwoods — Density less than 560 kg/m³ — Density greater than 560 kg/m³	AS 2796.1	Medium feature — Standard Medium feature — Standard	19 19	510 580	390 450
Cypress	AS 1810	Grade 1 Grade 2	19 20	580 580	450 450
Radiata Pine	AS 4785.1	Standard Utility Standard	19 19 30	450 510 920	390 — 700
Softwood other than cypress or radiata pine: —Density less than 560 kg/m³ —Density greater than 560 kg/m³	AS 4785.1	Standard Standard	19 19	510 580	390 450
Sheet flooring					
	Standard	Thickness mm	Maximum spacing of joists, mm		
			Grade		
			F8	F11	F14

Table 5.3 (continued)

Flooring	Standard	Grade	Thickness mm	Maximum spacing of joists mm	
				Butt joined	End matched
Plywood (see Note 3)	AS/NZS 2269.0	12	400	420	440
		13	430	450	480
		14	460	480	510
		15	480	520	540
		16	510	540	570
		17	540	560	600
		18	560	590	620
		19	590	620	660
		20	610	650	680
		21	640	670	710
		22	660	700	740
Particleboard (see Note 4)	AS/NZS 1860.1	See AS/NZS 1860.1			
NOTE 1 An allowance has been made for light sanding.					
NOTE 2 Strip flooring boards may be regraded after elimination of imperfections by docking.					
NOTE 3 For plywood flooring thicknesses detailed above, it has been assumed that in any thickness of plywood the veneers are all of equal thickness. For plywood of a given total thickness, the dimensions listed in this Table will be slightly conservative if the outer veneers are thicker than any or all of the inner veneers.					
NOTE 4 For full details on particleboard flooring, see AS/NZS 1860.1.					

5.7 Decking

The maximum allowable spacing of joists for timber decking shall be in accordance with Table 5.4 (see also Clause 4.3.3).

For decking boards of nominal width up to 140 mm, the specifications in Tables 5.4 and 5.5 shall apply.

NOTE Spacing of decking boards should allow for possible shrinkage and/or expansion in service.

Table 5.4 — Decking boards

Decking	Minimum grade	Thickness mm	Maximum joist spacing mm
Hardwood	Standard grade (AS 2796.1)	19	500
Cypress	Grade 1 (AS 1810)	19	400
		21	450
Treated softwood	Standard grade (AS 4785.1)	19	400
		22	450
NOTE Pre-drilling at ends and butt ends will aid in reducing splitting of decking boards.			

Decking-board fixing requirements for decking up to 22 mm thickness shall be in accordance with Table 5.5.