AS 1684.2:2021

Residential timber-framed construction

Part 2: Non-cyclonic areas

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Residential timber-framed construction

Part 2: Non-cyclonic areas

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Preface

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee TM-010, Timber Structuring and Framing, to supersede AS 1684.2—2010.

The objective of this Standard 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 constructions in non-cyclonic areas.

The objectives of this revision are to —

(a) make editorial revisions and some technical changes to correct mistakes and clarify the application of the document;

(b) amend Section 5: Flooring and Decking to remove ambiguities and to reflect current research and experience which is able to provide for a quieter and more robust floor;

(c) amend Table 9.25 of AS1684.2 to include suitable nail and screw fixings for 45mm thick roof battens;

(d) reversing the values in Table 8.18 to represent JD5 capacities, while continuing to recognise JD4 capacities (an increase the values by 12.5%) where this is known;

(e) amend AS 1684.2 and AS 1684.3 to provide a suitable deemed-to-satisfy detail for metal tie down to timber connection that is compatible with AS 4773; and

(f) relaxing the notching requirements for non-loadbearing walls.

This is Part 2 of a series of Standards for residential timber-framed construction. The Standards in the series are as follows:

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*

AS 1684.4, *Residential timber-framed construction, Part 4: Simplified — Non-cyclonic areas*

While AS 1720.3-2016 Design Criteria for timber-framed residential building supersedes AS 1684.1:1999, notwithstanding this, AS 1684.1:1999 is not withdrawn as a standard, and remains relevant as the basis for Parts 2-4. AS 1684.4:2010 (derived from AS 1684.2:2010) remains current.

This Standard refers to Supplements that are an integral part of this Standard. Statements expressed in mandatory terms in Notes to the Span Tables in the Supplements are deemed to be requirements of this Standard.

Notes to the text contain information and guidance. They are not an integral part of the Standard.

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.

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Australian Standard®

Residential timber-framed construction

Part 2: Non-cyclonic areas

Section 1 Scope and general

1.1 Scope and application

1.1.1 Scope

This Standard specifies requirements for building practice and 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 National Construction Code and within the limitations given in Clause 1.4. The provisions of this Standard also apply to alterations and additions to such buildings.

This Standard 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 Standard 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 Standard.

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

NOTE 2 While this Standard 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 FWPA's Design Guide 8, see Bibliography.

1.1.2 Application

Throughout this Standard, reference is made to the Span Tables in the Supplements. The Supplements are an integral part of, and shall be used in conjunction with, this Standard.

The Supplements are as follows:

Supplement 0, *General introduction and index*

N1/N2 Supp. 1, *Wind classification N1/N2 — Seasoned softwood — Stress grade F5*

N1/N2 Supp. 2, *Wind classification N1/N2 — Seasoned softwood — Stress grade F7*

N1/N2 Supp. 3, *Wind classification N1/N2 — Seasoned softwood — Stress grade F8*

N1/N2 Supp. 4, *Wind classification N1/N2 — Seasoned softwood — Stress grade MGP 10*

N1/N2 Supp. 5, *Wind classification N1/N2 — Seasoned softwood — Stress grade MGP 12*

N1/N2 Supp.6, *Wind classification N1/N2 — Seasoned softwood — Stress grade MGP 15*

N1/N2 Supp. 7, *Wind classification N1/N2 — WA seasoned hardwood — Stress grade F14*

N1/N2 Supp. 8, *Wind classification N1/N2 — Seasoned hardwood — Stress grade F17*

N1/N2 Supp. 9, *Wind classification N1/N2 — Seasoned hardwood — Stress grade F27*

N1/N2 Supp. 10, *Wind classification N1/N2 — Unseasoned softwood — Stress grade F5*

N1/N2 Supp. 11, *Wind classification N1/N2 — Unseasoned softwood — Stress grade F7*

N1/N2 Supp. 12, *Wind classification N1/N2 — Unseasoned hardwood — Stress grade F8*

N1/N2 Supp. 13, *Wind classification N1/N2 — Unseasoned hardwood — Stress grade F11*

N1/N2 Supp. 14, *Wind classification N1/N2 — Unseasoned hardwood — Stress grade F14*

N1/N2 Supp. 15, *Wind classification N1/N2 — Unseasoned hardwood — Stress grade F17*

N3 Supp. 1, *Wind classification N3 — Seasoned softwood — Stress grade F5*

N3 Supp. 2, *Wind classification N3 — Seasoned softwood — Stress grade F7*

N3 Supp. 3, *Wind classification N3 — Seasoned softwood — Stress grade F8*

N3 Supp. 4, *Wind classification N3 — Seasoned softwood — Stress grade MGP 10*

N3 Supp. 5, *Wind classification N3 — Seasoned softwood — Stress grade MGP 12*

N3 Supp. 6, *Wind classification N3 — Seasoned softwood — Stress grade MGP 15*

N3 Supp. 7, *Wind classification N3 — WA seasoned hardwood — Stress grade F14*

N3 Supp. 8, *Wind classification N3 — Seasoned hardwood — Stress grade F17*

N3 Supp. 9, *Wind classification N3 — Seasoned hardwood — Stress grade F27*

N3 Supp. 10, *Wind classification N3 — Unseasoned softwood — Stress grade F5*

N3 Supp. 11, *Wind classification N3 — Unseasoned softwood — Stress grade F7*

N3 Supp. 12, *Wind classification N3 — Unseasoned hardwood — Stress grade F8*

N3 Supp. 13, *Wind classification N3 — Unseasoned hardwood — Stress grade F11*

N3 Supp. 14, *Wind classification N3 — Unseasoned hardwood — Stress grade F14*

N3 Supp. 15, *Wind classification N3 — Unseasoned hardwood — Stress grade F17*

N4 Supp. 1, *Wind classification N4 — Seasoned softwood — Stress grade F5*

N4 Supp. 2, *Wind classification N4 — Seasoned softwood — Stress grade F7*

N4 Supp. 3, *Wind classification N4 — Seasoned softwood — Stress grade F8*

N4 Supp. 4, *Wind classification N4 — Seasoned softwood — Stress grade MGP 10*

N4 Supp. 5, *Wind classification N4 — Seasoned softwood — Stress grade MGP 12*

N4 Supp. 6, *Wind classification N4 — Seasoned softwood — Stress grade MGP 15*

N4 Supp. 7, *Wind classification N4 — WA seasoned hardwood — Stress grade F14*

N4 Supp. 8, *Wind classification N4 — Seasoned hardwood — Stress grade F17*

N4 Supp. 9, *Wind classification N4 — Seasoned hardwood — Stress grade F27*

N4 Supp. 10, *Wind classification N4 — Unseasoned softwood — Stress grade F5*

N4 Supp. 11, *Wind classification N4 — Unseasoned softwood — Stress grade F7*

N4 Supp. 12, *Wind classification N4 — Unseasoned hardwood — Stress grade F8*

N4 Supp. 13, *Wind classification N4 — Unseasoned hardwood — Stress grade F11*

N4 Supp. 14, *Wind classification N4 — Unseasoned hardwood — Stress grade F14*

N4 Supp. 15, *Wind classification N4 — Unseasoned hardwood — Stress grade F17*

The Span Tables for unseasoned hardwood F8 and F11 may be used for unseasoned F8 and F11 softwood as well.

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

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 1691, *Domestic oil-fired appliances — Installation*

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

AS 1720.5, *Timber structures, Part 5: Naiplated timber roof trusses*

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

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

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

AS 2870, *Residential slabs and footings*

AS 3700, *Masonry structures*

AS 4055, *Wind loads for housing*

AS 4440, *Installation of nailplated timber trusses*

AS 4773.1, *Masonry in small buildings, Part 1: Design*

AS 4785.1, *Timber — 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 1604, *Specification for preservative treatment (all Parts)*

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

1.3 Terms and definitions

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

1.3.1
loadbearing wall
wall that supports roof or floor loads, or both roof and floor loads

1.3.2
may
indicates the existence of an option

1.3.3
non-loadbearing walls
1.3.3.1
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.

1.3.3.2
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

1.3.4
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.

1.3.5
rim board
member at right angles to and fixed to the end of deep joists (including I-joists) that provides restraint to the joists

1.3.6
roof
1.3.6.1
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 7.2.16, and rafters and ceiling joists securely fixed to the same top plate or to each other if they align, see Table 9.4. 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.

1.3.6.2
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.

1.3.6.3
pitched roof
roof where members are cut to suit, and which is erected on site

1.3.6.4
trussed roof
engineered roof frame system designed to carry the roof or roof and ceiling, usually without the support of internal walls

1.3.7
shall
indicates that a statement is mandatory

1.3.8
should
indicates a recommendation

1.3.9
spacing and span
1.3.9.1
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”.

1.3.9.2
span
face-to-face distance between points capable of giving full support to structural members or assemblies

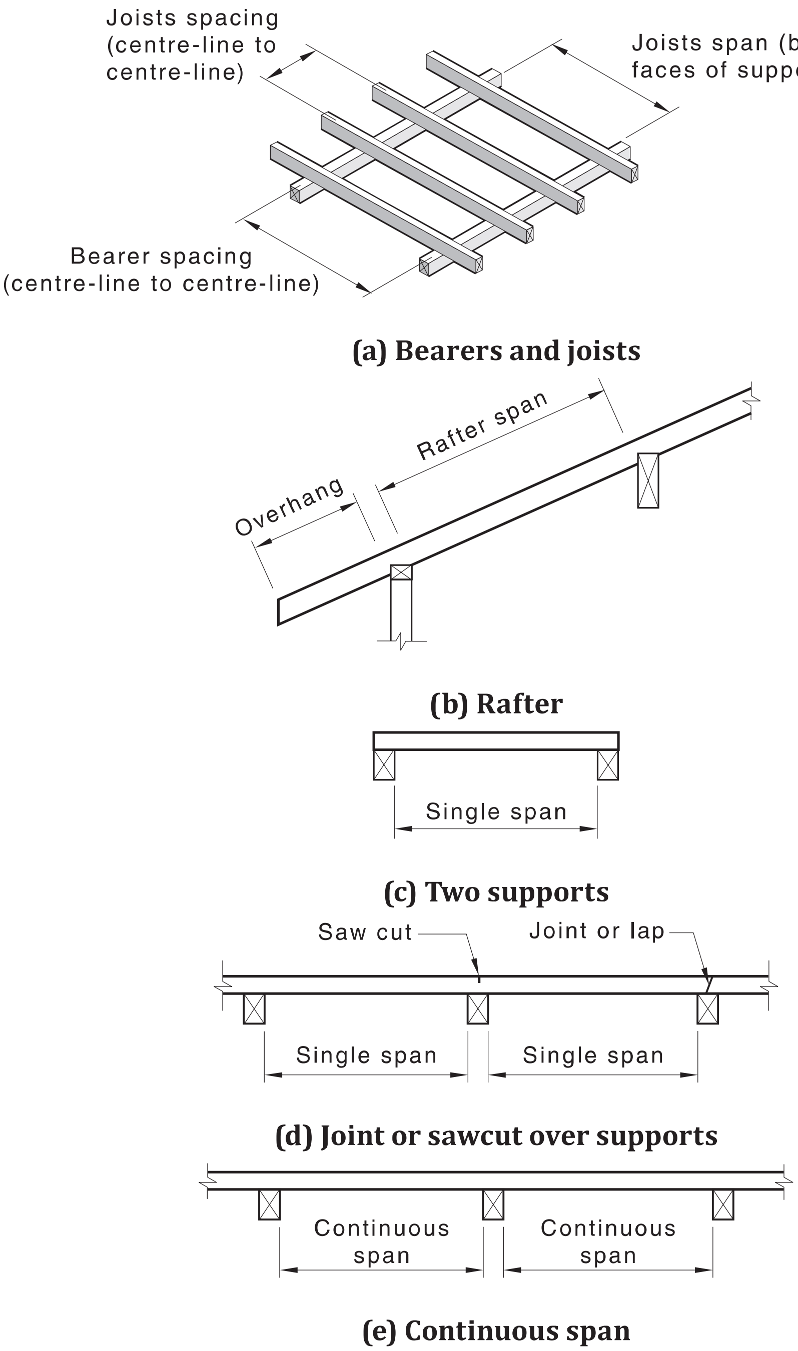
Note 1 to entry: In particular, rafter spans are measured as the distance between points of support along the length of the rafter and not as the horizontal projection of this distance.

1.3.9.3
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).

1.3.9.4
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.



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

1.3.10
stress grade
classification of timber to indicate, for the purposes of design, a set of structural design properties in accordance with AS 1720.1

1.3.11
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

1.3.12
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 Standard 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 1.4.10 and Figure 1.2.

1.4.2 Wind classification

For wind loads, the simplified wind classifications for non-cyclonic areas N1 to N4, 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 Standard.

The wind classifications covered by this Standard shall be 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 Standard. 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 5 % greater 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 the building height, terrain category, topographic classification and shielding classification given in AS/NZS 1170.2 or AS 4055.

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

Table 1.1 — Maximum design gust wind speed

Wind classification regions A and B	Maximum design gust wind speed, ms		
	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
N3	41 (W41N)	32	50
N4	50 (W50N)	39	61

1.4.3 Plan

Building shapes shall be essentially rectangular, square, L-shaped or a combination of rectangular elements including splayed-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 16 000 mm, excluding eaves, see Figure 1.2.

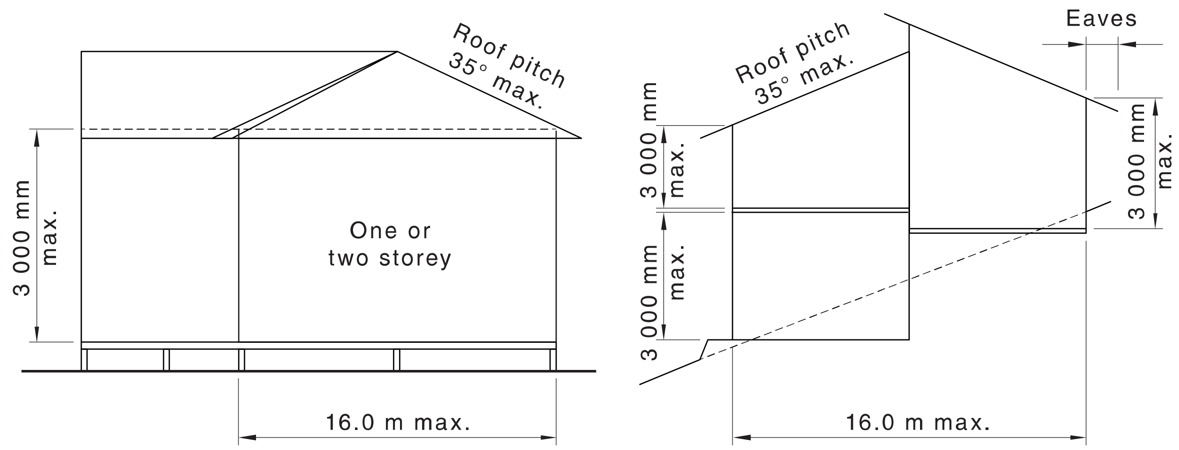
1.4.6 Wall height

The maximum wall height shall be 3 000 mm (floor to ceiling, as measured at common external walls, i.e. not gable or skillion ends), see Figure 1.2.

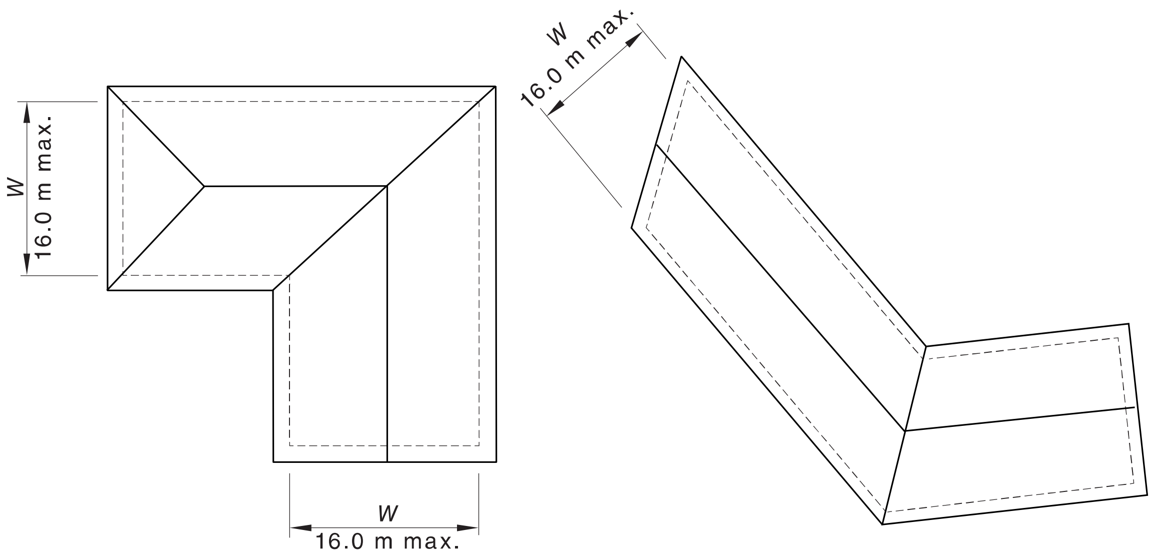
NOTE 1 The Span Tables provide for stud heights in excess of 3 000 mm to cater for gable, skillion and some other design situations where wall heights, other than those of common external walls, may exceed 3 000 mm.

NOTE 2 Building height limitations apply where wind classification is determined using AS 4055, see Clause 1.4.2.

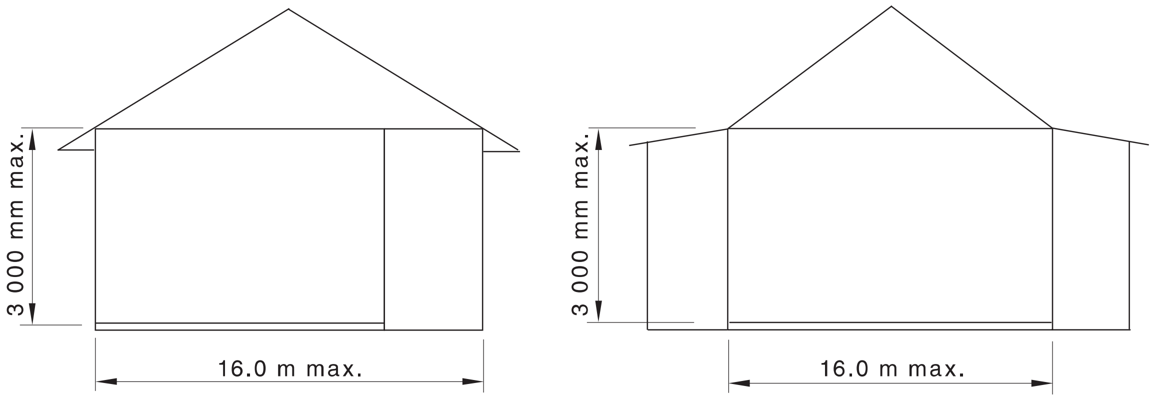
NOTE 3 The provisions contained in this Standard may also be applicable to houses with external wall heights up to 3 600 mm where appropriate consideration is given to the effect of the increased wall height on racking forces, reduction to bracing wall capacities, overturning and uplift forces, shear forces and member sizes.



(a) Sections



(b) Plan



(c) Verandahs

NOTE 1 Building height limitations apply where wind classification is determined using AS 4055, see Clause 1.4.2. See also Clause 1.4.4.

NOTE 2 Member sizes may be limited by the maximum roof load widths (*RLW*) given in the Span Tables in the Supplements.

Figure 1.2 — Geometric building parameters

1.4.7 Roof pitch

The maximum roof pitch shall be 35° (70:100).

1.4.8 Spacing of bracing

For single or upper storey construction, the spacing of bracing elements, measured at right angles to elements, shall not exceed 9 000 mm, see Section 8.

For the lower storey of two storey or subfloor of single or two storey construction, bracing walls shall be spaced in accordance with Clause 8.3.5.9.

NOTE Bracing walls may be spaced greater than the prescribed limits where the building is designed and approved in accordance with engineering principles.

1.4.9 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.

1.4.10 Building masses

Building masses appropriate for the member being designed shall be determined prior to selecting and designing from the Span Tables in the Supplements. Where appropriate, the maximum building masses relevant to the use of each member Span Table are noted under the Table.

The roof mass shall be determined for the various types of roof construction for input to the Span Tables in the Supplements for rafters or purlins, intermediate beams, ridge beams and underpurlins.

For rafters or purlins, mass of roof shall include all supported materials. For underpurlins, mass of roof shall include all supported materials except the rafters that are accounted for in the design. For counter beams, strutting beams, combined hanging strutting beams, and similar members, the mass of roof framing (rafters, underpurlins) is also accounted for in the Span Tables in the Supplements.

The mass of a member being considered has been accounted for in the design of that member.

NOTE Appendix A provides guidance and examples on the determination of masses.

1.5 Design criteria

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

(a) The bases of the design used in the preparation of this Standard are AS 1684.1 and AS 1720.1.

(b) The design dead, live, and wind loadings specified 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 also Clause 1.4.2.

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

(c) All pressures, loads, forces and capacities given in this Standard are based on limit state design.

(d) The member sizes, bracing and connection details are suitable for construction (including timber-framed brick veneer) of design category H1 and H2 domestic structures in accordance with AS 1170.4.

NOTE 2 This Standard does not provide specifications for unreinforced masonry construction subject to earthquake loads.

NOTE 3 Typical unreinforced masonry may include masonry bases for timber-framed houses.

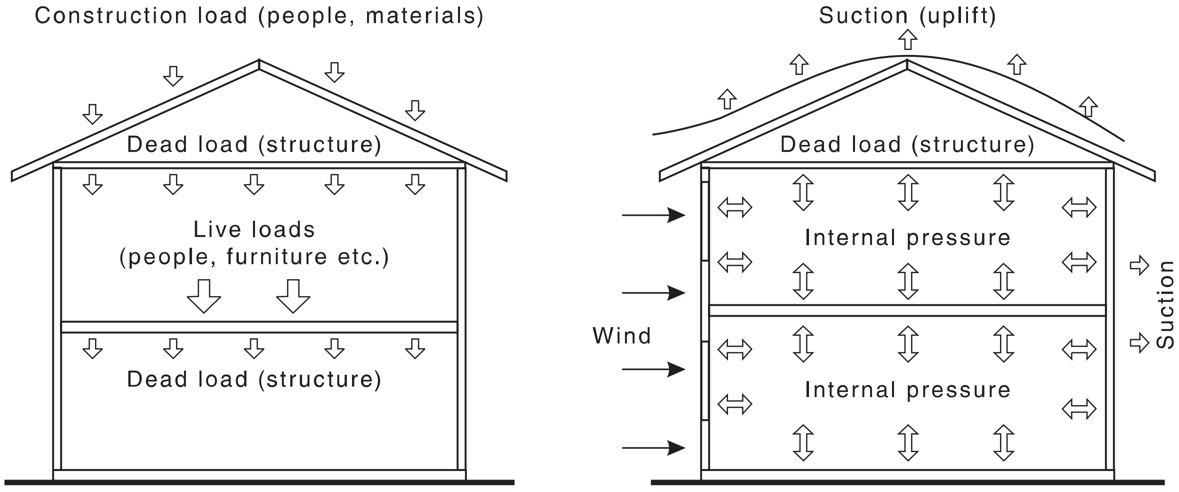
(e) The effects of snow loads up to 0.2 kPa on member sizes, bracing and connection details have been accommodated in the design.

1.6 Forces on buildings

The design of framing members may be influenced by the wind forces that act on the specific members. When using the Span Tables in the Supplements, the appropriate wind classification (e.g. N2), together with the stress grade, shall be established prior to selecting the appropriate supplement to obtain timber member sizes.

All framing members shall be adequately designed and joined to ensure suitable performance under the worst combinations of dead, live, wind and earthquake loads. Members shall also meet serviceability requirements for their application.

Assumptions used for forces, load combinations and serviceability requirements of framing members are given in AS 1684.1. Forces applied to timber-framed buildings, which shall be considered in the design of framing members, are indicated in Figure 1.3.

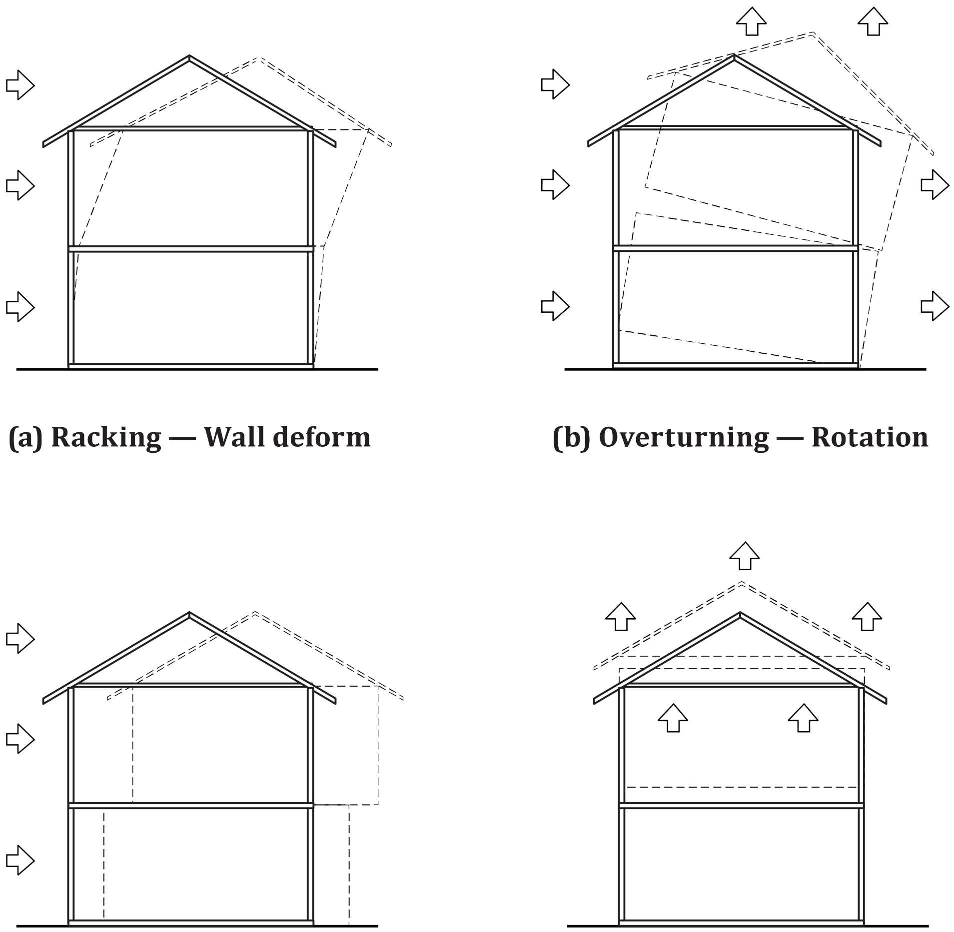


(a) Gravity loads **(b) Uplift wind loads**

NOTE For clarity, earthquake and snow loads are not shown, see Clause 1.5.

Figure 1.3 — Loads on buildings

Forces on buildings produce different effects on a structure. Each effect shall be considered individually and be resisted. Figure 1.4 summarizes some of these effects. This Standard takes account of these.



(a) Racking — Wall deform

(b) Overturning — Rotation

(c) Sliding — Tendency to slide

(d) Uplift — Connection failure

Figure 1.4 — Effects of forces on buildings

1.7 Load paths — Offsets and cantilevers

Where applicable, roof loads shall be transferred through the timber frame to the footings by the most direct route. 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 way, relying on structural members that transfer loads horizontally. Offset or cantilevered floor framing supporting loadbearing walls may also be used, see Figures 1.5 and 1.6.

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 within 1.5 times the depth of the floor member from the support, see also Clause 4.3.1.2 and Clause 4.3.2.3.

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

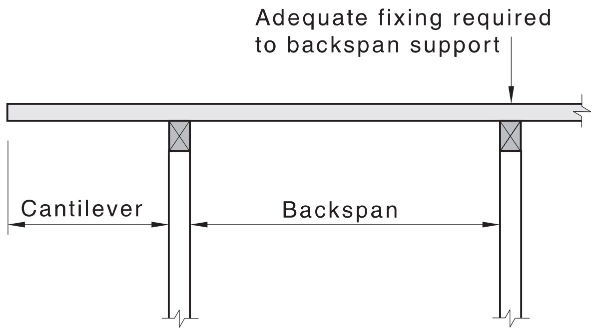


Figure 1.5 — Cantilever

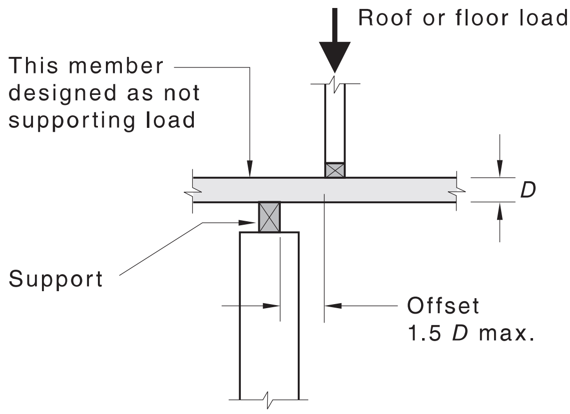


Figure 1.6 — Offset

1.8 Durability

Structural timber used in accordance with this Standard 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.

NOTE For guidance on durability design, see Appendix B.

1.9 Dimensions

Timber dimensions throughout this Standard are stated by nominating the depth of the member first, followed by its breadth (see Figure 1.7), e.g. 90 mm × 35 mm (studs, joists, etc.), 45 mm × 70 mm (wall plates, battens, etc.).

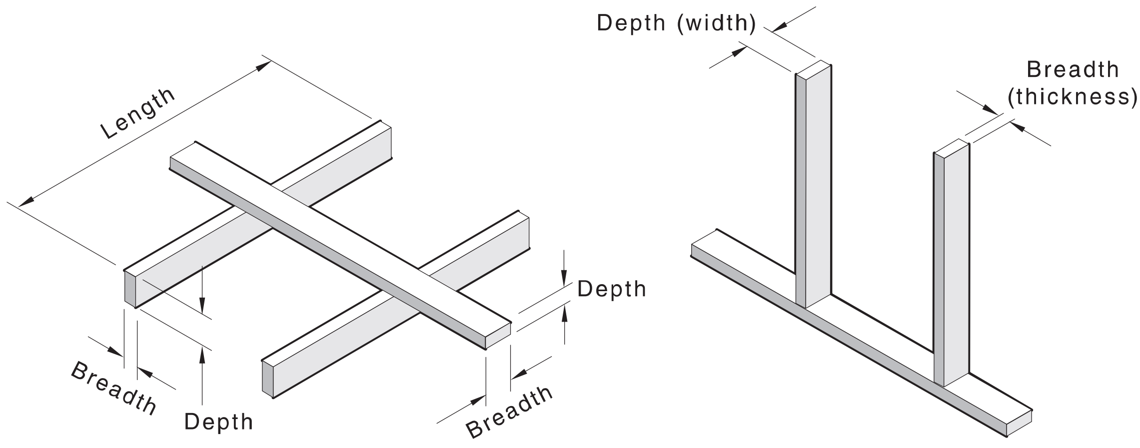


Figure 1.7 — Dimensions

1.10 Bearing

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

In all cases, except for battens, 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.

1.11 Stress grades

All structural timber used in conjunction with this Standard shall be stress graded in accordance with the relevant Australian Standard.

All structural timber to be used in conjunction with this Standard shall be identified in respect of stress grade.

The timber stress grade is usually designated alphanumerically, e.g. F17, MGP12. Stress grades covered by the Span Tables in the Supplements to this Standard are given in Table 1.2.

Table 1.2 — Stress grades

Species or species group	Most common stress grades available	Other stress grades available
Cypress (unseasoned)	F5	F7
Hardwood (unseasoned)	F8, F11, F14	F17
Hardwood (seasoned)	F17	F22, F27
Hardwood (seasoned Western Australia)	F14	—
Seasoned softwood (radiata, slash, hoop, Caribbean, pinaster pines, etc.)	F5, F7, F8, MGP10, MGP12	F4, F11, MGP15
Douglas fir (Oregon) (unseasoned)	F5, F7	F8[a], F11[a]
Spruce pine fir (SPF) (seasoned)	F5	F8
Hemfir (seasoned)	F5	F8

Table 1.2 *(continued)*

Species or species group	Most common stress grades available	Other stress grades available

[a] The Span Tables in the Supplements for unseasoned hardwood F8 and F11 may also be used for unseasoned F8 and F11 softwood.

NOTE 1 Timber that has been visually, mechanically or proof stress graded may be used in accordance with this Standard at the stress grade branded thereon.

NOTE 2 Check local timber suppliers regarding availability of timber stress grades.

1.12 Engineered timber products and engineered wood products (EWPs)

Fabricated components (e.g. roof trusses, glued-laminated timber members, I-beams, laminated veneer lumber, laminated strand lumber and nailplate-joined timber) may be used where their design is in accordance with AS 1720.1 and their manufacture and use conforms to the relevant Australian Standards.

Glued-laminated timber, I-beams, laminated veneer lumber (LVL) and laminated strand lumber (LSL) are also commonly referred to as engineered wood products (EWPs).

NOTE 1 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 Standard is subject to conformance to the manufacturer's specifications and the approval of the relevant authority, which may have additional requirements to those contained in this Standard. These may include, but are not restricted to, additional support, lateral restraint, blocking, and similar provisions.

1.13 Size tolerances

When using the Span Tables in the Supplements, the following maximum undersize tolerances on timber sizes shall apply:

(a) Unseasoned timber:

  (i) Up to and including F7 — 4 mm.

  (ii) F8 and above — 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.

1.14 Alternative timber dimensions

The alternative timber dimensions given by this Clause shall not apply to the Span Tables in the Supplements.

Where a timber dimension is stated in the clauses of this Standard, it refers to the usual minimum dimensions of seasoned timber. Alternative dimensions for seasoned timber, unseasoned timber and seasoned Western Australian hardwood shall be in accordance with Table 1.3.

The size tolerances given in Clause 1.13 are also applicable to these dimensions.

Table 1.3 — Alternative timber dimensions

Min. seasoned timber dimensions, mm	Nominal unseasoned timber dimensions, mm	Min. seasoned W.A. hardwood dimensions, mm
19	25	19
32	38	30
35	38	30
42	50	40
45	50	40
70	75	60
90	100	80
120	125	125
140	150	125
170	175	175
190	200	175
240	250	220
290	300	260

1.15 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 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 mm^2, unless noted otherwise.

NOTE Where other types of corrosion protection are provided, refer to the relevant authority for any requirements.

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.

1.16 Requirements for design using this Standard

Prior to using this Standard, the design gust wind speed and corresponding wind classification shall be determined. It shall include consideration of terrain category building height and topographic and shielding effects, see Clause 1.4.2. The wind classification is the primary reference used throughout this Standard.

NOTE The recommended procedure for designing the structural timber framework is to determine first the preliminary location and extent of bracing and tie-down and then the basic frame layout in relation to the floor plan and the proposed method of frame construction. Individual member sizes are determined by selecting the roof framing timbers and then systematically working through the remainder of the framework to the footings, or by considering the floor framing through to the roof framing. Bracing and tie-down requirements should also be considered when determining the basic frame layout to ensure any necessary or additional framing members are correctly positioned. The flow chart shown in Figure 1.8 provides guidance.

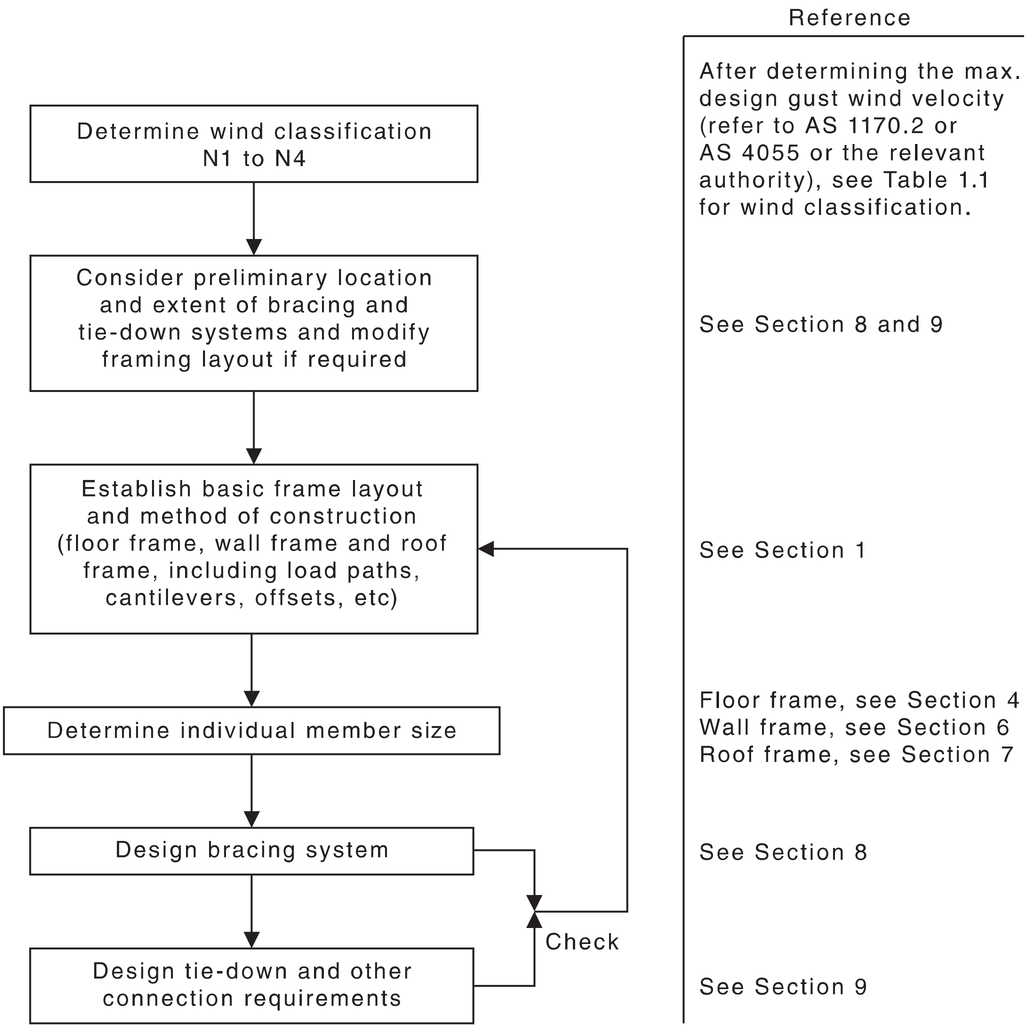


Figure 1.8 — Flow chart for design using this Standard

1.17 Interpolation

Interpolation shall be made in accordance with Appendix C.

1.18 Alternative methods and materials

This Standard does not preclude the use of framing, fastening or bracing methods or materials other than those specified provided the minimum requirements specified herein are met.

NOTE Refer to the National Construction Code for any specific requirements where alternative methods or materials are to be used.

Section 2 Framing members

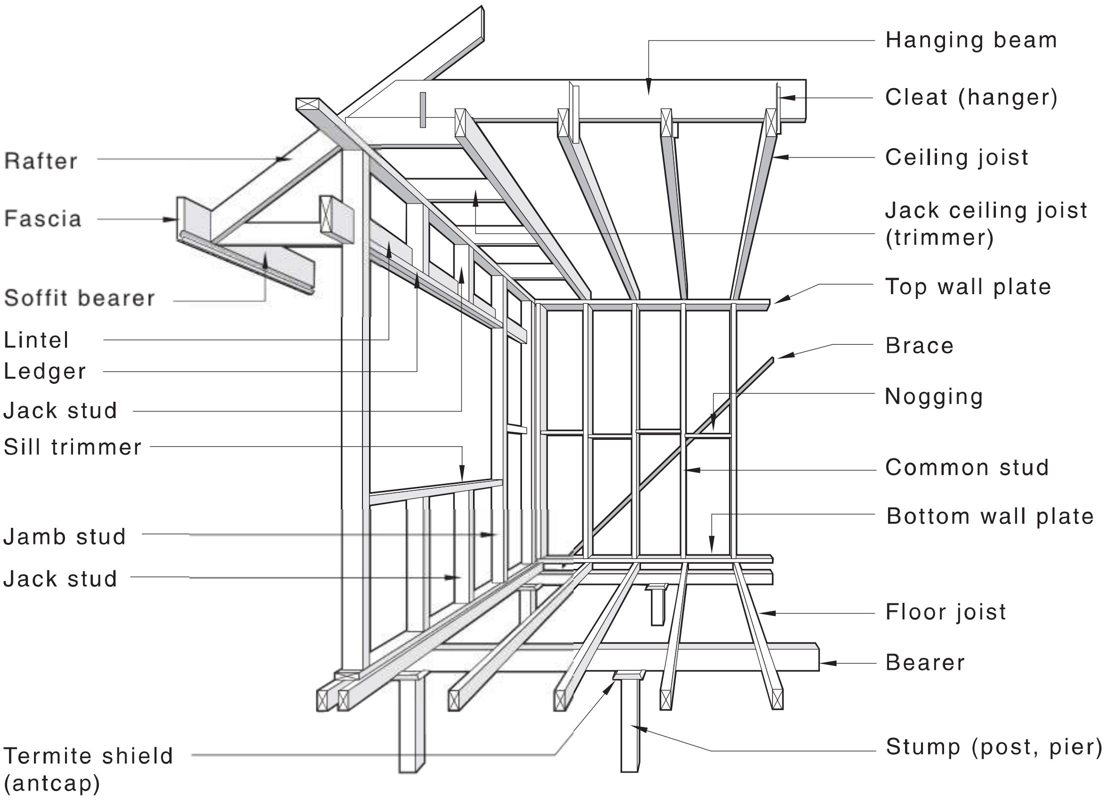
2.1 General

This Section provides terminology, general requirements and calculations for framing members.

2.2 Terminology of framing members

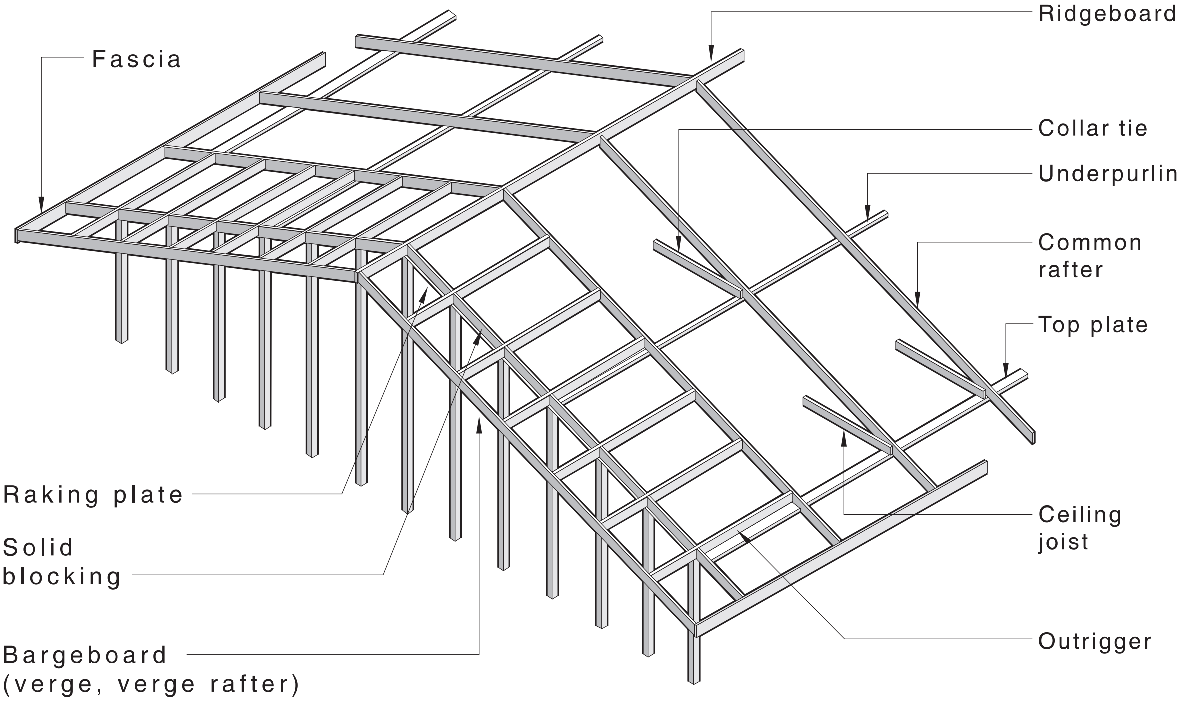
Figure 2.1 details traditional floor, wall and ceiling framing members in general. An alternative wall frame detail is given in Figure 6.1(b).

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 6.9(A).

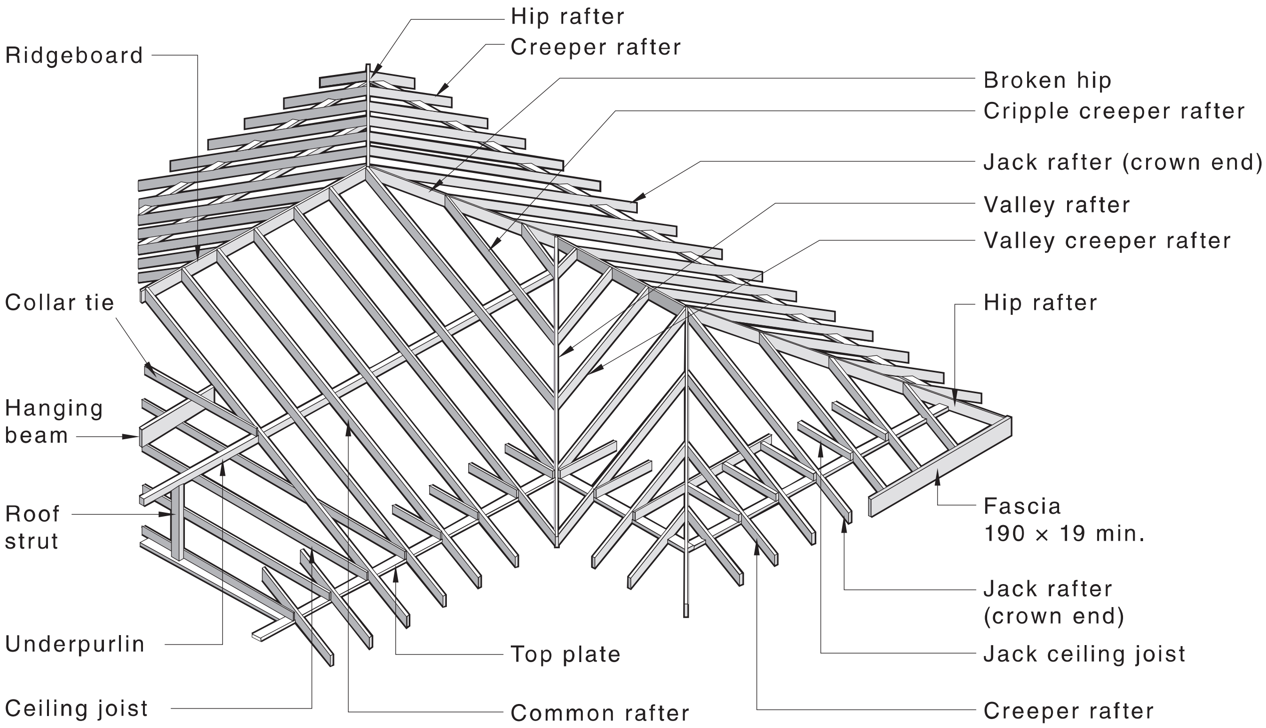
Figure 2.1 — Framing members — Floor, wall and ceiling



NOTE Some members have been omitted for clarity.

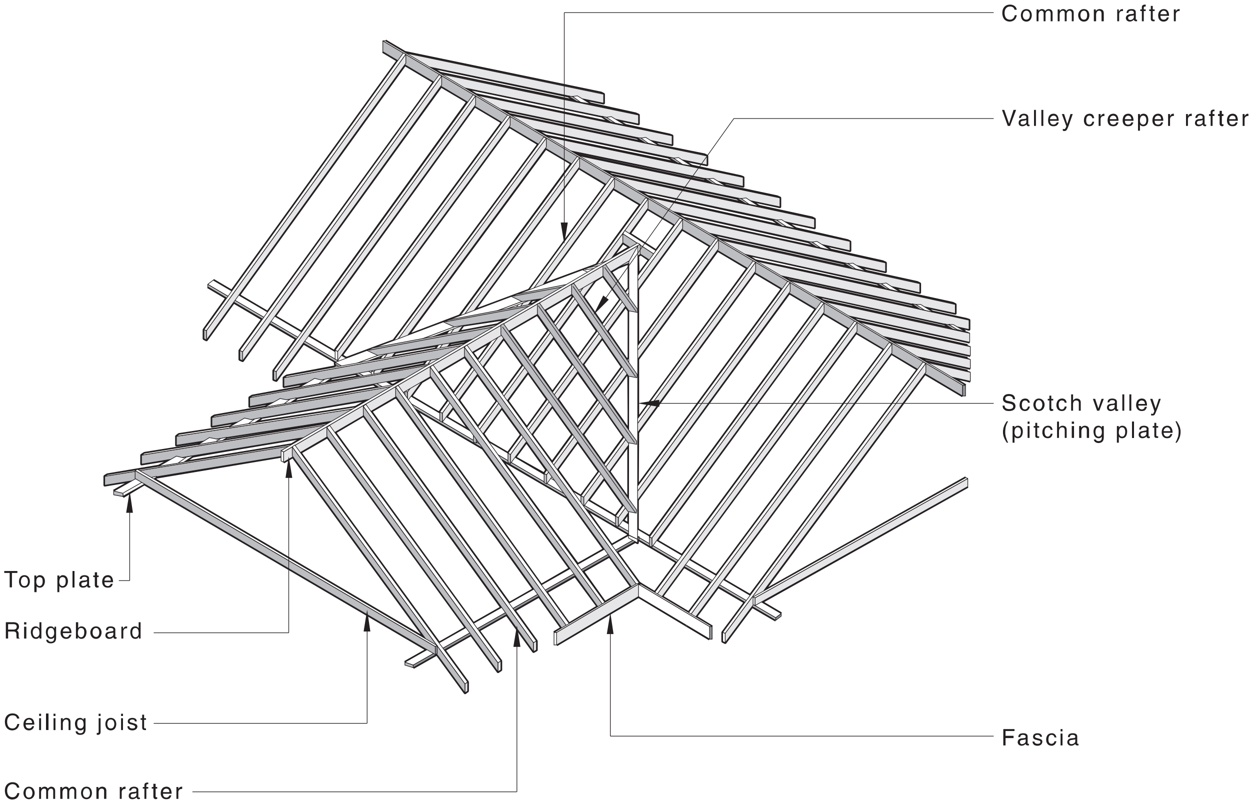
Figure 2.2 — Framing members — Gable roof construction

Dimensions in millimetres



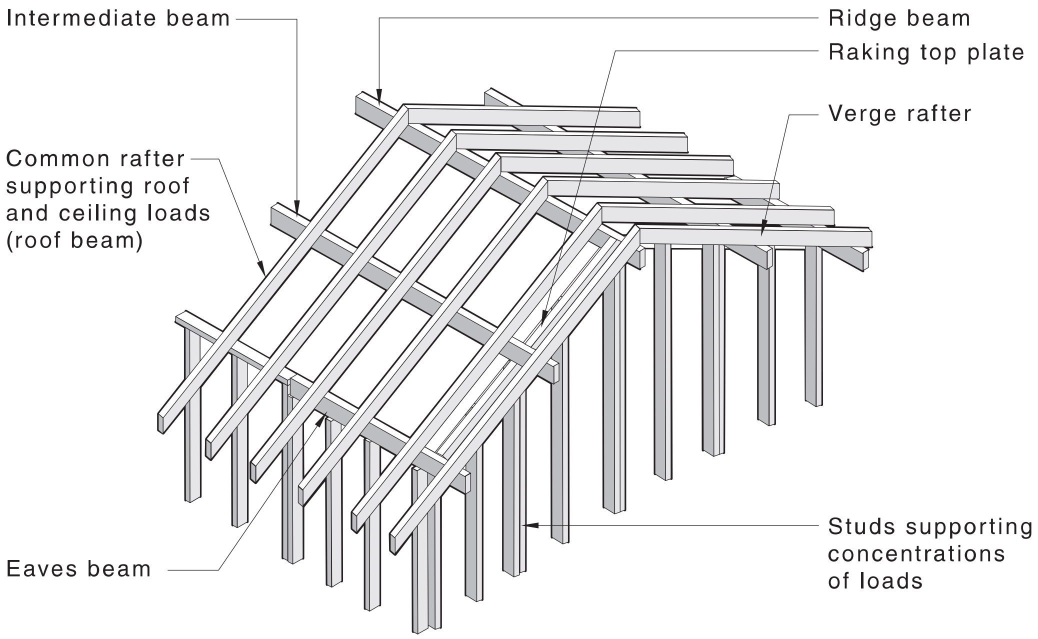
NOTE Some members have been omitted for clarity.

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

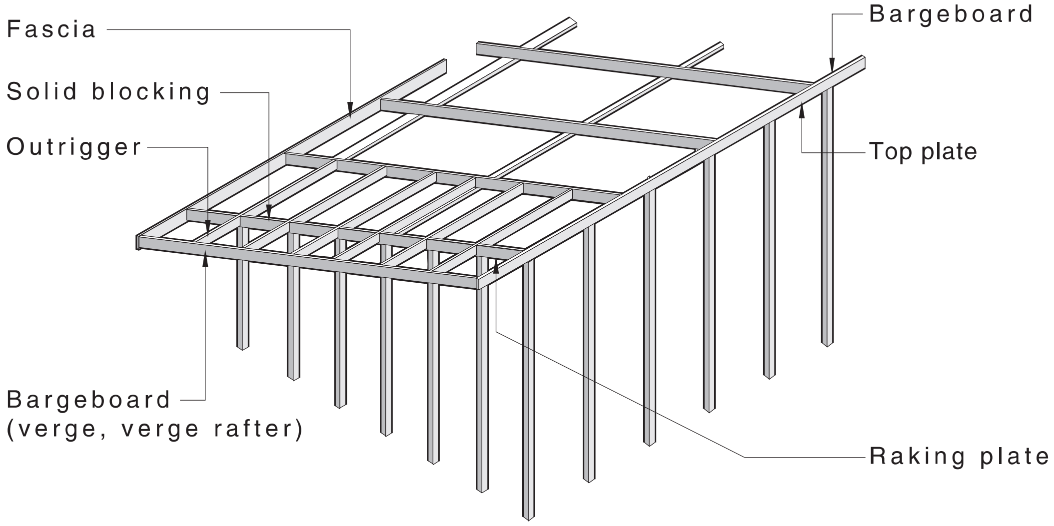
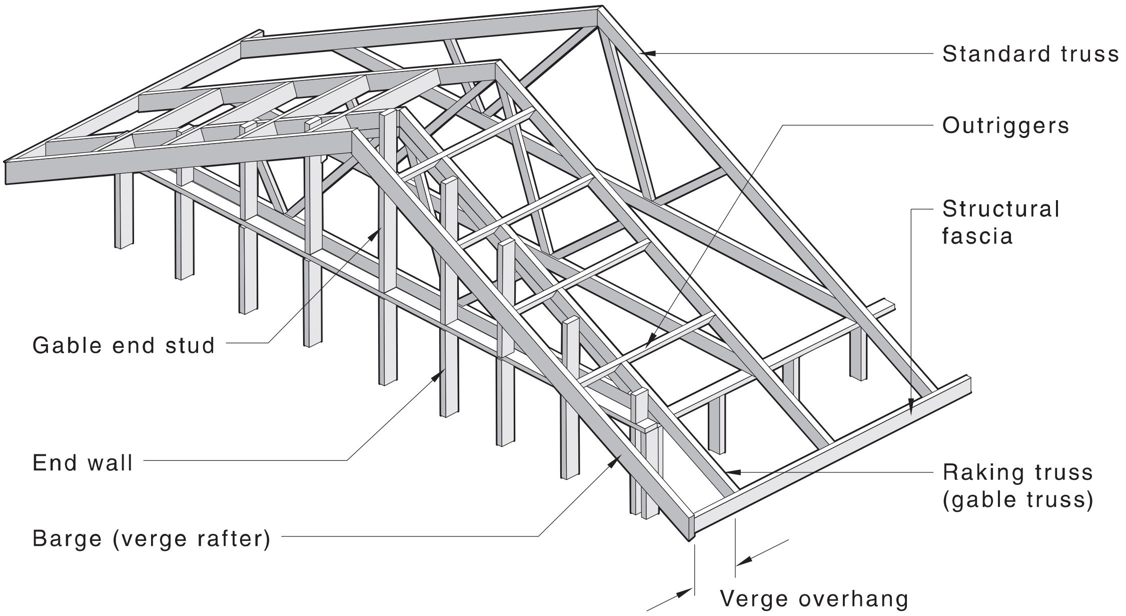


Figure 2.6 — Skillion roof



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

Figure 2.7 — Gable end — Trussed roof

2.3 Vertical lamination

2.3.1 Vertical nail lamination

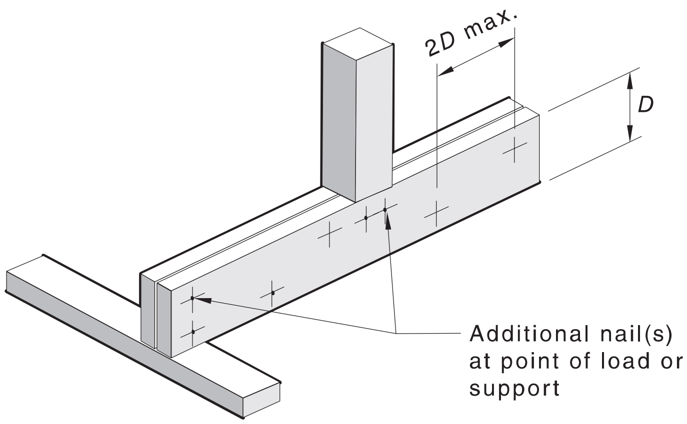
Vertical nail lamination may be used to achieve the required breadth for the larger section sizes given in the Span Tables of the Supplements using thinner and more readily obtainable sections. Where used, it shall apply only to seasoned timber laminations of the same timber type and stress grade. Laminations shall be unjoined in their length. Nails shall be a minimum of 2.8 mm in diameter and staggered as shown in Figure 2.8(a). 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.

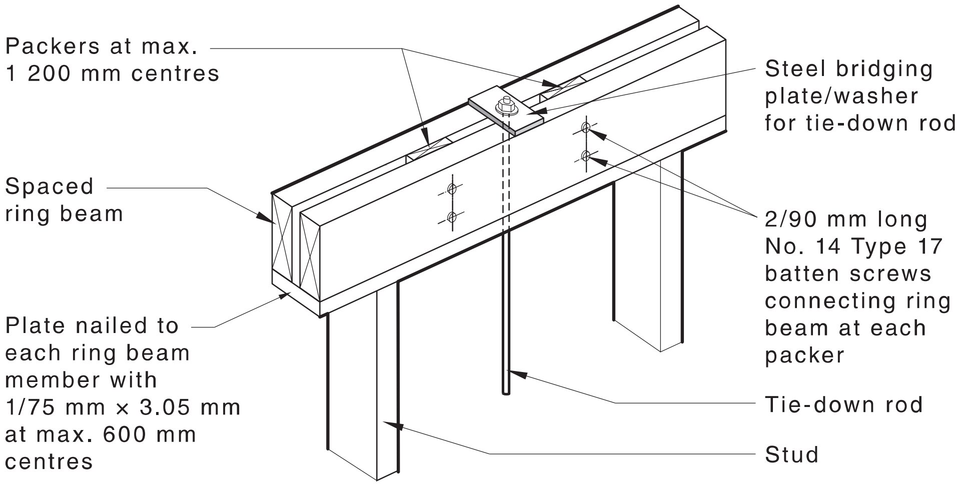
NOTE See Appendix J for guidance on building practices for engineered wood products (EWPs).

2.3.2 Lamination of spaced ring beams

Ring beams that are made up of two spaced members shall be laminated in accordance with Figure 2.8(b).



(a) Vertical nail lamination (strutting beam shown)



(b) Lamination of spaced ring beams

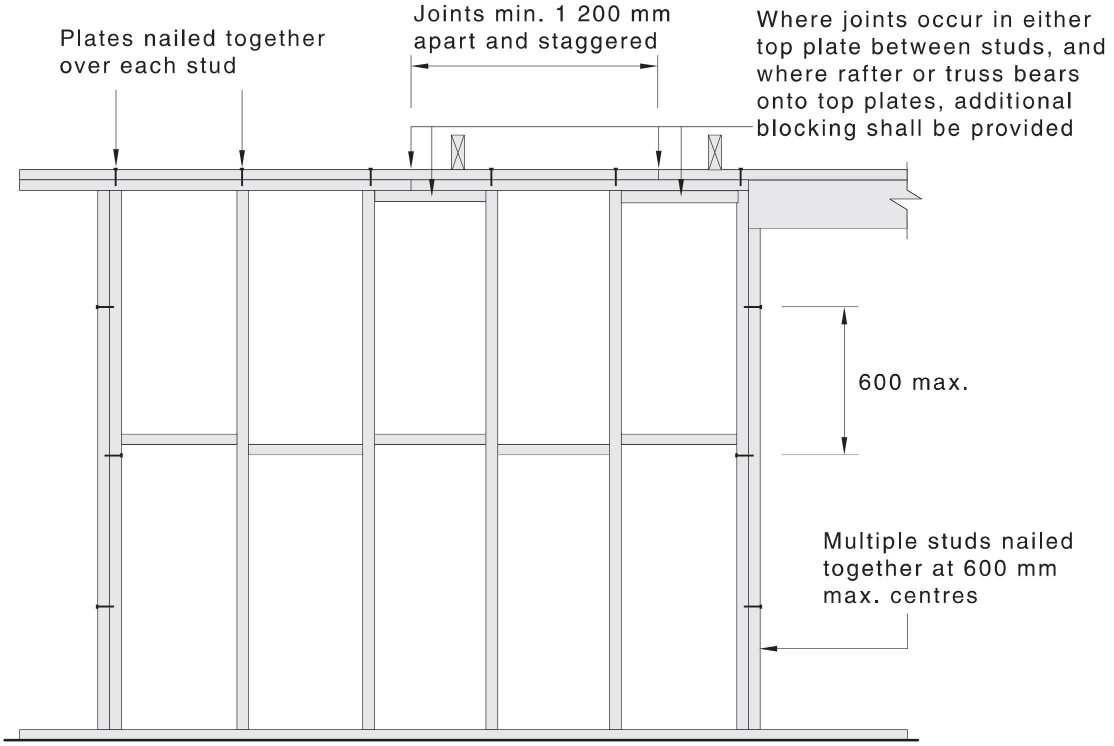
Figure 2.8 — Vertical lamination

2.4 Stud lamination

In the case of studs at sides of openings and studs supporting concentrations of load, 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 See Section 9 for other nominal fixing requirements including plates to studs.

Figure 2.9 — Stud/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 mm × 70 mm) 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 joins in multiple bottom plates shall occur over solid supports such as floor joists, solid blocking between bottom plate and bearer or concrete slab.

2.6 Load width and area supported

2.6.1 General

The supported load width and area are used to define the amount of load that is imparted onto a member. Load width, coupled with another geometric descriptor such as spacing, will define an area of load that a member is required to support.

Floor load width (*FLW*), ceiling load width (*CLW*) and roof load width (*RLW*) shall be determined from Clauses 2.6.2 to 2.6.4.

For uplift due to wind loads, the definition “uplift load width” (*ULW*) is used, as *ULW*s may differ significantly from *RLW*s depending upon where the structure is tied down. See Clause 9.6 for a definition of *ULW*.

2.6.2 Floor load width (*FLW*)

Floor load width (*FLW*) is the contributory width of floor, measured horizontally, that imparts floor load to a supporting member. *FLW* shall be used as an input to the Span Tables in the Supplements for all bearers and lower storey wall framing members. The *FLW* input is illustrated in Tables 2.1 and 2.2.

Table 2.1 — Floor load width (*FLW*) — Single or upper storey construction

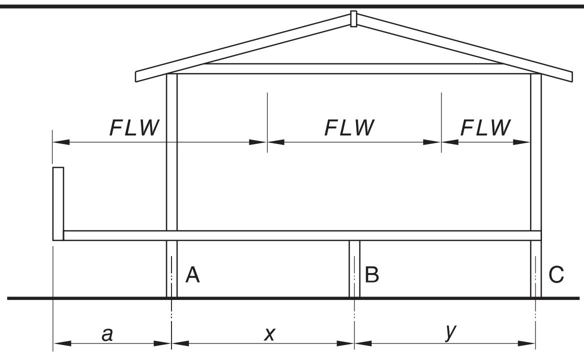
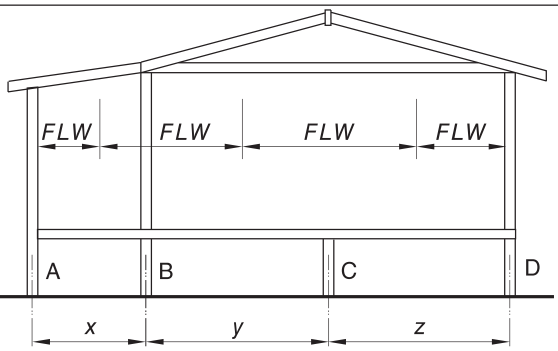
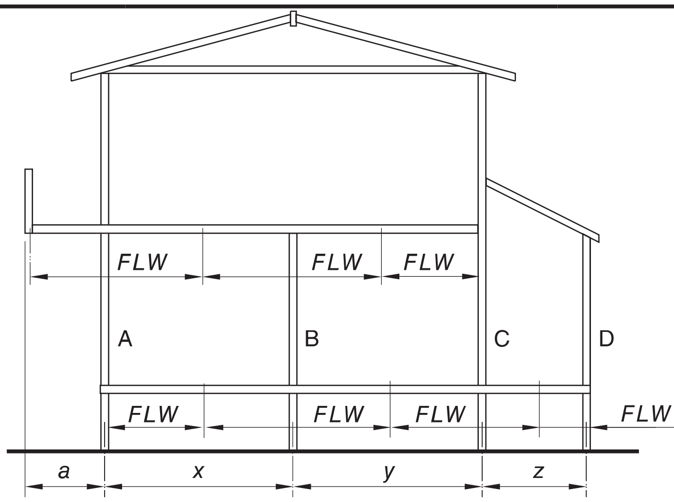
Type of construction		Location	Floor load width (*FLW*)
(a) Cantilevered balcony		Bearer A	$FLW = \frac{x}{2} + a$
		Bearer B	$FLW = \frac{x + y}{2}$
		Bearer C	$FLW = \frac{y}{2}$
(b) Supported balcony		Bearer A	$FLW = \frac{x}{2}$
		Bearer B	$FLW = \frac{x + y}{2}$
		Bearer C	$FLW = \frac{y + z}{2}$
		Bearer D	$FLW = \frac{z}{2}$

Table 2.2 — Floor load width (*FLW*) — Two storey construction



Type of construction	Location	Floor load width (*FLW*)
(a) Lower storey loadbearing walls	Wall A	Upper $FLW = \frac{x}{2} + a$
	Wall B	Upper $FLW = \frac{x+y}{2}$
	Wall C	Upper $FLW = \frac{y}{2}$
	Wall D	N/A[a]
(b) Bearers supporting lower storey loadbearing walls	Bearer A	Upper $FLW = \frac{x}{2} + a$ Lower $FLW = \frac{x}{2}$
	Bearer B	Upper $FLW = \frac{x+y}{2}$ Lower $FLW = \frac{x+y}{2}$
	Bearer C	Upper $FLW = \frac{y}{2}$ Lower $FLW = \frac{y+z}{2}$
	Bearer D	Upper FLW = N/A[a] Lower $FLW = \frac{z}{2}$

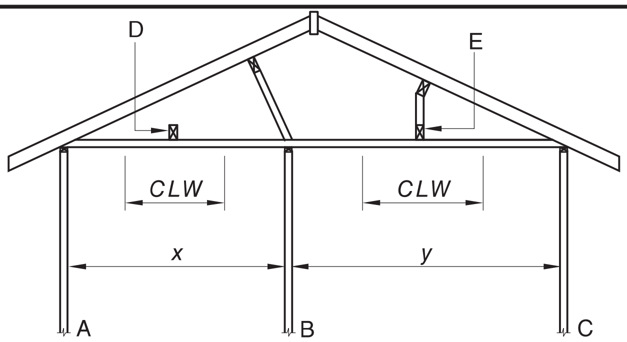
[a] See Table 2.1 for floor load widths for single or upper storey construction.

2.6.3 Ceiling load width (*CLW*)

Ceiling load width (*CLW*) is the contributory width of ceiling, usually measured horizontally, that imparts ceiling load to a supporting member.

CLW shall be used as an input to Span Tables for hanging beams, counter beams and strutting/hanging beams. The *CLW* input is illustrated in Table 2.3.

Table 2.3 — Ceiling load width (*CLW*)

Type of construction	Location	Ceiling load width (*CLW*)
	Walls A, B and C	N/A[a]
	Beam D (Hanging beam)	$CLW = \frac{x}{2}$
	Beam E (Strutting/hanging beam)	$CLW = \frac{y}{2}$

[a] *CLW* is not required as an input to the Span Tables for wall framing or bearers supporting loadbearing walls.

2.6.4 Roof load width (*RLW*)

The roof load width (*RLW*) is used as a convenient indicator of the roof loads that are carried by some roof members and loadbearing wall members and their supporting substructure. The *RLW* value shall be used as an input to the relevant wall framing and substructure Span Tables. Tables 2.4 to 2.7 define *RLW* in relation to various types of roof construction.

For Tables 2.5 and 2.6, *RLW* may not be applicable where strut loads are supported by studs supporting concentrations of load and the remainder of wall C is deemed non-loadbearing. In these cases, the supported roof area shall be determined for the studs supporting concentrated loads.

Table 2.4 — Roof load width (*RLW*) — Non-coupled roofs

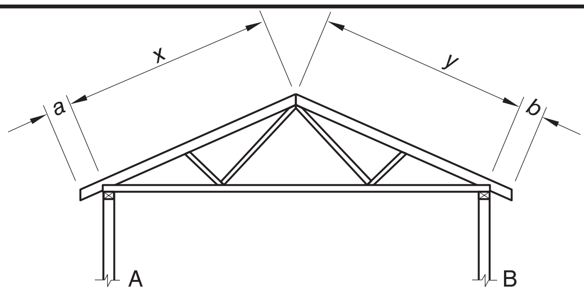
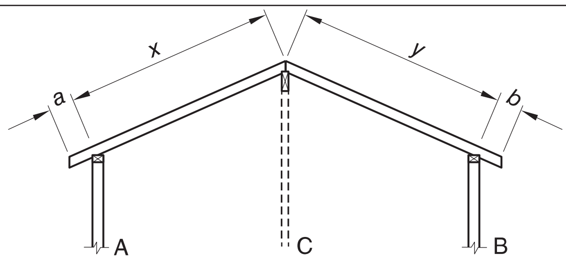
Type of construction		Wall	Roof load width (*RLW*) for member sizing
(a) Truss		A	$RLW = \frac{x + y}{2} + a$
		B	$RLW = \frac{x + y}{2} + b$
(b) Cathedral		A	$RLW = \frac{x}{2} + a$
		B	$RLW = \frac{y}{2} + b$
		C	$RLW = \frac{x + y}{2}$

Table 2.4 *(continued)*

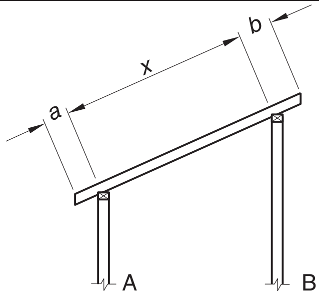
Type of construction		Wall	Roof load width (*RLW*) for member sizing
(c) Skillion		A	$RLW = \frac{x}{2} + a$
		B	$RLW = \frac{x}{2} + b$

Table 2.5 — Roof load width (*RLW*) — Coupled roofs with no underpurlins

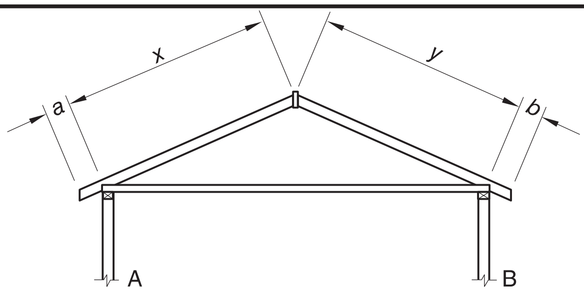
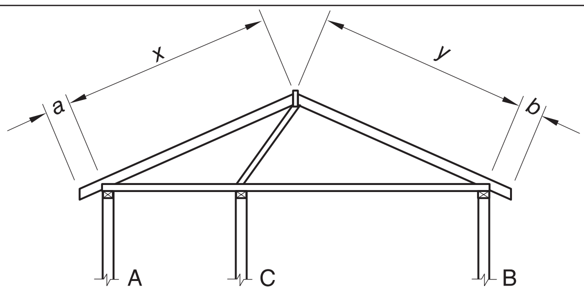
Type of construction	Wall	Roof load width (*RLW*) for member sizing
	A	$RLW = x + a$
(a) No ridge struts	B	$RLW = y + b$
	A	$RLW = \frac{x}{2} + a$
	B	$RLW = \frac{y}{2} + b$
(b) Ridge struts	C	N/A

Table 2.6 — Roof load width (*RLW*) — Coupled roofs with underpurlins

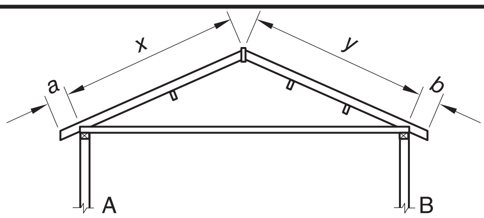
Type of construction	Wall	Roof load width (*RLW*) for member sizing
	A	$RLW = \frac{x}{2} + a$
(a) No ridge struts	B	$RLW = \frac{y}{3} + b$

Table 2.6 *(continued)*

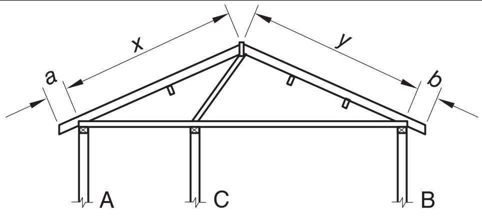
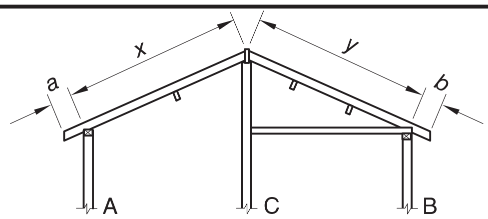
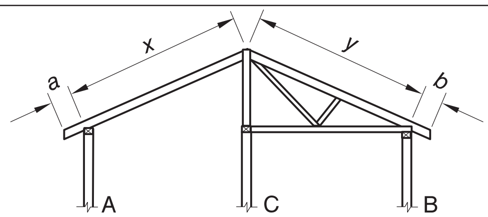
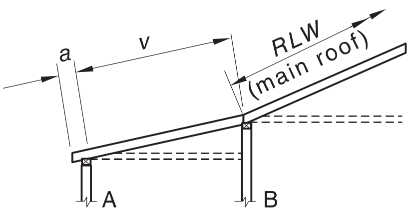
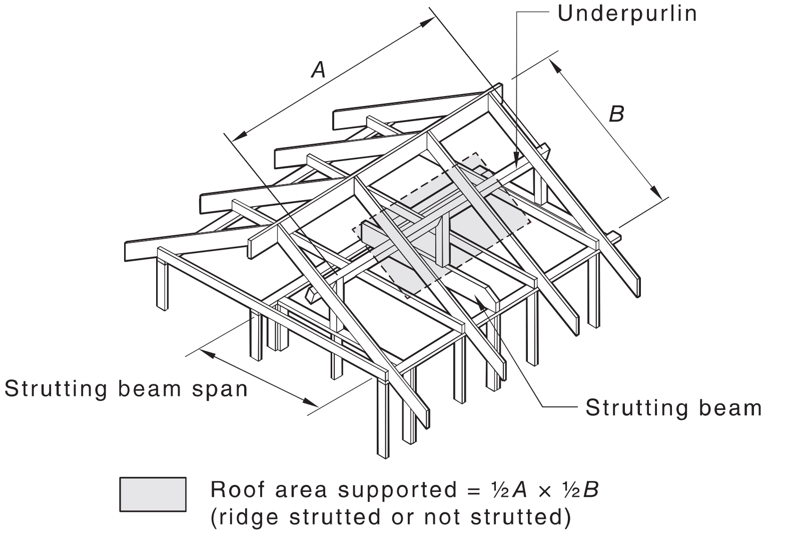
Type of construction	Wall	Roof load width (*RLW*) for member sizing
 (b) Ridge struts	A	$RLW = \frac{x}{4} + a$
	B	$\text{RLW} = \frac{y}{6} + b$
	C	N/A
NOTE Collar ties have been omitted for clarity.		

Table 2.7 — Roof load width (*RLW*) combinations and additions

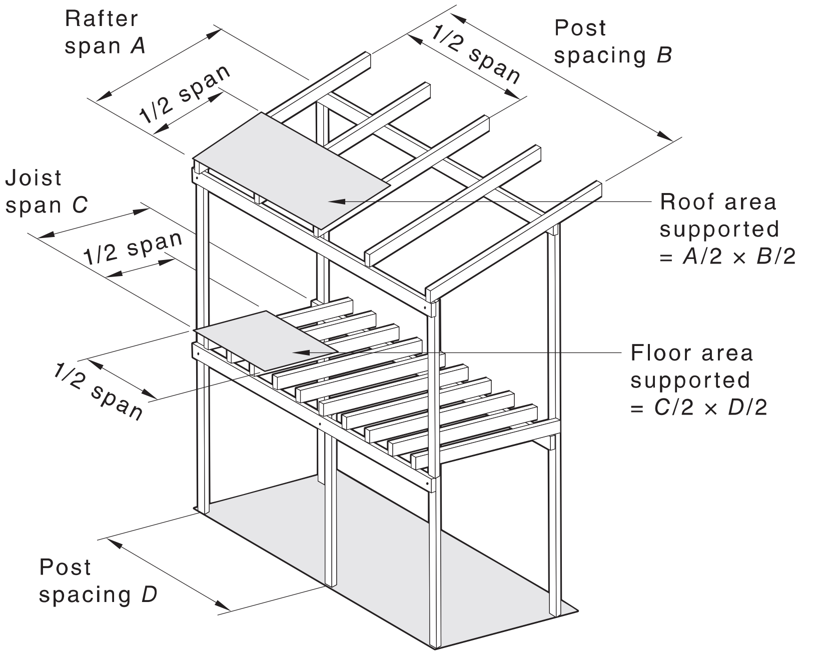
Type of construction	Wall	Roof load width (*RLW*) for member sizing
 (a) Cathedral — Framed	A	$RLW = \frac{x}{4} + a$
	B	$RLW = \frac{y}{6} + b$
	C	$RLW = \frac{x}{4} + \frac{y}{6}$
 (b) Cathedral — Truss	A	$RLW = \frac{x}{2} + a$
	B	$RLW = \frac{y}{2} + b$
	C	$\text{RLW} = \frac{x + y}{2}$
 (c) Verandah	A	$RLW = \frac{v}{2} + a$
	B	$RLW = RLW$ for main roof + $\frac{v}{2}$
NOTE Collar ties have been omitted for clarity.		

2.6.5 Area supported

The area supported by a member is the contributory area, measured in either the roof or floor plane, that imparts load onto supporting members. The roof area shall be used as an input to Span Tables in the Supplements for strutting beams, combined strutting/hanging beams, combined strutting/counter beams and studs supporting concentrated loads and posts. The floor area shall be used as an input to the Span Tables in the Supplements for studs supporting concentrated loads and posts. Typical "area supported" inputs for roofs and floors are illustrated in Figure 2.10.



(a) Typical roof area supported by strutting beam



(b) Typical roof and floor area or supported by post

NOTE If the post was the central support for a continuous span verandah beam and bearer, the areas supported would be as follows: (a) Roof area supported = $A/2 \times B$; (b) Floor area supported = $C/2 \times D$.

Figure 2.10 — Area supported

Section 3 Substructure

3.1 General

This Section sets out requirements for site preparation, subfloor supports and the determination of footing sizes suitable for supporting timber-framed houses. This Section is based on AS 2870, using allowable soil-bearing stresses.

3.2 Site preparation and drainage

3.2.1 General

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.

3.2.2 Site clearing

The site shall be cleared of any logs, tree roots or stumps and other wood debris, including waste material from the construction, likely to increase the termite risk or cause damage to footings or concrete slabs or subsoil drainage, within and around the building.

3.2.3 Site drainage

Surface and subsurface water occurring on the building site shall be diverted to prevent it from flowing under the structure. Ponding of water under the structure shall be prevented by filling, grading or the provision of drainage or diversion channels.

NOTE The ground surface should be graded to fall away from the building.

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 Durability

3.4.1 Termite management

Protection against termites shall be provided.

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

3.4.2 Species selection

Any species and durability classes of timber may be utilized for floor and subfloor framing where adequate ventilation and weather protection is provided, see also Clause 1.8.

NOTE For extremely damp or unventilated situations or timber in contact with the ground, see Appendix B.

3.5 Substructure bracing

The substructure shall be adequately braced against all of the applied loads, see Section 8.

3.6 Subfloor supports

3.6.1 General

This Clause provides a procedure to determine typical vertical gravity loads and the capacity and size of some footings. Stumps, posts, piers, and similar members that are positioned beneath the floor shall be designed to support vertical gravity loads.

Alternatively, for wind classifications N1 and N2, footings, stump and post sizes may be determined from Clause 3.7.

3.6.2 Soil classification

Details provided in this Clause are only applicable to A, S, M or H soil classification with a minimum allowable bearing capacity of 100 kPa. Soil classifications E and P are beyond the scope of this Section and further professional advice will be required.

Where the allowable bearing capacity of the soil has been determined from site investigation, then this capacity shall be used to determine the footing size in accordance with Clause 3.6.6.

Site soil classifications shall be made in accordance with AS 2870.

3.6.3 Procedure

The following procedure shall be used to determine the vertical gravity loads and the capacity and size of the footing:

(a) Determine the individual dead and live loads that contribute to the total vertical gravity load combination, see Clauses 3.6.4.2 and 3.6.4.3.

(b) Calculate the total vertical gravity load from the load combination given in Clause 3.6.5.

(c) Determine the size of the footing, or bearing area required, for piers, stumps, posts, and similar substructures, see Clause 3.6.6.

3.6.4 Determination of vertical gravity loads

3.6.4.1 General

Vertical gravity dead and live loads shall be determined in accordance with Clauses 3.6.4.2 and 3.6.4.3.

3.6.4.2 Permanent (dead) loads (*G*)

Permanent loads shall be determined as follows:

(a) *Floor loads* — The total floor loads (kN) shall be calculated by multiplying the floor area (m^2) supported by the individual stump, pier, post or similar substructures under consideration by the unit weight of the floor system (kN/m^2).

If supported floor areas have different weights, the contribution of individual areas shall be summed to determine the total load. Where items such as waterbeds, slate-based billiard tables, spas, hot tubs and other permanent loads are not included in the typical weights given in Table 3.1 and the weight of these items, where present, shall be added to the total.

Ceilings are assumed to be either 13 mm plasterboard, or material of similar weight ($0.12\ kN/m^2$).

NOTE 1 Table 3.1 provides guidance on the weight of typical floor systems. The weight of quarry or slate tiles and bedding compound are not covered by this Table.

(b) *Wall loads* — The total wall load (kN) shall be determined by multiplying the floor area (m^2) supported by the individual stump, pier, post or similar members under consideration by 0.4 kN/m^2. For two storey construction, the floor area of both upper and lower storeys shall be included in the floor area determination. Where the actual permanent wall load (kN) applied to individual footings has been calculated, this load shall be used.

NOTE 2 The value of 0.4 kN/m^2 applied to the floor area has been determined as a typical distributed wall load averaged over the floor area for most housing.

(c) *Roof loads* — The total roof load (kN) shall be determined by multiplying the roof area (m^2) supported by the individual stump, pier, post or similar members under consideration by 0.4 kN/m^2 for sheet roofs, and 0.9 kN/m^2 for tile roofs.

NOTE 3 The values of 0.4 kN/m^2 and 0.9 kN/m^2 have been determined as typical average unit weights for total roof weights for sheet and tile roofs respectively.

NOTE 4 Care should be taken when determining the contributory roof area and respective load paths applied to each footing under consideration.

Table 3.1 — Weight of typical floors

Floor and/or ceiling type	Weight, kN/m^2
Timber flooring up to 22 mm thick plus lightweight floor covering, i.e. carpet and underlay	0.30
Timber flooring up to 22 mm thick plus lightweight floor covering and ceilings	0.40
Timber flooring up to 22 mm thick plus ceramic or terracotta floor covering	0.60
Timber flooring up to 22 mm thick plus ceramic or terracotta floor coverings and ceilings	0.70

3.6.4.3 Live loads (*Q*)

Live loads shall be determined as follows:

(a) *Roof and floor live loads* — Roof live loads up to 0.25 kPa do not need to be included in the calculation of total vertical gravity loads. Floor live loads (kN) shall be determined by multiplying the floor area (m^2) supported by the individual stump, post, pier or similar members under consideration by 1.5 kN/m^2.

The value of 1.5 kN/m^2 shall only apply to the general floor and deck areas of Class 1 buildings.

For decks greater than 1.0 m above the ground, the live load contributed by the area of deck under consideration shall be 3.0 kN/m^2 except for decks greater than 40 m^2 where the live load reduces to 1.5 kN/m^2.

(b) *Other live loads* — In alpine and sub-alpine areas, the contribution of snow loads exceeding 0.2 kPa, determined in accordance with AS 1170.4, shall also be added to the live loads.

3.6.5 Determination of total vertical gravity load combination for footings

The total vertical gravity load combination, *P* (kN), shall be calculated as follows:

$$P = G + 0.5\,Q$$

where

G = sum of individual permanent floor, wall and roof loads, in kilonewtons

Q = sum of individual floor (and snow if applicable) live loads, in kilonewtons

NOTE The above load combination is derived from AS 2870.

3.6.6 Footing size or bearing area

The size of footing may be determined directly from Table 3.2 for the total vertical bearing load, P (kN), determined from Clause 3.6.5. Alternatively, the bearing area required for the footing, A (m^2), may be determined as follows:

$$A = P/100$$

NOTE 1 The 100 kPa is the allowable bearing capacity of the foundation for Table 3.2.

NOTE 2 For an alternative allowable bearing capacity, see the worked example in Clause D.2.

Table 3.2 — Bearing load and footing size

Total vertical bearing load, kN	Minimum concrete pier/stump or sole plate diameter, mm	Minimum concrete pier/stump or sole plate size, mm × mm
4.9	250	225 × 225
7.1	300	275 × 275
9.0	350	300 × 300
12	400	350 × 350
16	450	400 × 400

3.7 Footings and supports for wind classifications N1 and N2

3.7.1 General

This Clause covers the selection of stumps and posts, and pad footings and sole plates required to transfer roof, wall and floor loads to the soil foundation.

The bracing requirements of Section 8 shall be considered to ensure that the use of footing or post or stump details given in this Section are also adequate to resist lateral loads. For wind classifications greater than N2, see Clause 3.6.

3.7.2 Simplified footing classification

For the purposes of this Clause, footings for stumps or posts are classified as types 1 to 5, as shown in Table 3.3. 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.

Footings shall be proportioned to distribute evenly vertical and lateral loads from the building to the foundation material such that significant settlement or other movement is prevented.

Timber sole plates shall not project beyond any face of the stump or post they support by more than their own thickness, taken across the grain, or three times their own thickness measured along the grain.

NOTE Further information, including minimum depth requirements, is given in AS 2870.

Table 3.3 — Footing classification

Footing type	Minimum bearing area, m^2	Bearing capacity, kN	Minimum size of unreinforced concrete pad footing, mm	Nominal unseasoned size of timber soleplates, mm
1	0.045	4.5	230 × 230 × 100 deep or 250 dia. × 100 deep	200 × 225 × 38 thick
2	0.090	9.0	300 × 300 × 150 deep or 350 dia. × 150 deep	250 × 360 × 75 thick

Table 3.3 *(continued)*

Footing type	Minimum bearing area, m^2	Bearing capacity, kN	Minimum size of unreinforced concrete pad footing, mm	Nominal unseasoned size of timber soleplates, mm
3	0.120	12	350 × 350 × 200 deep or 400 dia. × 200 deep	300 × 400 × 75 thick
4	0.180	18	430 × 430 × 250 deep or 500 dia. × 200 deep	300 × 600 × 100 thick
5	0.180	22	430 × 430 × 250 deep or 500 dia. × 200 deep	300 × 600 × 100 thick

3.7.3 Stumps and posts

The following requirements apply:

(a) *Sizes* — Stump and post sizes shall be appropriate to the footing type used, as given in Table 3.4.

NOTE 1 The use of stumps or posts in material other than timber is subject to the requirements of the relevant authority. Refer to the National Construction Code for specifications for stumps or posts in material other than timber.

(b) *Height* — The height, above-ground, of any stump or post determined using Table 3.4 shall not exceed 15 times the minimum face width or diameter, unless designed in accordance with recognized engineering principles.

NOTE 2 Where posts or stumps are designed in accordance with engineering principles, the height limitation may not apply.

(c) *Embedment* — Stumps 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.

Table 3.4 — Stump/post sizes

Footing type	Stress grade					
	F4	F5	F7	F8	F11	F14
	Nominal unseasoned timber stump/post size, mm					
1	100 × 100 or 110 dia.	100 × 100 or 110 dia.	100 × 100 or 110 dia.	100 × 100 or 110 dia.	100 × 100 or 110 dia.	100 × 100 or 110 dia.
2	125 × 125 or 125 dia.	125 × 125 or 120 dia.	100 × 100 or 115 dia.	100 × 100 or 110 dia.	100 × 100 or 110 dia.	100 × 100 or 110 dia.
3	125 × 125 or 135 dia.	125 × 125 or 130 dia.	125 × 125 or 120 dia.	100 × 100 or 115 dia.	100 × 100 or 110 dia.	100 × 100 or 110 dia.
4	150 × 150 or 150 dia.	125 × 125 or 145 dia.	125 × 125 or 135 dia.	125 × 125 or 125 dia.	125 × 125 or 120 dia.	100 × 100 or 115 dia.
5	As approved					

NOTE 1 Stump or post size is also dependent upon height above-ground, see Clause 3.7.3(b).

NOTE 2 Timber durability/preservative treatment should be appropriate for the expected service conditions, see Appendices B and G.

NOTE 3 For termite protection, see Clause 3.4.1.

3.7.4 Footing type support limitations (load widths × bearer spans)

Tables 3.5, 3.6 and 3.7 give maximum permissible load widths and bearer spans for each footing type, based on footing capacity. The Span Tables give maximum bearer spans based on the capacity of the relevant timber cross-section. Both of these requirements shall be satisfied.

Table 3.5 — Load widths and bearer spans for footing types 1 to 5 for bearers supporting floor loads only

Footing type	Floor load width, mm						
	1 200	1 500	1 800	2 100	2 400	3 000	3 600
	Maximum permissible bearer span, mm						
1	2 400	1 900	1 600	1 400	1 200	1 000	800
2	4 800	3 900	3 200	2 800	2 400	1 900	1 600
3	6 400	5 200	4 300	3 700	3 200	2 600	2 100
4	9 700	7 700	6 400	5 500	4 800	3 900	3 200
5	12 100	9 700	8 100	6 900	6 000	4 800	4 000

NOTE 1 Maximum permissible bearer span is for each footing type. Bearer size is determined from the relevant Span Tables in the Supplements, see Section 4.

NOTE 2 The Table values are based on a distributed load of 1.55 kPa being 0.4 kPa non-loadbearing wall load spread over the floor area, 0.4 kPa floor load and 0.75 kPa permanent live load.

Table 3.6 — Load widths and bearer spans for footing types 1 to 5 for bearers supporting single storey loadbearing walls

Footing type	Roofing type	Roof load width, mm				
		1 500	3 000	4 500	6 000	7 500
		Maximum permissible bearer span, mm				
Floor load width 900 mm						
1	Sheet	2 300	1 700	1 400	1 200	1 000
2		4 500	3 500	2 800	2 400	2 000
3		6 000	4 600	3 800	3 200	2 700
4		9 000	6 900	5 600	4 700	4 100
5		11 300	8 700	7 000	5 900	5 100
1	Tile	1 600	1 000	800	NS	NS
2		3 300	2 200	1 600	1 300	1 100
3		4 400	2 900	2 200	1 800	1 500
4		6 600	4 400	3 300	2 600	2 200
5		8 200	5 500	4 100	3 300	2 800
Floor load width 1 800 mm						
1	Sheet	1 300	1 100	1 000	800	NS
2		2 600	2 300	2 000	1 700	1 600
3		3 500	3 000	2 600	2 300	2 100
4		5 300	4 500	3 900	3 500	3 100
5		6 600	5 600	4 900	4 300	3 900
1	Tile	1 100	800	NS	NS	NS
2		2 200	1 600	1 300	1 100	900
3		2 900	2 200	1 800	1 500	1 300
4		4 300	3 300	2 600	2 200	1 900

Table 3.6 *(continued)*

Footing type	Roofing type	Roof load width, mm				
		1 500	3 000	4 500	6 000	7 500
		Maximum permissible bearer span, mm				
5		5 400	4 100	3 300	2 700	2 400

NOTE 1 NS = not suitable.

NOTE 2 Maximum permissible bearer span is for each footing type. Bearer size is determined from the Span Tables in the Supplements, see Section 4.

NOTE 3 The Table values are based on roof loads of 0.4 and 0.9 kPa for sheet and tile roofs respectively, and a distributed load of 1.55 kPa being 0.4 kPa wall load spread over the floor area, 0.4 kPa floor load and 0.75 kPa permanent live load.

Table 3.7 — Load widths and bearer spans for footing types 1 to 5 for bearers supporting two storey loadbearing walls

Footing type	Roofing type	Roof load width, mm				
		1 500	3 000	4 500	6 000	7 500
		Maximum permissible bearer span, mm				
Floor load width (upper + lower storey) 2 400 mm						
1	Sheet	1 000	900	800	NS	NS
2		2 100	1 800	1 600	1 500	1 300
3		2 800	2 400	2 200	2 000	1 800
4		4 200	3 700	3 300	2 900	2 700
5		5 200	4 600	4 100	3 700	3 300
1	Tile	900				
2		1 800	1 400	1 200	1 000	900
3		2 400	1 900	1 500	1 300	1 100
4		3 500	2 800	2 300	2 000	1 700
5		4 400	3 500	2 900	2 500	2 100
Floor load width (upper + lower storey) 3 600 mm						
1	Sheet	NS	NS	NS	NS	NS
2		1 500	1 300	1 200	1 100	1 000
3		1 900	1 800	1 600	1 500	1 400
4		2 900	2 700	2 400	2 300	2 100
5		3 600	3 300	3	2 800	2 600
1	Tile	NS	NS	NS	NS	NS
2		1 300	1 100	900	800	NS
3		1 700	1 400	1 200	1 100	1 000
4		2 600	2 200	1 900	1 600	1 500
5		3 200	2 700	2 300	2 000	1 800
Floor load width (upper + lower storey) 4 800 mm						
1	Sheet	NS	NS	NS	NS	NS
2		1 100	1 000	1 000	900	800
3		1 500	1 400	1 300	1 200	1 100
4		2 200	2 100	1 900	1 800	1 700
5		2 800	2 600	2 400	2 300	2 200
1		NS	NS	NS	NS	NS

Table 3.7 *(continued)*

Footing type	Roofing type	Roof load width, mm				
		1 500	**3 000**	**4 500**	**6 000**	**7 500**
		Maximum permissible bearer span, mm				
2	Tile	1 000	900	NS	NS	NS
3		1 400	1 200	1 000	900	800
4		2 000	1 800	1 600	1 400	1 300
5		2 600	2 200	2 000	1 700	1 600

NOTE 1 NS = not suitable.

NOTE 2 Maximum permissible bearer span is for each footing type. Bearer size is determined from the relevant Span Tables in the Supplements, see Section 4.

NOTE 3 The Table values are based on roof loads of 0.4 and 0.9 kPa for sheet and tile roofs respectively, and a distributed load of 1.55 kPa being 0.4 kPa wall load spread over the floor area, 0.4 kPa floor load and 0.75 kPa permanent live load for each floor.

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, where applicable, decks, verandahs, and similar constructions. This Section shall be used in conjunction with Span Tables 1 to 6, 33 to 35 and 49 and 50 given in the Supplements.

4.1.2 Materials

Any timber species may be used for floor framing provided it is kept dry, i.e. it is not exposed to weather, it is well ventilated, and is not in contact with or close to the ground, see Clause 1.8 and Clause 3.3.

When constructing floors that will be exposed to the weather (e.g. decks, verandahs), attention shall be given to the durability of materials and detailing required to ensure an adequate service life, see Clause 1.8.

NOTE 1 For information on durability, see Appendix B.

NOTE 2 For information on moisture content and shrinkage, see Appendix E.

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 seasoned or small section unseasoned bearers and joists (overall depth of floor frame less than 200 mm) is usually of minimal significance to the overall performance of the structure, see Figure E.1.

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.

Only one surface at the end of any member shall be notched.

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 and EWPs may have their own specific limitations, see Clause 1.12.

Dimensions in millimetres

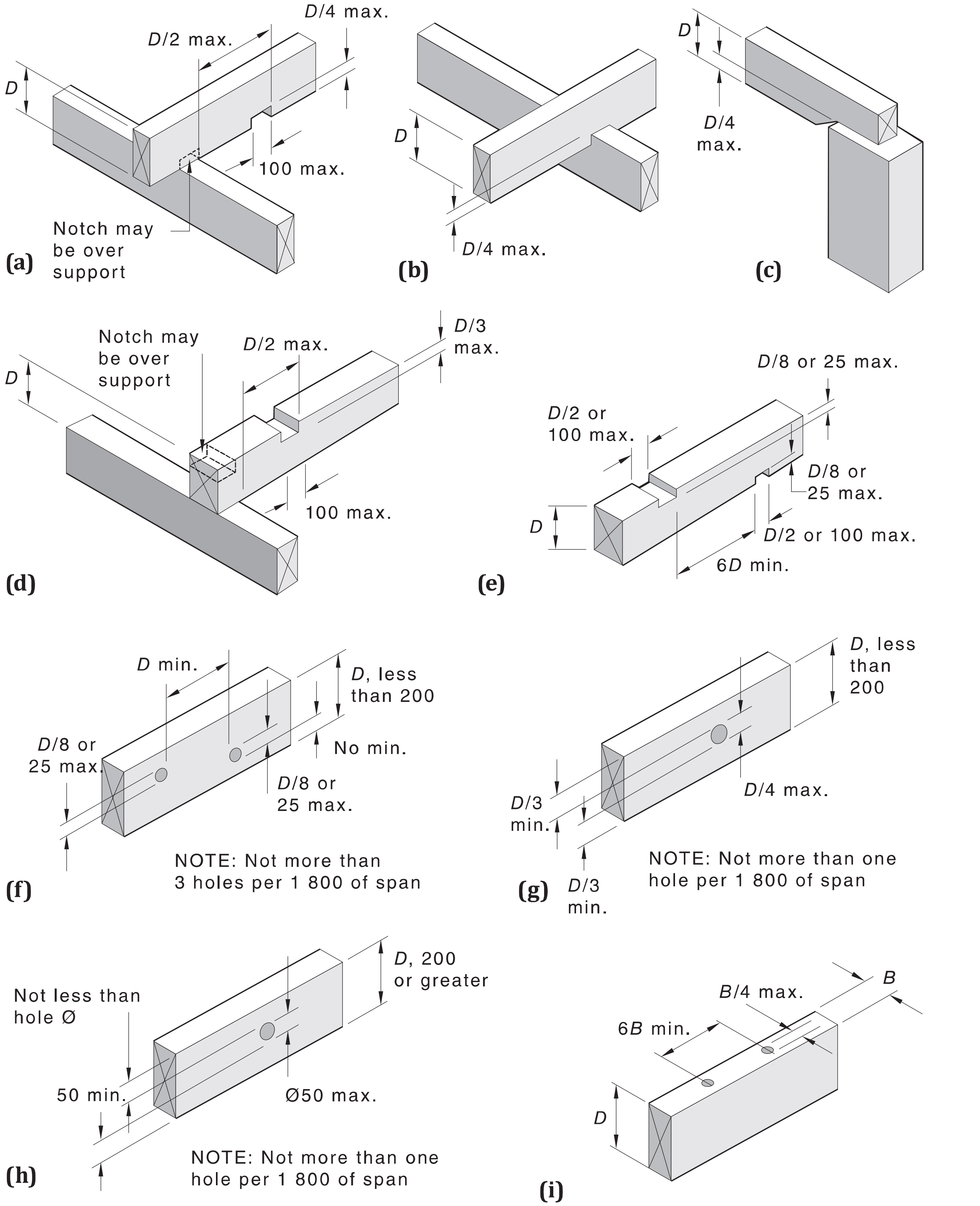


Figure 4.1 — Notches, cuts and holes in beams, bearers, joists, rafters

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 1.3.9.3 and 1.3.9.4.

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.

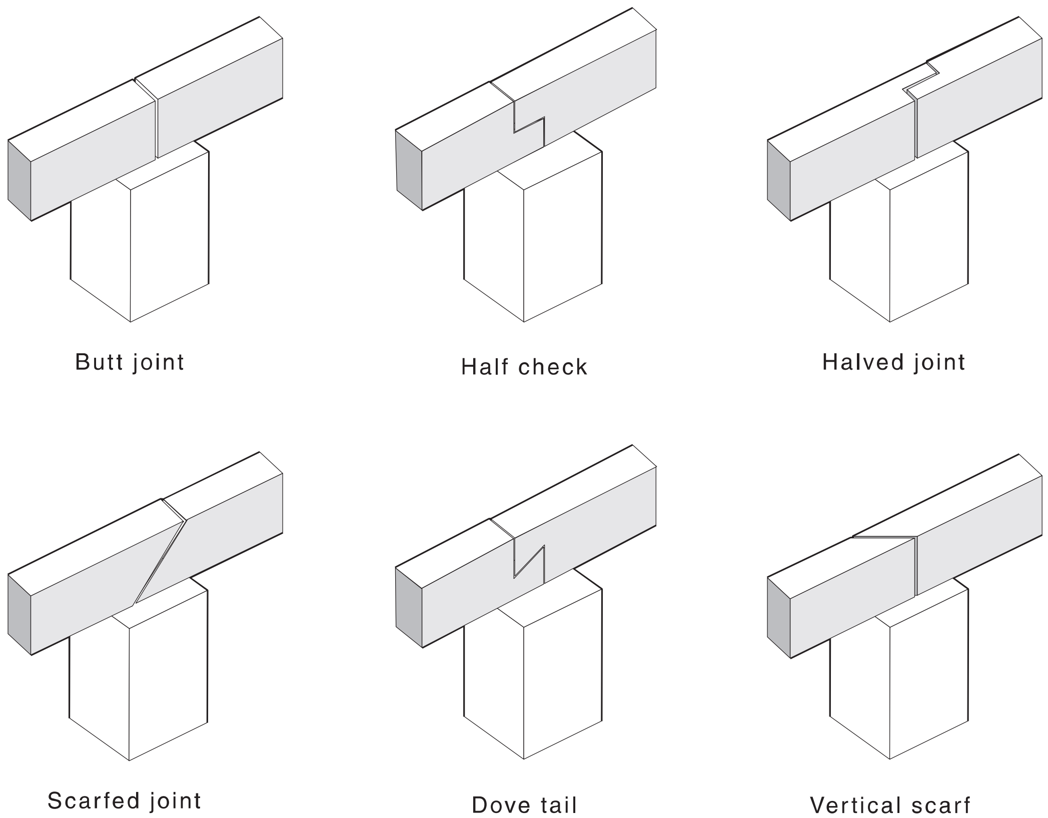
Bearers with minor spring, within the allowable limits, shall have the spring placed upwards to allow for straightening under loading.

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

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.

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

NOTE 2 Some engineered nail-plated products may permit joints to occur other than over supports, see Clause 1.12.



NOTE Bearers may also be lapped over supports.

Figure 4.2 — Connection methods over bearer supports (alternatives)

4.2.1.2 Fixing of bearers to supports

Bearers shall be fixed to their supporting stumps, posts or columns so as to give adequate bearing and provide restraint against lateral movement, see Clause 9.7.

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.

4.2.1.4 Double bearers (spaced bearers)

The required breadth of larger bearers may be obtained by using spaced double bearers. Spacer blocks shall be placed between the bearers and, where relevant, at supports, at the intervals specified in Table 4.1, see Figure 4.3.

Table 4.1 — Spacer block location and fixings

Bearer span, m	Block location	Fixing requirements
Under 2.0	Midspan	For 38 mm thick, 2/75 mm nails each side For 50 mm thick, 2/100 mm nails each side
2.0 to 3.6	One-third span points	4/75 mm nails each side
Over 3.6	One-quarter span points	2/M10 through bolts

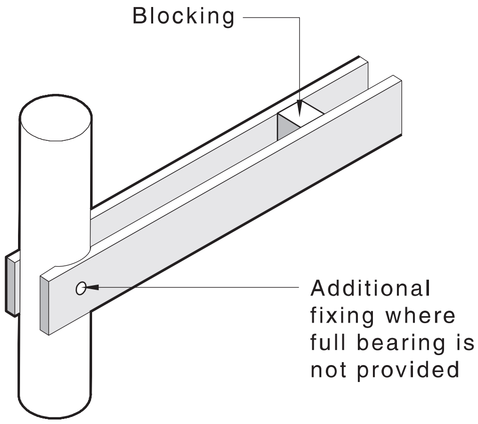


Figure 4.3 — Double bearer

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 4.3.2.4) or flooring, see Clause 5.3.

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 to correct bow or spring, 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 4.4 and shall be made only over bearers or supports. Joists joined over bearers or supports shall have a minimum 30 mm bearing for each joist. Joints in joists that are required to be in line (e.g. supporting wall plates or fitted flooring) shall be butted or scarfed, but not lapped.

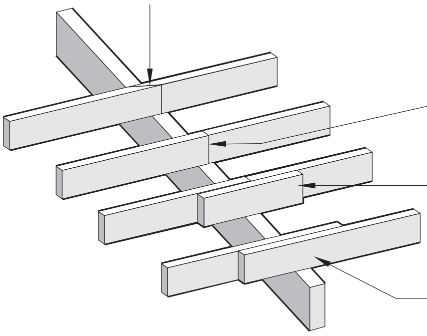


Figure 4.4 — Methods of joining joists

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. A single joist only is required under external non-loadbearing walls.

Joists are not required under internal non-loadbearing walls except where needed 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 —

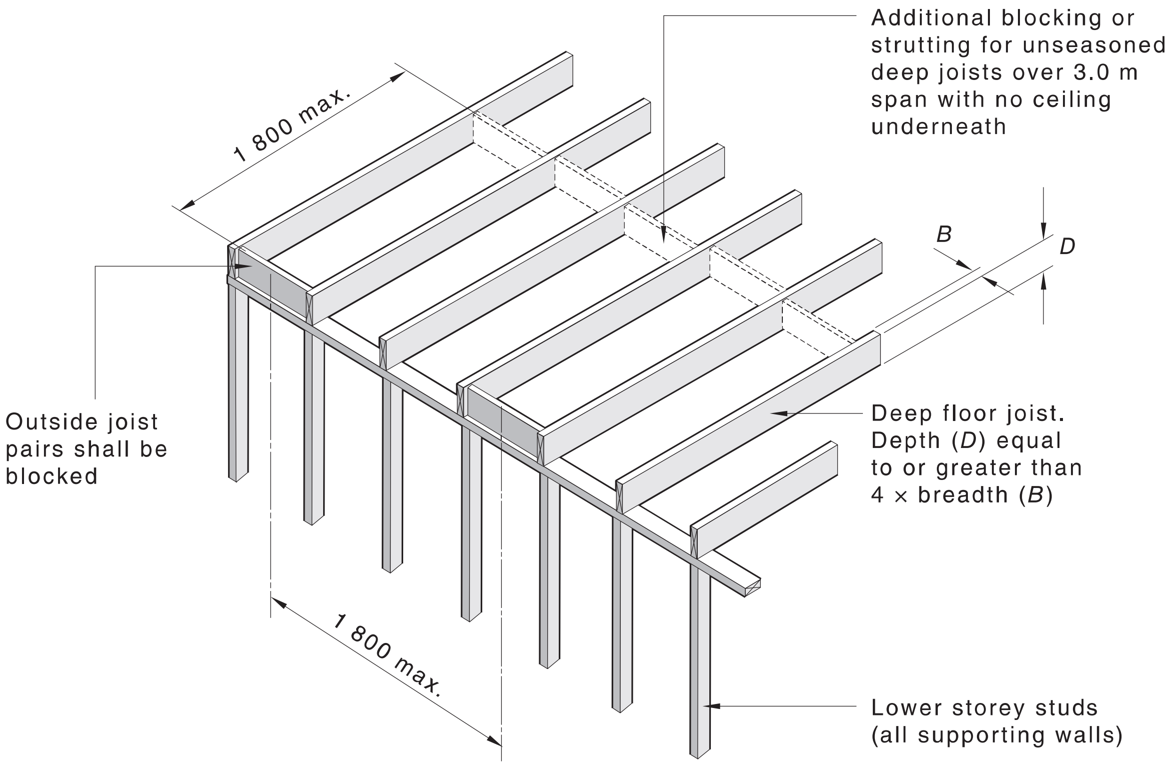
(a) a continuous trimming joist provided to the ends of joists above external bearers or wall plates; or

(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, as shown in Figure 4.5, or other equivalent method for the purpose of ventilation. Trimmers or solid blocking shall be a minimum thickness of 25 mm.

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.

Where rim boards (see 1.3.5) are used in conjunction with deep joists, including I joist and floor systems, they shall be suitable to carry relevant uniform and point loads that may be transferred to the rim board via the plates.



NOTE 1 For engineered timber products, see Clause 1.12.

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 4.5 — 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.

4.3 Member sizes

4.3.1 Bearers

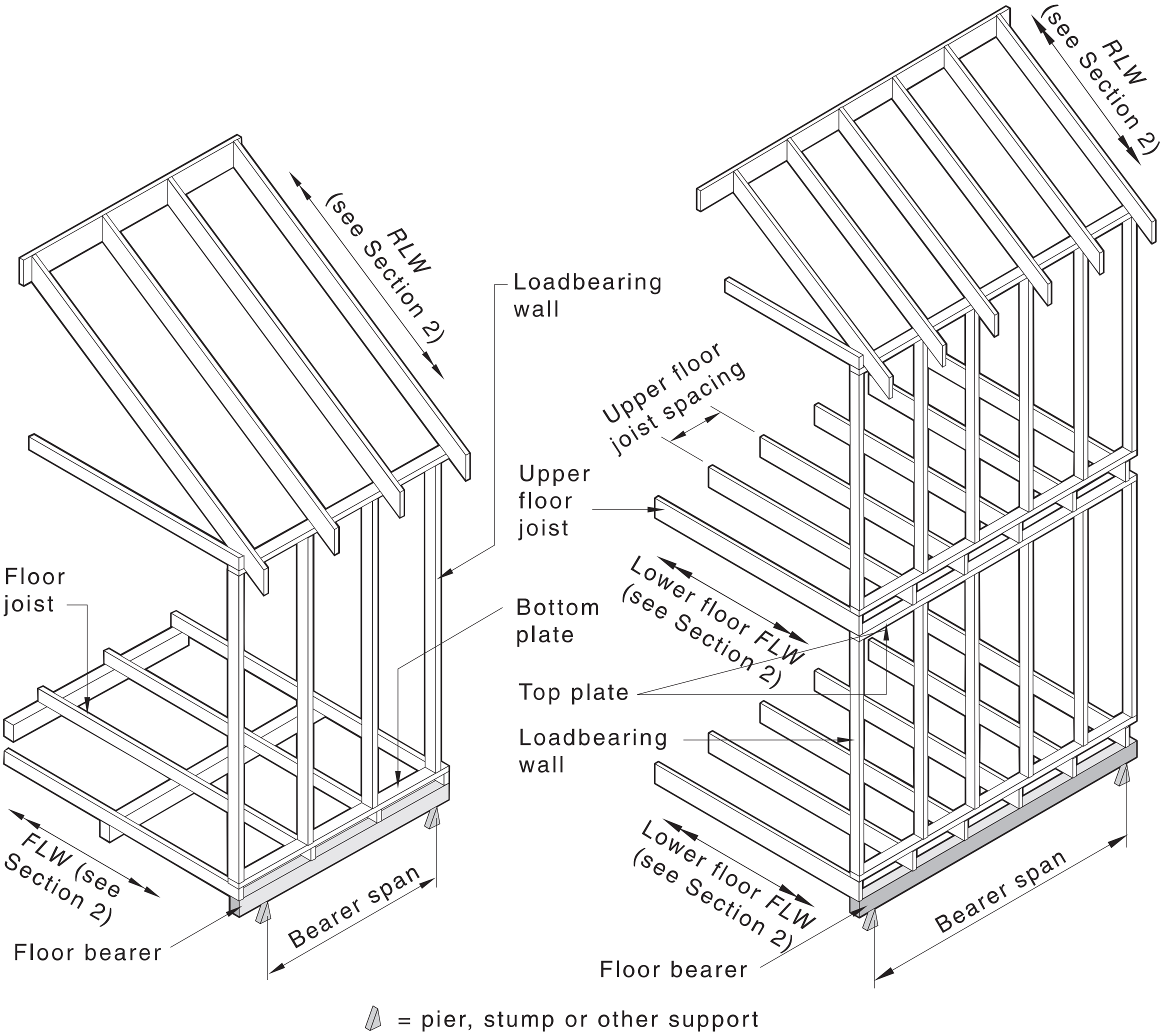
4.3.1.1 Bearers supporting loadbearing walls

The size of bearers supporting single or upper storey loadbearing walls shall be determined from Span Tables 1 to 4 of the Supplements for floor load width (*FLW*) of 1 200 mm, 2 400 mm, 3 600 mm and 4 800 mm, respectively.

The size of bearers supporting the lower storey of two storey loadbearing walls shall be determined from Span Tables 33 and 34 of the Supplements for floor load widths (FLW) of 1 800 mm and 3 600 mm, respectively. These Tables are applicable to loadbearing walls that are parallel to bearers and distribute loads evenly along these bearers.

Requirements for support of other loads are specified in Clauses 4.3.1.4 to 4.3.1.6.

Design parameters for bearers supporting loadbearing walls shall be as shown in Figure 4.6.



(a) Single or upper storey **(b) Lower storey or two storey**

Figure 4.6 — Bearers supporting loadbearing walls

4.3.1.2 Bearers supporting floor loads only

For bearers supporting floor loads only or for decks located equal to or less than 1 000 mm above the ground, the size of bearers shall be determined from Span Table 5 of the Supplements. For decks located more than 1 000 mm above the ground, the size of bearers supporting floor loads shall be determined from Span Table 49 of the Supplements.

The maximum cantilever of bearers shall be as given in the Span Tables of the Supplements.

Design parameters for bearers supporting floor loads shall be as shown in Figure 4.7.

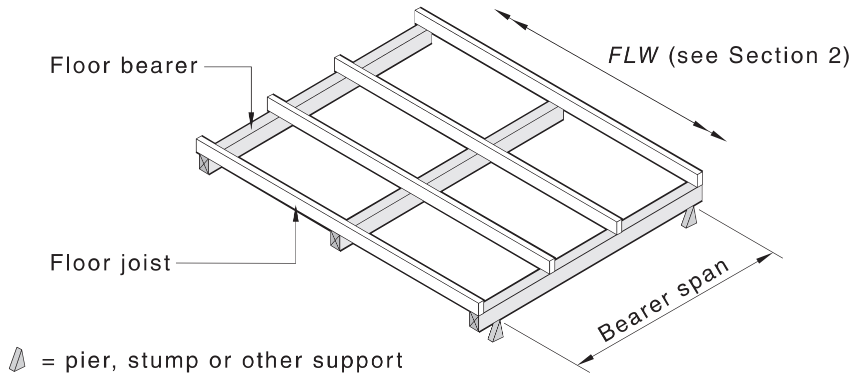


Figure 4.7 — Bearers supporting floor loads only

4.3.1.3 Bearers in lower storey supporting upper storey floor loads

The size of bearers in lower storey construction supporting floor loads from the upper storey shall be determined from Span Table 35 of the Supplements.

Floor load width shall be determined in accordance with Clause 2.6.2.

4.3.1.4 Bearers supporting gable or skillion end walls

Bearers supporting non-loadbearing gable or skillion end walls shall be considered as for bearers supporting single storey loadbearing walls with a sheet roof and a roof load width (*RLW*) of 1 500 mm, see Clause 4.3.1.1.

4.3.1.5 Single or upper storey bearers supporting loadbearing walls at right angles to their span

Where loadbearing walls are supported at or within 1.5 times the bearer depth from the bearer support, the bearer may be considered as not supporting roof loads.

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 4.2, see also Figure 4.8.

Table 4.2 — Offsets and cantilevers for bearers supporting loadbearing walls at right angles

Depth of member, mm	Permissible cantilevers and offsets for bearers under loadbearing walls (maximum roof load width 3 600 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
201 to 275	17	12	34	24
Over 275	19	14	38	28

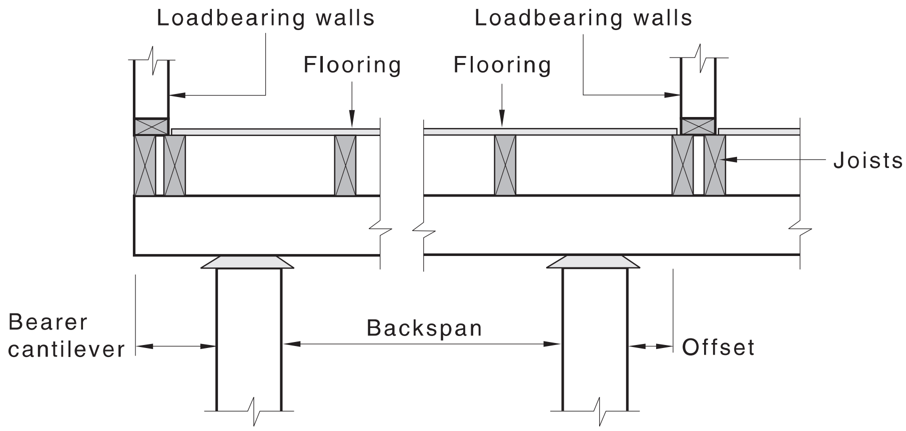


Figure 4.8 — Offsets and cantilevers

4.3.1.6 Bearers supporting roof point loads

The maximum roof point loads that bearers can support are given in Table 4.3.

Table 4.3 — Maximum roof point loads for bearers supporting parallel loadbearing walls

Roof type	Uniform load	Point load[a]
	Maximum roof load width (*RLW*), mm	Maximum area of roof supported, m^2
Sheet	As per Span Tables 1 to 4, 33 and 34	5
Tiles	As per Span Tables 1 to 4, 33 and 34	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.

4.3.1.7 Bearers supporting decks more than 1.0 m off the ground

The size of bearers supporting decks more than 1.0 m off the ground shall be determined from Span Table 49 of the Supplements.

4.3.2 Floor joists

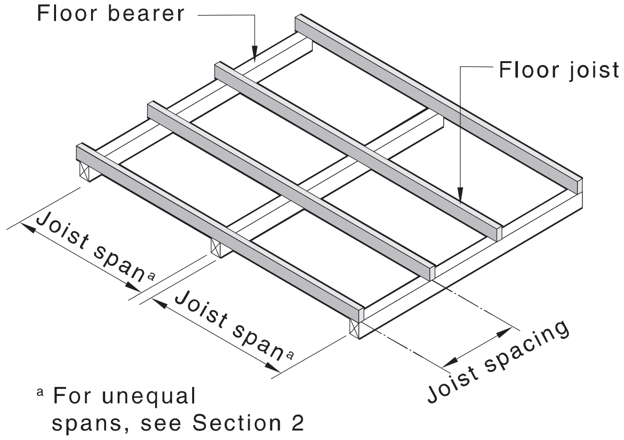
4.3.2.1 General

The size of floor joists shall be determined from Span Table 6 of the Supplements.

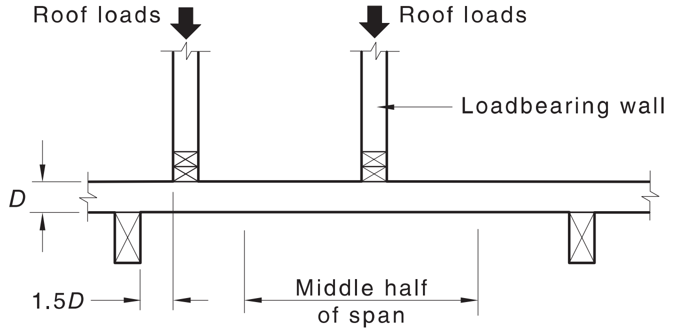
The size of joists for decks located more than 1 000 mm above the ground shall be determined from Span Table 50 of the Supplements. For floor joists supporting floor loads only, floor joists may cantilever up to 25 % of their allowable span provided the minimum backspan is at least twice the cantilever distance.

Design parameters for floor joists shall be as shown in Figure 4.9.

NOTE For decks up to 1 000 mm above the ground, the size may be determined from either Span Table 6 or 50 in the Supplements.



(a) Design parameters



(b) Loadbearing wall offset

Figure 4.9 — Floor joists

4.3.2.2 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 size as the adjacent floor joists. Unless otherwise required for the support of flooring, a single joist may be used.

4.3.2.3 Floor joists supporting 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 4.9.

In single or upper storey floors, where the loadbearing wall occurs within the middle half of the span of the joist, the joist size shall be determined from Span Table 6 of the Supplements for the appropriate roof load width (*RLW*). For loadbearing walls occurring between 1.5 times the depth from the support up to the middle half of the span, interpolation is permitted, see Figure 4.9. For loadbearing walls supported by cantilevered floor joists, the maximum cantilever shall not exceed 15 % of the allowable span determined from Span Table 6 of the Supplements for the appropriate roof load width (*RLW*). The minimum backspan shall be at least four times the cantilever distance.

In the lower storey of a two storey construction, floor joists shall not support loadbearing walls within their spans.

4.3.2.4 Single or upper storey floor joists supporting roof point loads and loadbearing walls parallel to joists

Floor joist sizes determined from Span Table 6 of the Supplements, using *RLW* = 0, may support roof point loads and loadbearing walls parallel to joists in accordance with Table 4.4. Where multiple joists are used, the maximum *RLW* or point load area may be increased in proportion to the number of additional joists.

For roof load widths greater than the values given in Table 4.4, the joists may be considered as for bearers in accordance with the bearer Span Tables of the Supplements and an equivalent joist size provided.

Table 4.4 — Joists supporting roof loads transferred through walls parallel to joists

Roof type	Uniform load parallel to joists Maximum roof load width (*RLW*) mm	Point load[a] 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.

4.3.2.5 Openings in floors

Trimming joists and trimmers supporting curtailed joists shall be of the same size and 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. The trimmers and joists shall be suitably connected (e.g. metal nailplate connectors), see Figure 4.10.

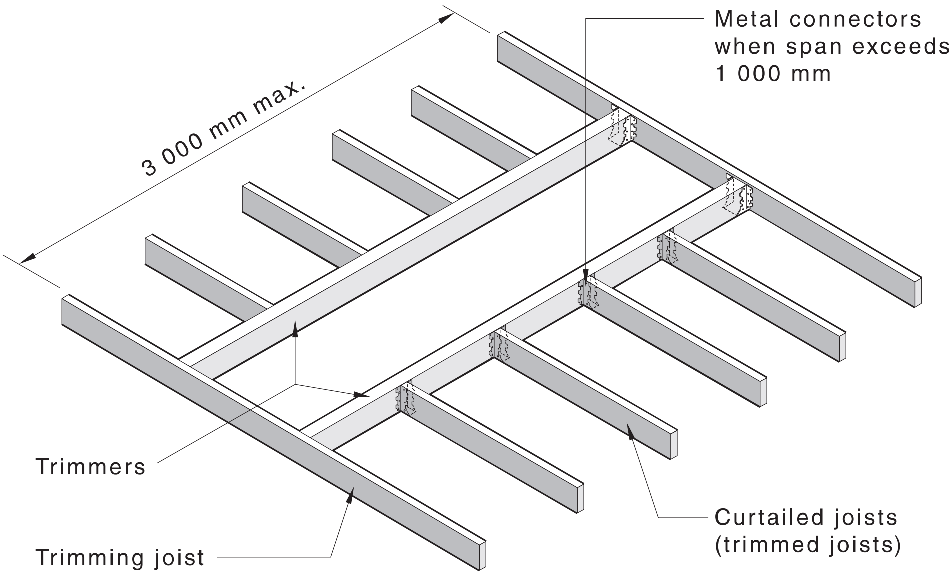


Figure 4.10 — Openings in floors

4.3.2.6 Joists supporting decks more than 1.0 m off the ground

The size of joists supporting decks more than 1.0 m off the ground shall be determined from Span Table 50 of the Supplements.

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 apply to 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.

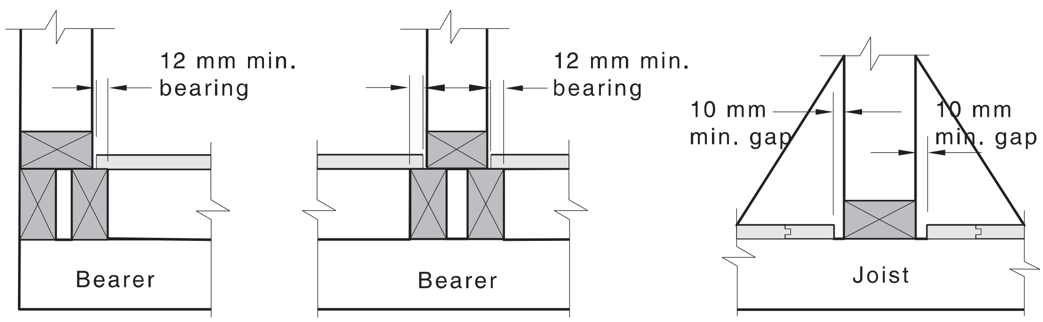


Figure 5.1 — Fitted floors

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.

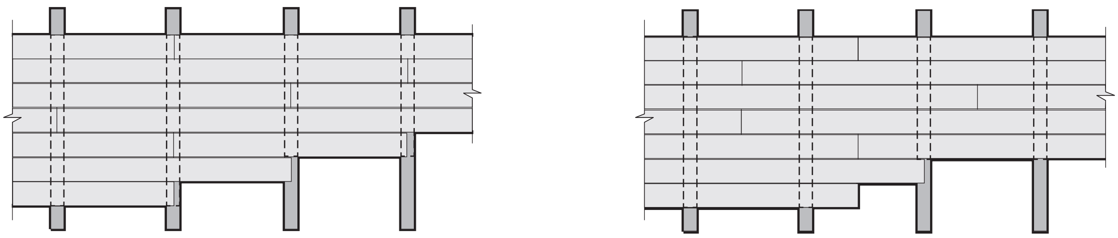
NOTE To manage expansion in high humidity locations, a combination of acclimatization and more allowance for intermediate expansion should be considered.

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 butt-joined tightly together over floor joists. Joints in adjoining boards shall be staggered, see Figure 5.2.



(a) Butt joints over joists — Staggered (not to occur in adjacent boards on same joist)

(b) End-matched joints — Staggered (not to occur in adjacent boards within same span)

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 (see Figure 5.3) or shall be secret nailed with one fixing at each joist (see Figure 5.4). Boards over 65 mm wide and up to 85 mm wide shall be fixed by face-nailing with two nails (see Figure 5.3) or be secret-nailed with one fixing at each joist, see Figure 5.4. Boards over 85 mm cover width shall be fixed with a minimum of 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.

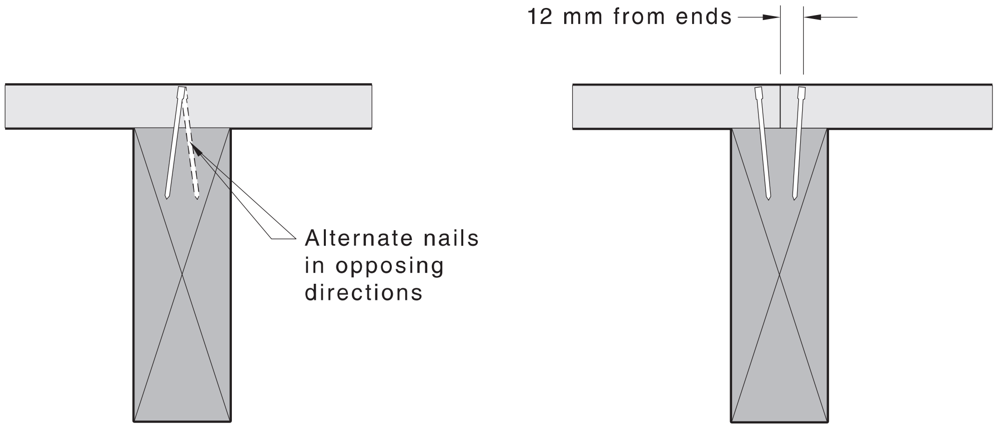
NOTE 2 Pre-drilling boards for fixings at butt ends aids in reducing splitting.

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 50 mm × 2.2 mm with minimum 6 mm glue bead to joist



(a) Intermediate joists **(b) Butt ends**

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

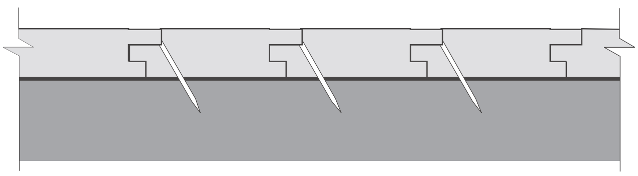


Figure 5.4 — Secret nailing

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 be continuous over at least two spans. Ends of sheets shall be butted over joists and joined over timber noggins between joists of a minimum size of 70 mm × 35 mm, set flush with the top of the joists. Edges of sheets, unless tongued and grooved, shall be joined over noggings between joists.

5.5.3.3 Fixing

Nails used for fixing of plywood shall be either 2.8 mm diameter flat-head or bullet-head hand-driven nails, or 2.5 mm diameter machine-driven nails of length 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 the edge of sheets, see Figure 5.5.

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/m^3 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.

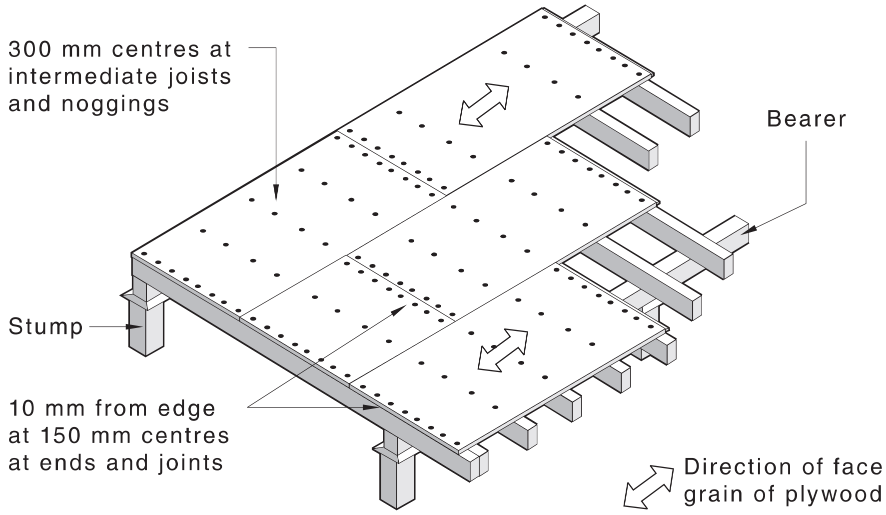


Figure 5.5 — Fixing of plywood sheet flooring

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/m^3 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 Wet area floors

Timber floors in wet areas (e.g. bathrooms, laundries) shall be protected from moisture.

NOTE Refer to the National Construction Code for requirements related to the protection of timber floors in wet areas from moisture.

5.7 Joist spacing — Flooring

The maximum 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 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	19	680	520
		Medium feature — Standard	19	620	470
Other hardwoods					
— Density less than 560 kg/m^3	AS 2796.1	Medium feature — Standard	19	510	390
— Density greater than 560 kg/m^3		Medium feature — Standard	19	580	450
Cypress	AS 1810	Grade 1	19	580	450
		Grade 220	580	450	
Radiata Pine	AS 4785.1	Standard	19	450	390
		Utility	19	510	—
		Standard	30	920	700
Softwood other than cypress or radiata pine:					
— Density less than 560 kg/m^3	AS 4785.1	Standard	19	510	390
— Density greater than 560 kg/m^3		Standard	19	580	450
Sheet flooring					
	Standard	**Thickness**	**Grade**		

Table 5.3 *(continued)*

Flooring	Standard	Grade	Thickness, mm	Maximum spacing of joists, mm	
				Butt joined	End matched
		mm	F8	F11	F14
Plywood	AS/NZS 2269.0	12	400	420	440
		13	430	450	480
		14	460	480	
		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	AS/NZS 1860.1	Refer to 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 the plywood flooring thicknesses in this Table, 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, refer to AS/NZS 1860.1.

5.8 Decking

The maximum allowable spacing of joists for timber decking shall be in accordance with Table 5.4, see also Clause 4.3.2.

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

Table 5.5 — Decking board fixing requirements

Decking	Joists	Nailing[a]			
		Machine-driven		Hand-driven	
Hardwood and cypress	Hardwood and cypress	50 × 2.5 flat-head or dome-head		50 × 2.8 bullet-head	
	Treated softwood	50 × 2.5 flat-head deformed shank	65 × 2.5 flat-head or dome-head	50 × 2.8 bullet-head deformed shank	65 × 2.8 bullet-head
Treated softwood	Hardwood and cypress	50 × 2.5 flat-head or dome-head		50 × 2.8 flat-head or dome-head	
	Treated softwood	50 × 2.5 flat-head deformed shank	65 × 2.5 flat-head	50 × 2.8 flat-head deformed shank	65 × 2.8 flat-head

[a] Nails shall be hot-dip galvanized or stainless steel. Two nails shall be used per board crossing.

NOTE 1 Decking boards may be screw-fixed with decking screws appropriately treated for decking applications (minimum 10 gauge, 50 mm long for boards up to 22 mm thick).

NOTE 2 Some deformed shank nails do not have high withdrawal strength and may need to be assessed for equivalence to equivalent length, plain shank galvanized nails.

Section 6 Wall framing

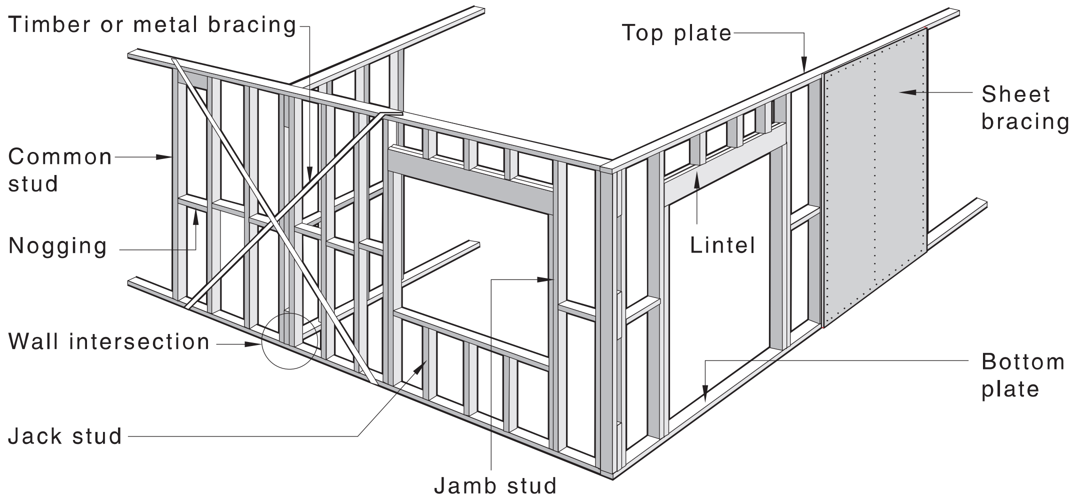
6.1 General

6.1.1 Application

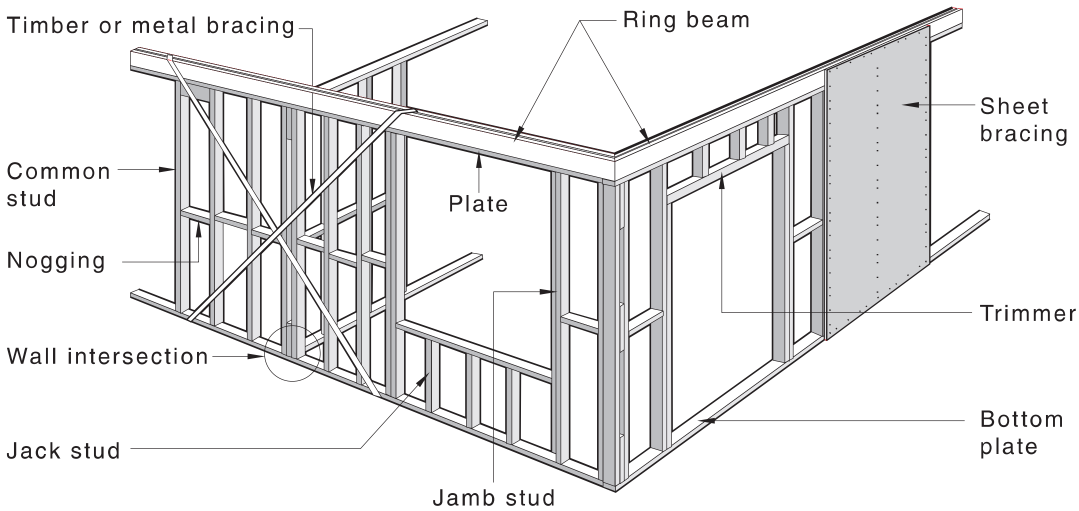
This Section sets out the requirements for the construction of conventional stud-framed walls. It shall be used in conjunction with Span Tables 7 to 20 (single or upper storey construction), 36 to 48 (lower storey construction), or 51A and 53 (verandahs and posts) of the Supplements.

6.1.2 Wall frame members

Walls shall be framed with studs, plates, noggings, bracing, lintels, and similar members, as shown in Figure 6.1 and as outlined in this Section.



(a) Traditional construction



(b) Ring beam construction

Figure 6.1 — Wall frame members

6.1.3 Bracing

Temporary and permanent bracing shall be provided to stud walls to resist horizontal forces applied to the building. Appropriate connections shall also be provided to transfer these forces through the framework and subfloor structure to the building foundation, see Section 8.

6.2 Building practice

6.2.1 Studs

6.2.1.1 Straightening of studs (crippling)

Common studs may be straightened by "crippling" with saw cuts and cleats, see Figure 6.2. Up to 20 % of common studs, including those in bracing walls, may be crippled.

Studs at the sides of openings and studs supporting concentration of load shall not be crippled.

NOTE Studs may be planed provided the minimum size remaining is not less than the minimum design size required. For example, a stud of 90 mm depth may be planed down to 70 mm depth if the minimum design depth required is 70 mm.

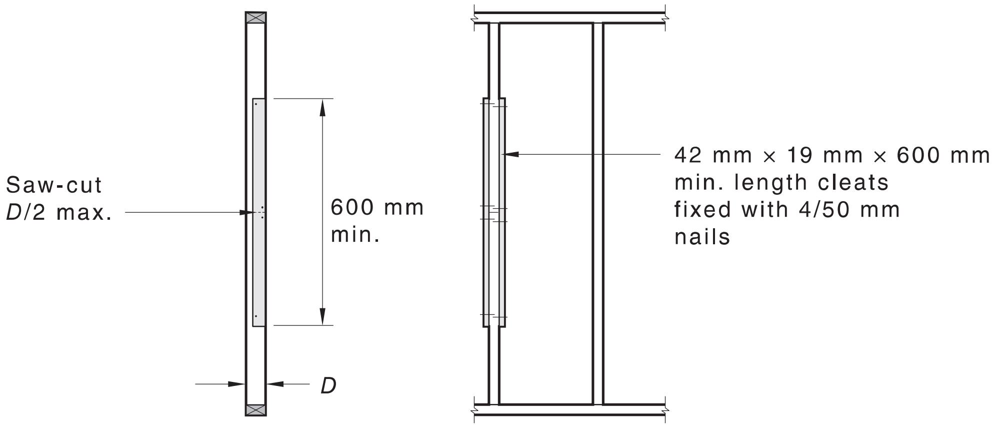


Figure 6.2 — Stud crippling

6.2.1.2 Common studs

Common studs shall be evenly spaced to suit loads, lining and cladding fixing.

Large size studs may be made up by nail-laminating together two or more smaller-sized studs, see Clause 2.4.

6.2.1.3 Wall junctions

Studs at wall junctions and intersections shall be in accordance with one of the details shown in Figure 6.3. Studs shall be not less in size than common studs. All junctions shall have sufficient studs, which shall be located so as to allow adequate fixing of linings.

All intersecting walls shall be fixed at their junction with blocks or noggings fixed to each wall with 2/75 mm nails. Blocks or noggings shall be installed at 900 mm max. centres.

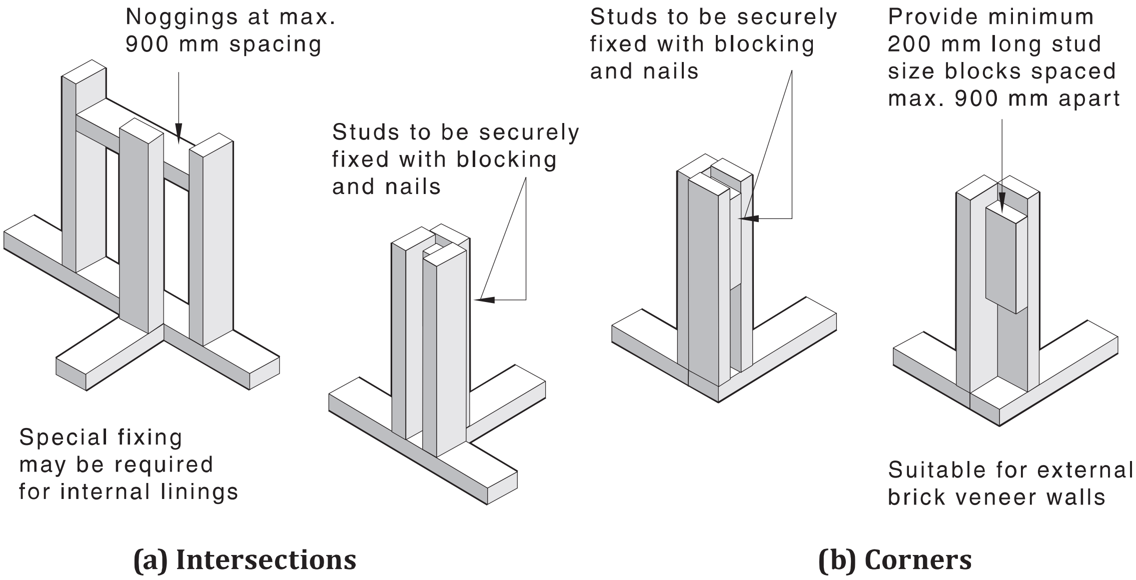


Figure 6.3 — Typical wall junctions

6.2.1.4 Notching, trenching and holes in studs and plates

The following provisions relate to the maximum size of notches, trenching and holes in wall studs and plates, depending whether the wall is external, loadbearing or non-loadbearing.

(a) *General (external walls, loadbearing walls and braced sections of internal non-loadbearing walls)*

The maximum size and spacing of cuts, holes, notches and similar section-reductions in studs and plates shall be in accordance with Figure 6.4 and Table 6.1. Holes in studs and plates shall be located within the middle half of the depth and breadth of the member, respectively. A longitudinal groove up to 18 mm wide × 10 mm deep may be machined into the middle third depth of a stud to accept full-length anchor rods. Where the groove exceeds this dimension, the remaining net breadth and depth of the stud shall be not less than the minimum size required.

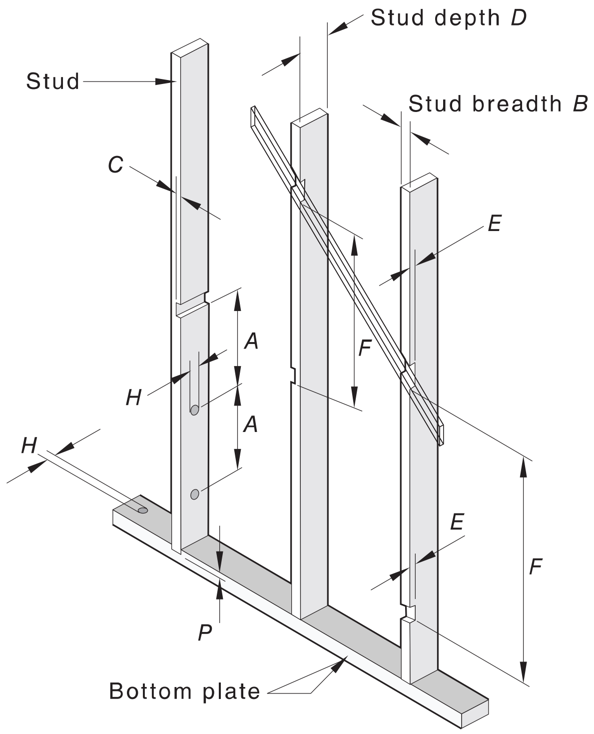


Figure 6.4 — Notching of wall studs

Table 6.1 — Holes and notches in studs and plates

Symbol	Description	Limits	
		Notched	Not notched
A	Distance between holes and/or notches in stud breadth	Min. 3*D*	Min. 3*D*
H	Hole diameter (studs and plates)	Max. 25 mm (wide face only)	Max. 25 mm (wide face only)
C	Notch into stud breadth	Max. 10 mm	Max. 10 mm
E	Notch into stud depth	Max. 20 mm (for diagonal cut in bracing only) (see Notes 1 and 2)	Not permitted (see Note 1)
F	Distance between notches in stud depth	Min. 12*B*	N/A
P	Trenches in plates	3 mm max.	

NOTE 1 A horizontal line of notches up to 25 mm may be provided for the installation of baths.

NOTE 2 Except as permitted for diagonal cut in bracing, notches up to 20 mm may occur in every fifth individual stud.

NOTE 3 For additional jamb stud requirements, see Figures 6.5, 6.9(A) and 6.9(B).

NOTE 4 Top and bottom plates in internal non-loadbearing and non-bracing walls may be discontinuous up to 60 mm (cut or drilled) to permit installation of services provided that, at the discontinuity, the plates are trimmed or otherwise reinforced either side of the discontinuity to maintain the lateral and longitudinal integrity of the wall.

Studs may be designed as notched or not-notched. For common studs, the maximum notch depth for single or upper storey or lower storey construction shall be 20 mm.

When determined in accordance with the Span Tables given in the Supplements, top and bottom plate sizes may be trenched up to a maximum of 3 mm. Where trenching exceeds this depth, the minimum remaining net depth of the plate shall be used when determining the allowable design limits from the Span Tables.

NOTE As an example, if a 45 mm deep plate is trenched 10 mm, then the design using the Span Tables will be based on a 35 mm deep plate.

Jamb studs in external walls and other loadbearing walls shall not be notched within the middle half of their height or within the height of the opening. A notch up to a maximum of 20 mm in depth is permissible outside this region at the top and/or the bottom of the stud, see Figure 6.5.

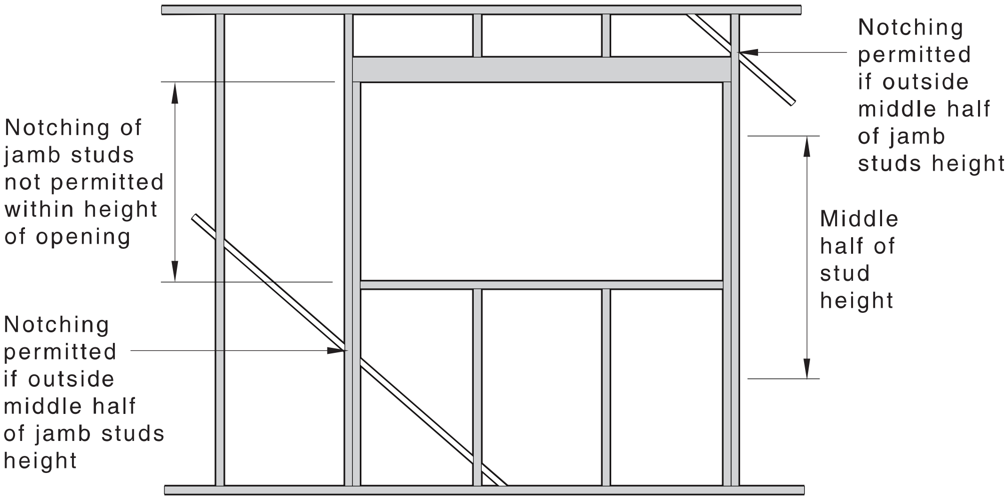


Figure 6.5 — Notching of jamb studs

(b) *Internal non-loadbearing walls (excluding sections of wall that have diagonal or structural sheet bracing installed)*

The general requirements for internal non-loadbearing walls (excluding sections of wall that have diagonal or structural sheet bracing installed) shall be as specified in Item (a) above. The following additional allowances are permitted:

(i) Holes in plates and noggings of diameter up to 52 mm may be located on the centre-line of the wide face provided they are spaced a minimum of 1 800 mm apart and are not located adjacent to significant timber defects.

(ii) A single hole in a stud of diameter up to 52 mm may be located on the centre-line of the wide face provided they are not located adjacent to significant timber defects and can only occur not closer than in every fourth stud.

(iii) A single notch in a stud up to 50 % of the stud depth may be used where it is not located adjacent to significant timber defects. The notch can only occur not closer than in every fourth stud.

6.2.1.5 Noggings

Where required, wall studs shall have continuous rows of noggings, located on flat or on edge, at 1 350 mm maximum centres, see Figure 6.6.

Noggings need not be stress-graded.

Unless otherwise specified, the nogging shall have either a minimum size of the depth of the stud minus 25 mm × 25 mm thick, or a minimum cross-section of 50 mm × 38 mm for unseasoned timber and 42 mm × 35 mm for seasoned timber. The nogging shall be suitable, where required, for the fixing of cladding, linings, and bracing.

Where required to provide fixing or support to cladding or lining or for joining bracing sheets at horizontal joints, noggings shall be installed flush with one face of the stud.

Where required to permit joining bracing sheets at horizontal joints, noggings shall be the same size as the top or bottom plate required for that bracing wall.

In other cases, noggings may be installed anywhere in the depth of the stud. Stagger in the row of noggings shall be not greater than 150 mm.

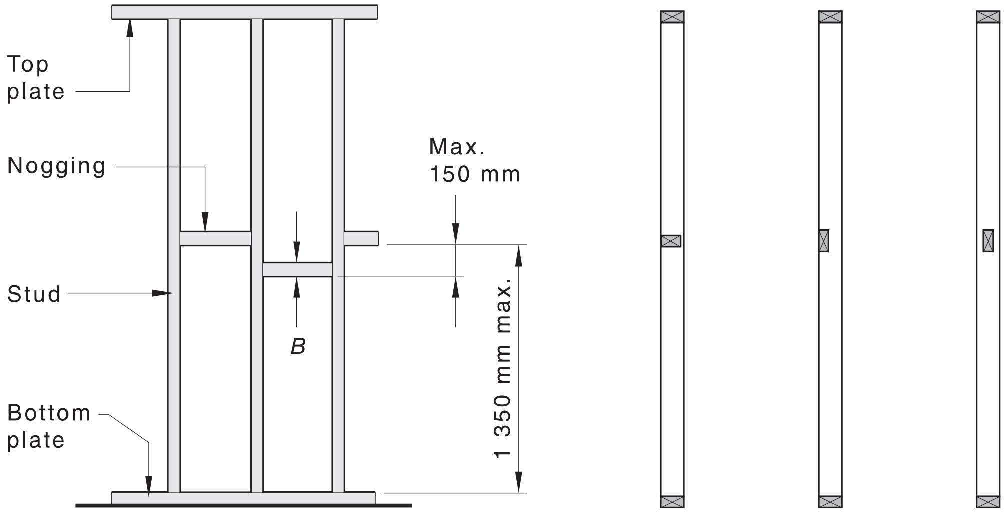


Figure 6.6 — Noggings

6.2.2 Plates

6.2.2.1 General

Top plates shall be provided along the full length of all walls, including over openings. Bottom plates shall be provided along the full length of all walls except at door openings.

6.2.2.2 Bottom plates

Bottom plates may be butt-jointed provided both ends are fixed and supported by floor joists, solid blocking or a concrete slab.

Bottom plates supporting jamb studs to openings exceeding 1 200 mm, or below studs supporting concentrations of load, shall be stiffened as shown in Figure 6.7.

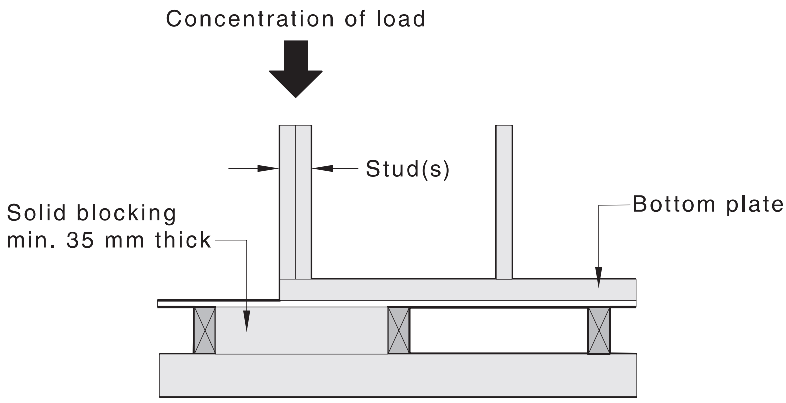


Figure 6.7 — Bottom plate stiffening

6.2.2.3 Stiffening of top plates

For supported roof area up to 10 m^2 and where a concentration of load (from roof beams, struts, strutting beams, hanging beams or counter beams 3 000 mm or more in length, combined strutting/hanging beams, combined strutting/counter beams or similar members) occurs between studs (i.e. studs supporting concentrations of load not provided), top plates shall be stiffened in accordance with Figure 6.8, or by placing the block on edge on top of the top plate from stud to stud.

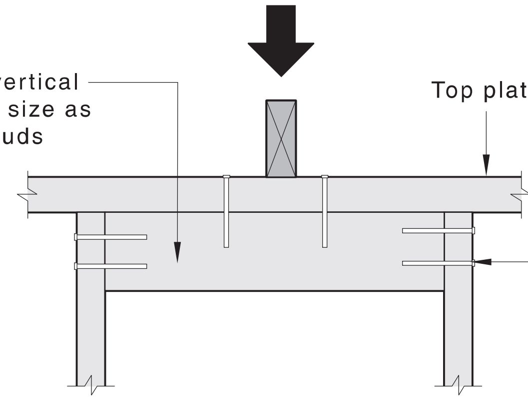


Figure 6.8 — Top plate stiffening

For a supported roof area between 10 m^2 and 20 m^2, metal nailplate connectors shall be used for the fixing of blocking to studs. Alternatively, double blocking shall be used and be provided with 3 nails at each end of blocking (total 6 nails at each stud).

6.2.2.4 Joints in top plates and ring beams

Top plates and ring beams shall be joined using one of the methods, as appropriate, given in Section 9 for the relevant wind classification.

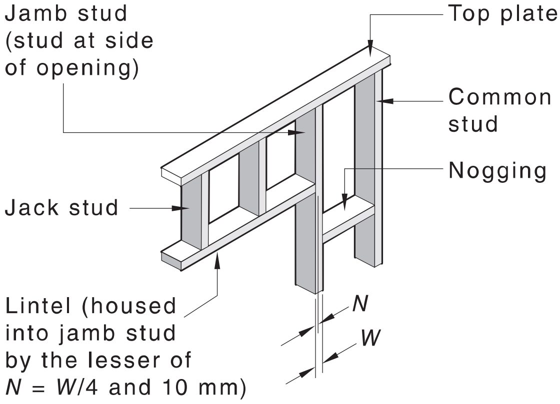
6.2.3 Openings

Openings shall be framed with jamb studs and lintels (heads) or ring beams as shown in Figures 6.9(A) and 6.9(B). Where required, jack studs shall be the same size, spacing, and orientation as the common studs, as shown in Figures 6.9(A) and 6.9(B). Alternatively, jack studs may be made up by horizontal nail lamination. A minimum clearance of 15 mm shall be provided between the underside of the lintel, ring beams, or lintel/ring-beam trimmer and the top of the window frame or door frame.

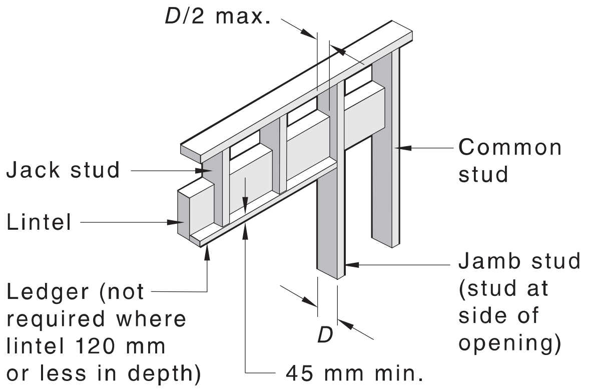
A continuous lintel may be located directly below the top plate as shown in Figure 6.9(B)(e). Where the breadth of the lintel is not the full depth of the wall frame, all studs shall be housed around the lintel as shown for jack studs in Figures 6.9(A) and 6.9(B).

Where jack studs are not appropriate, a full-length trimmer shall be fixed to the underside of the lintel.

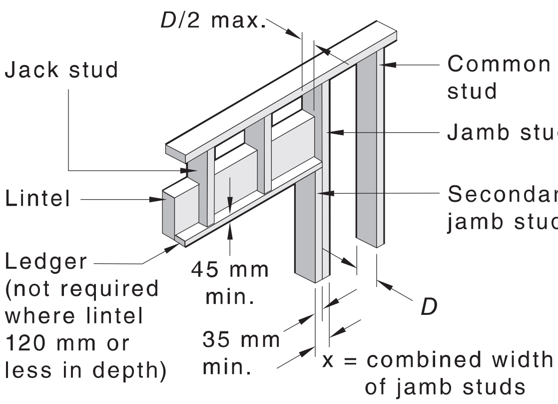
Alternatively, a continuous ring beam may be used without a top plate above provided it is designed as a standalone member without secondary contribution of a top plate as shown in Figures 6.9(B)(f) and 6.9(B)(g).



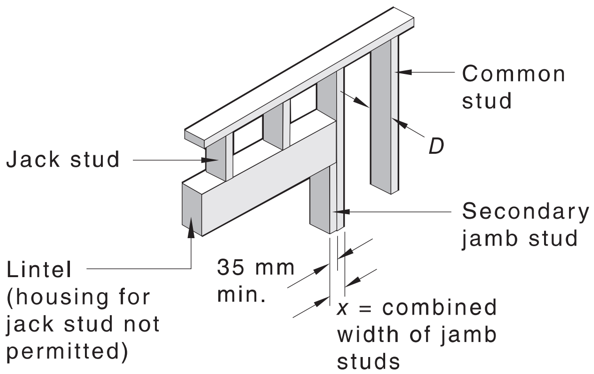
(a) Spans not exceeding 1 800 mm (non-loadbearing walls)



(b) Lintel breadth less than or equal to half stud depth

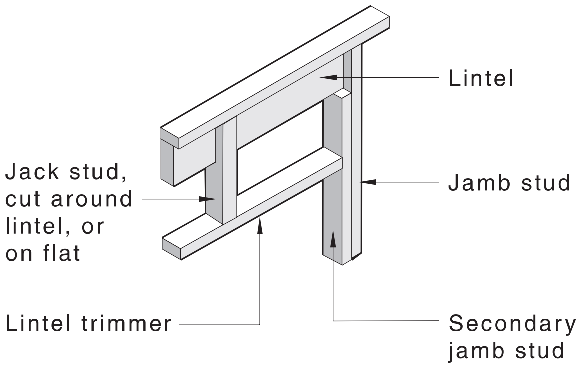


(c) Lintel breadth less than or equal to half stud depth — Alternative

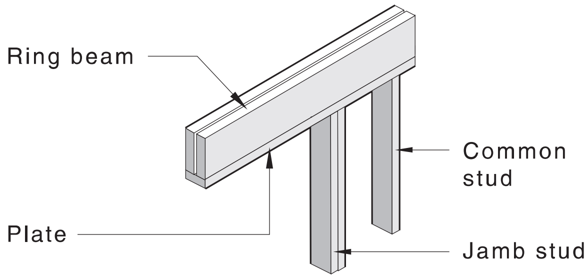


(d) Lintels having breadth greater than half stud depth

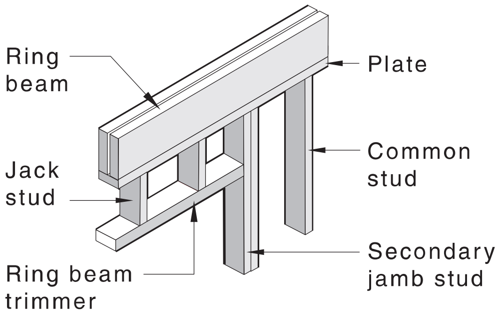
Figure 6.9(A) — Openings



(e) Lintel directly below top plate



(f) Ring beam



(g) Ring beam with trimmer

Figure 6.9(B) — Openings

6.2.4 Framing around chimneys and flues

Placement of all framing members shall be in accordance with AS 1691 and AS/NZS 2918.

6.2.5 Lateral support for non-loadbearing walls

6.2.5.1 External walls

External walls shall be laterally supported against wind forces. External walls supporting ceiling joists, rafters or trusses are deemed to have adequate lateral support.

Non-loadbearing external walls, such as gable end walls and verandah walls, where trusses are supported by a verandah plate or other beam, shall be restrained laterally at a maximum of 3 000 mm centres by means of —

(a) intersecting walls;

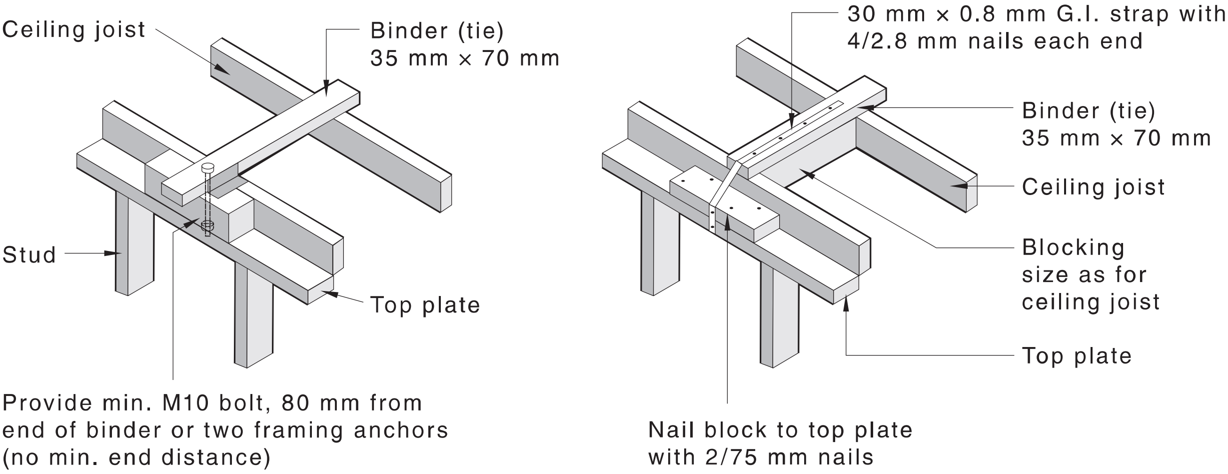
(b) ends of hanging or strutting beams;

(c) continuous timber ceiling battens; or

(d) tie members (binders), see Figure 6.10.

Where binders are required, they shall be 35 mm × 70 mm min. continuous members fixed to the external top plate as shown in Figure 6.10. Binders may be spliced where 4/75 mm nails or equivalent are provided for each side of the joint, i.e. binders overlap at least two ceiling joists with 2/75 mm nails to each joist and/or binder crossing.

NOTE Alternative details for the lateral support of non-loadbearing external walls, such as may occur in trussed roof construction, when trusses are pitched off verandah beams, are given in Section 9.

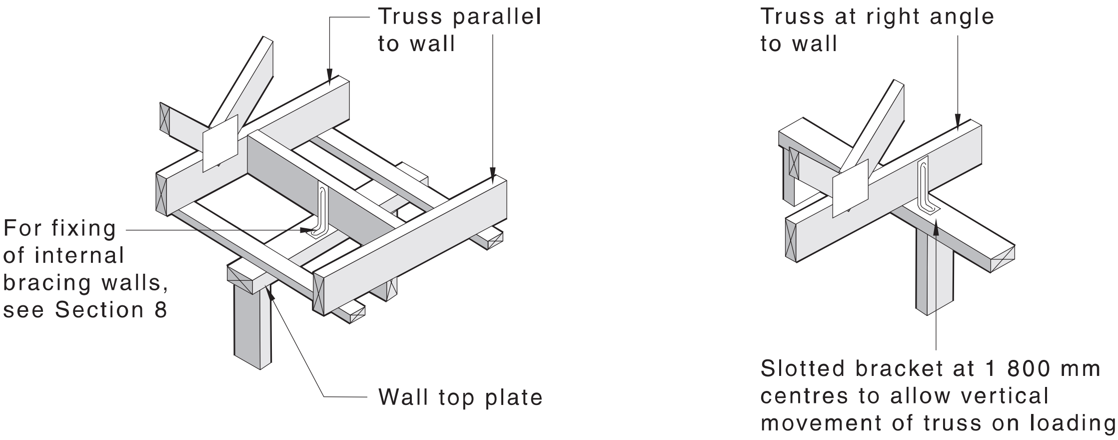


(a) Bolt or framing anchors **(b) Metal strap**

Figure 6.10 — Binders

6.2.5.2 Internal walls — Trussed roofs

Non-loadbearing walls shall be kept a minimum of 10 mm below the underside of the bottom chord or ceiling battens when used. Trusses shall be fixed to internal non-loadbearing walls as shown in Figure 6.11 or as required for bracing, see Clause 8.3.6.9.



(a) Truss parallel to wall **(b) Truss perpendicular to wall**

Figure 6.11 — Fixing of trusses to a non- loadbearing internal wall

6.3 Member sizes

6.3.1 General

Clauses 6.3.2 to 6.3.7 provide details for the determination of wall framing member sizes, which shall be determined from the appropriate Span Table given in the Supplements.

NOTE 1 Statements expressed in mandatory terms in notes to the Span Tables are deemed to be requirements of this Standard.

NOTE 2 In some instances, sheeting, lining or cladding fixing requirements may necessitate larger sizes than those determined from the Span Tables.

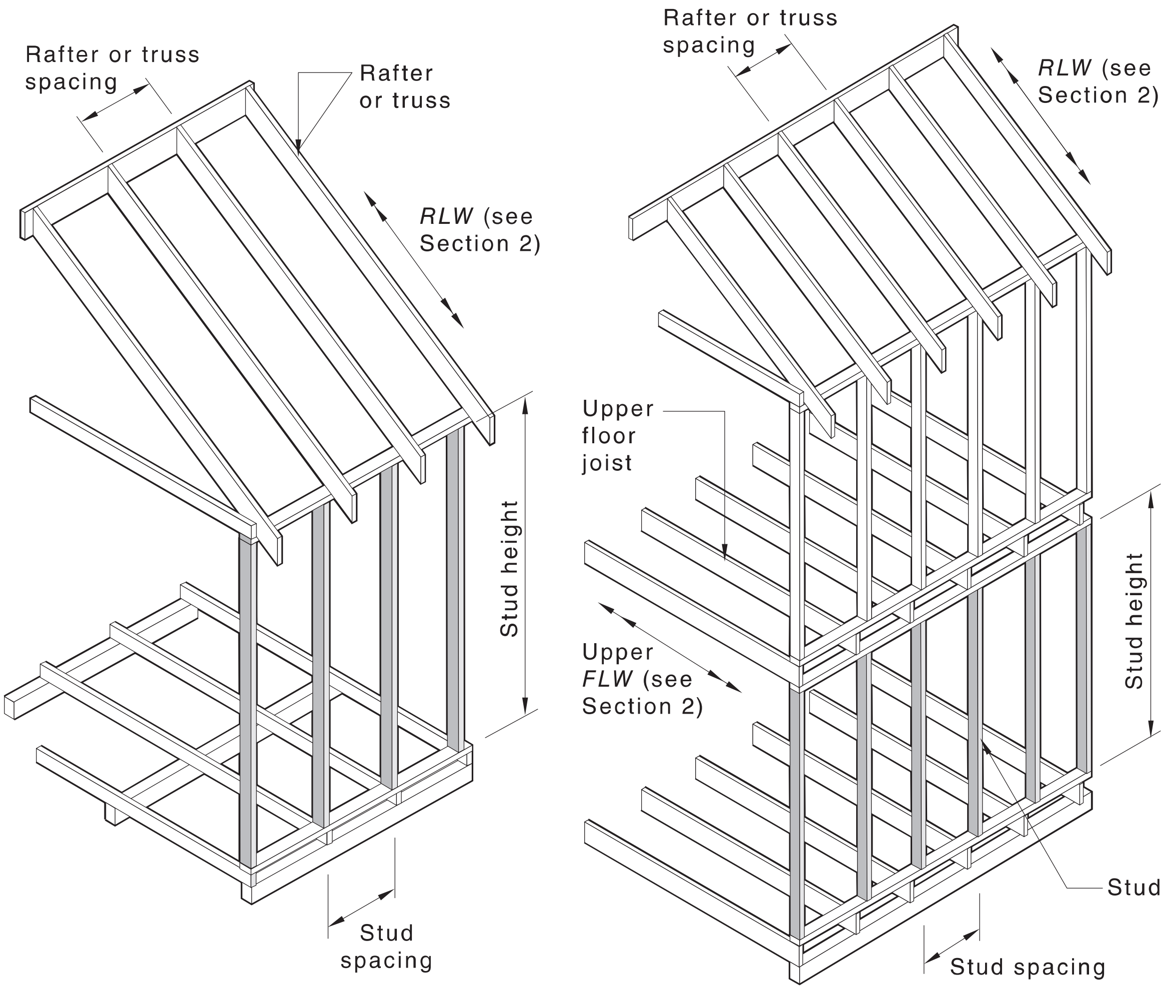
6.3.2 Wall studs

6.3.2.1 Common studs

The size of studs in single or upper storey loadbearing walls shall be determined from Span Tables 7 and 8 of the Supplements for not-notched and notched studs respectively.

The size of studs in the lower storey of two storey loadbearing walls shall be determined from Span Tables 36 and 37 of the Supplements for not-notched and notched studs respectively.

Design parameters for wall studs shall be as shown in Figure 6.12.



(a) Single or upper storey loadbearing walls **(b) Lower storey loadbearing walls**

NOTE Noggings have been omitted for clarity.

Figure 6.12 — Wall studs

The Span Tables provide for the design of not-notched and notched wall studs. Where cut-in or metal angle bracing is used (see Clause 6.2.1.4), the studs shall be designed as notched.

For studs at wall junctions and intersections, see Clause 6.2.1.3.

6.3.2.2 Studs supporting concentrated loads

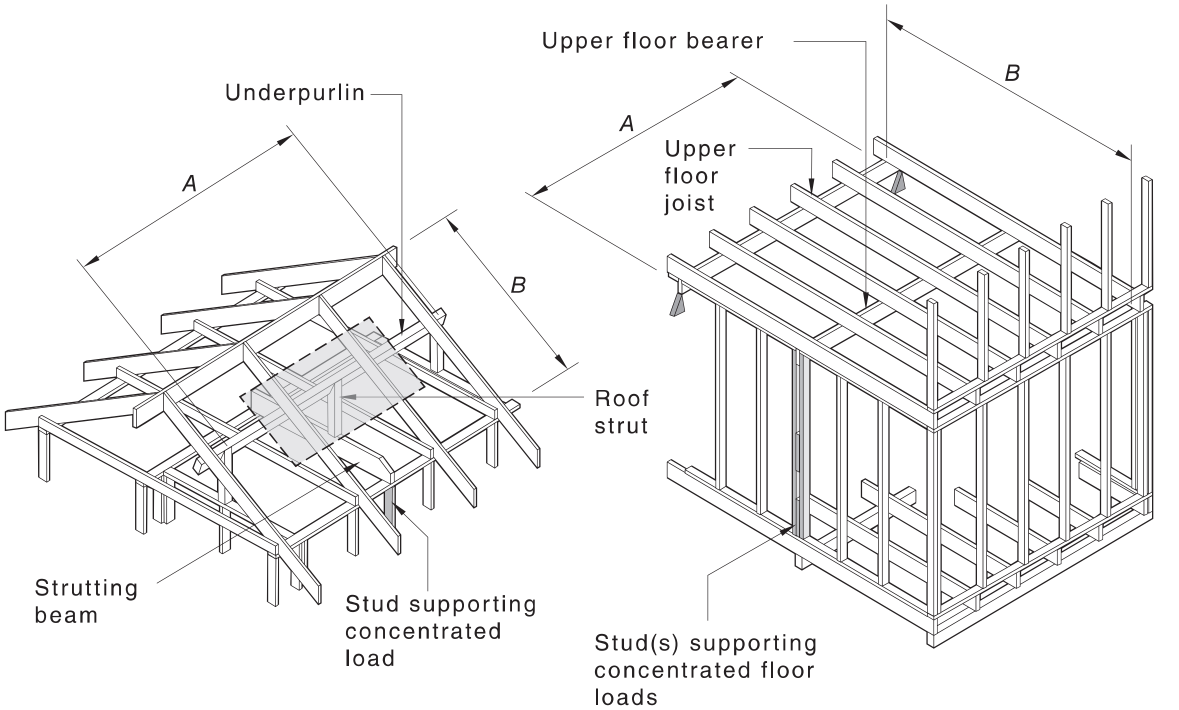
The size of studs supporting concentrated loads in single or upper storey construction shall be determined from Span Tables 9 and 10 of the Supplements for not-notched and notched studs respectively.

The size of studs supporting concentrated floor loads in the lower storey of a two storey construction shall be determined from Span Tables 38 and 39 of the Supplements for not-notched and notched studs respectively.

The Span Tables for studs supporting concentrations of load (upper storey) can be used to determine the size of studs supporting concentrated loads such as from strutting beams, roof struts, girder trusses or hanging beams 3 000 mm or more in length.

The Span Tables require an input in terms of roof area supported. Where studs support hanging beam loads only, “roof area” is not relevant. In such cases, an area equal to half the area of ceiling supported by the hanging beam shall be used in the Span Tables in lieu of area of sheet roof supported.

Design parameters for studs supporting concentrated loads shall be as shown in Figure 6.13.



Roof area supported = (A × B)/4
A = total of underpurlin spans
B = total of rafter spans

(a) Roof area supported

Floor area supported = (A × B)/4
A = span of upper floor bearer
B = total of joist spans

(b) Studs supporting concentrated floor loads

NOTE Ridge is assumed to be strutted.

Figure 6.13 — Studs supporting concentrations of load

6.3.2.3 Jamb studs (studs at sides of openings)

The size of jamb studs for single or upper storey construction shall be determined from Span Table 11 of the Supplements.

The size of jamb studs in the lower storey of a two storey construction shall be determined from Span Tables 40, 41 and 42 of the Supplements for floor load widths (*FLW*s) of 1 800 mm, 3 600 mm and 4 800 mm, respectively.

Jamb studs that support lintels or ring beams, which in turn support major concentrated loads from strutting beams, roof struts, girder trusses, floor bearers or similar members (see Clause 6.3.6.4), shall have their size increased by the size required for a stud supporting the equivalent concentrated load as determined from Span Tables 9, 10, 38 and 39 of the Supplements.

Where the concentrated load is located at or within the central third of the lintel or ring beam span, the breadth of the jamb studs, either side of the opening, shall be increased by half of the breadth of the stud required to support the concentrated load.

Where the concentrated load is located at or within one-third of the lintel or ring beam span from the jamb stud, this jamb stud shall be increased in size by the size of the stud supporting the concentrated load.

For doorway openings up to 900 mm, jamb studs at sides of openings may be the same size as the common studs provided jamb linings or other comparable stiffeners are used and these studs do not support concentrated loads.

Where the jamb stud size required by the Span Tables is made up of multiple members, the following shall apply except for the requirements in connection types (d) and (e) of Table 9.20:

(a) *2 members (e.g. 2/90 mm × 35 mm)* — provide 1 full-length stud plus 1 secondary jamb stud.

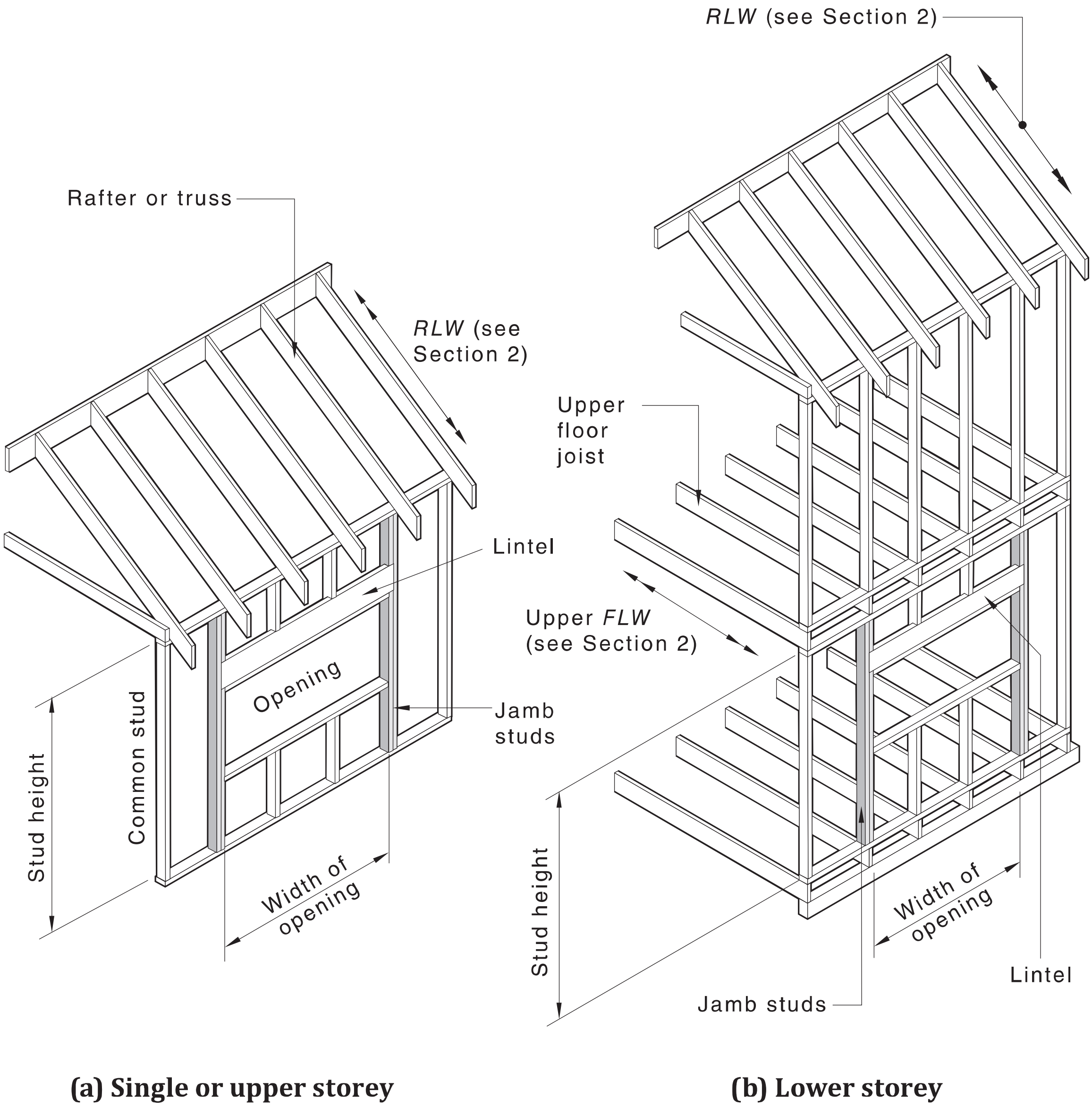
(b) *3 members (e.g. 3/70 mm × 35 mm)* — provide 2 full-length studs plus 1 secondary jamb stud.

(c) *4 members (e.g. 4/90 mm × 45 mm)* — provide 2 full-length studs plus 2 secondary jamb studs.

For the term and use of a secondary jamb stud, see Figures 6.9(A) and 6.9(B).

Where the lintel or ring beam tables require bearing lengths greater than that provided by the secondary jamb stud, an additional secondary jamb stud shall be provided.

Design parameters for jamb studs shall be as shown in Figure 6.14.



NOTE Noggings have been omitted for clarity.

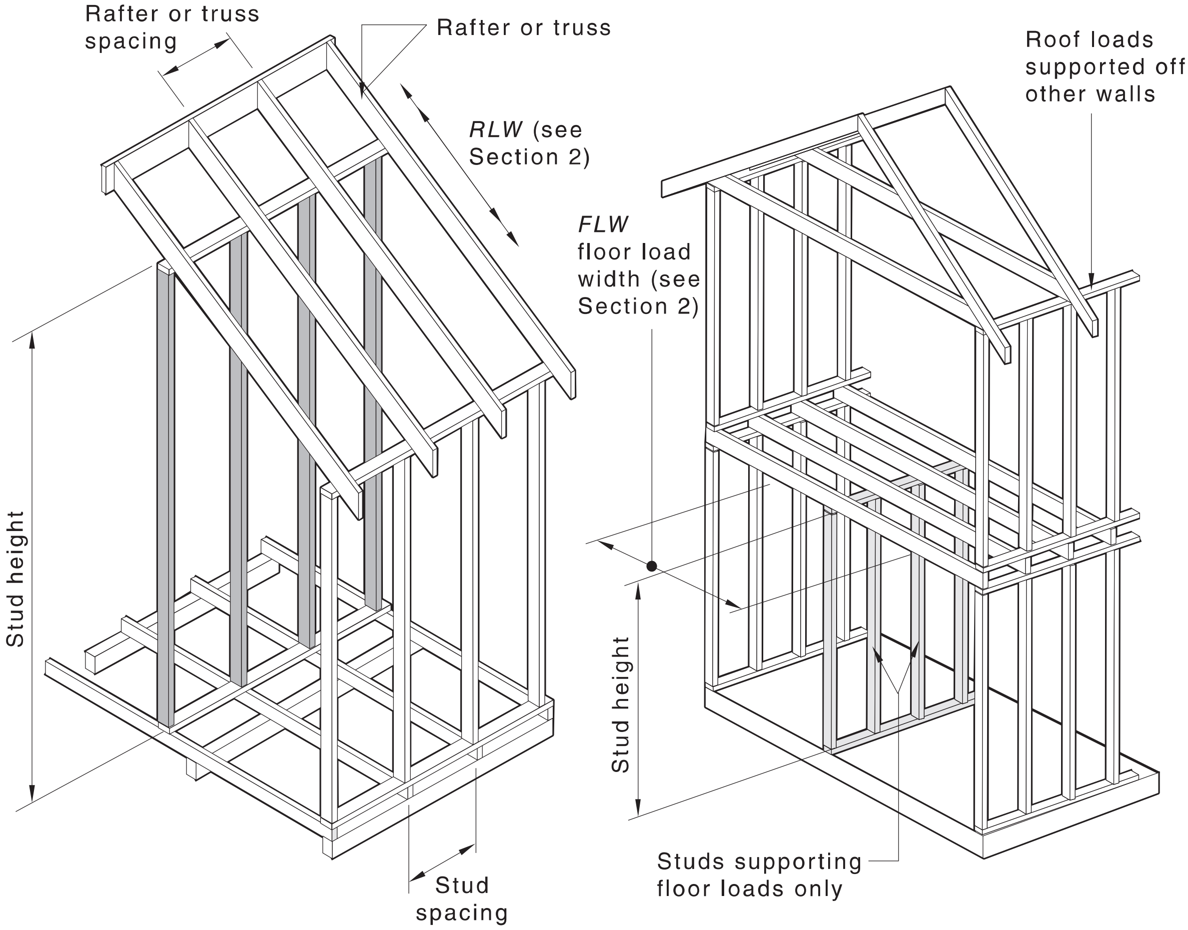
Figure 6.14 — Jamb studs

6.3.2.4 Internal loadbearing wall studs

The size of studs in single or upper storey internal loadbearing walls supporting roof loads only shall be determined from Span Tables 12 and 13 of the Supplements for not-notched and notched studs respectively.

The size of studs supporting floor loads only in lower storey construction shall be determined from Span Tables 43 and 44 of the Supplements for not-notched and notched studs respectively.

Design parameters for internal loadbearing wall studs shall be as shown in Figure 6.15.



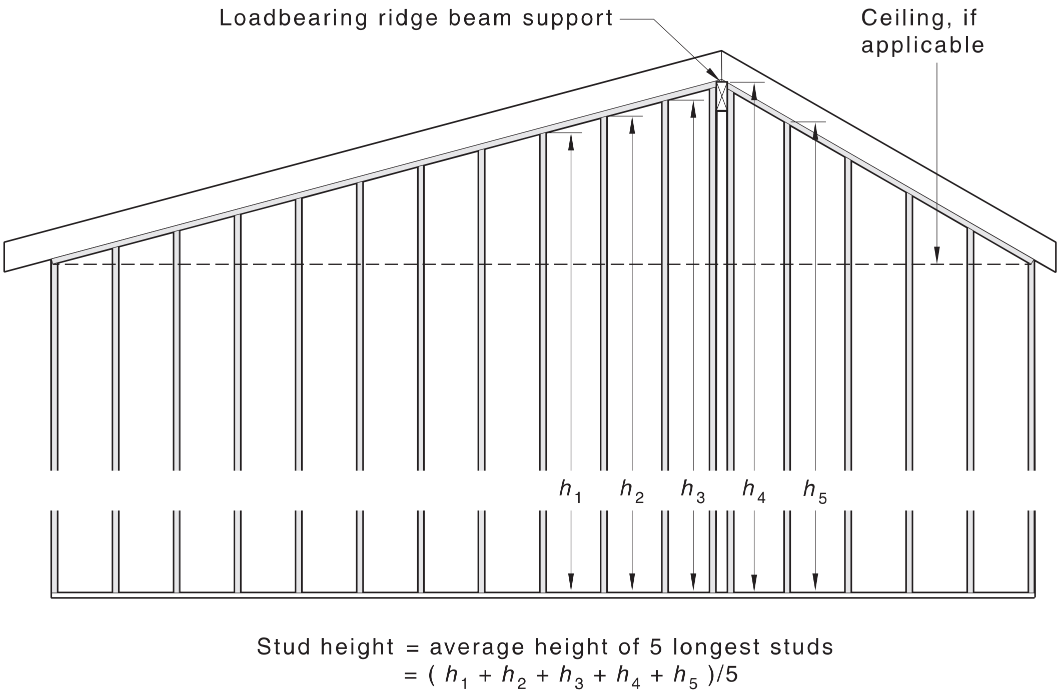
(a) Single or upper storey **(b) Lower storey**

NOTE Noggings have been omitted for clarity.

Figure 6.15 — Internal loadbearing wall studs

6.3.2.5 Gable or skillion end and non-loadbearing external wall studs

Gable or skillion end wall stud sizes shall be determined from the appropriate Span Tables of the Supplements, i.e. wall studs — single or upper storey, or lower storey. These studs shall be not less than the smallest stud permitted for the stud height (see Figure 6.16), stud spacing, and for sheet roof of any *RLW*.



NOTE 1 Where the house has a horizontal ceiling or where a specially designed horizontal wind beam is provided, the stud height is measured as the greater of the ceiling height or the height from ceiling to roof.

NOTE 2 Where studs support a loadbearing ridge or intermediate beam, separate consideration is required, e.g. studs supporting concentration of load.

NOTE 3 Noggings have been omitted for clarity.

Figure 6.16 — Gable or skillion end wall stud height

6.3.2.6 Mullions

The size of mullions shall be determined as for jamb studs in Clause 6.3.2.3. The opening width shall be equal to the combined opening width either side of the mullion less 600 mm. Design parameters for mullions shall be as shown in Figure 6.17.

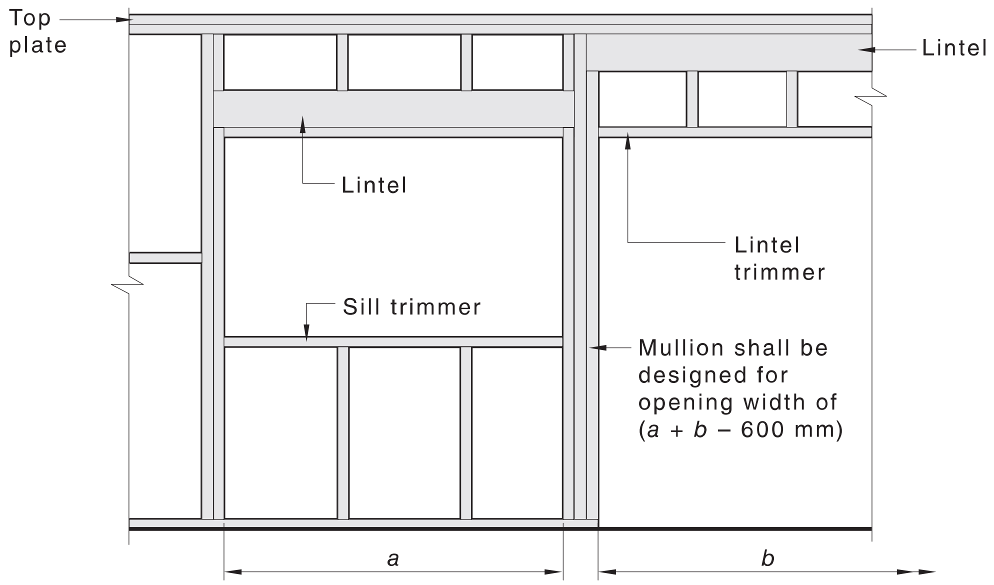


Figure 6.17 — Mullions

6.3.2.7 Concentrated loads on non-loadbearing internal walls

Where studs supporting concentrated loads (see Clause 6.3.2.2) are incorporated in an internal wall that is otherwise non-loadbearing, the remainder of the wall shall be deemed to be non-loadbearing.

6.3.3 Bottom plates

The size of bottom plates in single or upper storey construction shall be determined from Span Table 14 of the Supplements.

The size of bottom plates in the lower storey of a two storey construction shall be determined from Span Table 45 of the Supplements.

If wall studs are positioned at or within 1.5 times the depth of bottom plates from supporting floor joists, the bottom plates may be the same size as the common studs for any stress grade. If the wall studs are positioned directly above floor joists or are supported by blocking or a concrete floor, bottom plates may be 35 mm minimum depth for any stress grade.

Double or multiple bottom plates (ribbon plates) may be used provided the allowable roof load width (*RLW*) is determined in accordance with the Span Tables for members indicated as being made up of multiples, e.g. 2/35 mm × 70 mm; 3/38 mm × 75 mm.

Where plates of different thicknesses are used in combination, the design can be based on the principle given in the following example:

35 mm × 70 mm plate on top of a 45 mm × 70 mm plate.

(a) Calculate the *RLW* assuming 2/35 mm × 70 mm = RLW_1.

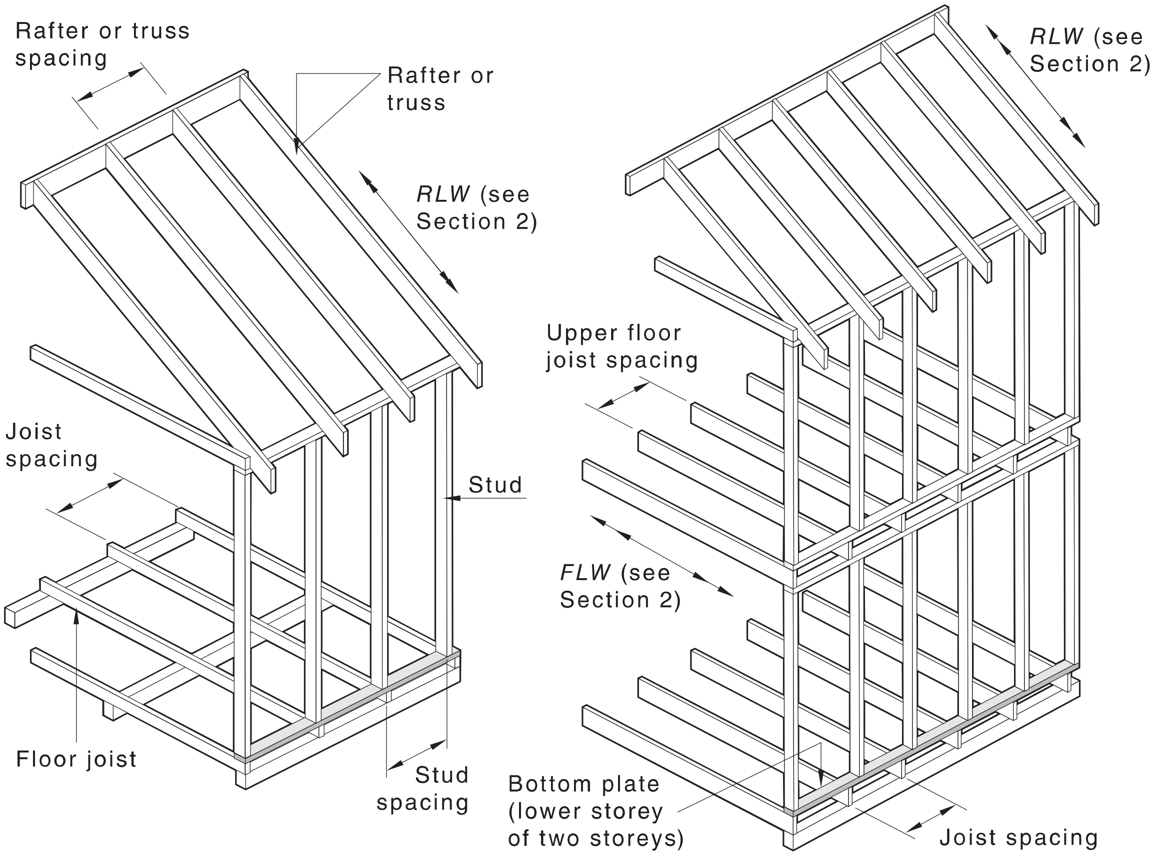
(b) Calculate the *RLW* assuming 2/45 mm × 70 mm = RLW_2.

(c) Allowable *RLW* = (RLW_1 + RLW_2) divided by 2.

Where the bottom plate supports studs supporting concentrated loads, posts or jamb studs, the plate shall be supported over a floor joist, solid blocking between bottom plate and bearer or concrete slab.

Trenching and holes in bottom plates shall not exceed the limitations given in Clause 6.2.1.4.

Design parameters for bottom plates shall be as shown in Figure 6.18.



(a) Single or upper storey **(b) Lower storey**

NOTE Noggings have been omitted for clarity.

Figure 6.18 — Bottom plates

6.3.4 Top plates

The size of top plates for single storey or upper storey of a two storey construction shall be determined from Span Tables 15 and 16 of the Supplements respectively for sheet and tile roofs.

The size of top plates for the lower storey of a two storey construction shall be determined from Span Table 46 of the Supplements for both sheet and tile roofs.

Wall plate sizes in the Span Tables may be used for wall plates supporting defined roof loads located at any position along the length of the plate.

Top plates may be a minimum of 35 mm deep multiplied by the breadth of the stud for any stress grade where —

(a) they are not required to resist wind uplift forces, such as where rafters or trusses are nominally fixed (see Table 9.2), or where tie-down spacing is 0 (refer to Note vii in Span Tables 15 and 16); and

(b) loads from roof trusses, rafters, floor joists, and similar members, are located directly above studs at or within 1.5 times the depth of the plate from the stud.

Top plates fully supported on masonry walls shall be determined from the Span Tables assuming a stud spacing of 300 mm and a tie-down spacing equivalent to the tie-down spacing of the plate to the masonry.

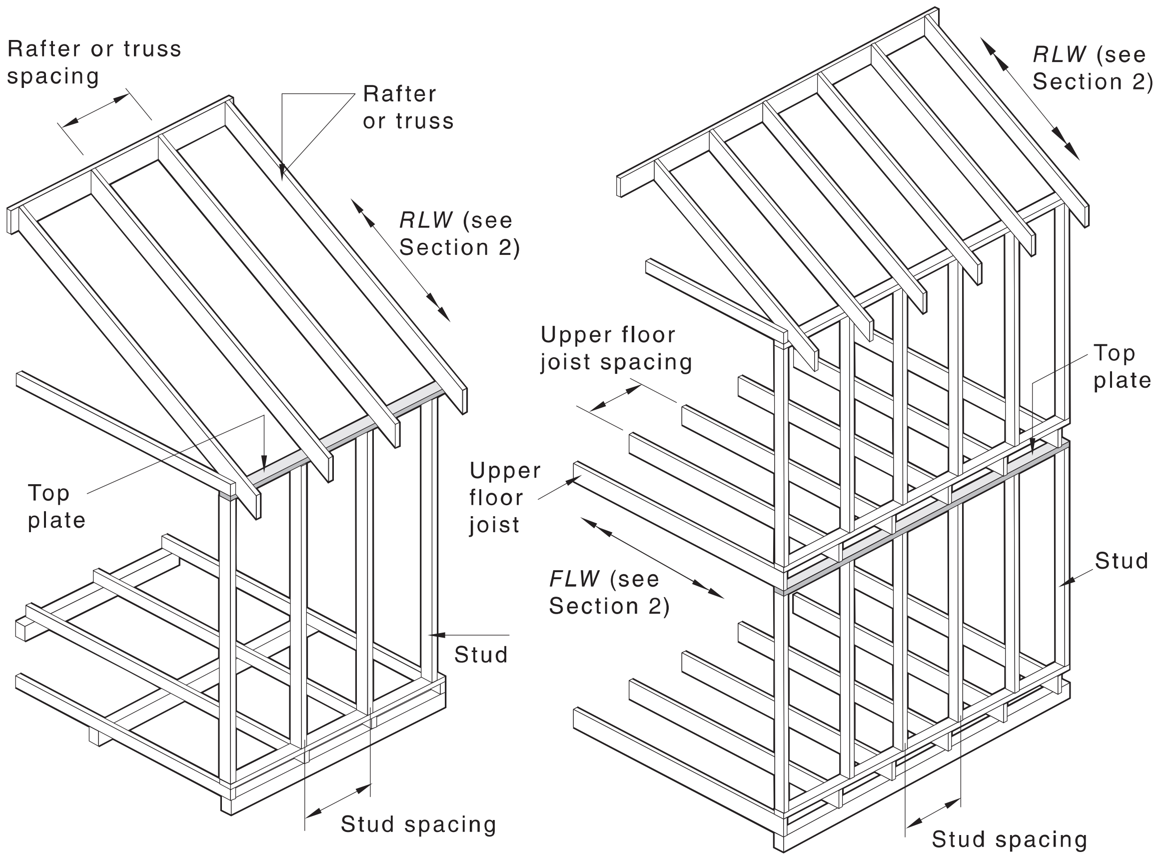
Double or multiple top plates (ribbon plates) may be used provided the allowable roof load width (*RLW*) is determined in accordance with the Span Tables for members indicated as being made up of multiples, e.g. 2/35 mm × 70 mm; 3/38 mm × 75 mm.

If plates of different thicknesses or stress grades are used in combination, design shall be based on the following principles:

Case 1: 35 mm × 70 mm on top of a 45 mm × 70 mm	**Case 2: 35 mm × 70 mm F7 on top of a 45 mm × 70 mm F17**
— Calculate the *RLW* assuming 2/35 × 70 = RLW_1	— Calculate the *RLW* for 2/35 × 70 F7 = RLW_1
— Calculate the *RLW* assuming 2/45 × 70 = RLW_2	— Calculate the *RLW* for 2/35 × 70 F17 = RLW_2
— Allowable *RLW* = (RLW_1 + RLW_2) divided by 2	— Allowable *RLW* = (RLW_1 + RLW_2) divided by 2

Roof beams, struts, strutting beams, girder trusses, hanging beams or counter beams 3 000 mm or more in length, combined strutting/hanging beams, combined strut/counter beams and similar members shall be supported directly by jamb studs, studs supporting concentrations of load or posts. Stiffening or blocking of top plates shall be in accordance with Figure 6.8.

Design parameters for top plates shall be as shown in Figure 6.19.



(a) Single or upper storey **(b) Lower storey**

NOTE Noggings have been omitted for clarity.

Figure 6.19 — Top plates

6.3.5 Studs, plates and noggings in non-loadbearing internal walls

In conventional construction, non-loadbearing walls, with or without openings, may be constructed using the sizes shown in Table 6.2 in any stress grade. Where studs supporting concentrations of load are incorporated in an internal wall that is otherwise non-loadbearing, the remainder of the wall shall be deemed non-loadbearing.

Table 6.2 — Framing sizes for non-loadbearing internal walls

Member	Minimum size, mm	Maximum spacing, mm
Top and bottom plates	35 × 70	—
Common studs of maximum height		
2 700 mm	70 × 35	600
3 300 mm	90 × 35 or 2/70 × 35	600
3 600 mm	90 × 35 or 2/70 × 35	600
4 200 mm	90 × 45 or 2/90 × 35	600
Studs supporting lintels	As for common studs	—

NOTE 1 Plates may be trenched up to 5 mm.

NOTE 2 Studs may be notched up to 20 mm.

6.3.6 Lintels and ring beams

6.3.6.1 General

Top plates shall be provided above lintels.

Ribbon plates may be provided above ring beams.

Adequate bearing for lintels and ring beams shall be provided as required by the Notes to the Span Tables given in the supplements.

NOTE The actual opening widths may be up to 70 mm greater than the maximum spans given in the Span Tables of the Supplements.

6.3.6.2 Lintels and ring beams in loadbearing walls

The size of lintels in loadbearing walls shall be determined from Span Tables 17 and 18 of the Supplements for single storey or upper storey of two storey construction, or from Span Tables 47 and 48 of the Supplements for the lower storey of a two storey construction for sheet and tile roofs respectively.

The size of ring beams in loadbearing walls shall be determined from Span Tables 17 and 18 of the Supplements for single storey or upper storey of two storey construction for sheet and tile roofs respectively except for the following:

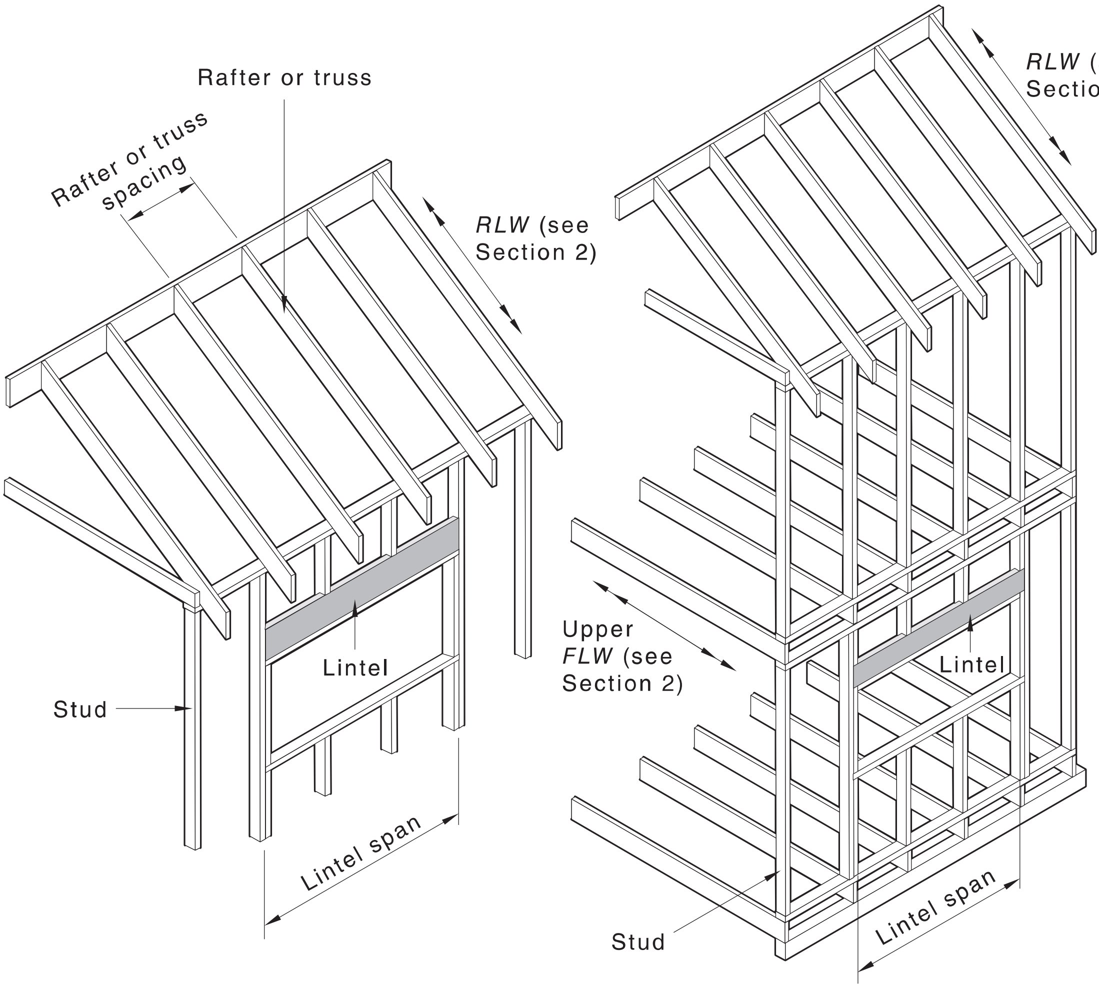
(a) The size of ring beams shall be determined using the maximum opening width (ring beam span) in the wall below the ring beam, and the depth of the ring beam shall be a minimum of one depth greater than as determined for a standard lintel.

NOTE 1 For example, if a ring beam (lintel) is required to span a 2 400 mm opening and the size determined for this is 2/170 mm × 35 mm, then the minimum ring beam size required is 2/190 mm × 35 mm.

(b) For all other wind classifications and roof types, the size of ring beams shall be determined using the greater of the maximum opening width (ring beam span) in the wall below the ring beam or the ring beam tie-down spacing (span of ring beam under wind uplift), and the depth of the ring beam shall be a minimum of one depth greater than as determined for a standard lintel.

NOTE 2 For instance, if a ring beam (lintel) is required to span a 2 400 mm opening but is tied down at 2 700 mm centres, then the opening width required to determine the size is 2 700 mm. If the size determined for this is 2/190 mm × 35 mm, the minimum ring beam size required is 2/240 mm × 35 mm.

Design parameters for lintels shall be as shown in Figure 6.20.



(a) Single or upper storey **(b) Lower storey**

NOTE Noggings have been omitted for clarity.

Figure 6.20 — Lintels

6.3.6.3 Lintels or ring beams in gable end walls not required to transfer tie-down

The size of lintels or ring beams in gable end walls not supporting roof loads and not required to transfer tie-down shall be determined as for lintels supporting sheet roofing with a roof load width (*RLW*) of 1 500 mm and a rafter or truss spacing of 600 mm.

Lintels in gable ends not supporting roof loads may also be sized as lintel trimmers (see Clause 6.3.6.6) provided wall loads are adequately supported by other means such as the ability of the sheeting to self-span over the opening.

6.3.6.4 Lintels or ring beams supporting concentrated roof loads

The size of lintels supporting concentrated roof loads shall be determined from Span Tables 19 and 20 of the Supplements for sheet and tile roofs respectively.

Area of supported roof is defined in Clause 2.6.5.

The size of ring beams supporting concentrated roof loads shall be determined from Tables 19 and 20 of the supplements for sheet and tile roofs respectively, but using the same procedures for ring beams as given in Clause 6.3.6.2.

6.3.6.5 Lintels in non-loadbearing walls

The size of lintels in internal walls supporting ceiling joists only, or supporting hanging beams, shall be determined by using the hanging beam Span Table 23 (see Clause 7.3.7) or the counter beam (beams supporting hanging beams) Span Table 24 (see Clause 7.3.8) for these two applications respectively.

For internal walls where ceiling loads are not supported and wall openings are wider than 1 800 mm, the size of the lintel shall be determined from Span Table 23 using a ceiling load width of 1 800 mm.

Where wall openings wider than 1 800 mm occur in non-loadbearing external walls, a lintel shall be provided and the size of the lintel shall be determined from Span Table 23 using a ceiling load width of 1 800 mm.

6.3.6.6 Windowsill, lintel and ring beam trimmers

For opening widths up to 1 500 mm, windowsill trimmers may be the same size and grade as the common studs in that wall.

For opening widths greater than 1 500 mm, the windowsill trimmer size shall be determined from Table 6.3.

Lintel trimmers (see Figure 6.9(B)), designed as per windowsill trimmers, shall be provided above windows or doors where the lintel is placed directly under the top plate and the distance between the top of the window or door to the top plate exceeds 650 mm.

Ring beam trimmers (see FFigure 6.9(B)), designed as per window sill trimmers, shall be provided below ring beams and immediately above windows or door frames where the distance between the top of the window or door to the underside of the ring beam exceeds 200 mm. In all other cases, the top of the window or door may be trimmed with a member of a size and grade not less than those of the common stud.

Design parameters for windowsill trimmers shall be as shown in Figure 6.21.

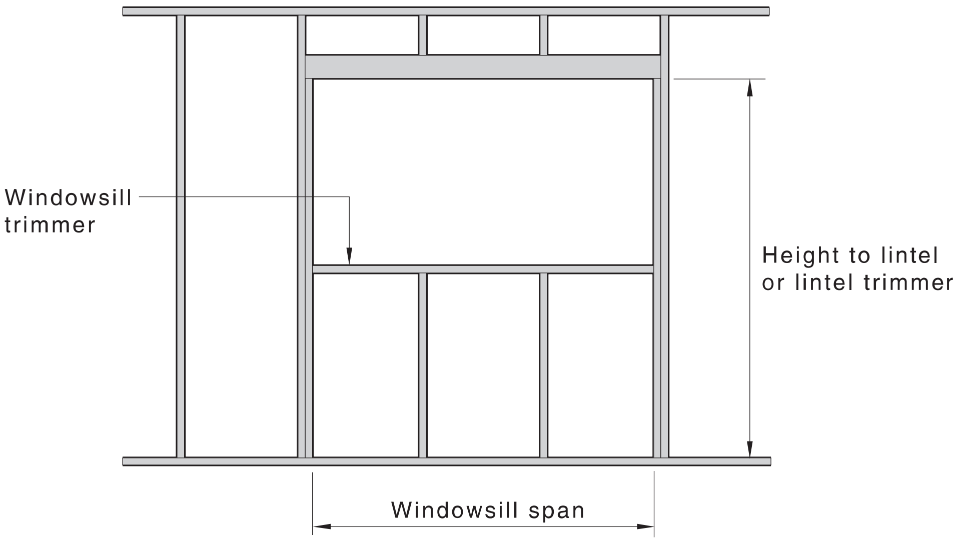


Figure 6.21 — Windowsill, lintel and ring beams trimmers

Table 6.3 — Size of windowsill trimmers (2 100 mm high to lintel/ring beam or lintel/ring beam trimmer)

Opening width, mm	Stress grade	Wind classification, mm		
		N1/N2	N3	N4
1 800	F5/MGP10	70 × 35 or 90 × 35	70 × 35 or 90 × 35	70 × 35 or 90 × 35
	F8/MGP12	70 × 35 or 90 × 35	70 × 35 or 90 × 35	70 × 35 or 90 × 35
	F14	70 × 35 or 90 × 35	70 × 35 or 90 × 35	70 × 35 or 90 × 35
2 100	F5/MGP10	70 × 35 or 90 × 35	70 × 45 or 90 × 35	2/70 × 35 or 90 × 45
	F8/MGP12	70 × 35 or 90 × 35	70 × 35 or 90 × 35	70 × 35 or 90 × 35
	F14	70 × 35 or 90 × 35	70 × 35 or 90 × 35	70 × 35 or 90 × 35
2 400	F5/MGP10	70 × 35 or 90 × 35	2/70 × 35 or 90 × 35	2/70 × 45 or 2/90 × 35
	F8/MGP12	70 × 35 or 90 × 35	70 × 35 or 90 × 35	2/70 × 35 or 90 × 35
	F14	70 × 35 or 90 × 35	70 × 35 or 90 × 35	70 × 35 or 90 × 35
2 700	F5/MGP10	2/70 × 35 or 90 × 35	2/70 × 45 or 2/90 × 35	3/70 × 45 or 2/90 × 35
	F8/MGP12	70 × 35 or 90 × 35	2/70 × 35 or 90 × 35	2/70 × 35 or 90 × 45
	F14	70 × 35 or 90 × 35	70 × 35 or 90 × 35	70 × 45 or 90 × 35
3 000	F5/MGP10	2/70 × 35 or 90 × 45	3/70 × 35 or 2/90 × 35	2/90 × 45
	F8/MGP12	70 × 45 or 90 × 35	2/70 × 35 or 90 × 45	3/70 × 35 or 2/90 × 35
	F14	70 × 35 or 90 × 35	70 × 45 or 90 × 35	2/70 × 35 or 90 × 45
3 300	F5/MGP10	2/70 × 45 or 2/90 × 35	3/70 × 45 or 2/90 × 45	3/90 × 45
	F8/MGP12	2/70 × 35 or 90 × 35	2/70 × 45 or 2/90 × 35	3/70 × 35 or 2/90 × 45
	F14	2/70 × 35 or 90 × 35	2/70 × 35 or 90 × 35	3/70 × 35 or 2/90 × 35
3 600	F5/MGP10	3/70 × 45 or 2/90 × 35	3/90 × 35	—
	F8/MGP12	3/70 × 35 or 90 × 45	3/70 × 45 or 2/90 × 35	3/90 × 35
	F14	2/70 × 45 or 90 × 45	3/70 × 35 or 90 × 45	3/70 × 45 or 2/90 × 45
4 200	F5/MGP10	3/90 × 45	—	—
	F8/MGP12	3/90 × 35	3/90 × 45	—
	F14	2/90 × 45	3/90 × 45	—

Table 6.3 *(continued)*

Opening width, mm	Stress grade	Wind classification, mm		
		N1/N2	N3	N4
4 800	F5/MGP10	—	—	—
	F8/MGP12	—	—	—
	F14	3/90 × 45	—	—

NOTE 1 Openings may be 70 mm wider than the nominal width given above.

NOTE 2 The sizes in this Table are applicable to hardwood, softwood, seasoned and unseasoned timber.

6.3.7 Verandah beams (plates)

The size of verandah beams shall be determined from Span Table 51A of the Supplements for single span and continuous spans respectively.

Design parameters for verandah beams shall be as shown in Figure 6.22.

The ends of beams that are supported on stud walls shall be carried by jamb studs (with beams considered as lintels) or posts.

Cantilevered beams (e.g. gable ends) shall be sized in accordance with Clause 7.3.16 and Figure 7.31.

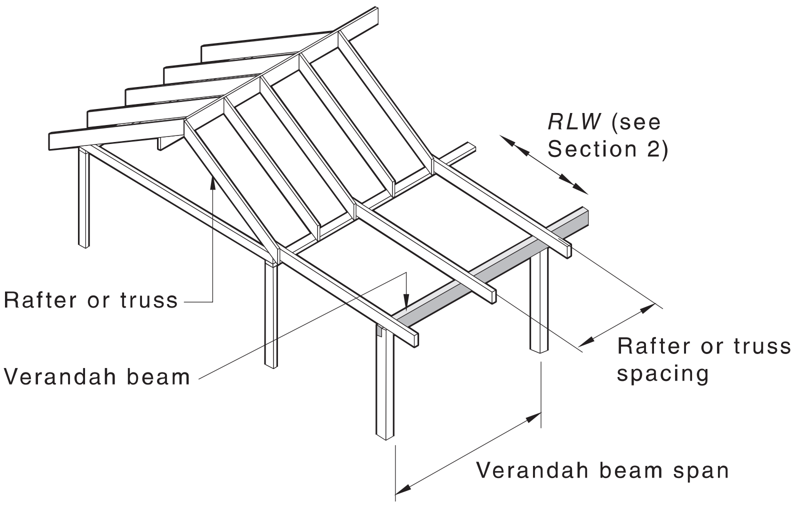
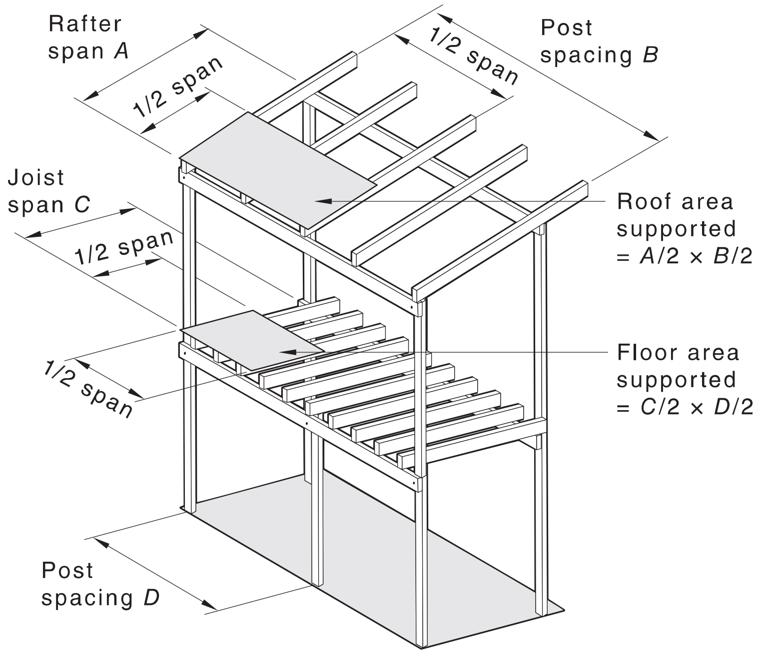


Figure 6.22 — Verandah beams

6.3.8 Posts supporting roof and/or floor loads

The size of posts supporting roof and/or floor loads shall be determined from Span Table 53 of the Supplements.

Design parameters for posts supporting roof and/or floor loads shall be as shown in Figure 6.23.



NOTE If the post is the central support for a continuous span verandah beam and bearer, the areas supported are as follows: (a) Roof area supported = $A/2 \times B$; (b) Floor area supported = $C/2 \times D$.

Figure 6.23 — Posts supporting roof and/or floor loads

Seasoned posts of sizes up to 3 mm under the minimum depth and breadth of the size specified in Span Table 53 of the Supplements shall be used. The roof and/or floor area to be used in Span Table 53 shall be 10 % greater than the sum of the actual roof and/or floor area.

Section 7 Roof framing

7.1 General

7.1.1 Application

This Section sets out specific requirements for building practice, design, and specification of roof framing members. Reference shall also be made to the footnotes for each member given in the Span Tables of the Supplements.

NOTE In some diagrams some members have been omitted for clarity.

7.1.2 Types of roofs and limitations

7.1.2.1 General

Raftered roofs ("pitched" roofs) shall be either coupled or non-coupled (cathedral or skillion), see Clause 1.3.6.

Where splices in rafters or ceiling joists are necessary, they shall be made only at points of support. Splices shall be butt-joined with fishplates to both sides with minimum length six times the joist depth. Fishplates shall be a minimum of 19 mm thick by the full depth of rafters or ceiling joists. Alternatively, the rafters or ceiling joists may be lapped over the support for a distance equivalent to at least three times their depth.

Lapped rafters or ceiling joists, or both ends of the butted rafters or ceiling joists to fishplates, shall be secured with at least six hand-driven nails, or 8/3.05 mm diameter machine-driven nails, or with an M12 bolt, see Section 9.

Engineered nailplated rafters or ceiling joists spliced and supported in accordance with this clause shall have their size determined in accordance with AS 1720.1 and/or AS 1720.5.

7.1.2.2 Coupled roof

The roof pitch in a coupled roof construction (see Figure 7.1) shall be not less than 10°. Ceiling joists and collar ties shall be fixed to opposing pairs of rafters, in accordance with Section 9.

Rafters shall be either continuous in length, or lapped or spliced at their support points, see Clause 7.1.2.1. Rafters may be supported on underpurlins.

For a coupled roof with no roof struts, provided with nominal fixing only (see Section 9), the maximum distance between external walls shall not exceed 6 000 mm for sheet roofs or 4 000 mm for tile roofs except where the roof connections and members are designed in accordance with AS 1720.1.

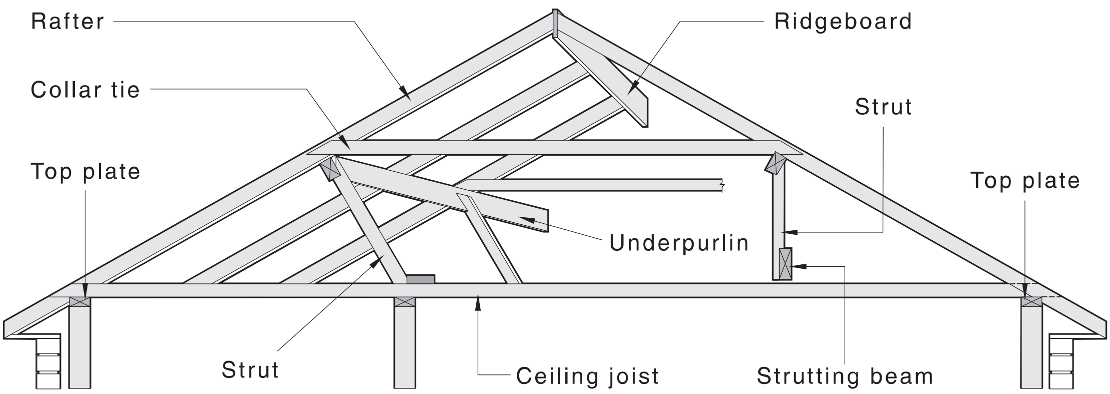


Figure 7.1 — Coupled roof

7.1.2.3 Non-coupled roof

A non-coupled roof (including cathedral and skillion) shall have rafters (raking beams) supported off walls, ridge beams and/or intermediate beams. It may have ceilings in the same plane as the roof. Rafters, ridge and intermediate beams may be exposed internally, see Figure 2.5.

7.1.2.4 Trussed roof

The design of a timber roof truss shall be in accordance with engineering principles and AS 1720.1. The wind design criteria shall be consistent with that used in this Standard, see Clause 1.4.2.

7.2 Building practice

7.2.1 Ceilings

Ceilings may be fixed to the underside of ceiling joists, rafters or purlins or the bottom chord of trusses, with or without battens.

7.2.2 Construction loads on ceiling framing

Ceiling joist sizes determined in accordance with the Span Tables in the Supplements shall not be used to support construction loads or the loads of workers until the joists are adequately fixed and laterally restrained by the installation of ceiling lining or ceiling battens (see also Clause 7.3.4), or until the construction planks are used on the top of ceiling joists during construction, to support workers.

Ceiling battens shall not support construction loads or the loads from workers.

7.2.3 Ceiling battens

Where ceiling battens are used, the size and fixings shall be appropriate for the mass of the ceiling material used, to provide a flat finish to the ceiling.

7.2.4 Ceiling joists

7.2.4.1 General

Ceiling joists shall be at spacings to support ceiling linings.

For coupled roofs, ceiling joists shall be in single lengths or spliced in accordance with Clause 7.2.4.2, and at the same spacing and in the same direction as the main rafters so that they may be fixed to, and act as ties between, the feet of pairs of opposing rafters. Intermediate ceiling joists may be required to support ceiling linings. End bearings of joists shall be the full width of the supporting wall plate except as provided for in Clause 7.2.4.2.

7.2.4.2 Splices and joints in coupled roof

Requirements for splices and joints in coupled roof are given in Clause 7.1.2.1.

7.2.4.3 Connection to hanging beams

Ceiling joists shall be fixed to hanging beams using 35 mm × 32 mm min. timber cleats, 25 mm × 1.6 mm galvanized steel strapping, steel ceiling joist hangers or equivalent approved fasteners. Each alternate connection shall be fixed to opposite sides of the hanging beam, see Figure 7.3.

7.2.4.4 Trimming around openings

In a joisted ceiling, any opening (manholes, skylights, and similar openings) shall be trimmed to provide full support for ceiling linings. Where no loads other than normal ceiling loads will be carried, trimmers shall be as follows:

(a) Openings up to 1 000 mm — same size as ceiling joist.

(b) Openings greater than 1 000 mm and up to a maximum of 3 000 mm — breadth of trimmer to be increased by 20 % for each 300 mm in length greater than 1 000 mm. Members shall be connected by framing brackets.

(c) Openings greater than 3 000 mm — trimmer size as for hanging beams.

7.2.4.5 Platforms in roof spaces

Ceiling joists shall support ceiling loads only. Any platforms constructed in the roof space above a ceiling for the support of a storage water heater, feed tank, flushing cistern or similar members shall be designed for these loads.

7.2.5 Hanging beams

7.2.5.1 General

Hanging beams shall support ceiling joists and the attached ceiling materials only.

Hanging beams are usually at right angles (or may be angled or placed off centre) to ceiling joists and are located directly above them, see Figure 7.2.

Requirements for beams supporting roof and ceiling loads are given in Clauses 7.2.7 and 7.2.8.

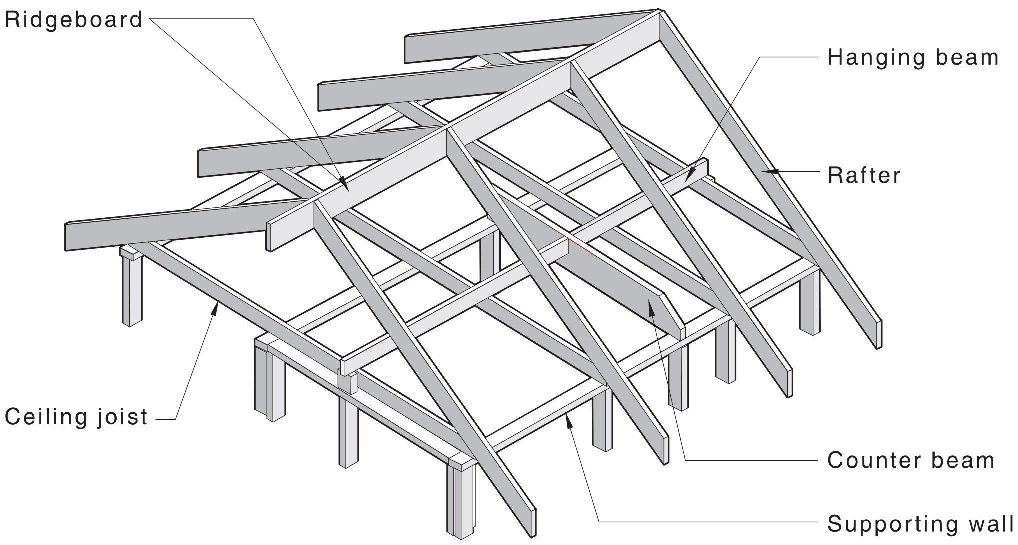


Figure 7.2 — Counter beam supporting hanging beams

7.2.5.2 End support of hanging beams

Hanging beams shall be held in a vertical position at both ends by nailing or bolting to an available rafter, gable end struts or by means of angle strutting from internal walls.

End-bearings of hanging beams shall be the full width of the wall plate. Where hanging beams span 3.0 m or more, they shall be located directly above a stud, or the plates shall be stiffened, see Figure 6.8.

Where hanging beams are used as lateral binders, the connection to the external walls shall be equivalent to that shown in Figure 6.10.

Where the slope of rafters is such that the depth of a hanging beam has to be reduced by more than two-thirds in order to avoid interference with roof cladding, provision shall be made for additional support incorporating a jack ceiling joist (trimmer) as shown in Figure 7.3.

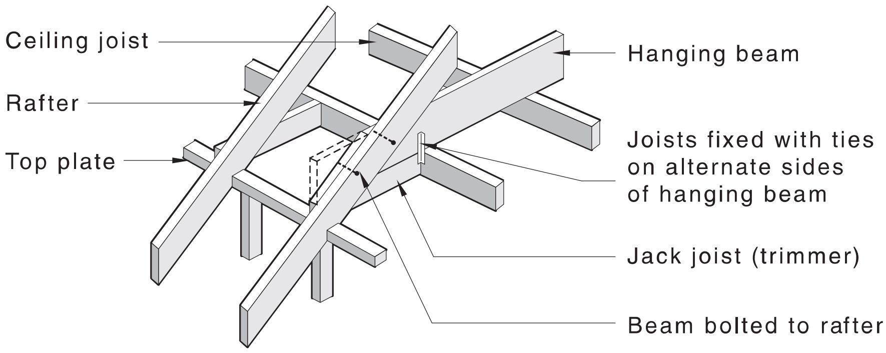


Figure 7.3 — Support of hanging beam with jack ceiling joist (trimmer)

7.2.6 Counter beams

7.2.6.1 General

Counter beams may be provided to support hanging beams, see Figures 7.2 and 7.4. End support of counter beams shall be similar to that for hanging beams, see Clause 7.2.5.2.

Where roof loads are required to be supported on counter beams, they shall be designed as combined strutting/counter beams, see Clause 7.2.8.

7.2.6.2 Intersection of hanging and counter beams

At intersections of hanging and counter beams, the hanging beam may be checked out over the counter beam, or butted up to the counter beam. The hanging beams shall be supported by 45 mm × 42 mm minimum ledgers fixed at each side of the counter beam with 5/3.05 mm diameter nails or 2/No. 14 Type 17 screws, or by other proprietary connectors such as joist hangers, see Figure 7.4.

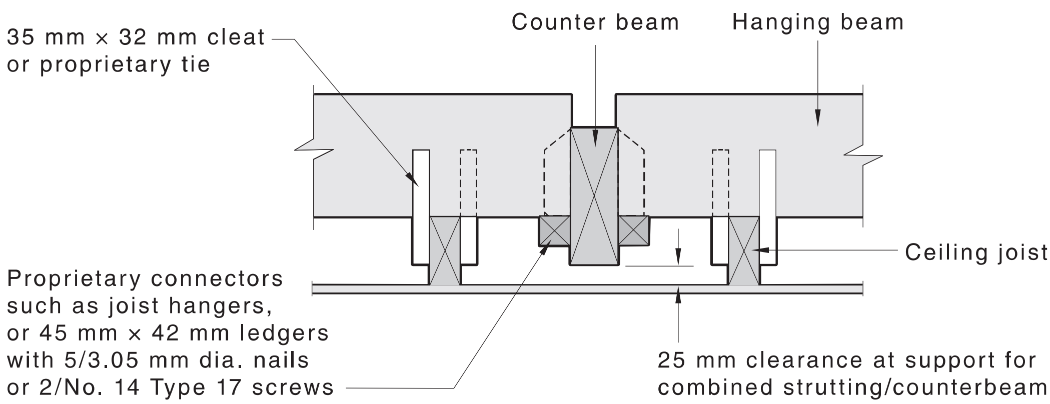


Figure 7.4 — Fixing hanging beam to counter beam

7.2.7 Combined strutting/hanging beams

Combined strutting/hanging beams are usually at right angles (or may be angled or placed off centre) to ceiling joists and are located directly above them.

Requirements for end supports shall be as for strutting beams, as specified in Clause 7.2.9.

NOTE 1 The clearance requirements specified for the strutting beam are not necessary, as the hanging beam is located directly over the ceiling joists.

NOTE 2 Combined strutting/hanging beams support both roof and ceiling loads. Roof loads are placed onto the beam by roof struts and ceiling loads are as for hanging beams, i.e. joists suspended on cleats.

7.2.8 Combined strutting/counter beams

Combined strutting/counter beams shall be used to support roof loads and ceiling loads via hanging beams. They are usually located at right angles to hanging beams and parallel to ceiling joists, but may be angled or placed off centre.

At intersections of hanging beams and combined strutting/counter beams, the hanging beam may be checked out over or butted up to the strutting/counter beam. It shall be supported by 45 mm × 42 mm timber ledgers fixed at each side of the strutting beam or by other proprietary connectors such as joist hangers. See Figure 7.4 for a similar detail.

Requirements for end supports shall be as for strutting beams, as specified in Clause 7.2.9. Where counter beams are located between the ceiling joists, the 25 mm clearance specified for strutting beams is required.

7.2.9 Strutting beams

Ends of strutting beams shall bear on the full width of wall plates.

Strutting beams shall support roof loads only. They may extend in any direction in the roof space.

Beams shall bear directly above studs supporting concentrated loads or distributed over two or more studs by means of top plate stiffening, see Figure 6.8. Where strutting beams occur over openings, the lintels shall be designed for a concentrated load.

Blocking shall be provided between strutting beams and wall plates to provide an initial clearance of 25 mm at midspan between the underside of the beams and the tops of ceiling joists, ceiling lining or ceiling battens, as appropriate, see Figure 7.5.

The ends of strutting beams may be chamfered to avoid interference with the roof claddings. Where the end dimension is less than 100 mm, or one-third the beam depth, whichever is greater, an alternative support method shall be provided similar to that shown for hanging beams, see Figure 7.3.

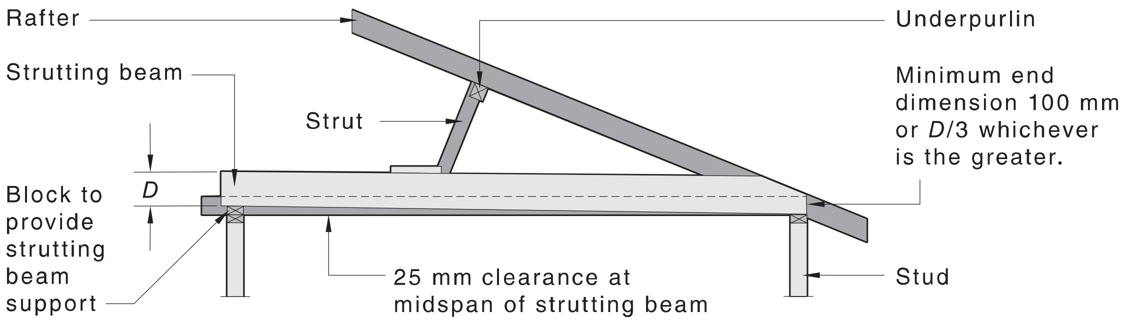


Figure 7.5 — Installation of strutting beams

7.2.10 Underpurlins

7.2.10.1 General

Underpurlins shall be in single lengths and straight runs at right angles to the direction of rafters. Where two or more rows of underpurlins are required, they shall be spaced evenly between the ridge and the wall's top plates or where the even spacing of underpurlins cannot be achieved, the sizing of rafters shall be in accordance with Clauses 1.3.6 and 1.3.9.4 as appropriate.

7.2.10.2 Joints in underpurlins

Where underpurlins are joined in their length, the joint shall be made over a point of support, with the joint halved, lapped, and nailed, see Figure 7.6.

Alternatively, underpurlins shall be lapped a minimum of 450 mm and spliced with 6 through-nails or 3/ No. 14 Type 17 screws or 2/M10 bolts through the splice. Laps shall be made over a support.

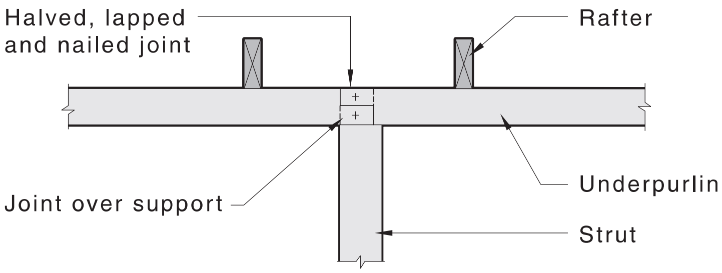


Figure 7.6 — Joining underpurlins

7.2.10.3 Cantilevered underpurlins

The ends of an underpurlin may project (cantilever) beyond a support by up to 25 % of the maximum allowable span of the underpurlin provided the actual backspan is at least three times the cantilever length.

7.2.10.4 Support of underpurlins

Underpurlins shall be securely fastened to hip or valley rafters in accordance with one of the following options:

(a) *Underpurlins supporting hip or valley rafters*, which shall meet the following requirements:

   (i) They shall not cantilever more than one-eighth of their allowable span.

   (ii) They shall be fastened to the hip or valley using one of the following means:

      (A) Cutting the underpurlin to and around the hip or valley and providing support directly below via a roof strut.

      (B) Proprietary framing anchors and blocking that provide three-way support (see Figure 7.7) or by a method providing equivalent support.

      (C) Proprietary joist hangers.

(D) Using a proprietary/patented tension rod system (equivalent to the old BARAP system).

(b) *Underpurlins supported by hip or valley rafters*, which shall be fastened to the hip or valley using one of the following means:

(i) Proprietary/patented framing anchors and blocking that provide three-way support.

(ii) Proprietary/patented joist hangers.

Where underpurlins are not strutted at the junctions with hip or valley rafters and the allowable underpurlin cantilever is exceeded, the underpurlins shall be deemed to be supported by the hip or valley rafters to which they are attached.

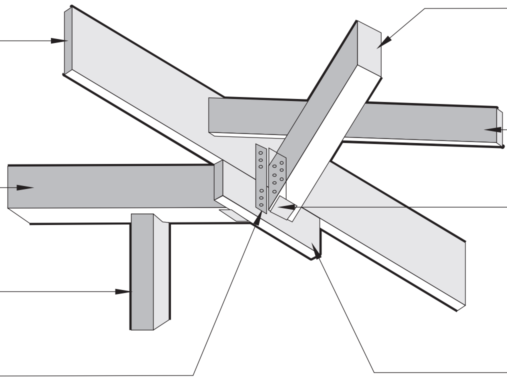


Figure 7.7 — Typical underpurlin connections to hip or valley

7.2.11 Rafters

7.2.11.1 General

Rafters shall be single length members or joined over supports.

Rafters in cathedral roofs shall be designed to carry both roof and ceiling loads.

Purlins that support ceiling loads and roof loads shall be designed as rafters/purlins with ceiling attached.

7.2.11.2 Birdsmouthing

Rafters may be birdsmouthed to a depth not exceeding one-third of the rafter depth, see Figure 7.28.

7.2.12 Ridgeboards

7.2.12.1 General

Ridgeboards shall be provided to locate and stabilize rafter ends. Opposing pairs of rafters shall not be staggered by more than their own thickness at either side of their ridge junction.

The size of ridgeboards shall be determined from Table 7.6.

Junctions of ridgeboard and hip or valley rafters shall be strutted where the hip or valley rafters exceed 5 m span, or where underpurlins are supported off hip or valley rafters.

Where a ridgeboard is required to be strutted along its length but there are insufficient strutting supports, the ridgeboard shall be designed as a ridge beam for a non-coupled roof, or an alternative method used for the full support of the roof loads.

NOTE An example of an alternative method would be to use a tie-bolt truss.

7.2.12.2 Joints in ridgeboards

Ridgeboards may be joined using a scarf joint or butt joint at the abutment of a rafter pair or, nail-spliced (minimum of 6 nails per side of splice) using full depth fishplates on both sides of the ridgeboard, see Figure 7.8.

NOTE Full-length ridgeboards or nail-spliced fishplates should be used wherever possible.

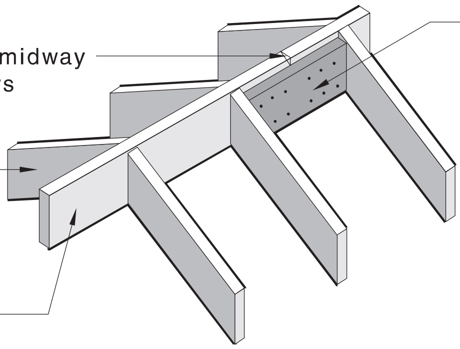


Figure 7.8 — Fishplated ridgeboard splice

7.2.13 Hip and valley rafters

Where strutting points are available, hip and valley rafters shall be supported by struts at the same number of equally spaced intermediate points as for common rafters.

Where strutting points are not available, hip rafters shall be supported by an underpurlin in at least one direction, and valley rafters shall be supported by underpurlins in both directions.

Where the underpurlins are supported by hip or valley rafters, a tie-bolt truss system, as shown in Figure 7.14, may be installed, or the hip or valley rafter may be designed to support the underpurlin loads. This construction may be used where the underpurlins cantilever beyond a strut by more than 25 % of the maximum span, and no strutting point is available at the junction of the hip or valley and underpurlin.

If the hip or valley rafters support the underpurlin, a strut shall be used at the intersection of the hip or valley and ridgeboard.

7.2.14 Scotch valleys

Where "scotch valley" construction (see Figure 2.4) is used at the junction of two roof surfaces, the pitching plate to which creeper rafters of the secondary roof are fixed shall be securely nailed at each common rafter crossing. The pitching plate shall be minimum 35 mm thick by such width as will provide adequate bearing for the feet of creepers.

7.2.15 Roof strutting

7.2.15.1 Roof struts

Where necessary, struts shall be provided to support roof members, such as underpurlins ridgeboards and hip and valley rafters. Struts shall be supported off walls, strutting beams, combined hanging/strutting beams, or combined counter/strutting beams.

Struts shall not be supported on hanging or counter beams.

Except as provided for in Clauses 7.2.15.2, 7.2.15.3 and 7.2.15.4, struts shall be either vertical or perpendicular to the rafters or at an angle between vertical and 35° angle to the vertical. They shall be either birdsmouthed or halved to underpurlins as shown in Figures 7.9 and 7.10. Alternatively, for struts that are not birdsmouthed or halved to the underpurlin, a 30 mm × 0.8 mm G.I. strap shall be passed over the underpurlin and nailed to each side of the strut with 4/30 mm × 2.8 mm diameter nails and to the underpurlin with 2/30mm × 2.8 mm diameter nails each side in addition to at least two skew nails. One framing anchor with four nails to each leg may be used as an alternative to the strap.

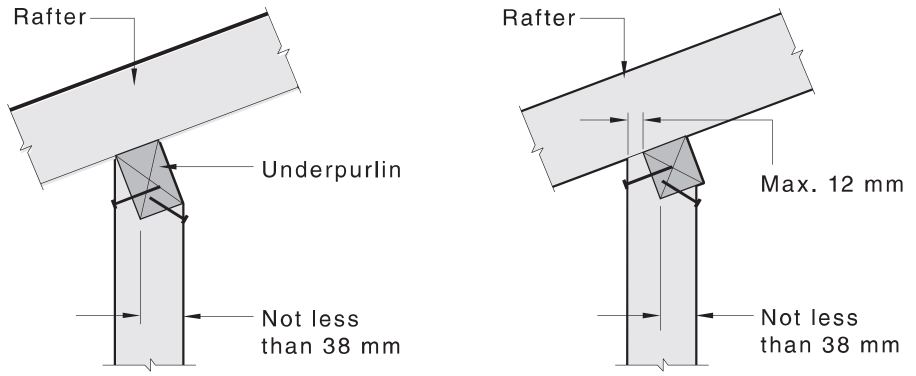


Figure 7.9 — Vertical struts

Studs supporting struts shall be determined in accordance with Clause 6.3.2.2, or top plates shall be stiffened in accordance with Clause 6.2.2.3, as appropriate.

Struts that are not vertical shall be restrained by blocks or chocks, as shown in Figure 7.10.

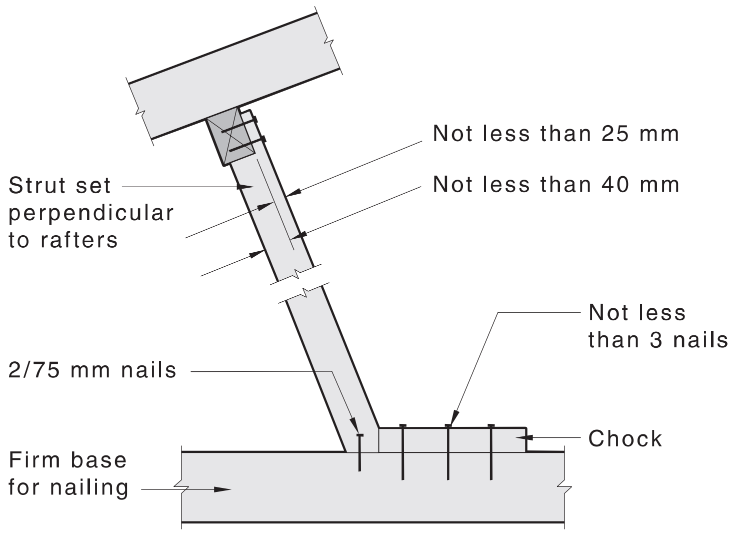


Figure 7.10 — Struts perpendicular to rafters

7.2.15.2 Tied and braced strut system

Where struts are located at an angle greater than perpendicular to the rafter but less than 60° to the vertical, they shall be tied and braced to form a frame in accordance with Figure 7.11, or they shall be in accordance with Clause 7.2.15.4. In Figure 7.11, the length of of L_1 shall be between L_2 and 1.25 times L_2.

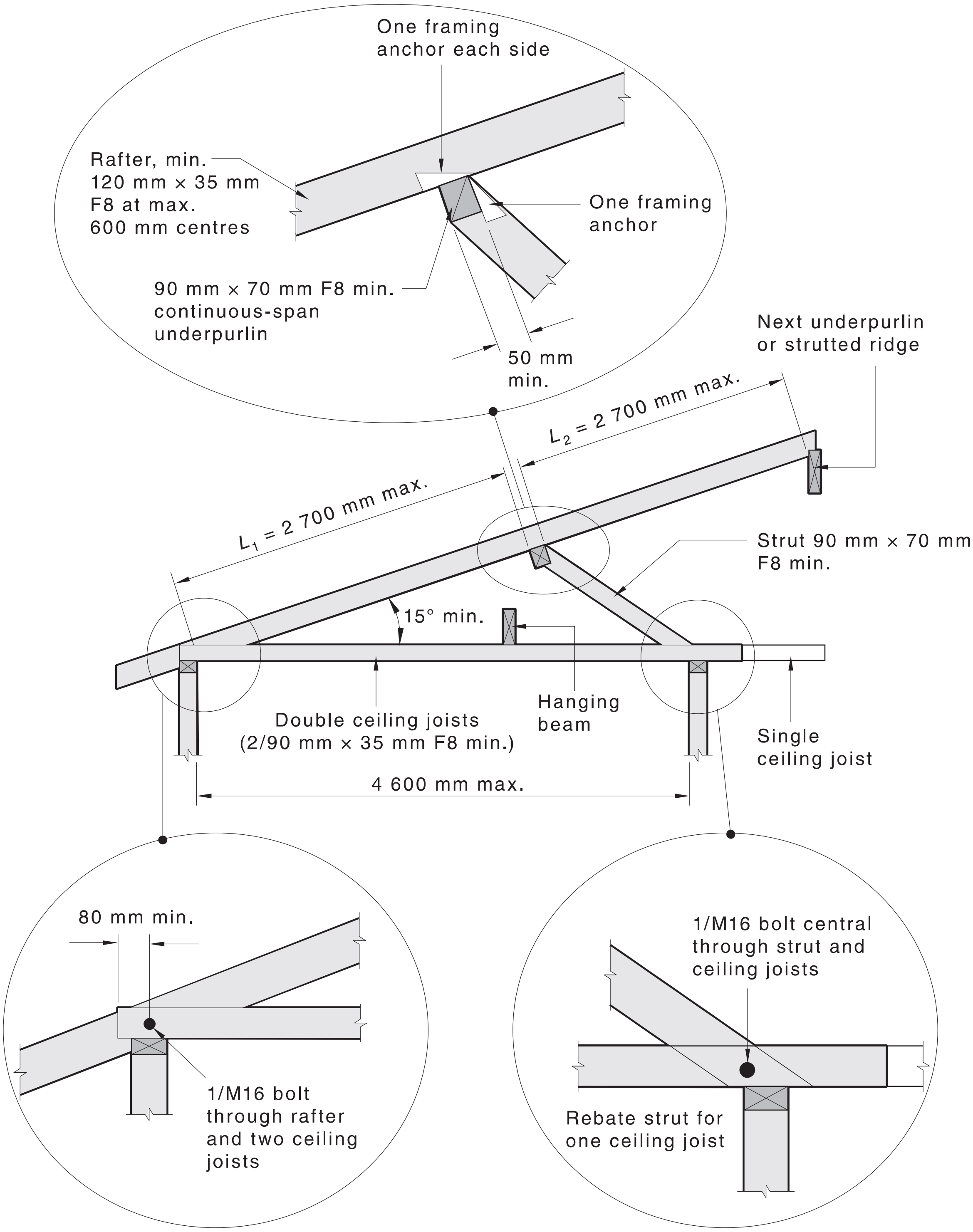


Figure 7.11 — Tied roof struts

7.2.15.3 Fan struts

A pair of struts (fan or flying struts) may be used in the same line as, or perpendicular to, the underpurlin with their supports opposing each other. The pair of struts shall be at the same angle, and not greater than 45° to the vertical, as shown in Figure 7.12.

The maximum fan strut length shall be 4.5 m with maximum 3.0 m spacing between the struts and underpurlin connection. The maximum rafter span shall be 3.0 m.

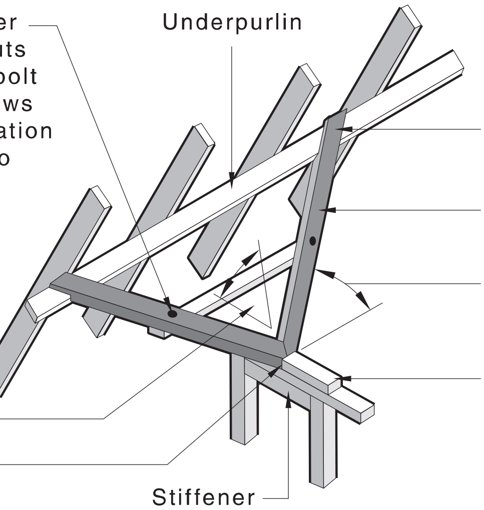


Figure 7.12 — Fan or flying struts

7.2.15.4 Opposing struts

Where roofs are strutted using opposing struts, they shall conform to Figure 7.13.

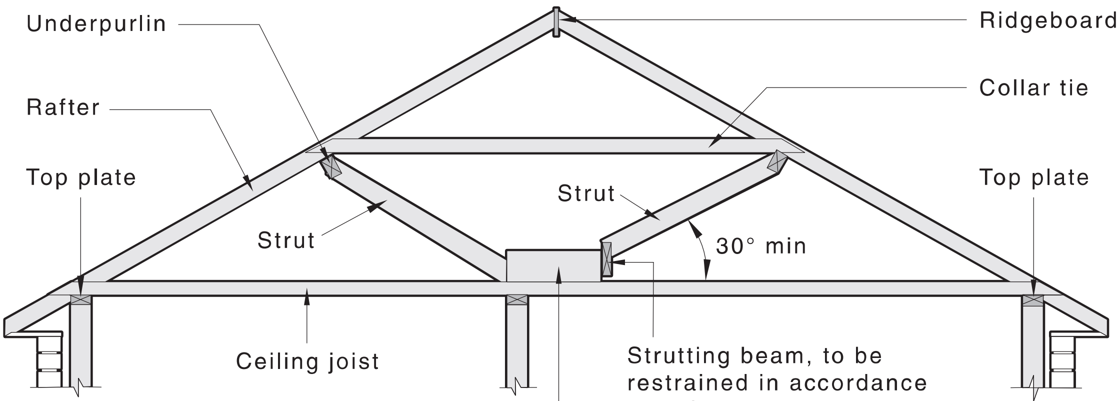


Figure 7.13 — Opposing struts

7.2.16 Collar ties

Collar ties shall be provided in all coupled roof construction. Size of collar ties shall be in accordance with Table 7.6.

Where the rafter span is such as to require support from underpurlins, collar ties shall be fitted to opposing rafters at a point immediately above the underpurlins. Where underpurlins are not required, the collar ties shall be fitted to opposing rafters at a height above the top plate not greater than two-thirds of the rise of the roof.

Collar ties shall be fitted to every second pair of opposing rafters, or at 1 200 mm maximum spacing, whichever is the lesser. Collar ties shall be fixed to rafters with one M10 bolt for ties greater than 4.2 m long or min. 2/75 mm hand-driven nails or 3/75 mm × 3.05 mm diameter machine-driven nails for ties up to 4.2 m long.

Collar ties that exceed 4.2 m in length shall be fixed in accordance with Figure I.1.

NOTE Opposing rafters meet on opposite sides of a ridgeboard.

7.2.17 Hip ends

Hip ends shall be constructed in accordance with one or more of the alternative methods shown in Figure 7.14.

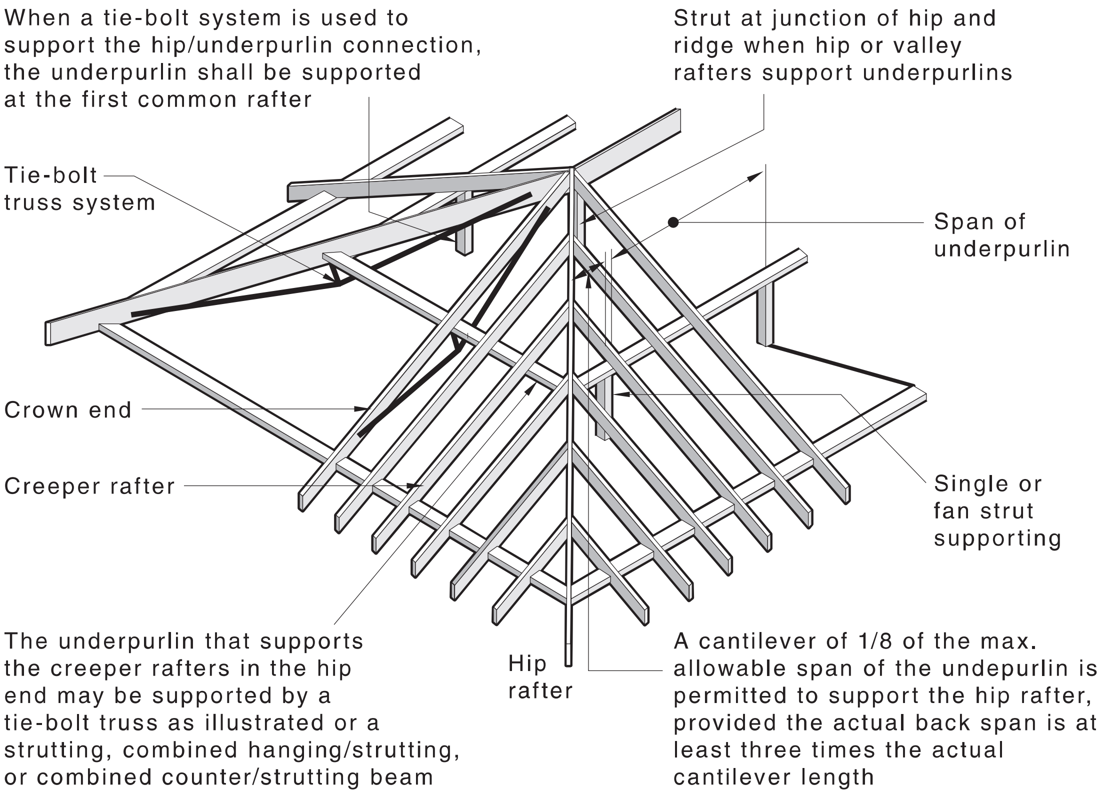


Figure 7.14 — Hip ends — Alternative methods

7.2.18 Alternative support systems

Where shown to be suitable through engineering design principles, tie-bolt trusses or other alternative support systems may be used in combination with underpurlins, hip, valley rafters, or common or jack rafters, as appropriate.

7.2.19 Non-coupled roofs

7.2.19.1 General

This Clause applies to a pitched or flat roof that is not a coupled roof. Non-coupled roof systems include cathedral roofs (ceiling in line with roof) as well as other raftered roofs outside the limits for “coupled roof construction”, e.g. roof pitch below 10°.

Non-coupled roofs shall have rafters, or raking roof beams, supported off walls, ridge beams and/or intermediate beams.

Rafters or raking roof beams to cathedral roofs shall be designed to support roof and ceiling loads.

Studs supporting ridge or intermediate beams shall be designed as "supporting concentration of load" or as posts.

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

7.2.19.2 Ridge and intermediate beams

Ridge beams or walls shall be provided at the apex in the roof and designed to support roof loads and ceiling loads (where required).

Ridge beams shall be at right angles to the rafters and continuous to points of support. They shall be placed either under the rafters or positioned between pairs of rafters, as for a ridgeboard.

Intermediate beams shall be provided where required between the ridge and top plate of the wall.

Intermediate beams shall support the rafters (and ceiling loads where required) and be at right angles to the rafters.

7.2.20 Roof battens

Where possible, battens shall be continuous spanned and joined over supports. Where battens are butt-joined between supports, they shall be spliced using a minimum 600 mm long fishplate of the same size and grade as the batten. The fishplate shall be screw-fixed to the side or underside of the batten using 2/No. 14 type 17 screws each side of the butt joint. The screws shall be positioned not more than 75 mm from the ends of the fishplate and butt joint.

7.2.21 Trussed roofs

7.2.21.1 General

Trusses shall be handled, erected, installed and braced in accordance with AS 4440. Trusses shall be designed in accordance with engineering principles.

7.2.21.2 Structural fascias

A structural fascia that is capable of distributing overhang loads to adjacent trusses shall be installed.

A minimum timber (softwood) structural fascia of 190 mm × 19 mm shall be used.

NOTE 1 Other fascias or combinations of members with similar stiffnesses may be used.

NOTE 2 Grooves in fascia, to fit eaves lining, are permitted.

7.2.21.3 Truss layout

Placement of trusses shall be in accordance with the truss design.

7.2.21.4 Support of trusses

Loadbearing walls supporting trusses shall be in accordance with Section 6.

Girder trusses shall be considered concentrations of load and supported as outlined in Section 6. Lintels supporting girder trusses over openings shall be designed as lintels supporting point loads.

Trusses shall not be supported off internal walls unless the wall and the truss are specifically designed for the purpose.

7.2.22 Bracing for raftered and trussed roofs

All roof frames shall be adequately braced to withstand horizontal forces applied to the building. Bracing shall be designed and fixed to transfer any loads to the supporting structure, see Section 8.

7.2.23 Fixing of ceiling framing to internal bracing walls

All bracing walls shall be fixed to ceiling or roof framing, see Section 8.

7.2.24 Eaves construction

7.2.24.1 General

Where fascias and bargeboards are used as structural members to support roof loads, the size shall be determined as either for a rafter or a verandah beam.

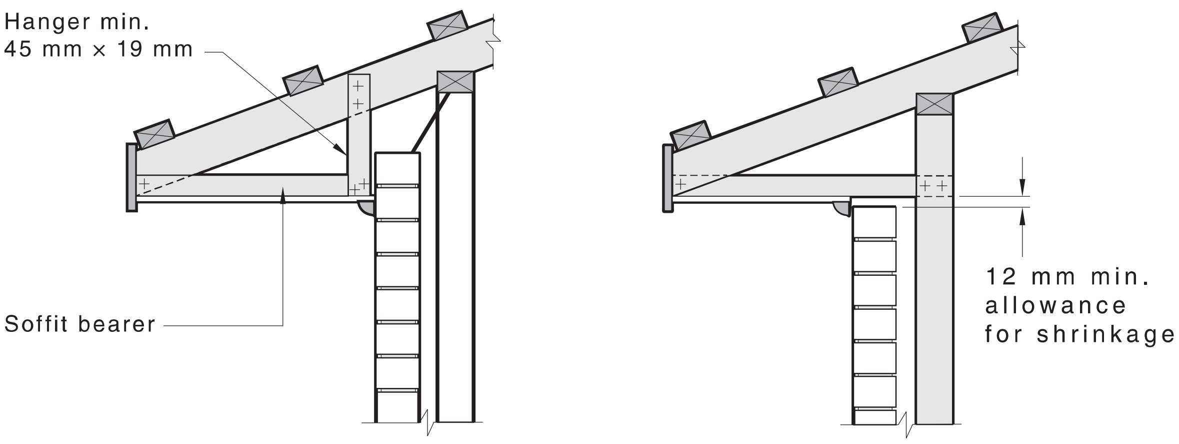
7.2.24.2 Boxed eaves

Soffit bearers used in the construction of boxed eaves shall be spaced to suit eaves lining and not be less than the following sizes:

(a) 45 mm × 32 mm where the span does not exceed 600 mm.

(b) 70 mm × 35 mm where their span is greater than 600 mm but not greater than 1.5 m.

In masonry veneer buildings, the inner ends of soffit bearers shall either be supported by means of minimum 45 mm × 19 mm hangers from rafters [see Figure 7.15(a)], or be fixed to the external wall studs, see Figure 7.15(b). For masonry veneer buildings, where soffit bearers are supported by the wall frame, a minimum 12 mm clearance shall be provided between the soffit bearer and the top of the masonry to allow for frame shrinkage.



(a) Hanger support **(b) Wall frame fixing**

Figure 7.15 — Typical boxed eaves construction

7.2.25 Gable or verge construction

7.2.25.1 General

Gables or verges shall be formed either —

(a) with rafters supported on cantilevered extensions of ridgeboards or beams, underpurlins, intermediate beams and wall plates; or

(b) with outriggers or outriggers at right angles to and trimmed into common rafters or trusses, which shall be adequately fixed and nogged to prevent overturning and to provide fixing for roof battens.

Members cantilevered to support gables shall not project beyond their supports by more than 25 % of the allowable span of the member. Their backspan shall be at least twice that of the cantilever.

7.2.25.2 Open gables

Open gable end walls may be constructed using —

(a) for exposed rafter (cathedral) roofs, studs continuous up to a raking top plate below rafters;

(b) for pitched roofs with a horizontal ceiling, gable end studs supported off the top plate; or

(c) gable trusses fully supported off the gable end wall, or raking truss (gable end truss) with gable end studs supported off the top plates, see Figure 7.16.

Gable end studs or additional vertical members and trusses shall be provided at the spacing required to fix cladding, or brick veneer where used. They shall be of sufficient size and stress grade to support dead, live and wind loads.

Requirements for gable end studs shall be as specified in Clause 6.3.2.5.

Open gable eaves may be unlined or may be sheeted on the upper side or the underside of rafters.

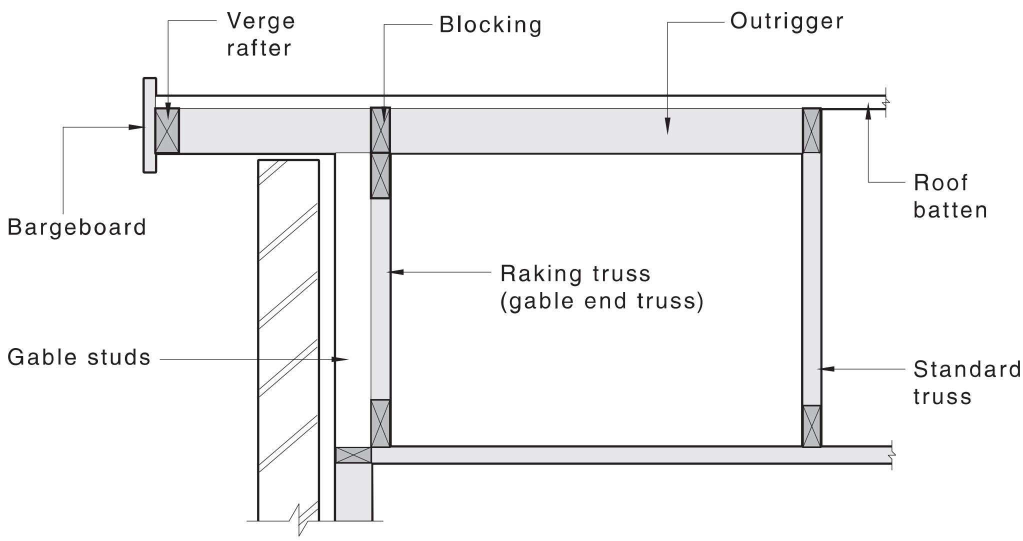


Figure 7.16 — Open gable or verge — Trussed roof

7.2.25.3 Boxed gables

Boxed gables shall have 70 mm × 35 mm soffit bearers fixed between the lower ends of gable studs or gable truss and the frame wall. Gable lining shall be fixed either directly to the gable truss or to the gable studs, see Figure 7.17.

Boxed gables shall be securely fixed off the structural wall plate with strutting or bracing as necessary to support the load of the gable framing and the roof covering.

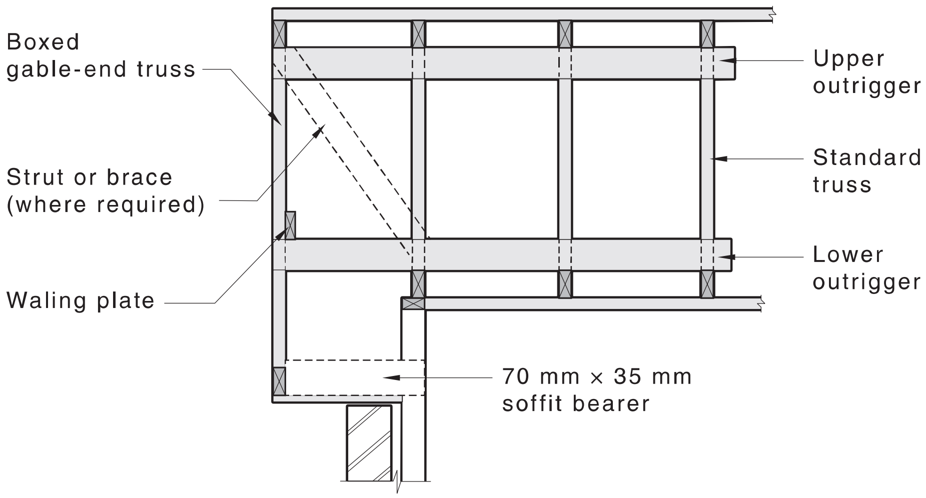
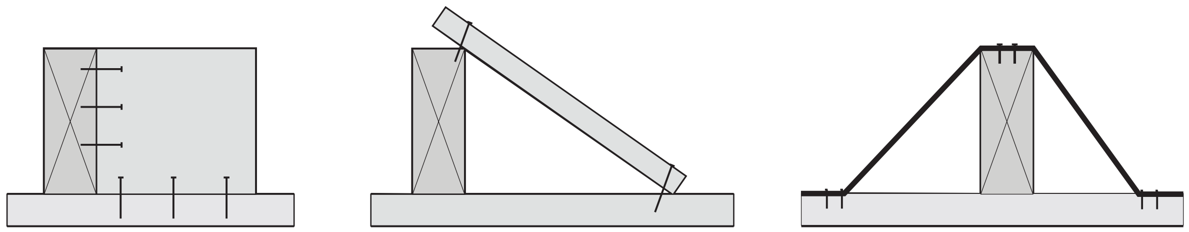


Figure 7.17 — Boxed gable — Trussed roof

7.2.26 Lateral restraint of hanging, strutting, strutting/hanging beams, and similar members

Where required, lateral restraint shall be provided by one of the methods shown in Figure 7.18.



NOTE 1 Method used depends upon whether the ceiling joists are at 90° or parallel to the beam.

NOTE 2 Methods given in (b) and (c) are particularly suitable for restraining strutting beams and strutting/hanging beams at the intermediate points where the beams are supported, as they also permit these beams to be supported up clear of the ceiling joists by packing under at their supports.

Figure 7.18 — Lateral restraint

7.2.27 Framing around chimneys and flues

Placement of all framing members around chimneys and flues shall be in accordance with AS 1691 and AS/NZS 2918.

7.3 Member sizes

7.3.1 General

Member sizes shall be determined from the Span Tables of the Supplements for coupled or non-coupled roof construction, as appropriate, see Clauses 1.3.6.1 and 1.3.6.2.

7.3.2 Ceiling battens

For glued, or glued and screwed, or machine-driven nailed ceiling linings with a mass up to 12 kg/m^2, the minimum ceiling batten sizes shall be in accordance with Table 7.1.

For hand-driven nailed or hand-driven nailed and glued ceiling linings, batten sizes may need to be increased to avoid damage to ceiling lining or fixings due to flexibility.

Table 7.1 — Ceiling batten size

Ceiling batten grade	Rafter or truss spacing, mm								
	600			900			1 200		
	Batten spacing, mm								
	300	450	600	300	450	600	300	450	600
F5 Unseasoned	38 × 38	38 × 38	38 × 38	38 × 38	38 × 38	38 × 38	38 × 50	38 × 75	38 × 75
F8 Unseasoned	25 × 38	25 × 38	25 × 38	25 × 50	38 × 38	38 × 38	38 × 38	38 × 38	38 × 50
F5 Seasoned	35 × 42	35 × 42	35 × 42	35 × 42	35 × 42	35 × 42	35 × 42	35 × 42	38 × 42

7.3.3 Ceiling lining and non-trafficable roof decking

7.3.3.1 General

Ceiling lining or non-trafficable roof decking shall be attached directly to rafters or purlins, the underside of ceiling joists, bottom or top chord of trusses or to battens to ensure the integrity of the roof and/or the ceiling diaphragm.

Suspended ceiling systems shall not be assumed to provide diaphragm action to transfer wind loads to bracing walls.

7.3.3.2 Tongued and grooved non-trafficable roof decking

Tongued and grooved timber boards used for non-trafficable roofs shall be in accordance with Table 7.2.

Where boards are not at right angles to rafters, the spacing of support shall be taken along the length of the board.

Table 7.2 — Tongued and grooved boards for non-trafficable roofs

Standard	Timber	Visual grade	Minimum thickness of boards, mm			
			Spacing of supports, mm			
			450	600	900	1 200
AS 2796.1	Western Australian hardwoods	Standard	11	13	19	24
		Select	10	12	17	22
AS 2796.1	Southeastern Australian hardwoods	Standard	10	13	19	24
		Select	11	12	17	22
AS 2796.1	Northeastern Australian hardwoods	Standard	10	13	18	23
		Select	10	12	17	22

Table 7.2 *(continued)*

Standard	Timber	Visual grade	Minimum thickness of boards, mm			
			Spacing of supports, mm			
			450	600	900	1 200
AS 4785.1	Radiata	One grade	12	15	21	26
AS 1810	Cypress	Grade 1 and Grade 2	12	15	21	27
AS 4785.1	Softwood	Standard and Select	12	15	21	26
AS 2796.1	Hardwood (density less than 560 kg/m^3)					
AS 4785.1	Softwood	Standard and Select	11	14	20	25
AS 2796.1	Hardwood (density greater than, or equal to, 560 kg/m^3)					

NOTE 1 Where battens are used and sized for the rafter spacing, lining is not considered structural.

NOTE 2 Finger jointing is permitted.

NOTE 3 Allowance has been made for light sanding.

7.3.3.3 Structural plywood for non-trafficable roof decking

Structural plywood used for non-trafficable roof decking shall be in accordance with Table 7.3.

Table 7.3 — Structural plywood to AS/NZS 2269.0 for non-trafficable roofs

Maximum rafter or truss spacing, mm	Minimum allowable plywood thickness, mm		
	Stress grade		
	F8	F11	F14
800	13	12	12
900	16	15	15
1 200	19	17	16

NOTE Allowance has been made for light sanding.

Plywood sheets shall be laid with the grain of the face ply parallel to the span. They shall be continuous over at least two spans. Tabulated spacing shall be reduced by 25 % if supported over one span only.

Edges of sheets that are not tongued and grooved shall be supported.

Structural plywood shall be fixed to all end and intermediate supports in accordance with Table 7.4.

Table 7.4 — Minimum fixing requirements for structural plywood non-trafficable roofs

Rafter or truss spacing, mm	Connector type	Wind classification		
		N1 or N2	N3	N4
800 or 900	Flat-head nails	2.8 mm ⌀ × 40 mm	2.8 mm ⌀ × 50 mm	2.8 mm ⌀ × 75 mm or 3.15 mm × 65 mm
	Countersunk self-drilling timber screws	No. 8 × 40 mm	No. 8 × 40 mm	No. 8 × 50 mm
1 200	Flat-head nails	2.8 mm ⌀ × 50 mm	2.8 mm ⌀ × 65 mm or 3.15 mm × 60 mm	3.15 mm × 75 mm
	Countersunk self-drilling timber screws	No. 8 × 40 mm	No. 8 × 50 mm	No. 8 × 50 mm

Table 7.4 *(continued)*

Rafter or truss spacing, mm	Connector type	Wind classification		
		N1 or N2	N3	N4
Fastener	**Roof area**			**Spacing mm**
Nail	— General roof areas			200
	— Within 1 200 mm of roof perimeter			100
Screw	All roof areas			200

NOTE Fixings in this Table are applicable to timber species of minimum joint strength J4 or JD4 and to plywood up to 20 mm thick.

7.3.4 Loads on ceilings

The member sizes given for ceiling joists, hanging beams, and similar members, are suitable for the support of normal ceiling loads and linings. Where ceiling framing is required to support other loads including ladder or stair systems, storage, hot water systems or similar building services, the framing shall be designed in accordance with AS 1720.1, see also Clause 7.2.2.

7.3.5 Binders

Binders may be required in ceilings to provide lateral restraint to external walls. Where required, they shall be a minimum of 35 mm × 70 mm.

Requirements for lateral restraint of external walls are specified in Clause 6.2.5.

7.3.6 Ceiling joists

The size of ceiling joists shall be determined from Span Table 21 (without overbatten) or Span Table 22 (with overbatten) of the Supplements. Overbattens shall be a minimum of 35 mm × 70 mm F5.

Design parameters for ceiling joists shall be as shown in Figure 7.19.

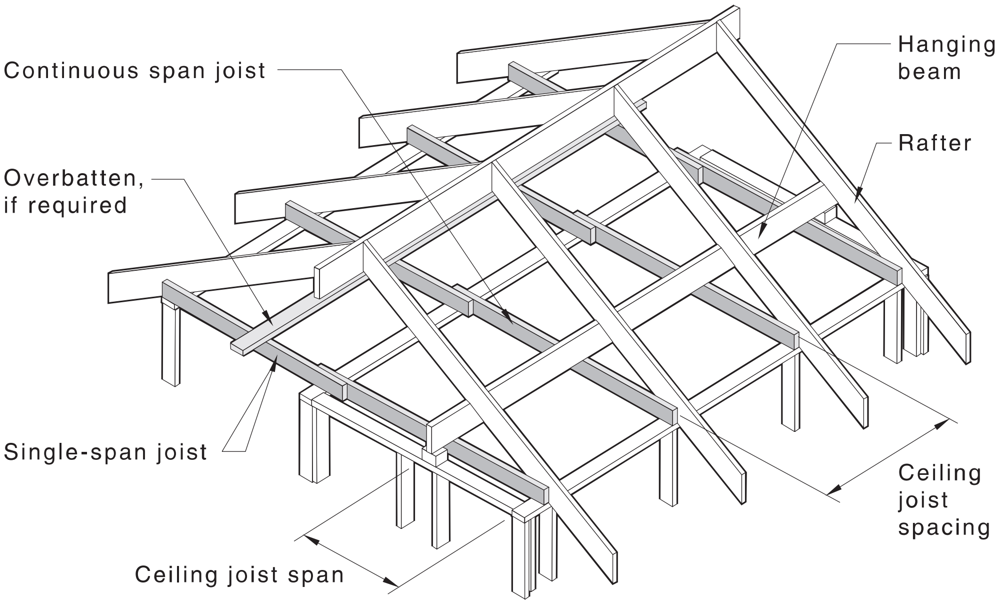


Figure 7.19 — Ceiling joists

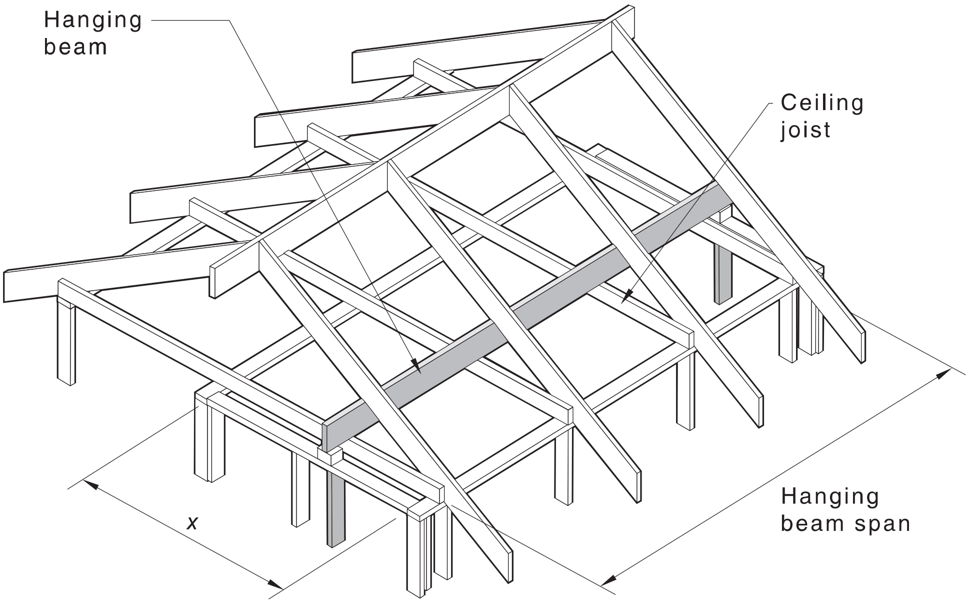
7.3.7 Hanging beams

The size of hanging beams shall be determined from Span Table 23 of the Supplements.

Hanging beams shall support ceiling loads only via ceiling joists.

The top edge of hanging beams with a depth to breadth ratio exceeding 7 shall be laterally restrained at their supports, as shown in Figure 7.18.

Design parameters for hanging beams shall be as shown in Figure 7.20.



Key

Ceiling load width (*CLW*) $= \frac{x}{2}$

x = total of ceiling joist spans either side of hanging beam

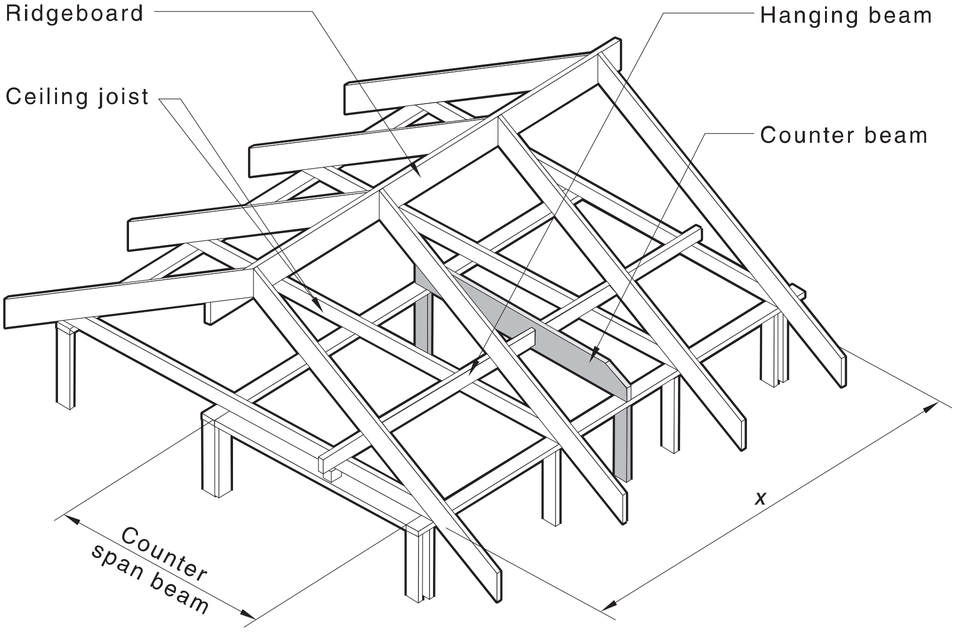
Figure 7.20 — Hanging beams

7.3.8 Counter beams

The size of counter beams shall be determined from Span Table 24 of the Supplements. This Span Table may also be used for lintels in internal walls supporting hanging beams.

Counter beams shall support ceiling loads via hanging beams.

Design parameters for counter beams shall be as shown in Figure 7.21.



Key

Ceiling load width (CLW) $= \frac{x}{2}$

x = total of hanging beam spans either side of the counter beam

Figure 7.21 — Counter beams

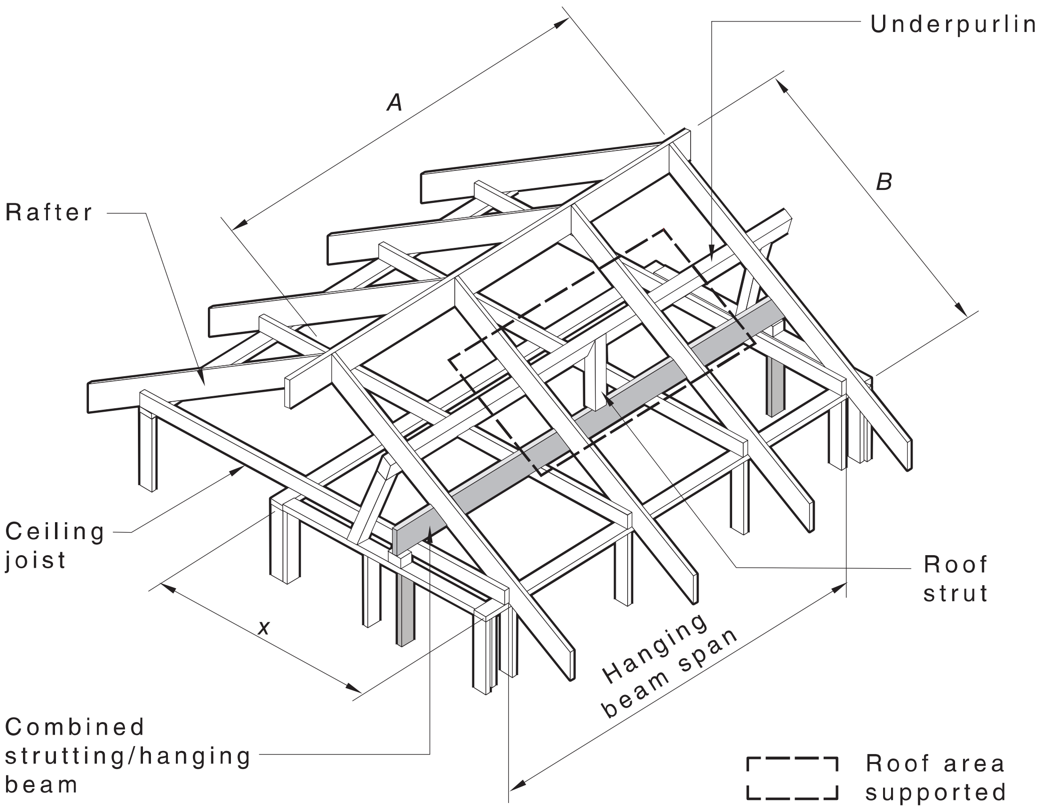
7.3.9 Combined strutting/hanging beams

The size of combined strutting/hanging beams shall be determined from Span Table 25 of the Supplements.

Combined strutting/hanging beams may support both roof loads from struts and ceiling loads from ceiling joists.

The top edge of combined strutting/hanging beams with a depth to breadth ratio exceeding 3 shall be laterally restrained at their supports and intermediately at the strutting points, as shown in Figure 7.18.

Design parameters for combined strutting/hanging beams shall be as shown in Figure 7.22.



Key

Roof area supported $= \frac{A}{2} \times \frac{B}{2}$

A = total of underpurlin spans either side of strut

B = total of rafter spans

Ceiling load width (CLW) $= \frac{x}{2}$

x = total of ceiling joist spans either side of hanging beam

NOTE 1 Strutting/hanging beams support both roof and ceiling loads.

NOTE 2 Ridge struts have been omitted for clarity.

Figure 7.22 — Combined strutting/hanging beams

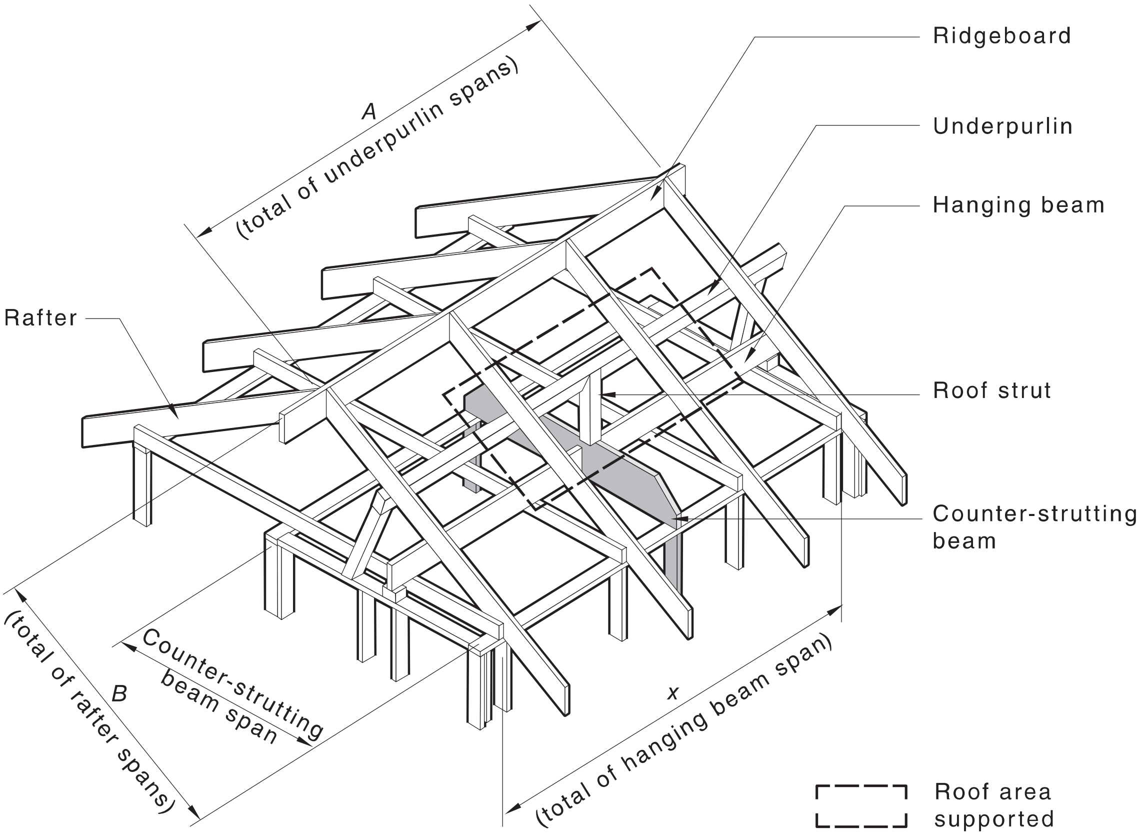
7.3.10 Combined counter/strutting beams

The size of combined counter/strutting beams shall be determined from Span Table 26 of the Supplements.

Combined counter/strutting beams may support roof loads from struts and hanging beams from ceiling loads.

The top edge of combined counter/strutting beams with a depth to breadth ratio exceeding three shall be laterally restrained at their supports, as shown in Figure 7.18.

Design parameters for combined counter/strutting beams shall be as shown in Figure 7.23.



Key

Roof area supported $= \frac{A}{2} \times \frac{B}{2}$

A = total of underpurlin spans either side of strut

B = total of rafter spans

Ceiling load width (CLW) $= \frac{x}{2}$

Counter-strutting beam spacing $= \frac{x}{2}$

x = total of hanging beam spans

NOTE Ridge struts have been omitted for clarity.

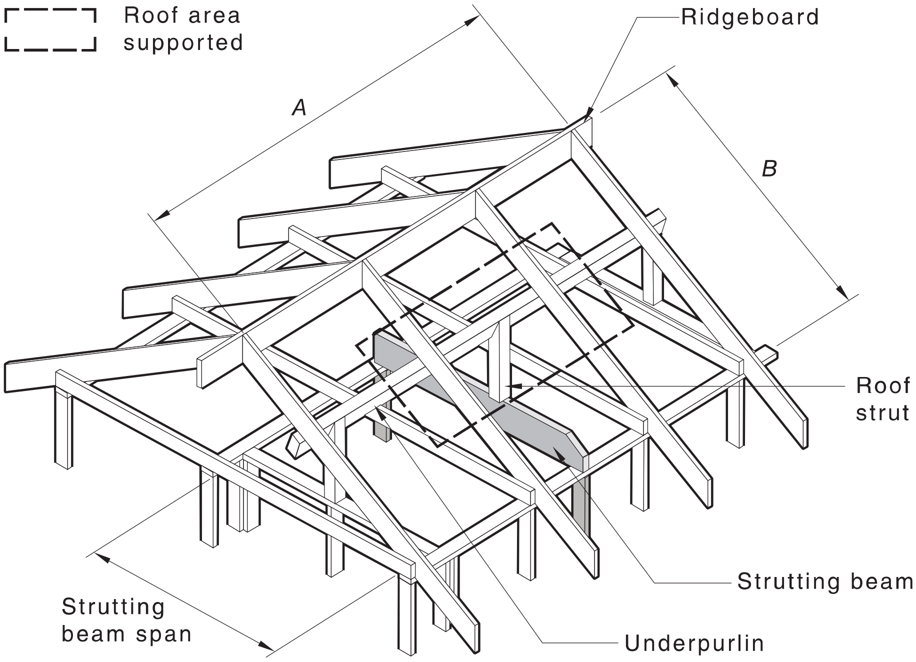
Figure 7.23 — Combined counter/strutting beams

7.3.11 Strutting beams

The size of strutting beams shall be determined from Span Table 27 of the Supplements. Strutting beams shall support roof loads only.

The top edge of strutting beams with a depth to breadth ratio exceeding three shall be laterally restrained at their supports and intermediately at the strutting points, as shown in Figure 7.18.

Design parameters for strutting beams shall be as shown in Figure 7.24.



Key

Roof area supported $= \frac{A}{2} \times \frac{B}{2}$ where ridge is strutted

A = total of underpurlin spans

B = total of rafter spans

NOTE 1 Strutting beams to support roof loads only.

NOTE 2 Ridge struts have been omitted for clarity.

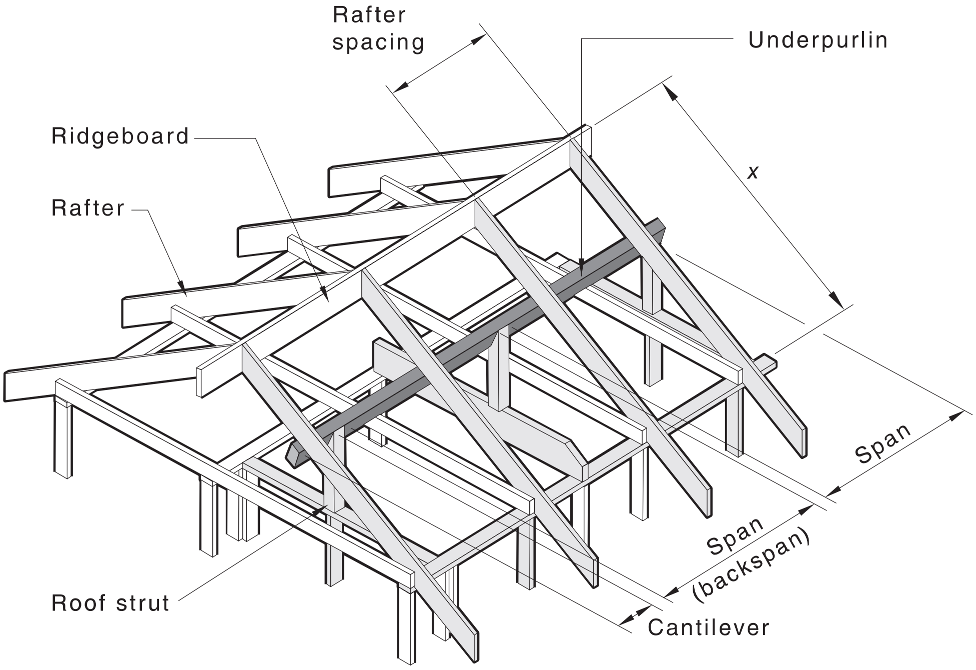
Figure 7.24 — Strutting beams

7.3.12 Underpurlins

The size of underpurlins shall be determined from Span Table 28 of the Supplements.

The ends of underpurlins may project (cantilever) beyond a support by up to 25 % of the maximum allowable span of the underpurlin provided the actual backspan is at least three times the cantilever length.

Design parameters for underpurlins shall be as shown in Figure 7.25.



Key

Max. cantilever	=	(1/4) allowable backspan
Min. backspan	=	3 × actual cantilever
Roof load width (*RLW*)	=	$\frac{x}{2}$
x =		total of rafter spans either side of underpurlin

NOTE 1 For single spans, continuous spans, and unequal spans, see Clause 1.3.5.

NOTE 2 Ridge struts have been omitted for clarity.

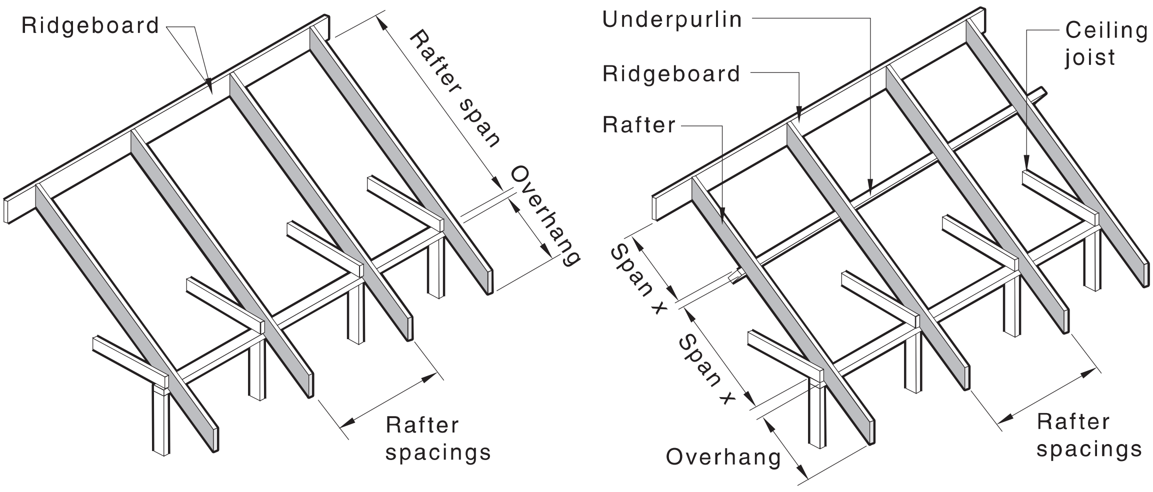
Figure 7.25 — Underpurlins

7.3.13 Rafters and purlins

7.3.13.1 General

The size of rafters or purlins shall be determined from Span Table 29 of the Supplements.

Design parameters for rafters supporting roof loads only shall be as shown in Figure 7.26. The maximum birdsmouth shall be one-thirds of the rafter depth. Design parameters for rafters supporting both roof and ceiling loads shall be as shown in Figure 7.27.

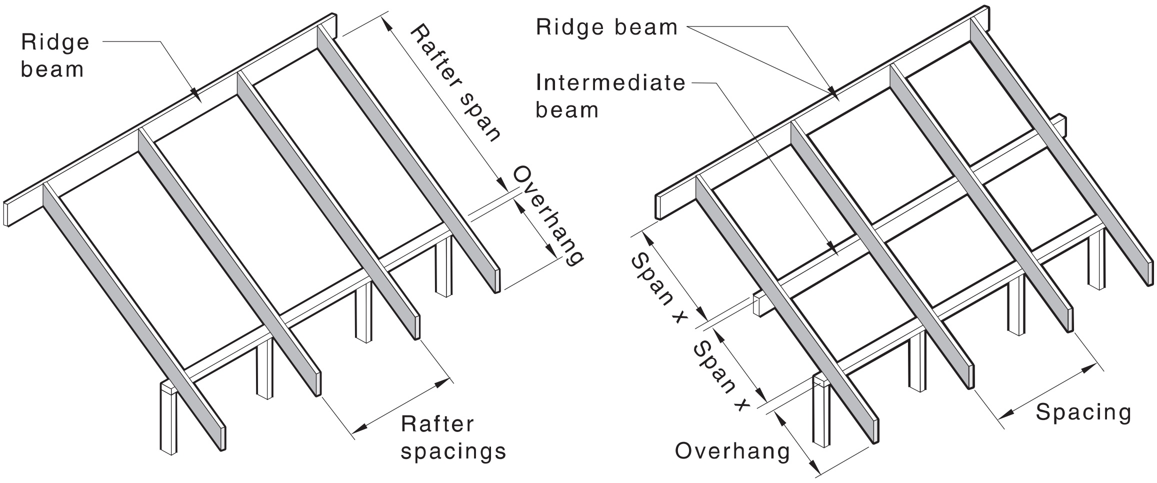


(a) Single span **(b) Continuous span**

NOTE 1 For overhang and span limits, see Span Tables given in the Supplements.

NOTE 2 For unequal spans, see Figure 1.1.

Figure 7.26 — Rafters/purlins (coupled roofs)



(a) Single span **(b) Continuous span**

NOTE 1 Birdsmouthed rafters may be notched up to 1/3 of their depth.

NOTE 2 For overhang and span limits, see the Span Tables of the Supplements and Clauses 7.3.13.2 and 7.3.13.3.

NOTE 3 For unequal spans, see Figure 1.1.

Figure 7.27 — Rafters supporting roof and ceiling loads (non-coupled or cathedral roofs)

7.3.13.2 Rafter overhangs

Rafter overhang limits contained in the Span Tables are applicable for use with a birdsmouth notch not exceeding one-third of the rafter depth in combination with a structural fascia that is rigidly connected to the ends of the rafters, see Figure 7.28(a). A minimum timber (softwood) structural fascia of 190 mm × 19 mm shall be used.

Where non-structural fascias are used, the allowable overhangs shall be two-thirds of those permitted by the Span Tables.

NOTE 1 The maximum overhangs permitted by the Span Tables and Clause 7.3.13.3 may not be suitable for the support of attachments (pergolas and similar constructions) to the ends of overhangs.

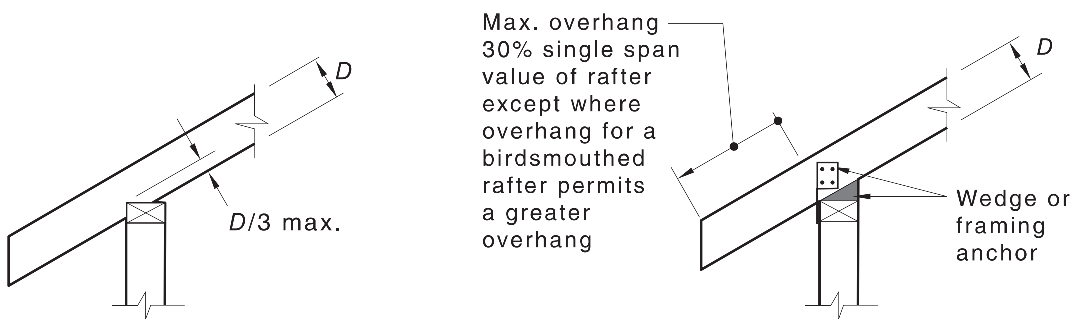
NOTE 2 For additional limitations on rafter overhangs, refer to the Notes to Span Table 29 in the Supplements and Figure 7.15(b).

7.3.13.3 Birdsmouthed and non-birdsmouthed rafters

Where rafters are not birdsmouthed over top plates as shown in Figure 7.28(b), the allowable overhang may be 30 % of the single span value, for all roof masses. Rafters shall be supported by means of wedges or other alternative support systems, such as framing anchors that provide equivalent bearing support.

Where rafters are birdsmouthed less than one-third of the depth of the rafter, the allowable overhang may be determined by interpolation between the overhang permitted for a one-third-depth birdsmouth and the overhang permitted for a non-birdsmouthed rafter.

In hipped roofs, where common rafters are projected to form rafter overhangs that equal or exceed 750 mm, the hip or valley rafters shall be reinforced with 2/70 mm × 35 mm × 900 mm long fishplates extending 450 mm either side of the birdsmouth.



(a) Birdsmouthed **(b) Non-birdsmouthed**

Figure 7.28 — Rafter overhang and birdsmouthing

7.3.13.4 Dressed rafters

Table 7.5 provides span and overhang reductions for dressed (undersize) rafters, as may be used in cathedral or flat/skillion roofs where rafters are exposed to view.

Unseasoned timber dressed sizes shall be not more than 10 mm in depth or thickness under the nominal sizes stated in the rafter Span Tables, except that for 38 mm nominal thickness, the dressed thickness shall be not less than 32 mm.

Seasoned timber dressed sizes shall be not more than 10 mm in depth and 5 mm in thickness under the sizes stated in the rafter Span Tables. Where the nominated sections suitable for nail lamination are used, each lamination shall be not more than 10 mm in depth and 5 mm in thickness under the sizes stated.

The allowable overhang shall not exceed 30 % of the reduced span value for a dressed rafter.

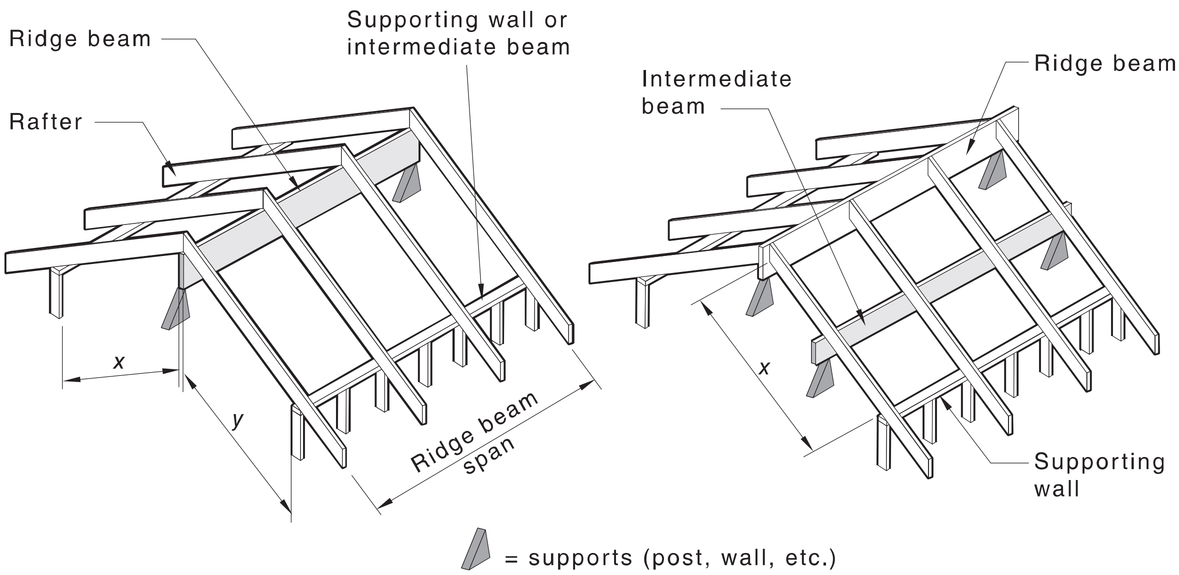
Table 7.5 — Reduced spans and overhangs for dressed rafters

Rafter depth, mm	Allowable span for dressed beams as a percentage of allowable undressed beam span	
	Seasoned timber	Unseasoned timber
Under 200	80 %	85 %
200 to 300	85 %	90 %
Over 300	Not applicable	95 %

7.3.14 Ridge or intermediate beams — Cathedral, skillion or similar roofs

The size of ridge or intermediate beams in non-coupled cathedral or skillion roofs shall be determined from Span Tables 30 and 31 of the Supplements for single and continuous spans respectively.

Design parameters for ridge and intermediate beams shall be as shown in Figure 7.29. Beams shall not be checked or birdsmouthed at their supports.



(a) Ridge beams **(b) Intermediate beams**

Key

Roof load width (RLW) = $\frac{x + y}{2}$

x and y = rafter spans

Roof load width (RLW) = $\frac{x}{2}$

x = total of rafter spans either side of intermediate beam

NOTE 1 For overhang and span limits, see the Span Tables given in the Supplements.

NOTE 2 Rafters may butt into or pass over ridge beams.

Figure 7.29 — Ridge and intermediate beams

7.3.15 Roof battens

The size of roof battens shall be determined from Span Table 32 of the Supplements. The Span Table provides sizes for roof battens supporting roofing loads only for spans up to 1 200 mm. For spans greater than 1 200 mm or where roofing and ceiling loads are supported, the size may be determined from Span Table 29 of the Supplements for rafters and purlins where those members are to be used only on their edge.

Design parameters for roof battens shall be as shown in Figure 7.30.

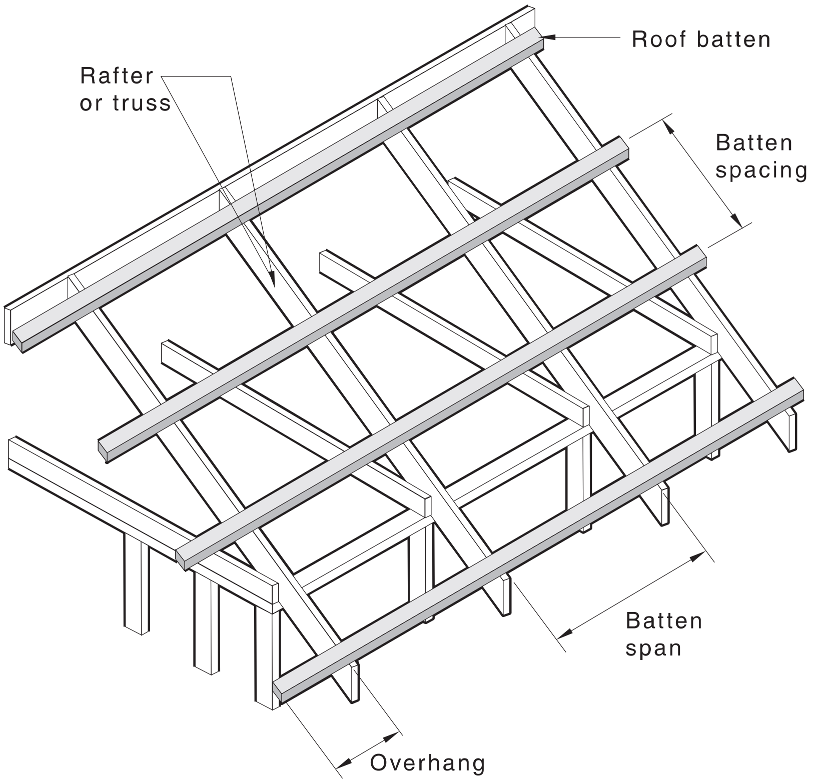
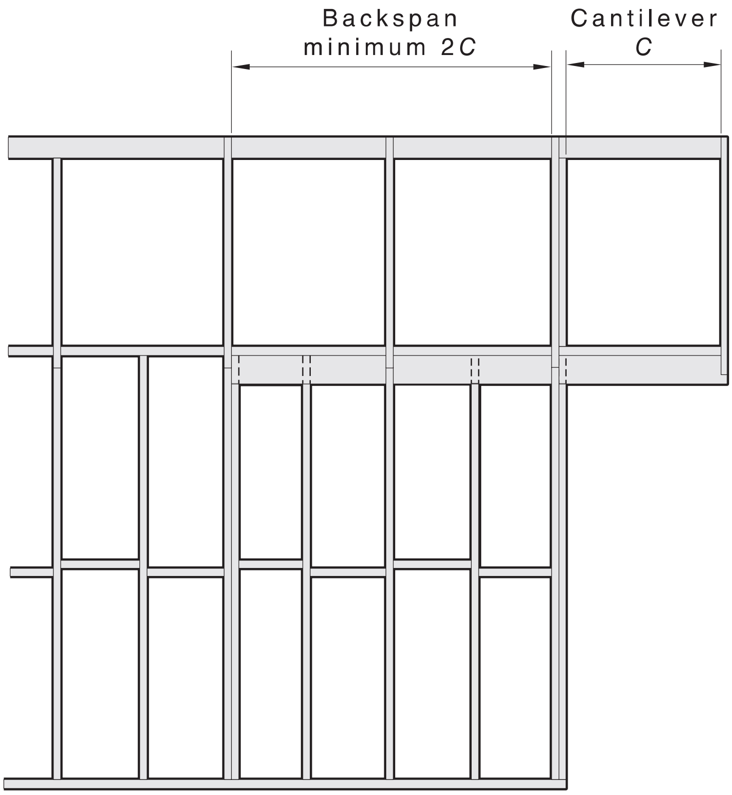


Figure 7.30 — Roof battens

7.3.16 Cantilevered gable ends

The size of lintels, ring beams, verandah beams, underpurlins, and similar members, where cantilevered at gable ends, as shown in Figure 7.31, shall be determined from the appropriate Clauses and Span Table in the Supplements for a single span equal to three times the cantilever distance. The backspan of the cantilevered member shall be at least twice the cantilever length. For ridge and intermediate beams, the cantilever shall not exceed the value given in the Span Tables.



NOTE To determine the size of a cantilevered member, refer to the appropriate Span Table in the Supplements, using single span = 3 *C*.

Figure 7.31 — Cantilevered gable ends

7.3.17 Other members or components

Requirements for miscellaneous roof framing members, which are not given in the Span Tables of the Supplements, are specified in Table 7.6.

The junction of ridgeboard and hip or valley rafters shall be strutted where hip or valley rafters exceed 5 m span, or where underpurlins are supported off hip rafters.

The roof strut length shall be measured from the underside of the underpurlin/ridgeboard/hip rafter to the top of the strutting beam/wall.

Table 7.6 — Other members and components

Member	Application	Minimum size, mm
Ridgeboards	Unstrutted ridge in coupled roof	Depth not less than length of the rafter plumb-cut × 19 thick
	Strutted ridge in coupled roof with strut spacing not greater than 1 800 mm	Depth not less than length of the rafter plumb-cut × 19 thick
	Strutted ridge in coupled roof with strut spacing greater than 1 800 mm and up to 2 300 mm	Depth not less than length of the rafter plumb-cut × 35 thick

Table 7.6 *(continued)*

Member	Application	Minimum size, mm
Hip rafters	Stress grade F11/MGP15 minimum and not less than rafter stress grade	50 greater in depth than rafters × 19 thick (seasoned) or 25 thick (unseasoned)
	Stress grades less than F11/MGP15	50 greater in depth than rafters × min. thickness as for rafters
Valley rafters	Minimum stress grade, as for rafters	50 greater in depth than rafters with thickness as for rafters (min. 35)
Valley boards[a]	—	19 min. thick × width to support valley gutter
Roof struts (sheet roof)	Struts to 1 500 mm long for all stress grades	90 × 45 or 70 × 70
	Struts 1 500 mm to 2 400 mm long for all stress grades	70 × 70
Collar ties	Ties to 4 200 mm long for F8/MGP12 or higher stress grade	70 × 35
	Ties to 4 200 mm long for less than F8/MGP12 stress grade	70 × 45 or 90 × 35
	Ties over 4 200 mm long for F8/MGP12 or higher stress grade	90 × 35
	Ties over 4 200 mm long for less than F8/MGP12 stress grade	90 × 45 or 120 × 35
Soffit bearers (boxed eaves)	Max. span 600 mm	42 × 35
	Span 600 mm to 1 500 mm	70 × 35
Soffit bearer hangers	Where applicable	42 × 19
Fascias	Rigidly connected to rafter overhangs	190 × 19
Gable struts	Braces for gable ends	See Section 8
Roof struts (tiled roof)	Struts to 1 500 mm long for F8/MGP12 and higher stress grades	90 × 45 or 70 × 70
	Struts to 1 500 mm long for less than F8/MGP12 stress grade	70 × 70
	Struts 1 500 to 2 400 mm long for F8/MGP12 and higher stress grades	70 × 70
	Struts 1 500 to 2 400 mm long for less than F8/MGP12 stress grade	90 × 70

Roof struts (Roof load area up to 12 m^2)

Roof type	Length, mm	Grade	Type	Size, mm
Sheet	Up to 1 500	F5 or better	Solid, glued or nail-laminated	90 × 45 or 2/70 × 35
	1 501 to 2 400			2/90 × 45
	2 401 to 3 000	F8 or better		2/90 × 45
	3 001 to 3 600	MGP12 or better		2/90 × 45
Tile	Up to 1 500	F5 or better	Solid, glued or nail-laminated	2/70 × 45 or 2/90 × 35
	1 501 to 2 400	F8 or better	Nail-laminated	2/120 × 45
			Solid or glue-laminated	2/90 × 35
	2 401 to 3 000	MGP 12 or better	Nail-laminated	2/120 × 45
			Solid or glue-laminated	2/90 × 35
	3 001 to 3 600	MGP 12 or better	Solid or glue-laminated	2/90 × 45

[a] 175 × 25 × 6 mm hardwood weatherboards may also be used for valley boards.

Section 8 Racking and shear forces (bracing)

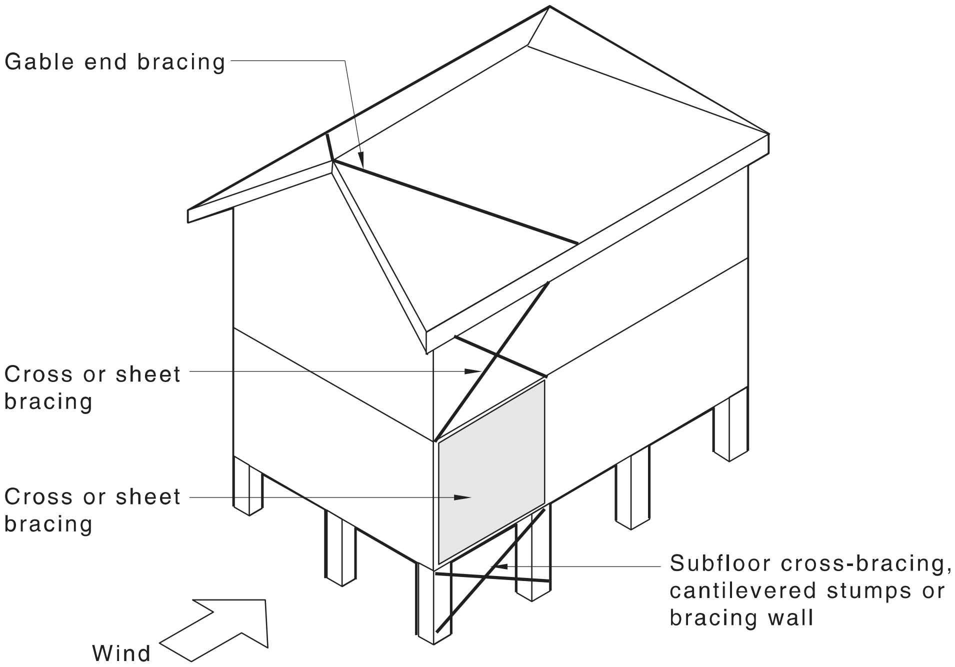
8.1 General

Permanent bracing shall be provided to enable the roof, wall and floor framework to resist horizontal forces applied to the building (racking forces). Appropriate connection shall also be provided to transfer these forces through the framework and subfloor structure to the building's foundation.

Where required, bracing within the building, which normally occurs in vertical planes, shall be constructed into walls or subfloor supports and shall be distributed evenly throughout.

Where buildings are more than one storey in height, wall bracing shall be designed for each storey.

NOTE Figure 8.1 illustrates examples of the types and positions where bracing is required.



NOTE 1 The wind forces on unclad frames may be equal to, or greater than, those on a completed clad or veneered house.

NOTE 2 Horizontal wind (racking) forces are applied to external surfaces that are supported by horizontal or near horizontal diaphragms. Diaphragms include roofs, ceilings and floor surfaces including their associated framing.

NOTE 3 Each horizontal diaphragm transfers racking forces to lower level diaphragms by connections and bracing. This continues down to the subfloor supports or concrete slab on the ground, where the forces are then resisted by the foundations.

Figure 8.1 — Various bracing systems connecting horizontal diaphragms

8.2 Temporary bracing

Temporary bracing is necessary to support wind and construction loads on the building during construction. Temporary bracing shall be equivalent to at least 60 % of permanent bracing required. Temporary bracing may form part of the installed permanent bracing.

8.3 Wall and subfloor bracing

8.3.1 General

Bracing shall be designed and provided for each storey of the house and for the subfloor, where required, in accordance with the following procedure:

(a) Determine the wind classification, see Clause 1.5 and refer to AS 4055 and AS/NZS 1170.2.

(b) Determine the wind pressure, see Clause 8.3.2.

(c) Determine area of elevation, see Clause 8.3.3 and Figures 8.2(A), 8.2(B) and 8.2(C).

(d) Calculate racking force, see Clause 8.3.4.

(e) Design bracing systems for —

   (i) subfloors, see Clause 8.3.5; and

   (ii) walls, see Clause 8.3.6.

   NOTE To calculate the number of braces required for wall bracing, the racking force (kN) is divided by the capacity of each brace. The total capacity of each brace is equal to the length of the braced wall multiplied by its unit capacity (kN/m) as given in Table 8.18. For example, a diagonal brace Type (c) as per Table 8.18 has a total capacity of 1.5 kN/m × length of bracing wall = 1.5 × 2.4 = 3.6 kN for a 2.4 m long section of braced wall.

(f) Check even distribution and spacing, see Clauses 8.3.6.6 and 8.3.6.7 and Tables 8.20 and 8.21.

(g) Check connection of bracing to roof/ceilings and floors, see Clauses 8.3.6.9 and 8.3.6.10.

8.3.2 Wind pressure on the building

Wind pressures on the surfaces of the building depend on the wind classification, width of building and roof pitch. Tables 8.1 to 8.5 give pressures depending on these variables.

Pressures are given for single storey and upper storey of two storeys for both long and short sides of the building, and lower storey of two storeys or subfloor for both long and short sides of the building.

8.3.3 Area of elevation

The wind direction used shall be that resulting in the greatest load for the length and width of the building, respectively. As wind can blow from any direction, the elevation used shall be that for the worst direction. In the case of a single storey house having a gable at one end and a hip at the other, the gable end facing the wind will result in a greater amount of load at right angles to the width of the house than the hip end facing the wind.

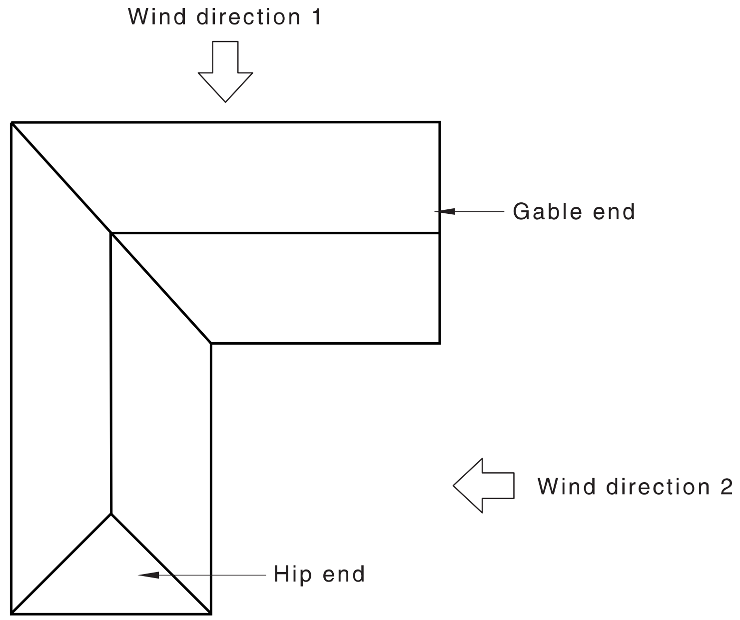
For complex building shapes, buildings that are composed of a combination of storeys or rectangles (i.e. L, H or U shapes), the shapes may be considered individually and added together later or the total area as a whole can be calculated. Irrespective of which method is used, bracing shall be calculated to address the most adverse situation. Bracing shall be distributed throughout the house approximately in proportion to the forces (or areas) relevant to each shape, see Clause 8.3.6.6.

If a verandah or similar structure is present and is to be enclosed, it shall be included in the "area of elevation" calculations.

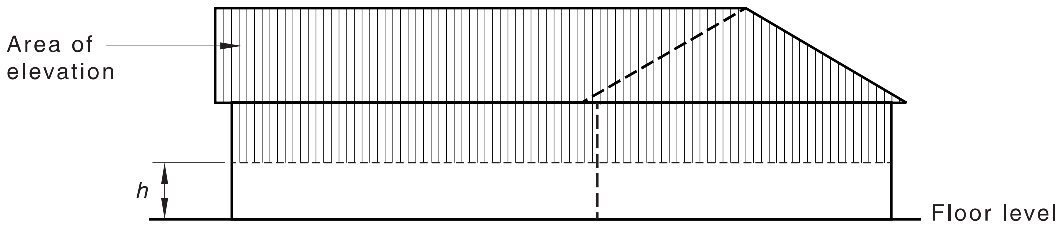
Where there is more than one floor level in a building, each level shall be considered separately for the purpose of calculating the minimum bracing required.

Determination of the area of elevation shall be as shown in Figures 8.2(A), 8.2(B) and 8.2(C). .Regarding Figure 8.2(B), in the subfloor of a two-storey construction, the maximum distance (*H*) from the ground to the underside of the bearer in the lower floor shall be 1 800 mm.

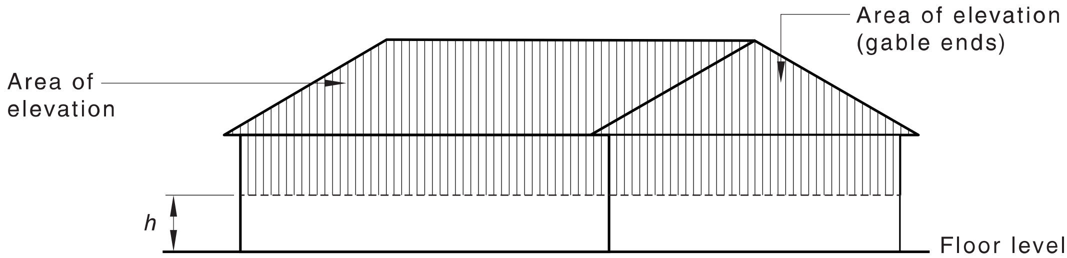
Bracing shall be evenly distributed, as specified in Clauses 8.3.6.6 and 8.3.6.7.



(a) Plan



(b) Wind direction 1



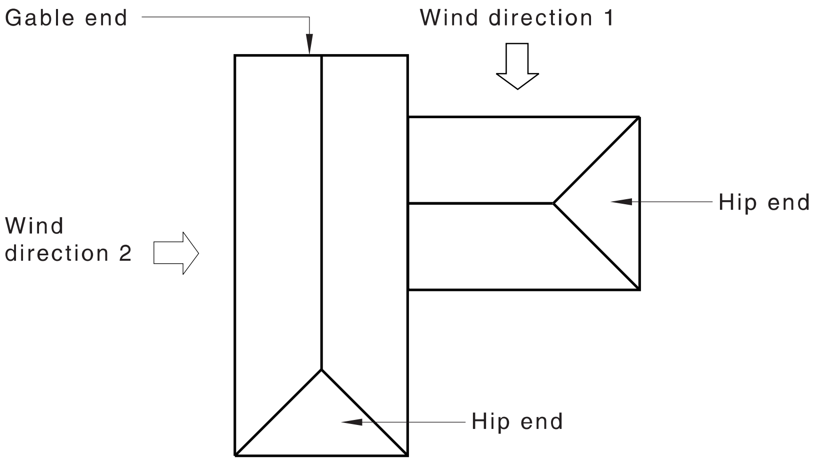
(c) Wind direction 2

NOTE 1 *h* = half the height of the wall (half of the floor to ceiling height).

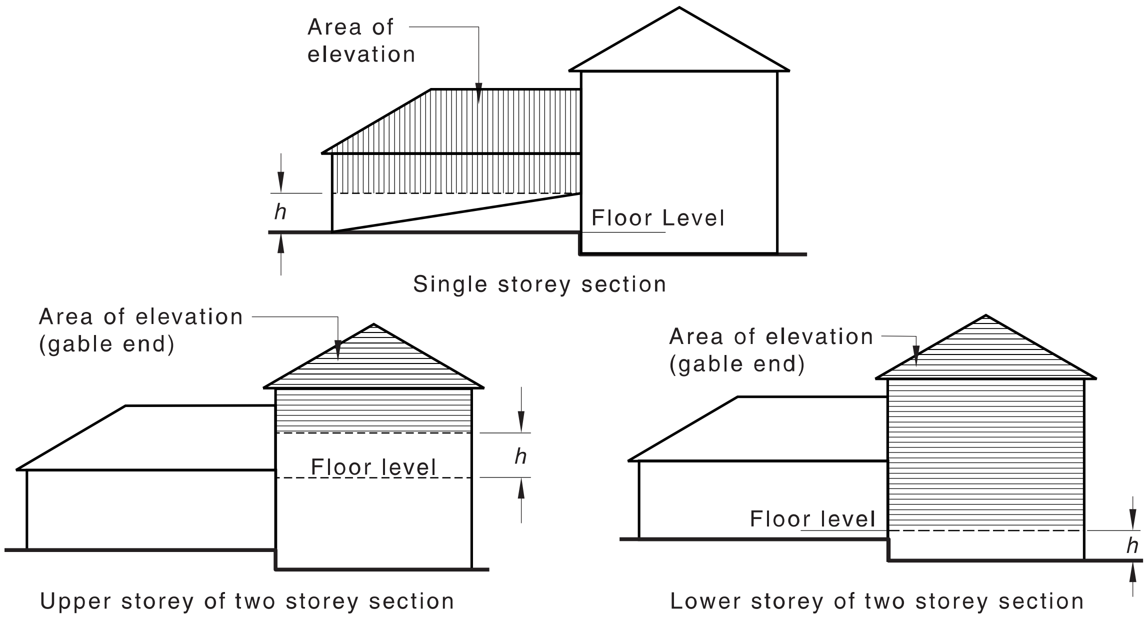
NOTE 2 For wind direction 2, the pressure on the gable end is determined from Table 8.1 and the pressure on the hip section of the elevation is determined from Table 8.2. The total of racking forces is the sum of the forces calculated for each section.

NOTE 3 The area of elevation of the triangular portion of eaves overhang up to 1 000 mm wide may be ignored in the determination of area of elevation.

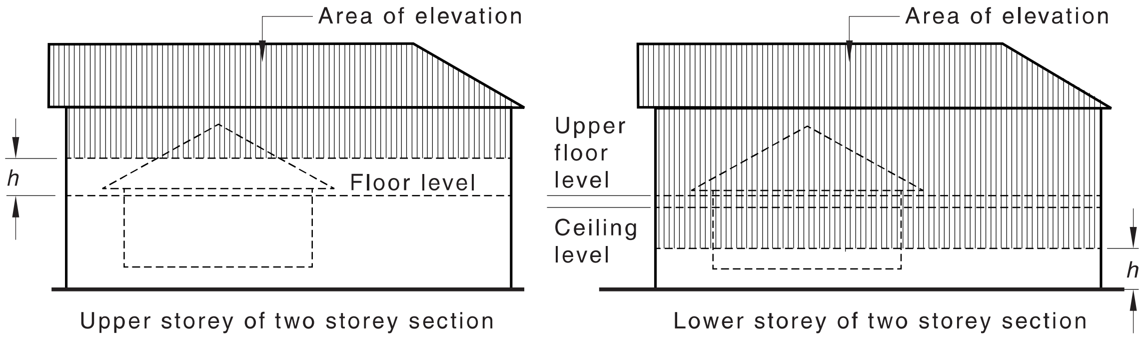
Figure 8.2(A) — Determining area of elevation — A single storey building



(a) Plan



(b) Wind direction 1



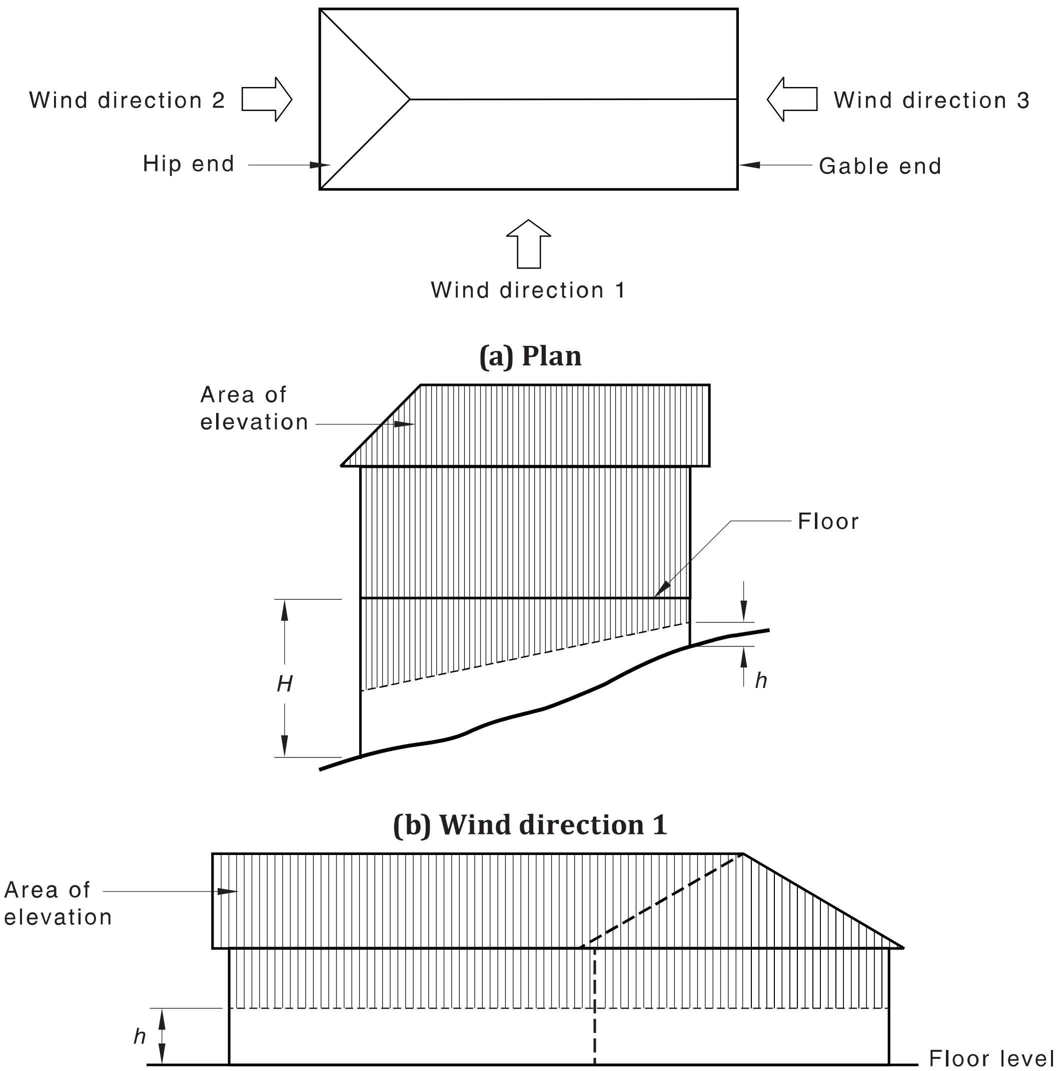
(c) Wind direction 2

NOTE 1 *h* = half the height of the wall (half of the floor to ceiling height).

NOTE 2 For lower storey of two storey section, *h* = half the height of the lower storey, i.e. lower storey floor to lower storey ceiling.

NOTE 3 The area of elevation of the triangular portion of eaves overhang up to 1 000 mm wide may be ignored in the determination of area of elevation.

Figure 8.2(B) — Determining area of elevation — Two storey or split level building



NOTE 1 *h* = half the height from the ground to the lower storey floor.

NOTE 2 For houses on sloping ground, the area of elevation will vary depending upon the wind direction or elevation being considered. The racking force calculated for the worst case should be selected.

NOTE 3 The area of elevation of the triangular portion of eaves overhang up to 1 000 mm wide may be ignored in the determination of area of elevation.

Figure 8.2(C) — Determining area of elevation — Subfloors

8.3.4 Racking force

The racking force on the building shall be determined by using the method given in this Clause or by using the alternative method given in Appendix F.

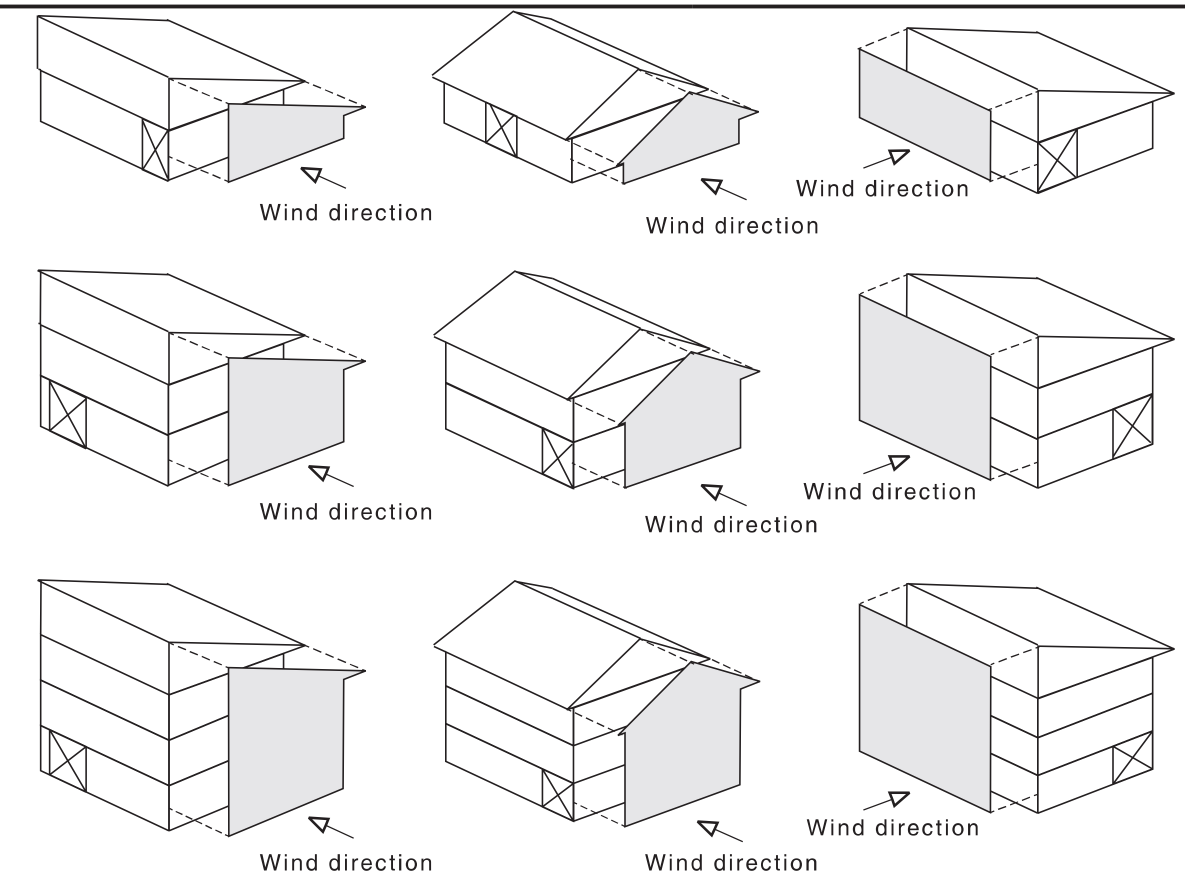
NOTE Appendix F provides a simplified procedure that may lead to a more conservative solution.

The total racking force for each storey or level of the building shall be the product of the projected area of elevation of the building multiplied by the lateral wind pressure determined from Tables 8.1 to 8.5. The racking force shall be calculated for both directions (long and short sides) of the building.

The total racking force, in kN, shall be calculated as follows:

Total racking force = Area of elevation (m^2) × Lateral wind pressure (kPa)

Table 8.1 — Pressure (kPa) on area of elevation (m^2) — Single storey, upper of two storeys, lower storey or subfloor of single storey or two storeys — All vertical surface elevations (gable ends, skillion ends and flat wall surfaces)



Wind classification	Pressure, kPa
N1	0.67
N2	0.92
N3	1.4
N4	2.1

Table 8.2 — Pressure (kPa) on area of elevation (m^2) — Single storey or upper storey of two storeys — Long length of building — Hip or gable ends

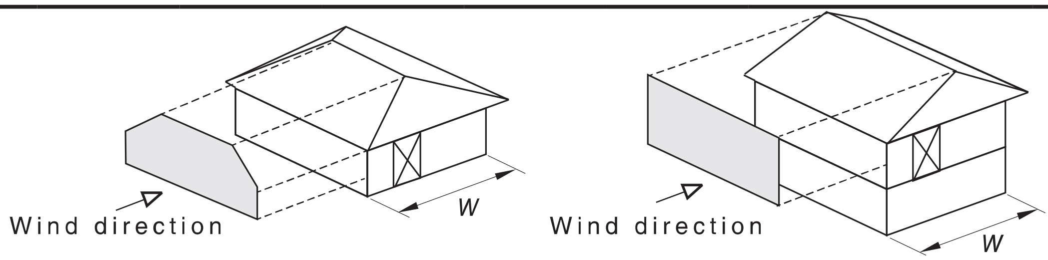


Table 8.2 *(continued)*

W, m	Roof pitch, degrees							
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
N1								
4.0	0.61	0.53	0.48	0.44	0.44	0.52	0.56	0.55
5.0	0.61	0.52	0.46	0.41	0.42	0.50	0.54	0.53
6.0	0.61	0.50	0.44	0.39	0.42	0.50	0.53	0.54
7.0	0.61	0.49	0.42	0.38	0.43	0.51	0.53	0.54
8.0	0.61	0.47	0.40	0.37	0.43	0.51	0.52	0.54
9.0	0.61	0.46	0.39	0.36	0.44	0.52	0.51	0.54
10.0	0.61	0.45	0.38	0.35	0.44	0.52	0.51	0.54
11.0	0.61	0.44	0.36	0.35	0.45	0.52	0.51	0.55
12.0	0.61	0.42	0.34	0.35	0.45	0.52	0.51	0.55
13.0	0.61	0.41	0.33	0.36	0.46	0.52	0.52	0.55
14.0	0.61	0.40	0.31	0.36	0.46	0.53	0.52	0.56
15.0	0.61	0.39	0.30	0.36	0.47	0.53	0.52	0.56
16.0	0.61	0.39	0.29	0.37	0.47	0.53	0.52	0.56
N2								
4.0	0.84	0.74	0.67	0.61	0.61	0.72	0.77	0.76
5.0	0.84	0.71	0.64	0.57	0.58	0.69	0.75	0.74
6.0	0.84	0.69	0.61	0.55	0.59	0.70	0.74	0.74
7.0	0.84	0.67	0.58	0.53	0.59	0.70	0.73	0.74
8.0	0.84	0.65	0.56	0.51	0.60	0.71	0.72	0.75
9.0	0.84	0.64	0.54	0.49	0.61	0.71	0.71	0.75
10.0	0.84	0.62	0.52	0.48	0.61	0.72	0.70	0.75
11.0	0.84	0.60	0.50	0.48	0.62	0.72	0.71	0.75
12.0	0.84	0.59	0.47	0.49	0.63	0.72	0.71	0.76
13.0	0.84	0.57	0.45	0.49	0.63	0.73	0.71	0.77
14.0	0.84	0.56	0.43	0.50	0.64	0.73	0.72	0.77
15.0	0.84	0.55	0.42	0.50	0.65	0.73	0.72	0.77
16.0	0.84	0.53	0.40	0.51	0.65	0.73	0.72	0.78
N3								
4.0	1.3	1.2	1.0	0.95	0.96	1.1	1.2	1.2
5.0	1.3	1.1	1.00	0.89	0.91	1.1	1.2	1.2
6.0	1.3	1.1	0.95	0.85	0.91	1.1	1.2	1.2
7.0	1.3	1.1	0.91	0.82	0.93	1.1	1.1	1.2
8.0	1.3	1.0	0.88	0.79	0.94	1.1	1.1	1.2
9.0	1.3	0.99	0.84	0.77	0.95	1.1	1.1	1.2
10.0	1.3	0.97	0.81	0.75	0.95	1.1	1.1	1.2
11.0	1.3	0.94	0.78	0.75	0.97	1.1	1.1	1.2
12.0	1.3	0.92	0.74	0.76	0.98	1.1	1.1	1.2
13.0	1.3	0.90	0.71	0.77	0.99	1.1	1.1	1.2
14.0	1.3	0.87	0.68	0.78	1.0	1.1	1.1	1.2
15.0	1.3	0.85	0.65	0.79	1.0	1.1	1.1	1.2
16.0	1.3	0.83	0.62	0.79	1.0	1.1	1.1	1.2
N4								

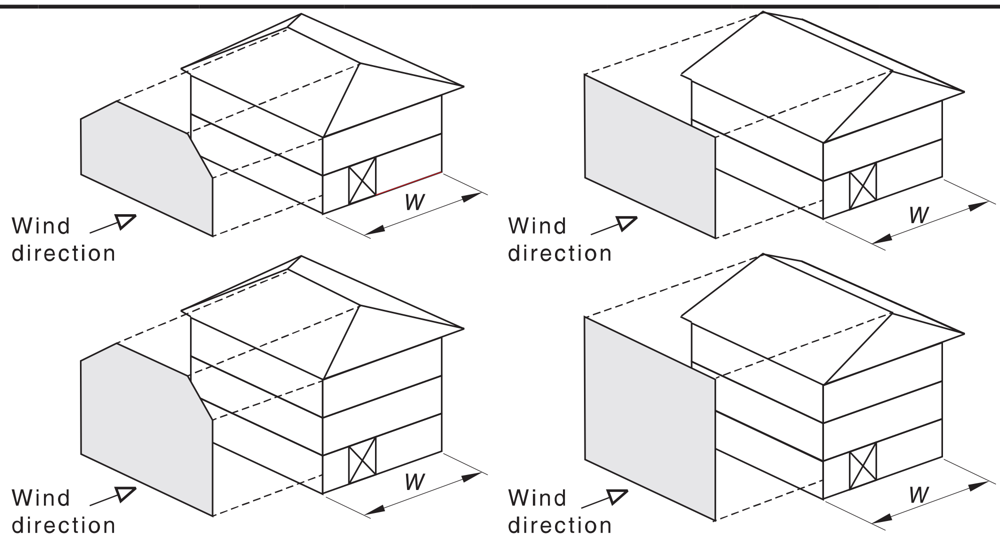
Table 8.2 *(continued)*

4.0	2.0	1.7	1.6	1.4	1.4	1.7	1.8	1.8
5.0	2.0	1.7	1.5	1.3	1.3	1.6	1.8	1.7
6.0	2.0	1.6	1.4	1.3	1.4	1.6	1.7	1.7
7.0	2.0	1.6	1.4	1.2	1.4	1.6	1.7	1.7
8.0	2.0	1.5	1.3	1.2	1.4	1.6	1.7	1.7
9.0	2.0	1.5	1.3	1.1	1.4	1.7	1.7	1.7
10.0	2.0	1.4	1.2	1.1	1.4	1.7	1.6	1.7
11.0	2.0	1.4	1.2	1.1	1.4	1.7	1.6	1.8
12.0	2.0	1.4	1.1	1.1	1.5	1.7	1.7	1.8
13.0	2.0	1.3	1.1	1.1	1.5	1.7	1.7	1.8
14.0	2.0	1.3	1.0	1.2	1.5	1.7	1.7	1.8
15.0	2.0	1.3	0.97	1.2	1.5	1.7	1.7	1.8
16.0	2.0	1.2	0.93	1.2	1.5	1.7	1.7	1.8

NOTE 1 0° pitch is provided for interpolation purposes only.

NOTE 2 See Figure 1.2 for guidance on determining *W*.

Table 8.3 — Pressure (kPa) on area of elevation (m²) — Lower storey or subfloor of single storey or two storeys — Long length of building — Hip or gable ends



W, m	Roof pitch, degrees							
	0	5	10	15	20	25	30	35
N1								
4.0	0.61	0.58	0.56	0.54	0.54	0.60	0.62	0.61
5.0	0.61	0.58	0.55	0.53	0.53	0.59	0.61	0.60
6.0	0.61	0.57	0.54	0.52	0.52	0.59	0.60	0.59
7.0	0.61	0.57	0.53	0.51	0.52	0.59	0.59	0.59
8.0	0.61	0.56	0.53	0.50	0.52	0.58	0.58	0.59
9.0	0.61	0.55	0.52	0.49	0.52	0.58	0.58	0.59
10.0	0.61	0.55	0.51	0.48	0.52	0.58	0.57	0.59
11.0	0.61	0.54	0.50	0.48	0.52	0.58	0.57	0.59
12.0	0.61	0.54	0.49	0.48	0.52	0.58	0.57	0.59
13.0	0.61	0.53	0.48	0.48	0.52	0.58	0.57	0.59

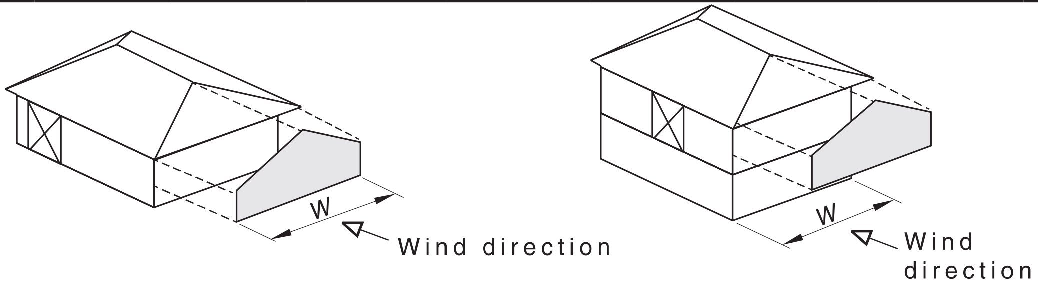
Table 8.3 *(continued)*

14.0	0.61	0.53	0.47	0.48	0.52	0.58	0.57	0.59
15.0	0.61	0.52	0.46	0.48	0.53	0.58	0.57	0.59
16.0	0.61	0.52	0.45	0.48	0.53	0.58	0.57	0.59
N2								
4.0	0.84	0.81	0.78	0.75	0.75	0.83	0.85	0.84
5.0	0.84	0.80	0.77	0.73	0.73	0.82	0.84	0.83
6.0	0.84	0.79	0.75	0.72	0.73	0.81	0.83	0.82
7.0	0.84	0.78	0.74	0.70	0.72	0.81	0.82	0.82
8.0	0.84	0.78	0.73	0.69	0.72	0.81	0.81	0.82
9.0	0.84	0.77	0.71	0.68	0.72	0.81	0.80	0.81
10.0	0.84	0.76	0.70	0.67	0.72	0.81	0.79	0.81
11.0	0.84	0.75	0.69	0.66	0.72	0.80	0.79	0.81
12.0	0.84	0.74	0.68	0.66	0.72	0.80	0.79	0.81
13.0	0.84	0.74	0.66	0.66	0.72	0.80	0.79	0.82
14.0	0.84	0.73	0.65	0.66	0.73	0.80	0.79	0.82
15.0	0.84	0.72	0.64	0.66	0.73	0.80	0.79	0.82
16.0	0.84	0.72	0.63	0.66	0.73	0.80	0.79	0.82
N3								
4.0	1.3	1.3	1.2	1.2	1.2	1.3	1.3	1.3
5.0	1.3	1.2	1.2	1.1	1.1	1.3	1.3	1.3
6.0	1.3	1.2	1.2	1.1	1.1	1.3	1.3	1.3
7.0	1.3	1.2	1.2	1.1	1.1	1.3	1.3	1.3
8.0	1.3	1.2	1.1	1.1	1.1	1.3	1.3	1.3
9.0	1.3	1.2	1.1	1.1	1.1	1.3	1.2	1.3
10.0	1.3	1.2	1.1	1.0	1.1	1.3	1.2	1.3
11.0	1.3	1.2	1.1	1.0	1.1	1.3	1.2	1.3
12.0	1.3	1.2	1.1	1.0	1.1	1.3	1.2	1.3
13.0	1.3	1.2	1.0	1.0	1.1	1.3	1.2	1.3
14.0	1.3	1.1	1.0	1.0	1.1	1.3	1.2	1.3
15.0	1.3	1.1	1.0	1.0	1.1	1.2	1.2	1.3
16.0	1.3	1.1	0.98	1.0	1.1	1.2	1.2	1.3
N4								
4.0	2.0	1.9	1.8	1.7	1.7	1.9	2.0	2.0
5.0	2.0	1.9	1.8	1.7	1.7	1.9	2.0	1.9
6.0	2.0	1.8	1.8	1.7	1.7	1.9	1.9	1.9
7.0	2.0	1.8	1.7	1.6	1.7	1.9	1.9	1.9
8.0	2.0	1.8	1.7	1.6	1.7	1.9	1.9	1.9
9.0	2.0	1.8	1.7	1.6	1.7	1.9	1.9	1.9
10.0	2.0	1.8	1.6	1.6	1.7	1.9	1.9	1.9
11.0	2.0	1.7	1.6	1.5	1.7	1.9	1.9	1.9
12.0	2.0	1.7	1.6	1.5	1.7	1.9	1.9	1.9
13.0	2.0	1.7	1.5	1.5	1.7	1.9	1.9	1.9
14.0	2.0	1.7	1.5	1.5	1.7	1.9	1.9	1.9
15.0	2.0	1.7	1.5	1.5	1.7	1.9	1.9	1.9
16.0	2.0	1.7	1.5	1.5	1.7	1.9	1.9	1.9

Table 8.3 *(continued)*

NOTE 1	0° pitch is provided for interpolation purposes only.
NOTE 2	See Figure 1.2 for guidance on determining *W*.

Table 8.4 — Pressure (kPa) on area of elevation (m²) — Single storey or upper of two storeys — Short end of building — Hip ends



W, m	Roof pitch, degrees							
	0	5	10	15	20	25	30	35
N1								
4.0	0.67	0.62	0.59	0.55	0.55	0.57	0.59	0.58
5.0	0.67	0.61	0.57	0.53	0.53	0.56	0.58	0.57
6.0	0.67	0.60	0.56	0.52	0.53	0.56	0.57	0.57
7.0	0.67	0.59	0.54	0.50	0.52	0.56	0.56	0.57
8.0	0.67	0.58	0.53	0.49	0.52	0.56	0.56	0.57
9.0	0.67	0.57	0.51	0.48	0.52	0.56	0.55	0.57
10.0	0.67	0.56	0.50	0.47	0.52	0.56	0.54	0.57
11.0	0.67	0.55	0.49	0.46	0.52	0.56	0.54	0.57
12.0	0.67	0.55	0.47	0.46	0.52	0.56	0.54	0.57
13.0	0.67	0.54	0.46	0.46	0.52	0.56	0.55	0.57
14.0	0.67	0.53	0.45	0.46	0.53	0.56	0.55	0.57
15.0	0.67	0.52	0.44	0.46	0.53	0.56	0.55	0.58
16.0	0.67	0.52	0.43	0.46	0.53	0.56	0.55	0.58
N2								
4.0	0.92	0.86	0.81	0.77	0.76	0.79	0.82	0.81
5.0	0.92	0.84	0.79	0.74	0.73	0.77	0.81	0.79
6.0	0.92	0.83	0.77	0.72	0.73	0.77	0.79	0.79
7.0	0.92	0.82	0.75	0.70	0.73	0.77	0.78	0.79
8.0	0.92	0.80	0.73	0.68	0.72	0.77	0.77	0.79
9.0	0.92	0.79	0.71	0.66	0.72	0.77	0.76	0.79
10.0	0.92	0.78	0.69	0.65	0.72	0.77	0.75	0.78
11.0	0.92	0.77	0.68	0.64	0.72	0.77	0.75	0.79
12.0	0.92	0.76	0.66	0.64	0.72	0.77	0.75	0.79
13.0	0.92	0.75	0.64	0.64	0.73	0.77	0.75	0.79
14.0	0.92	0.73	0.62	0.64	0.73	0.77	0.76	0.79
15.0	0.92	0.72	0.60	0.64	0.73	0.77	0.76	0.80
16.0	0.92	0.71	0.59	0.64	0.73	0.77	0.76	0.80
N3								
4.0	1.4	1.3	1.3	1.2	1.2	1.2	1.3	1.3

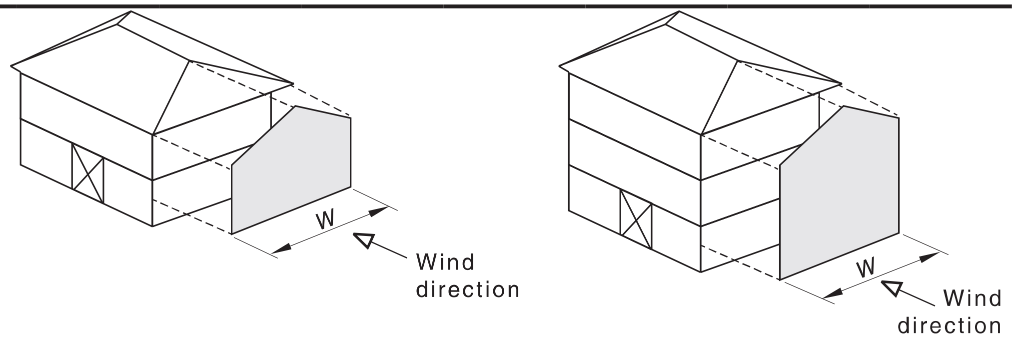
Table 8.4 *(continued)*

5.0	1.4	1.3	1.2	1.2	1.1	1.2	1.3	1.2
6.0	1.4	1.3	1.2	1.1	1.1	1.2	1.2	1.2
7.0	1.4	1.3	1.2	1.1	1.1	1.2	1.2	1.2
8.0	1.4	1.3	1.1	1.1	1.1	1.2	1.2	1.2
9.0	1.4	1.2	1.1	1.0	1.1	1.2	1.2	1.2
10.0	1.4	1.2	1.1	1.0	1.1	1.2	1.2	1.2
11.0	1.4	1.2	1.1	1.0	1.1	1.2	1.2	1.2
12.0	1.4	1.2	1.0	1.0	1.1	1.2	1.2	1.2
13.0	1.4	1.2	1.0	1.0	1.1	1.2	1.2	1.2
14.0	1.4	1.1	0.97	1.0	1.1	1.2	1.2	1.2
15.0	1.4	1.1	0.94	1.0	1.1	1.2	1.2	1.2
16.0	1.4	1.1	0.92	1.0	1.1	1.2	1.2	1.2
N4								
4.0	2.1	2.0	1.9	1.8	1.8	1.8	1.9	1.9
5.0	2.1	2.0	1.8	1.7	1.7	1.8	1.9	1.8
6.0	2.1	1.9	1.8	1.7	1.7	1.8	1.8	1.8
7.0	2.1	1.9	1.7	1.6	1.7	1.8	1.8	1.8
8.0	2.1	1.9	1.7	1.6	1.7	1.8	1.8	1.8
9.0	2.1	1.8	1.7	1.5	1.7	1.8	1.8	1.8
10.0	2.1	1.8	1.6	1.5	1.7	1.8	1.8	1.8
11.0	2.1	1.8	1.6	1.5	1.7	1.8	1.8	1.8
12.0	2.1	1.8	1.5	1.5	1.7	1.8	1.8	1.8
13.0	2.1	1.7	1.5	1.5	1.7	1.8	1.8	1.8
14.0	2.1	1.7	1.4	1.5	1.7	1.8	1.8	1.8
15.0	2.1	1.7	1.4	1.5	1.7	1.8	1.8	1.9
16.0	2.1	1.7	1.4	1.5	1.7	1.8	1.8	1.9

NOTE 1 0° pitch is provided for interpolation purposes only.

NOTE 2 See Figure 1.2 for guidance on determining *W*.

Table 8.5 — Pressure (kPa) on area of elevation (m²) — Lower storey or subfloor of single storey or two storeys — Short end of building — Hip ends



W, m	Roof pitch, degrees							
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
N1								
4.0	0.67	0.65	0.64	0.63	0.62	0.63	0.64	0.63
5.0	0.67	0.65	0.63	0.62	0.61	0.62	0.63	0.63

Table 8.5 *(continued)*

6.0	0.67	0.64	0.63	0.61	0.61	0.62	0.63	0.62
7.0	0.67	0.64	0.62	0.60	0.61	0.62	0.62	0.62
8.0	0.67	0.64	0.62	0.60	0.61	0.62	0.62	0.62
9.0	0.67	0.63	0.61	0.59	0.60	0.61	0.61	0.62
10.0	0.67	0.63	0.60	0.58	0.60	0.61	0.61	0.61
11.0	0.67	0.63	0.60	0.58	0.60	0.61	0.60	0.61
12.0	0.67	0.62	0.59	0.58	0.60	0.61	0.60	0.61
13.0	0.67	0.62	0.58	0.58	0.60	0.61	0.60	0.61
14.0	0.67	0.62	0.58	0.58	0.60	0.61	0.60	0.61
15.0	0.67	0.61	0.57	0.57	0.60	0.61	0.60	0.61
16.0	0.67	0.61	0.57	0.57	0.60	0.61	0.60	0.61
N2								
4.0	0.92	0.90	0.89	0.87	0.86	0.87	0.88	0.87
5.0	0.92	0.90	0.88	0.85	0.85	0.86	0.87	0.87
6.0	0.92	0.89	0.87	0.84	0.85	0.86	0.87	0.86
7.0	0.92	0.89	0.86	0.84	0.84	0.86	0.86	0.86
8.0	0.92	0.88	0.85	0.83	0.84	0.85	0.85	0.86
9.0	0.92	0.88	0.84	0.82	0.84	0.85	0.84	0.85
10.0	0.92	0.87	0.84	0.81	0.83	0.85	0.84	0.85
11.0	0.92	0.87	0.83	0.80	0.83	0.85	0.84	0.85
12.0	0.92	0.86	0.82	0.80	0.83	0.85	0.83	0.85
13.0	0.92	0.86	0.81	0.80	0.83	0.84	0.83	0.85
14.0	0.92	0.85	0.80	0.80	0.83	0.84	0.83	0.85
15.0	0.92	0.85	0.79	0.79	0.83	0.84	0.83	0.85
16.0	0.92	085	0.78	0.79	0.83	0.84	0.83	0.85
N3								
4.0	1.4	1.4	1.4	1.4	1.3	1.4	1.4	1.4
5.0	1.4	1.4	1.4	1.3	1.3	1.3	1.4	1.3
6.0	1.4	1.4	1.4	1.3	1.3	1.3	1.4	1.3
7.0	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3
8.0	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3
9.0	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3
10.0	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3
11.0	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3
12.0	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3
13.0	1.4	1.3	1.3	1.2	1.3	1.3	1.3	1.3
14.0	1.4	1.3	1.3	1.2	1.3	1.3	1.3	1.3
15.0	1.4	1.3	1.2	1.2	1.3	1.3	1.3	1.3
16.0	1.4	1.3	1.2	1.2	1.3	1.3	1.3	1.3
N4								
4.0	2.1	2.1	2.1	2.0	2.0	2.0	2.1	2.0
5.0	2.1	2.1	2.0	2.0	2.0	2.0	2.0	2.0
6.0	2.1	2.1	2.0	2.0	2.0	2.0	2.0	2.0
7.0	2.1	2.1	2.0	1.9	2.0	2.0	2.0	2.0
8.0	2.1	2.1	2.0	1.9	2.0	2.0	2.0	2.0

Table 8.5 *(continued)*

9.0	2.1	2.0	2.0	1.9	1.9	2.0	2.0	2.0
10.0	2.1	2.0	1.9	1.9	1.9	2.0	2.0	2.0
11.0	2.1	2.0	1.9	1.9	1.9	2.0	1.9	2.0
12.0	2.1	2.0	1.9	1.9	1.9	2.0	1.9	2.0
13.0	2.1	2.0	1.9	1.9	1.9	2.0	1.9	2.0
14.0	2.1	2.0	1.9	1.9	1.9	2.0	1.9	2.0
15.0	2.1	2.0	1.8	1.8	1.9	2.0	1.9	2.0
16.0	2.1	2.0	1.8	1.8	1.9	2.0	1.9	2.0

NOTE 1 0° pitch is provided for interpolation purposes only.

NOTE 2 See Figure 1.2 for guidance on determining *W*.

8.3.5 Subfloor bracing

8.3.5.1 General

All lateral loads (wind, earthquake and similar loads) shall be resisted by the foundations (ground) of the building. Roof and wall bracing is designed to transfer these loads to the floor plane. Below the floor, the subfloor support structure shall be designed to transfer these loads to the footings.

Elevated floors require subfloor bracing, i.e. cantilevered stumps or columns, cross-bracing or masonry supports or a combination of wall and subfloor bracing. Slab-on-ground construction requires no consideration.

8.3.5.2 Braced and cantilevered timber or concrete stumps

There are two types of stump arrangements — braced or cantilevered stumps. Braced stumps have lateral support provided by cross-bracing, and cantilevered stumps allow the lateral forces to be resisted by the foundations.

The stump may be either of timber or concrete and placed into either a concrete or soil backfill.

The following shall apply:

(a) *Stumps backfilled with concrete* — Stumps shall be backfilled with a concrete mix of minimum N20 grade with a maximum 20 mm nominal aggregate size.

(b) *Stumps backfilled with soil* — Stumps shall be placed centrally onto a concrete pad. The minimum thickness of the pad shall be 200 mm thick with not less than 150 mm of concrete below the end of the stump. Concrete for the pad shall be N20 grade, using 20 mm nominal maximum size aggregate.

Soil to be used for backfill shall be free of rock and vegetable matter. Loose sand shall not be used as backfill. The soil shall be compacted in depths of no more than 300 mm, with each layer rammed with a rod or mechanical compacting equipment.

8.3.5.3 Soil classification reduction factor

The bracing capacities given in Tables 8.7 to 8.13 are based on soil classifications A, S and M. When other soil classifications are found, the capacity shall be reduced by multiplying the values in these tables by the load capacity reduction factor given in Table 8.6.

Tables 8.7 to 8.13 are based on nil or minimal net uplift on supports and are suitable for wind classifications up to N3. For wind classification N4, the values in the tables shall be modified in accordance with AS 2870.

Table 8.6 — Load capacity reduction factor for other soil classifications for wind classifications up to N3

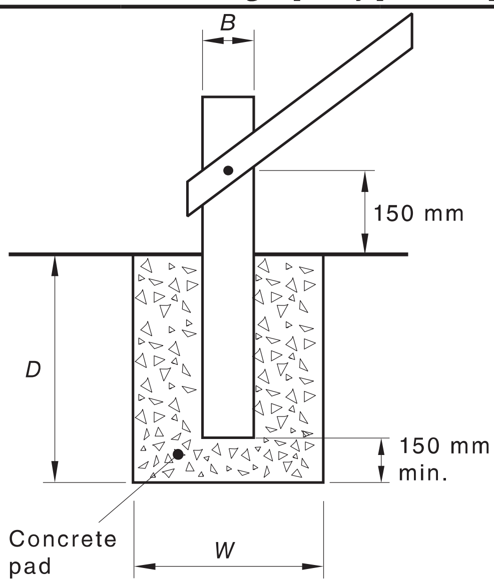
Soil classification	Lateral load capacity reduction factor
Classes M-D and H	0.8

8.3.5.4 Braced timber stumps

Braced timber stumps utilize either steel or timber cross-bracing to achieve racking capacity. The lateral capacity of the individual stumps is not taken into account.

The stumps shall be set into a pier hole, which may be backfilled with either soil or concrete. Tables 8.7 and 8.8 give the bracing capacity of concrete and soil-backfilled stumps respectively. The specific details of the method of attachment and the strength of the braces shall be in accordance with Clause 8.3.5.5 and Table 8.9.

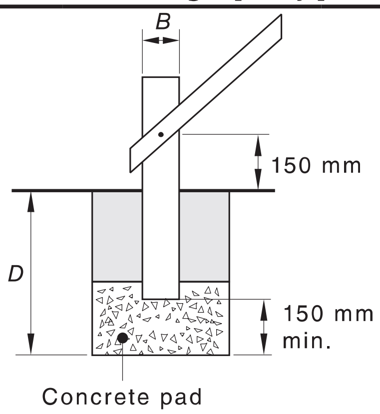
Table 8.7 — Bracing capacity of a diagonally braced stump in concrete backfill — soil classifications A, S and M — Wind classifications up to N3



Concrete pier diameter (*W*), mm	Concrete depth (*D*), mm			
	400	600	800	1 000
	Bracing capacity per stump (*H*), kN			
250	6.0	10	15	19
300	7.2	12	18	23
350	8.4	14	21	27
400	9.6	16	23	31
450	11	19	26	35

NOTE Footing size needs also to be assessed for bearing, see Clause 3.6.

Table 8.8 — Bracing load capacity of a diagonally braced stump in soil backfill — soil classifications A, S and M — Wind classifications up to N3



Stump diameter (*B*), mm	Depth of stump into ground (*D*), mm			
	400	600	800	1 000
	Bracing capacity per stump (*H*), kN			
100	3.3	5.4	7.7	9.9
125	4.1	6.8	9.5	12
150	5.0	8.1	11	15
200	6.6	11	15	20

NOTE Footing size needs also to be assessed for bearing, see Clause 3.6.

8.3.5.5 Timber braces on concrete, masonry or timber columns

The size, connection and bracing of crossed diagonal timber braces attached to concrete, masonry or timber columns shall be determined from Table 8.9 and Figure 8.3.

The size of timber columns shall be determined from Span Table 53 given in the Supplements.

Table 8.9 — Timber braces on concrete, masonry or timber columns

Column type	Brace and bearer to column connection	Brace to column connection	Bracing capacity, kN
Timber columns min. 90 mm × 90 mm	90 mm × 45 mm F11 or better over 3 columns or 140 mm × 45 mm F11 or better over 2 columns	4/No. 14 Type 17 screws	13
Concrete/masonry or timber column min. 90 mm × 90 mm	90 mm × 45 mm F11 or better over 3 columns or 140 mm × 45 mm F11 or better over 2 columns Bearers fixed to columns with 1/M12 or 2/M10 bolts	1/M16 bolt	15
Timber columns only, min. 120 mm × 120 mm or 150 mm diameter	170 mm × 45 mm F11 or better braces over 2 or 3 columns. Bearers fixed to columns with 1/M16 or 2/M12 bolts	1/M20 bolt	22

NOTE Alternate bearer to column connections of equivalent shear capacity to the bracing capacity of the braced set may be obtained from Table 9.28. The shear capacity of the set may be equally distributed over the number of columns in the set.

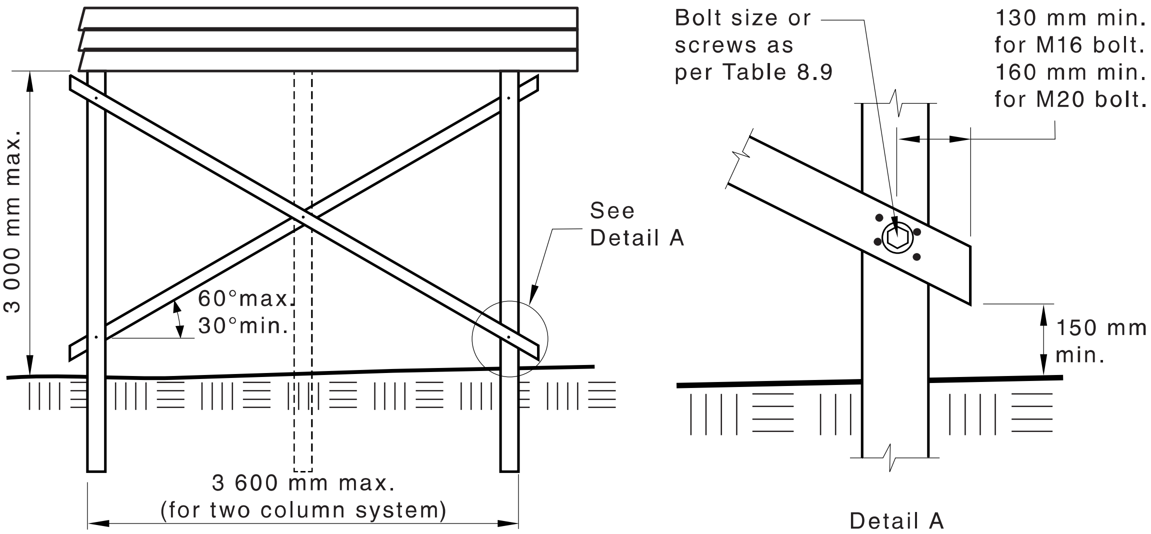


Figure 8.3 — Timber braces on masonry or timber columns

8.3.5.6 Cantilevered stumps in concrete or soil backfill

Table 8.10 gives the bracing capacities of the footings for timber or concrete stumps encased in concrete backfill. Tables 8.11 to 8.13 give the bracing capacities of the footings for timber or concrete stumps encased in soil backfill. The soil classifications for these Tables are based on Classes A, S and M. The reduction factor for other soil classifications given in Table 8.6 shall be applied to these Tables.

Tables 8.10 to 8.13 are suitable for wind classification up to N3 where no uplift occurs. For wind classification N4, refer to AS 2870.

The maximum bracing capacity of timber stumps inserted in the footings given in Tables 8.10 to 8.13 shall not exceed the values given in Table 8.14 for the relevant footing depth or timber size. The minimum stress grade of timber stumps derived from Table 8.14 shall be F8.

The lateral capacity or size of timber stumps shall be determined from Table 8.14.

The footing size shall also be assessed for bearing, see Clause 3.6.

All cantilevered timber stumps with bracing capacities of 7.5 kN or greater shall be fixed to bearers with structural connections having a shear capacity equivalent to the bracing capacity of that stump.

NOTE Shear capacities of stump to bearer connections are given in Table 9.28.

Table 8.10 — Bracing capacity — Cantilevered stumps in concrete backfill — soil classifications A, S and M — Wind classifications up to N3

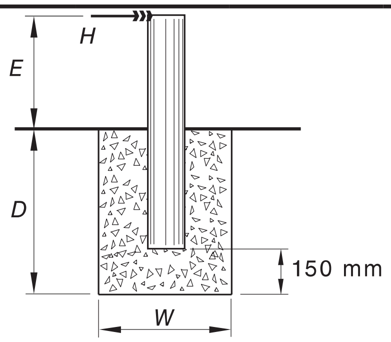


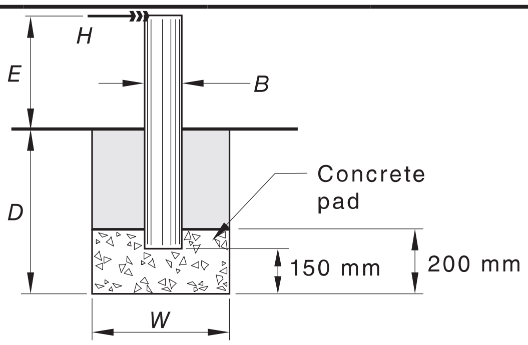
Table 8.10 *(continued)*

Height above footing (*E*), mm	Pier depth (*D*), mm	Bracing capacity (*H*), kN					
		Pier diameter (*W*), mm					
		250	300	350	400	450	600
200	400	1.9	2.3	2.6	3.0	3.4	4.5
	600	4.0	4.8	5.6	6.4	7.2	9.6
	800	6.5	7.8	9.1	10	12	16
	1 000	9.5	11	13	15	17	23
	1 200	13	15	18	21	23	31
	1 400	16	19	23	26	29	39
400	400	1.3	1.6	1.8	2.1	2.4	3.2
	600	3.0	3.6	4.2	4.8	5.4	7.2
	800	5.1	6.1	7.1	8.2	9.2	12
	1 000	7.7	9.2	11	12	14	18
	1 200	11	13	15	17	19	26
	1 400	14	17	19	22	25	33
600	400	1.0	1.2	1.4	1.6	1.8	2.4
	600	2.4	2.9	3.3	3.8	4.3	5.7
	800	4.2	5.0	5.9	6.7	7.5	10
	1 000	6.5	7.8	9.1	10	11	16
	1 200	9.2	11	13	15	17	22
	1 400	12	14	15	19	22	29
800	400	0.8	1.0	1.1	1.3	1.5	2.0
	600	2.0	2.4	2.8	3.2	3.6	4.8
	800	3.6	4.3	5.0	5.7	6.4	8.6
	1 000	5.6	6.7	7.8	9.0	10	13
	1 200	8.1	9.7	11	13	15	19
	1 400	11	13	15	17	19	25
1 000	400	0.7	0.8	1.0	1.1	1.2	1.7
	600	1.7	2.1	2.4	2.7	3.1	4.1
	800	3.1	3.7	4.3	5.0	5.6	7.4
	1 000	4.9	5.9	6.9	7.9	8.9	12
	1 200	7.2	8.6	10	11	13	17
	1 400	9.5	11	13	15	17	23
1 200	400	0.6	0.7	0.8	1.0	1.1	1.4
	600	1.5	1.8	2.1	2.4	2.7	3.6
	800	2.7	3.3	3.8	4.4	4.9	6.6
	1 000	4.4	5.3	6.2	7.0	7.9	11
	1 200	6.5	7.8	9.1	10	12	15
	1 400	8.6	10	12	14	15	21
1 400	400	0.5	0.6	0.7	0.8	0.9	1.3
	600	1.3	1.6	1.9	2.1	2.4	3.2
	800	2.5	2.9	3.4	3.9	4.4	5.9
	1 000	4.0	4.8	5.6	6.4	7.1	9.5
	1 200	5.9	7.1	8.2	9.4	11	14
	1 400	7.9	9.5	11	13	14	19

Table 8.10 *(continued)*

1 600	400	0.4	0.8	0.6	0.7	0.8	1.1
	600	1.2	1.4	1.7	1.9	2.2	2.9
	800	2.2	2.7	3.1	3.6	4.0	5.3
	1 000	3.6	4.3	5.1	5.8	6.5	8.7
	1 200	5.4	6.5	7.6	8.6	9.7	13
	1 400	7.3	8.7	10	12	13	17
1 800	400	0.4	0.5	0.6	0.7	0.8	1.0
	600	1.1	1.3	1.5	1.7	2.0	2.6
	800	2.0	2.4	2.9	3.3	3.7	4.9
	1 000	3.3	4.0	4.7	5.3	6.0	8.0
	1 200	5.0	6.0	7.0	8.0	9.0	12
	1 400	6.7	8.1	9.4	11	12	16

Table 8.11 — Bracing capacity — Cantilevered stumps in soil backfill — Soil classifications A, S and M — Wind classifications up to N3



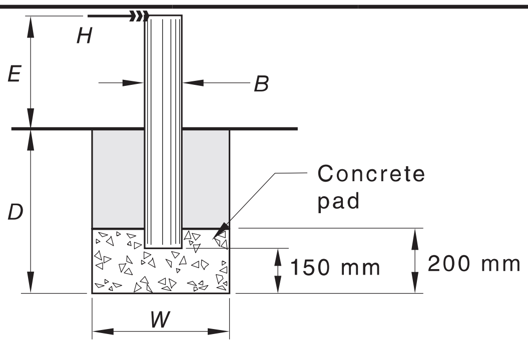
Concrete base support W = 300 mm.

Height above footing (*E*), mm	Stump depth (*D*), mm	Bracing capacity (*H*), kN				
		Stump thickness/diameter (*B*), mm				
		100	**125**	**150**	**200**	**250**
200	400	0.5	0.6	0.7	1.0	1.2
	600	1.4	1.7	2.1	2.8	2.8
	800	2.5	3.2	3.3	3.7	4.7
	1 000	3.8	3.9	4.6	6.2	7.7
	1 200	4.4	5.5	6.6	8.8	11
	1 400	5.6	7.1	8.5	11.3	14
400	400	0.3	0.4	0.5	0.7	0.9
	600	1.1	1.4	1.6	1.8	1.8
	800	2.1	2.4	2.4	2.8	3.6
	1 000	2.8	2.9	3.5	4.7	5.8
	1 200	3.4	4.3	5.2	6.9	8.6
	1 400	4.8	5.9	7.1	9.5	12

Table 8.11 *(continued)*

600	400	0.3	0.3	0.4	0.5	0.7
	600	0.9	1.1	1.4	1.4	1.4
	800	1.8	1.8	1.8	2.3	2.9
	1 000	2.3	2.4	2.9	3.9	4.8
	1 200	2.9	3.6	4.4	5.8	7.3
	1 400	4.1	5.1	6.1	8.2	10
800	400	0.2	0.3	0.3	0.4	0.5
	600	0.8	1.0	1.1	1.1	1.1
	800	1.5	1.5	1.5	1.9	2.4
	1 000	1.9	2.0	2.5	3.3	4.1
	1 200	2.5	3.2	3.8	5.1	6.3
	1 400	3.6	4.5	5.4	7.2	9.0
1 000	400	0.2	0.2	0.3	0.4	0.5
	600	0.7	0.8	0.9	0.9	0.9
	800	1.3	1.3	1.3	1.7	2.1
	1 000	1.7	1.8	2.2	2.9	3.6
	1 200	2.2	2.8	3.3	4.5	5.6
	1 400	3.2	4.0	4.8	6.4	8.0
1 200	400	0.2	0.2	0.2	0.3	0.4
	600	0.6	0.7	0.8	0.8	0.8
	800	1.1	1.1	1.1	1.5	1.8
	1 000	1.5	1.6	1.9	2.6	3.2
	1 200	2.0	2.5	3.0	4.0	5.0
	1 400	2.9	3.6	4.3	5.8	7.2
1 400	400	—	—	—	—	—
	600	0.5	0.7	0.7	0.7	0.7
	800	1.0	1.0	1.0	1.3	1.6
	1 000	1.3	1.4	1.7	2.3	2.9
	1 200	1.8	2.3	2.7	3.6	4.5
	1 400	2.6	3.3	3.9	5.3	6.6
1 600	400	—	—	—	—	—
	600	0.5	0.6	0.6	0.6	0.6
	800	0.9	0.9	0.9	1.2	1.5
	1 000	1.2	1.3	1.6	2.1	2.6
	1 200	1.6	2.1	2.5	3.3	4.1
	1 400	2.4	3.0	3.6	4.8	6.0
1 800	400	—	—	—	—	—
	600	0.4	0.5	0.5	0.5	0.6
	800	0.8	0.8	0.8	1.1	1.3
	1 000	1.0	1.1	1.4	1.9	2.4
	1 200	1.5	1.9	2.3	3.0	3.8
	1 400	2.2	2.8	3.3	4.4	5.6

Table 8.12 — Bracing capacity — Cantilevered stumps in soil backfill — Soil classifications A, S and M — Wind classifications up to N3



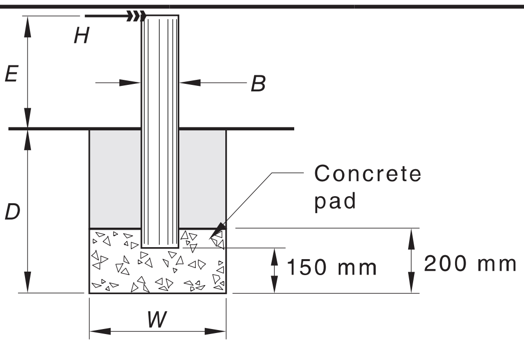
Concrete base support W = 400 mm.

Height above footing (*E*), mm	Stump depth (*D*), mm	Bracing capacity (*H*), kN — Stump thickness/diameter (*B*), mm: 100	125	150	200	250
200	400	0.5	0.6	0.7	1.0	1.2
	600	1.4	1.7	2.1	2.8	3.5
	800	2.5	3.2	3.8	4.3	4.7
	1 000	3.8	4.7	5.0	6.2	7.7
	1 200	5.2	5.7	6.6	8.8	11
	1 400	6.1	7.1	8.5	11	14
400	400	0.3	0.4	0.5	0.7	0.9
	600	1.1	1.4	1.6	2.2	2.2
	800	2.1	2.6	3.1	3.1	3.6
	1 000	3.2	3.8	3.8	4.7	5.8
	1 200	4.5	4.5	5.2	6.9	8.6
	1 400	4.9	5.9	7.1	9.5	12
600	400	0.3	0.3	0.4	0.5	0.7
	600	0.9	1.1	1.4	1.8	1.8
	800	1.8	2.2	2.5	2.5	2.9
	1 000	2.8	3.1	3.1	3.9	4.8
	1 200	3.7	3.7	4.4	5.8	7.3
	1 400	4.1	5.1	6.1	8.2	10
800	400	0.2	0.3	0.3	0.4	0.5
	600	0.8	1.0	1.1	1.5	1.5
	800	1.5	1.9	2.4	2.4	2.4
	1 000	2.6	2.6	2.6	3.3	4.1
	1 200	3.1	3.2	3.8	5.1	6.3
	1 400	3.6	4.5	5.4	7.2	9.0
1 000	400	0.2	0.2	0.3	0.4	0.5
	600	0.7	0.8	1.0	1.2	1.2
	800	1.4	1.7	1.7	1.7	2.1
	1 000	2.2	2.2	2.2	2.9	3.6
	1 200	2.7	2.8	3.3	4.5	5.6
	1 400	3.2	4.0	4.8	6.4	8.0

Table 8.12 *(continued)*

1 200	400	0.2	0.2	0.2	0.3	0.4
	600	0.6	0.7	0.9	1.1	1.1
	800	1.2	1.5	1.5	1.5	1.8
	1 000	1.9	1.9	1.9	2.6	3.2
	1 200	2.4	2.5	3.0	4.0	5.0
	1 400	2.9	3.6	4.3	5.8	7.2
1 400	400	—	—	—	—	—
	600	0.5	0.7	0.8	0.9	0.9
	800	1.1	1.3	1.3	1.3	1.6
	1 000	1.7	1.7	1.7	2.3	2.9
	1 200	2.1	2.3	2.7	3.6	4.5
	1 400	2.6	3.3	3.9	5.3	6.6
1 600	400	—	—	—	—	—
	600	0.5	0.6	0.7	0.8	0.8
	800	1.0	1.2	1.2	1.2	1.5
	1 000	1.5	1.5	1.6	2.1	2.6
	1 200	1.9	2.1	2.5	3.3	4.1
	1 400	2.4	3.0	3.6	4.8	6.0
1 800	400	—	—	—	—	—
	600	0.4	0.5	0.6	0.7	0.7
	800	0.9	1.1	1.1	1.1	1.3
	1 000	1.4	1.4	1.4	1.9	2.4
	1 200	1.8	1.9	2.3	3.0	3.8
	1 400	2.2	2.8	3.3	4.4	5.6

Table 8.13 — Bracing capacity — Cantilevered stumps in soil backfill — Soil classifications A, S and M — Wind classifications up to N3



Concrete base support *W* = 600 mm.

Height above footing (*E*), mm	Stump depth (*D*), mm	Bracing capacity (*H*), kN				
		Stump thickness/diameter (*B*), mm				
		100	**125**	**150**	**200**	**250**

Table 8.13 *(continued)*

200	400	0.5	0.6	0.7	1.0	1.2
	600	1.4	1.7	2.1	2.8	3.5
	800	2.5	3.2	3.8	5.1	6.3
	1 000	3.8	4.7	5.7	7.5	7.7
	1 200	5.2	6.5	7.8	8.8	11
	1 400	6.9	8.6	9.2	11	14
400	400	0.3	0.4	0.5	0.7	0.9
	600	1.1	1.4	1.6	2.2	2.7
	800	2.1	2.6	3.1	4.2	4.7
	1 000	3.2	4.0	4.8	5.7	5.8
	1 200	4.5	5.7	6.7	6.9	8.6
	1 400	6.1	7.3	7.3	9.5	12
600	400	0.3	0.3	0.4	0.5	0.7
	600	0.9	1.1	1.4	1.8	2.3
	800	1.8	2.2	2.6	3.5	3.7
	1 000	2.8	3.5	4.2	4.6	4.8
	1 200	4.0	5.0	5.5	5.8	7.3
	1 400	5.5	6.1	6.1	8.2	10
800	400	0.2	0.3	0.3	0.4	0.5
	600	0.8	1.0	1.1	1.5	1.9
	800	1.5	1.8	2.3	3.1	3.1
	1 000	2.6	3.1	3.7	3.9	4.1
	1 200	3.6	4.5	4.7	5.1	6.3
	1 400	4.9	5.3	5.4	7.2	9.0
1 000	400	0.2	0.2	0.3	0.4	0.5
	600	0.7	0.8	1.0	1.3	1.7
	800	1.4	1.7	2.0	2.6	2.6
	1 000	2.2	2.8	3.3	3.3	3.6
	1 200	3.3	4.1	4.1	4.5	5.6
	1 400	4.5	4.5	4.8	6.4	8.0
1 200	400	0.2	0.2	0.2	0.3	0.4
	600	0.6	0.7	0.9	1.2	1.5
	800	1.2	1.5	1.8	2.2	2.2
	1 000	2.0	2.5	2.9	2.9	3.2
	1 200	3.0	3.6	3.6	4.0	5.0
	1 400	4.2	4.2	4.3	5.8	7.2
1 400	400	—	—	—	—	—
	600	0.5	0.7	0.8	1.0	1.3
	800	1.1	1.4	1.6	2.0	2.0
	1 000	1.8	2.3	2.6	2.6	2.9
	1 200	2.7	3.2	3.2	3.6	4.5
	1 400	3.7	3.7	3.9	5.3	6.6

Table 8.13 *(continued)*

1 600	400	—	—	—	—	—
	600	0.5	0.6	0.7	1.0	1.2
	800	1.0	1.3	1.5	1.8	1.8
	1 000	1.7	2.1	2.3	2.3	2.6
	1 200	2.5	2.9	2.9	3.3	4.1
	1 400	3.4	3.4	3.6	4.8	6.0
1 800	400	—	—	—	—	—
	600	0.4	0.5	0.7	0.9	1.1
	800	0.9	1.2	1.4	1.6	1.6
	1 000	1.4	1.8	2.1	2.1	2.4
	1 200	2.4	2.7	2.7	3.0	3.8
	1 400	3.1	3.1	3.3	4.4	5.6

Table 8.14 — Maximum bracing (lateral) capacity of timber stumps

Height of stump (*E*) above footing, mm	Maximum bracing capacity of timber stumps, kN					
	Nominal unseasoned size of stumps, mm × mm					
	100 × 100	125 × 125	150 × 150	175 × 175	200 × 200	250 × 250
200	19	37	50	50	50	50
400	9.6	19	32	50	50	50
600	6.4	12	22	34	50	50
800	2.8	6.9	14	26	38	50
1 000	1.4	3.5	7.3	13	23	50
1 200	0.8	2.0	4.2	7.8	13	33
1 400	0.5	1.3	2.7	4.9	8.4	20
1 600	0.4	0.9	1.8	3.3	5.6	14
1 800	0.2	0.6	1.3	2.3	4	10

NOTE The following round timber stump sizes may be used in lieu of the square sizes given in this Table: (a) 100 mm × 100 mm — 125 mm diameter; (b) 125 mm × 125 mm — 150 mm diameter; (c) 150 mm × 150 mm — 175 mm diameter; (d) 175 mm × 175 mm — 200 mm diameter; (e) 200 mm × 200 mm — 225 mm diameter; and (f) 250 mm × 250 mm — 275 mm diameter.

8.3.5.7 Bracing columns

Timber, steel or concrete posts or columns placed into concrete footings may be used for transferring racking forces to the foundation. The horizontal load can be resisted by adding the capacity of individual stumps to resist the total force. Individual load capacities and details of columns or posts are given in Table 8.15 and Figure 8.4. No-fines concrete shall be used for external hardwood columns.

Where the column capacity is not adequate to resist the lateral load, additional bracing or cross-bracing shall be used.

All bracing shall be fixed to the floor or footing below and the floor above to enable the transfer of the full bracing capacity of the bracing system.

Steel columns over 900 mm above the ground shall not be used for bracing, unless incorporated in a bracing set.

Footing plan size and depth, as given in Table 8.15, shall apply to soil classifications A, S and M only.

Bracing systems for other soil classifications, materials or sizes shall be designed in accordance with engineering principles.

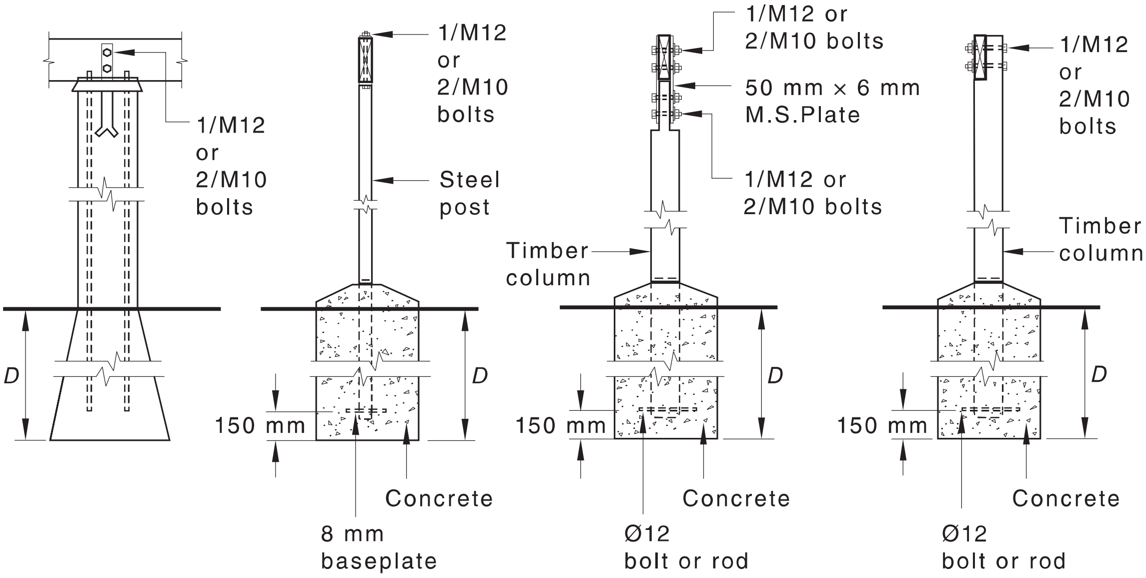
The footing depth specified in Table 8.15 may be reduced to 600 mm when enclosed by a minimum of 100 mm thick concrete slab cast on the ground and of a minimum size of 6 m^2.

For concrete and masonry columns and walls, refer to AS 3600 and AS 3700, respectively.

For bearer tie-down, see Section 9.

Table 8.15 — Column bracing capacity

Height of column above-ground, mm	Column details				Footing plan size or diameter, mm	Footing depth (*D*), mm	Bracing capacity, kN
	Concrete and masonry		Timber diameter, mm	Steel, mm			
	Plan size, mm	Reinforcement					
600 or less	M200 × 200	1-N12	125	76 × 76 × 3.2	350 × 350	900	6
601 to 900	M200 × 200	1-N12	150	76 × 76 × 4.0	350 × 350	900	4.5
901 to 1 800	C200 × 200 M200 × 400 M300 × 300	4-R10	200	—	350 × 350	900	3
1 801 to 2 400	C200 × 200 M200 × 400 M300 × 300	4-N12	225	—	400 × 400	900	3
2 401 to 3 000	C250 × 250 M200 × 400 M300 × 300	4-N12	250	—	600 × 600	900	2.3
NOTE C = reinforced concrete column; M = reinforced concrete masonry.							



NOTE For guidance on durability, see Appendix B.

Figure 8.4 — Concrete, masonry and steel bracing columns

8.3.5.8 Unreinforced masonry bracing

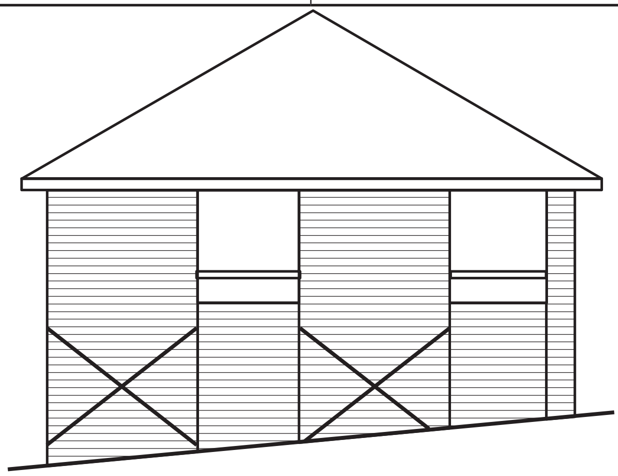
Unreinforced masonry walls may be used to transfer racking forces in the subfloor region. The walls shall be a minimum of 90 mm thick. Engaged-piers shall be regularly spaced. All brickwork shall conform to AS 3700.

NOTE Refer also to the National Construction Code for requirements related to brickwork.

Table 8.16 gives the capacity of masonry walls in the subfloor region only. The description of single or two storey, brick veneer or clad frame refers to the construction above the unreinforced masonry bracing wall under consideration. The bracing capacity of subfloor masonry is not applicable in regions where there are no walls above, e.g. under verandah roofs, decks or similar structures.

The total minimum length of unreinforced masonry bracing walls in any full length of wall shall be 3 000 mm with the minimum length of individual panels in the wall not less than 900 mm. The bracing capacities given in Table 8.16 are not applicable to standalone panels of masonry less than 3 000 mm.

Table 8.16 — Unreinforced masonry bracing capacity

Description	Bracing capacity, kN/m
 Tie-down shall be provided from bearers to footings	
Subfloor of single storey with brick veneer over	3
Subfloor of two storeys with brick veneer over	7.5
Subfloor of single storey with clad frame over	1.5
Subfloor of two storeys with clad frame over	3

8.3.5.9 Spacing of bracing in lower storey of two storey construction or the subfloor of single or two storey construction

Bracing in the subfloor or lower storey of two storey construction shall be evenly distributed. The maximum distance between bracing sets, stumps, piers, wall or posts, and similar constructions, under a strip or sheet timber floor system shall be as follows:

(a) For wind classifications N1 and N2, 14 000 mm if the minimum width of floor is 4 800 mm.

(b) For wind classification N3, 14 000 mm if the minimum width of floor is 6 000 mm.

(c) For wind classifications N4, 11 500 mm if the minimum width of floor is 6 000 mm.

If the width of the floor is less than as given above, the spacing of bracing shall be in accordance with Clause 8.3.6.7 where the width of the floor is considered as the ceiling depth.

NOTE The minimum width of the floor is measured parallel to the direction of wind under consideration.

8.3.6 Wall bracing

8.3.6.1 General

Walls shall be permanently braced to resist horizontal racking forces applied to the building. Wall bracing shall be designed to resist racking forces equal to or greater than the forces calculated from Clause 8.3.4.

The total capacity of bracing walls shall be the sum of the bracing capacities of individual walls. See Table 8.18 for the capacity of structural bracing walls, and Section 9 for fixing requirements.

NOTE The nail spacings given in Table 8.18 are nominal maximum spacings.

8.3.6.2 Nominal wall bracing

Nominal wall bracing is wall framing lined with sheet materials such as plywood, plasterboard, fibre cement, hardboard or similar materials with the wall frames nominally fixed to the floor and the roof or ceiling frame.

The maximum amount that can be resisted by nominal wall bracing is 50 % of the total racking forces determined from Clause 8.3.4. Nominal wall bracing shall be evenly distributed throughout the building. If this is not the case, the contribution of nominal bracing shall be ignored.

The minimum length of nominal bracing walls shall be 450 mm.

The bracing capacity of nominal bracing is specified in Table 8.17.

Table 8.17 — Nominal sheet bracing walls

Method	Bracing capacity, kN/m
Sheeted one side only	0.45
Sheeted two sides	0.75

8.3.6.3 Structural wall bracing

Structural wall bracing is purpose-fitted bracing, being either sheet or cross-timber or steel bracing. Table 8.18 gives the specific capacity for each metre length of various structural bracing types.

NOTE 1 Nominal bracing cannot contribute to bracing resistance where it occurs in the same section of wall as structural bracing, such as where plasterboard lining is fixed over a structural brace.

NOTE 2 Where applicable, reference to top plate in Table 8.18 may also apply to ring beam.

For sheet-braced walls, the sheeting shall be continuous from the top plate or ring beam to the bottom plate with any horizontal sheet joins made over nogging with fixings the same as required for top and bottom plates.

Unless otherwise specified, sheet-bracing walls shall be a minimum of 900 mm in length to satisfy the requirements of their nominated ratings.

The capacity of sheet bracing given in bracing types (g) to (n) in Table 8.18 is based on fixing the sheeting to framing having a minimum joint strength group of J5 or JD5. If JD4 is used, the bracing capacity given bracing types (g) to (k) in Table 8.18 shall be increased by 12.5 %, and in bracing types (l) to (n), by 16 %.

NOTE 3 Joint groups for commonly available timbers are given in Clause 9.6.5 and Appendix G.

NOTE 4 For wall heights greater than 2 700 mm, the values in Table 8.18 may be proportioned downward relative to the wall heights. For example, for a wall height of 3 600 mm multiply the values in the table by 2 700/3 600 = 0.75, see Clause 8.3.6.4.

Table 8.18(a) — Structural wall bracing (maximum wall height 2.7 m)

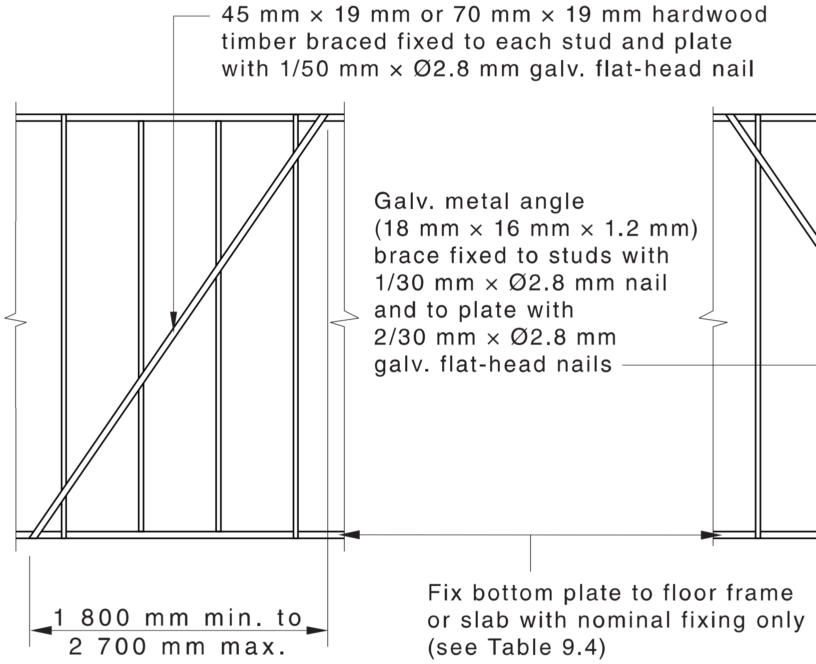
Type of bracing	Bracing capacity, kN/m
(a) *Two diagonally opposed timber or metal angle braces* — All flat head nails shall be galvanized or equivalent. 	0.8

Table 8.18(b) — Structural wall bracing (maximum wall height 2.7 m)

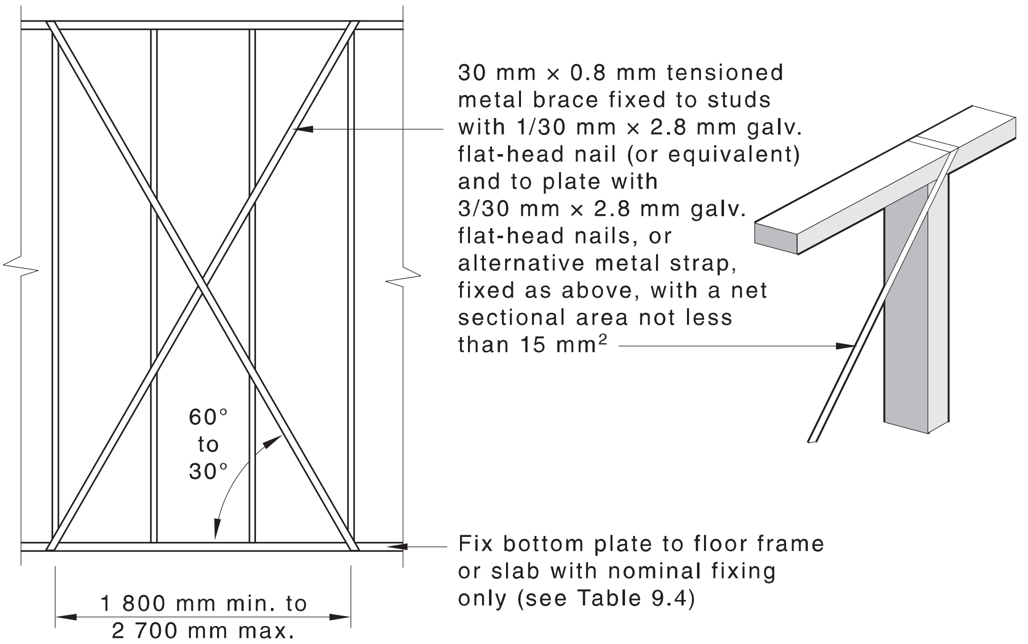
Type of bracing	Bracing capacity, kN/m
(b) *Metal straps — Tensioned* 	1.5

Table 8.18(c) — Structural wall bracing (maximum wall height 2.7 m)

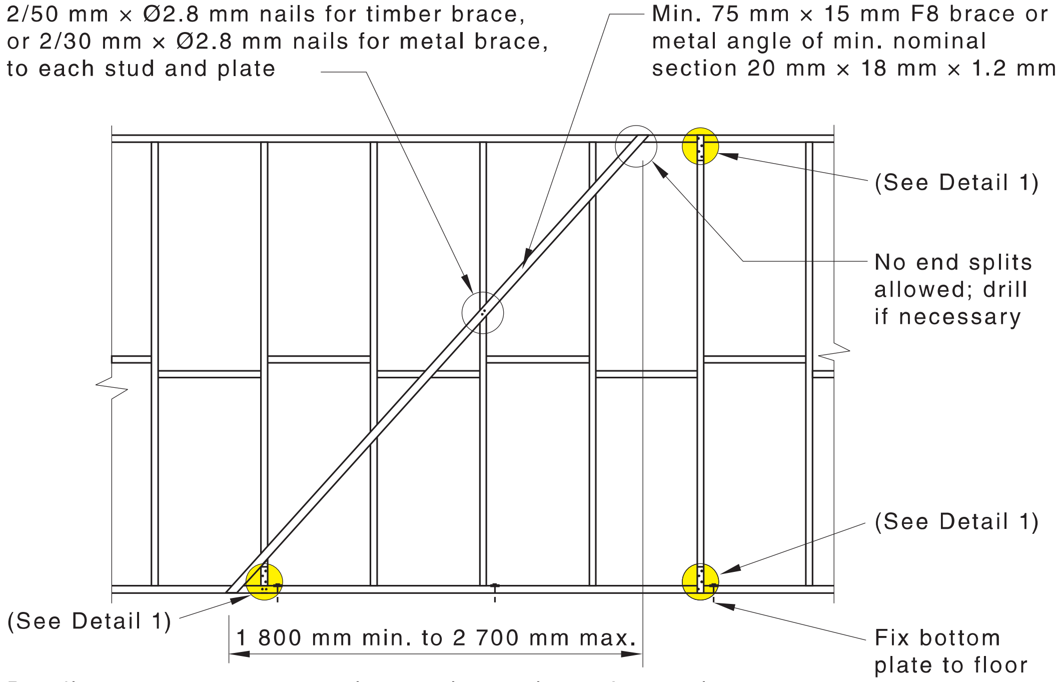
Type of bracing	Bracing capacity, kN/m
(c) *Timber and metal angle braces* — The maximum depth of a notch or saw-cut shall not exceed 20 mm. Saw-cuts studs shall be designed as notched.  Detail 1: 30 mm × 0.8 mm galv. metal strap looped over plate and fixed to stud with 3/30 mm × Ø2.8 mm galv. flat-head nails (or equivalent) to each end. Alternatively, provide single straps to both sides, with 3 nails per strap end, or equivalent anchors or other fasteners.	1.5

Table 8.18(d) — Structural wall bracing (maximum wall height 2.7 m)

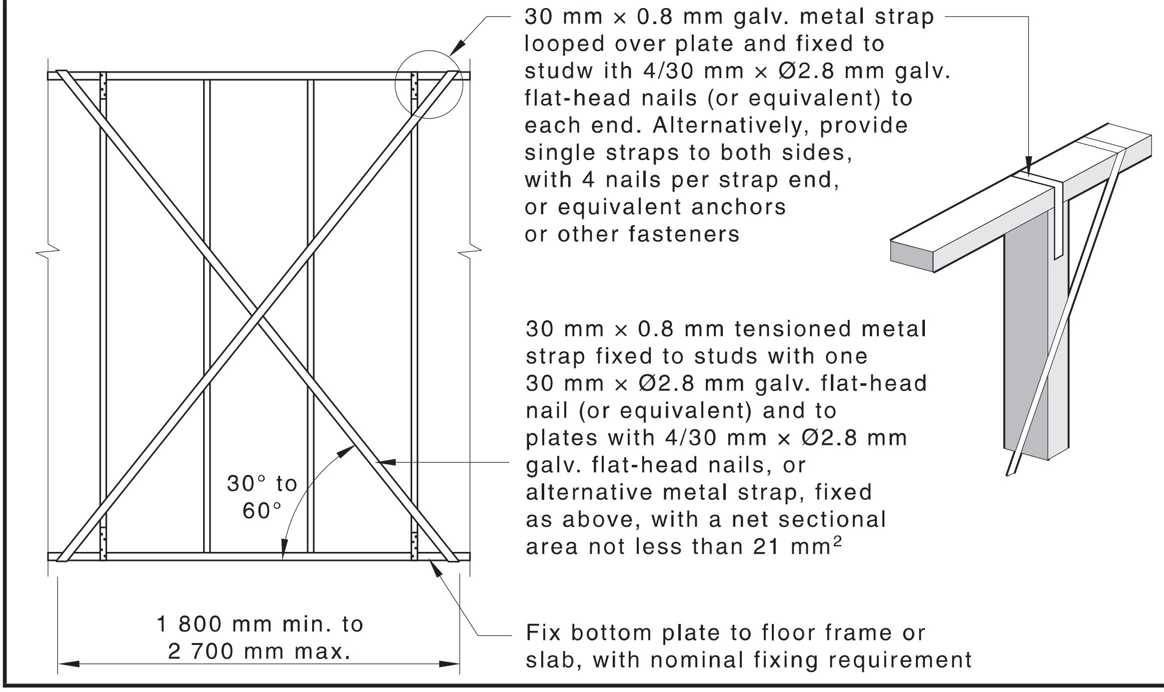
Type of bracing	Bracing capacity, kN/m
(d) *Metal straps — Tensioned — With stud straps* 	3.0

Table 8.18(e) — Structural wall bracing (maximum wall height 2.7 m)

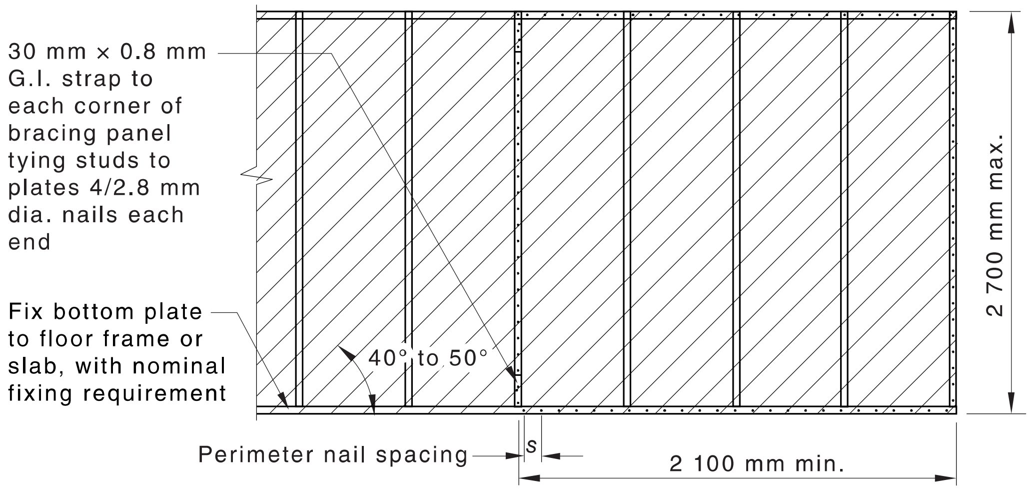
Type of bracing			Bracing capacity, kN/m
(e) *Diagonal timber wall lining or cladding* — Minimum thickness of board shall be 12 mm fixed with 2/20 mm × 50 mm long T-head nails. Intermediate crossings of boards and studs shall be fixed with one nail.			
			
	s, mm	60	2.1
		40	3.0
NOTE Noggings have been omitted for clarity.			

Table 8.18(f) — Structural wall bracing (maximum wall height 2.7 m)

Type of bracing
(f) Timber, metal angle and strap bracing [other than those specified in Tables 8.18(a) to 8.18(e)] shall be designed and installed in accordance with engineering principles.

Table 8.18(g) — Structural wall bracing (maximum wall height 2.7 m)

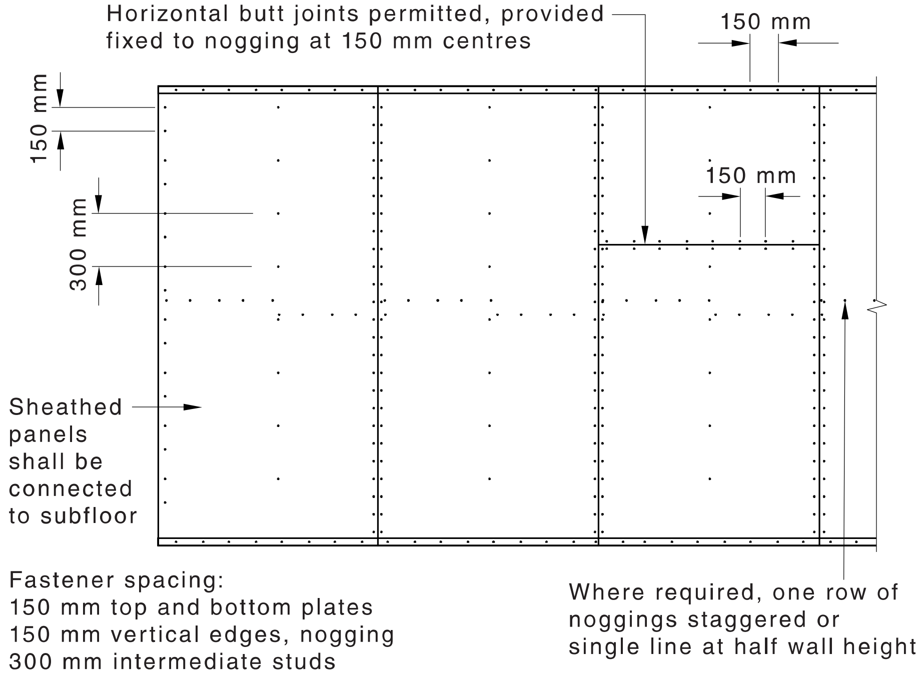
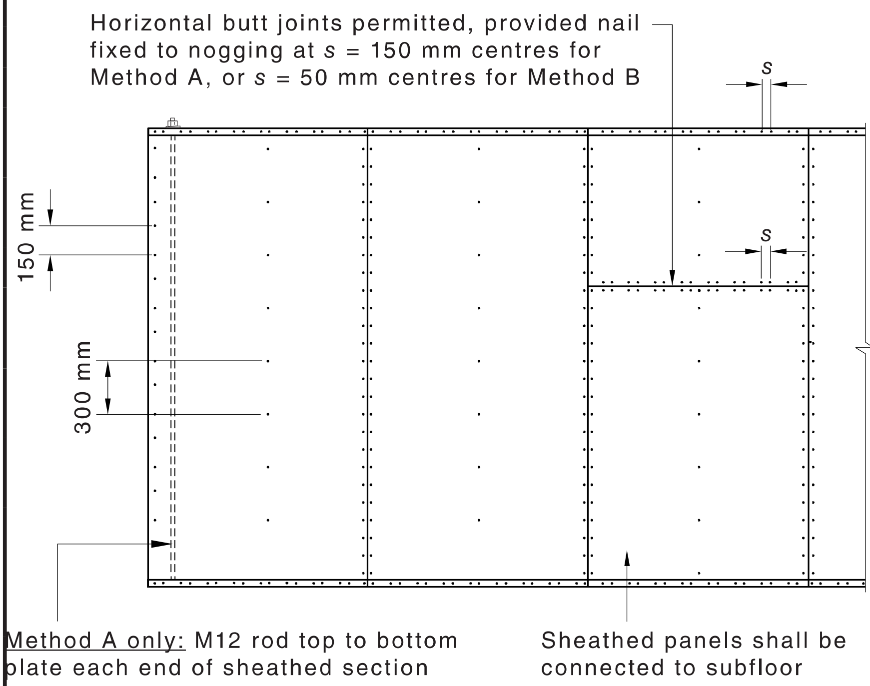
<table>
<tr><th colspan="4">Type of bracing</th><th>Bracing capacity, kN/m</th></tr>
<tr><td rowspan="14">(g) Plywood — Plywood shall be nailed to the frame using 30 mm × 2.8 mm ⌀ galvanized flat-head nails or equivalent. Minimum bracing panel length shall be 900 mm.

</td><td colspan="3">Minimum plywood thickness, mm</td><td rowspan="14">3.0</td></tr>
<tr><td rowspan="2">Stress grade</td><td colspan="2">Stud spacing, mm</td></tr>
<tr><td>450</td><td>600</td></tr>
<tr><td colspan="3">No nogging (except horizontal butt joints)</td></tr>
<tr><td>F8</td><td>7</td><td>9</td></tr>
<tr><td>F11</td><td>4.5</td><td>7</td></tr>
<tr><td>F14</td><td>4</td><td>6</td></tr>
<tr><td>F27</td><td>3</td><td>4.5</td></tr>
<tr><td colspan="3">One row of nogging</td></tr>
<tr><td>F8</td><td>7</td><td>7</td></tr>
<tr><td>F11</td><td>4.5</td><td>4.5</td></tr>
<tr><td>F14</td><td>4</td><td>4</td></tr>
<tr><td>F27</td><td>3</td><td>3</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="5">NOTE 1 For plywood fixed to both sides of the wall, see Clauses 8.3.6.5 and 8.3.6.10.
NOTE 2 No other rods or straps are needed between the top or bottom plate.
NOTE 3 Fix bottom plate to floor frame or slab with nominal fixing only, see Table 9.4 except that for double sided walls as per Table 8.18(h) Method A.</td></tr>
</table>

Table 8.18(h) — Structural wall bracing (maximum wall height 2.7 m)

<table>
<tr><th colspan="4">Type of bracing</th><th>Bracing capacity, kN/m</th></tr>
<tr><td rowspan="16">(h) Plywood — Plywood shall be nailed to frame using 30 mm × 2.8 mm ⌀ galvanized flat head nails or equivalent. For Method A only the minimum bracing panel length shall be 600 mm.

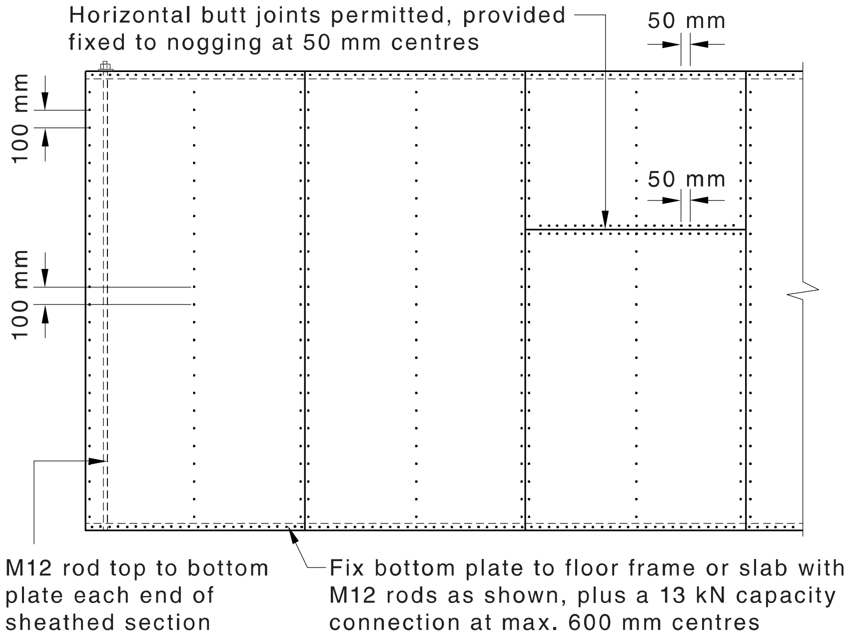
For Method A, M12 rods shall be used at each end of sheathed section top plate to bottom plate/floor frame, not greater than 150 mm from end. Method B has no rods but sheathing shall be nailed to top and bottom plates and any horizontal joints at 50 mm centres.


</td><td colspan="3">Minimum plywood thickness, mm</td><td rowspan="16">Method A
5.6

Method B
5.2</td></tr>
<tr><td rowspan="2">Stress grade</td><td colspan="2">Stud spacing, mm</td></tr>
<tr><td>450</td><td>600</td></tr>
<tr><td>F8</td><td>7</td><td>9</td></tr>
<tr><td>F11</td><td>6</td><td>7</td></tr>
<tr><td>F14</td><td>4</td><td>6</td></tr>
<tr><td>F27</td><td>4</td><td>4.5</td></tr>
<tr><td colspan="3">Fastener spacing (s), mm</td></tr>
<tr><td colspan="2">Top and bottom plate:</td><td></td></tr>
<tr><td colspan="2">— Method A</td><td>150</td></tr>
<tr><td colspan="2">— Method B</td><td>50</td></tr>
<tr><td colspan="2">Vertical edges</td><td>150</td></tr>
<tr><td colspan="2">Intermediate studs</td><td>300</td></tr>
<tr><td colspan="3">Fixing of bottom plate to floor frame or slab</td></tr>
<tr><td colspan="3">Method A: M12 rods as shown plus a 13 kN capacity connection at max. 1 200 mm centres</td></tr>
<tr><td colspan="3">Method B: A 13 kN capacity connection at each end and intermediately at max. 1 200 mm centres</td></tr>
<tr><td colspan="5">NOTE For plywood fixed to both sides of the wall, see Clauses 8.3.6.5 and 8.3.6.10.</td></tr>
</table>

Table 8.18(i) — Structural wall bracing (maximum wall height 2.7 m)

Type of bracing				Bracing capacity, kN/m
(i) *Plywood* — Plywood shall be nailed to frame using 30 mm × 2.8 mm ⌀ galvanized flat-head nails or equivalent. Minimum bracing panel length shall be 600 mm.	Minimum plywood thickness, mm			
	Stress grade	Stud spacing, mm		
		450	600	
	No nogging (except horizontal butt joints)			
	F11	4.5	4.5	6.6
	F11	7.0	7.0	7.6
	Fastener spacing			
	Top and bottom plate		50	
	Vertical edges		100	
	Intermediate studs		100	



NOTE For plywood fixed to both sides of the wall, see Clauses 8.3.6.5 and 8.3.6.10.

Table 8.18(j) — Structural wall bracing (maximum wall height 2.7 m)

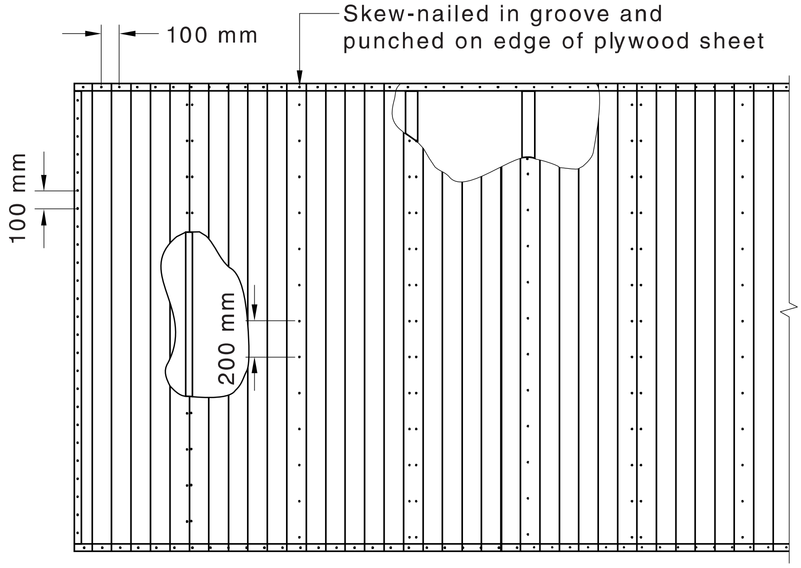
<table>
<tr><th colspan="3">Type of bracing</th><th>Bracing capacity, kN/m</th></tr>
<tr><td rowspan="7">(j) Decorative plywood — Nailed — Decorative plywood shall be nailed to frame using min. 40 mm × 2.5 mm ⌀ bullet-head nails. The depth of groove shall not exceed one-third the nominal thickness.

</td><td colspan="2">Minimum nominal thickness of decorative structural plywood, mm</td><td rowspan="7">1.8</td></tr>
<tr><td>Stress grade</td><td>Stud spacing, mm (600 max.)</td></tr>
<tr><td>F11</td><td>6</td></tr>
<tr><td colspan="2">Fastener spacing mm</td></tr>
<tr><td>Top and bottom plate:</td><td>100</td></tr>
<tr><td>Vertical edges</td><td>100</td></tr>
<tr><td>Intermediate studs</td><td>200</td></tr>
<tr><td colspan="4">NOTE Fix bottom plate to floor frame or slab with nominal fixing only, see Table 9.4.</td></tr>
</table>

Table 8.18(k) — Structural wall bracing (maximum wall height 2.7 m)

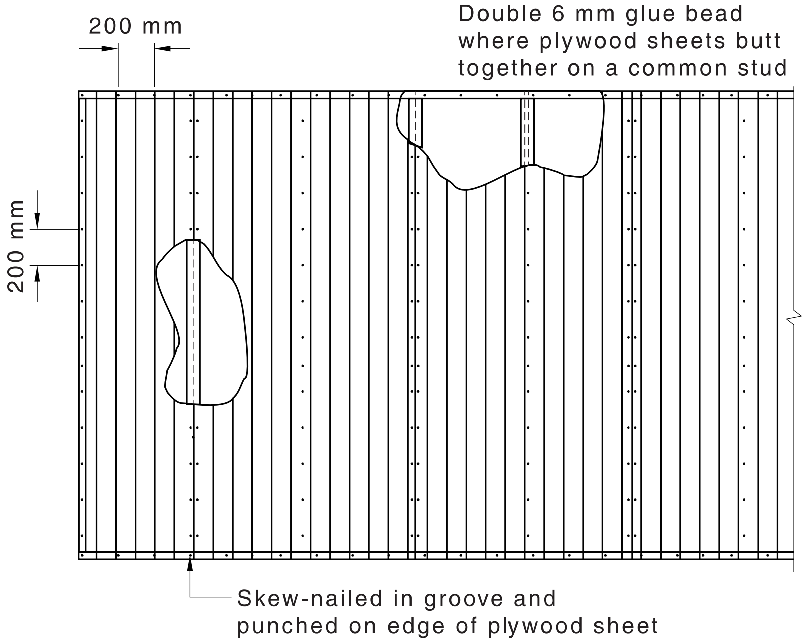
Type of bracing			Bracing capacity, kN/m
(k) *Decorative plywood — Glued and nailed* — Decorative plywood shall be nailed to frame using min. 40 mm × 2.5 mm ⌀ bullet-head nails. Continuous 6 mm bead of elastomeric adhesive shall be applied to studs and plates. Double 6 mm glue bead shall be used where plywood sheets butt together on a common stud. The depth of groove shall not exceed one-third the nominal thickness.	Minimum nominal thickness of decorative structural plywood, mm		
	Stress grade	Stud spacing, mm (600 max.)	4.6
	F11	6	
	Fastener spacing, mm		
	Top and bottom plates	200	
	Vertical edges	200	
	Intermediate studs	200	
NOTE Fix bottom plate to floor frame or slab with a 13 kN capacity connection at each end of braced panel and at max. 1 200 mm centres.			

Table 8.18(l) — Structural wall bracing (maximum wall height 2.7 m)

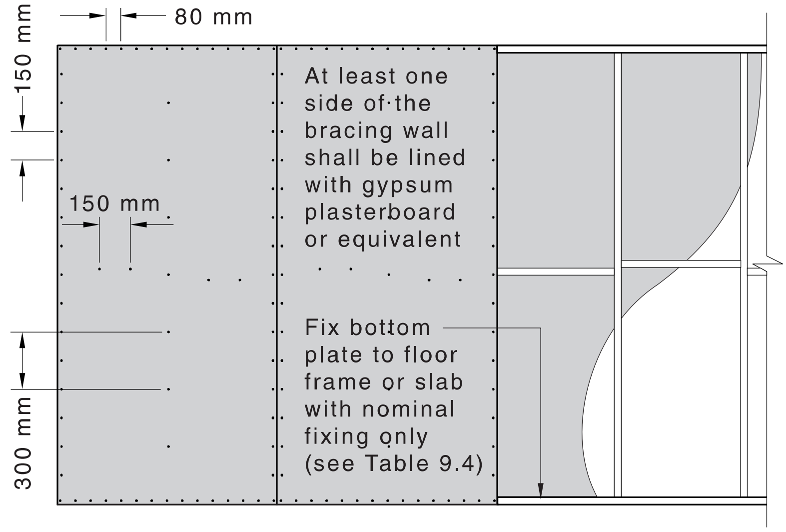
<table>
<tr><th colspan="3">Type of bracing</th><th>Bracing capacity, kN/m</th></tr>
<tr><td rowspan="7">(l) Hardboard Type A — Hardboard shall conform to AS/NZS 1859.4. Hardboard shall be nailed to frame using min. 30 mm × 2.8 mm ⌀ galvanized flat-head nails or equivalent. Nails shall be located a min. of 10 mm from the vertical edges and 15 mm from the top and bottom edges. Maximum stud spacing shall be 600 mm. Bracing panel min. width shall be 900 mm.

</td><td colspan="2">Minimum hardboard thickness, 4.8 mm</td><td rowspan="7">Type A
2.9</td></tr>
<tr><td colspan="2">Fastener spacing, mm</td></tr>
<tr><td>Top and bottom plates</td><td>80</td></tr>
<tr><td>Vertical edges and nogging</td><td>150</td></tr>
<tr><td>Intermediate studs</td><td>300</td></tr>
<tr><td colspan="2">Fixing of bottom plate to floor frame or slab</td></tr>
<tr><td colspan="2">Type A: Fixing bottom plate to floor frame or slab with nominal fixing requirement (see Table 9.4)</td></tr>
</table>

Table 8.18(m) — Structural wall bracing (maximum wall height 2.7 m)

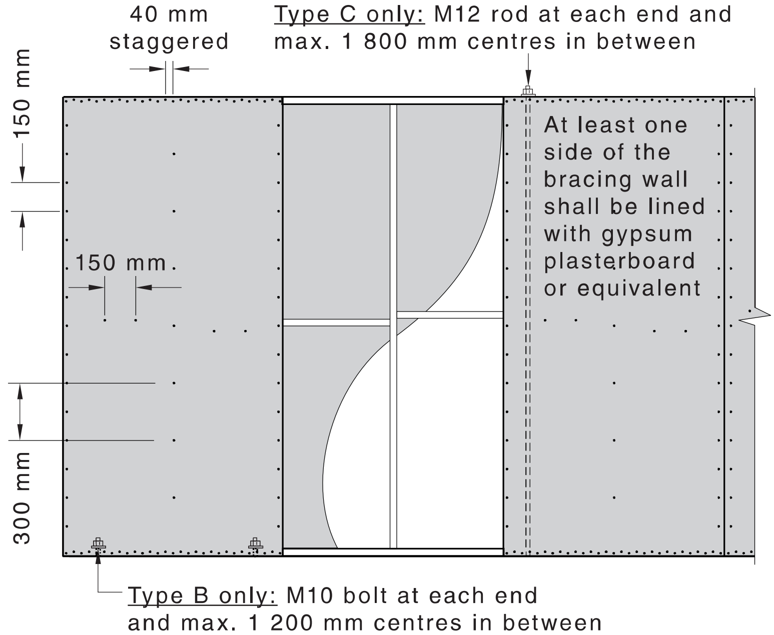
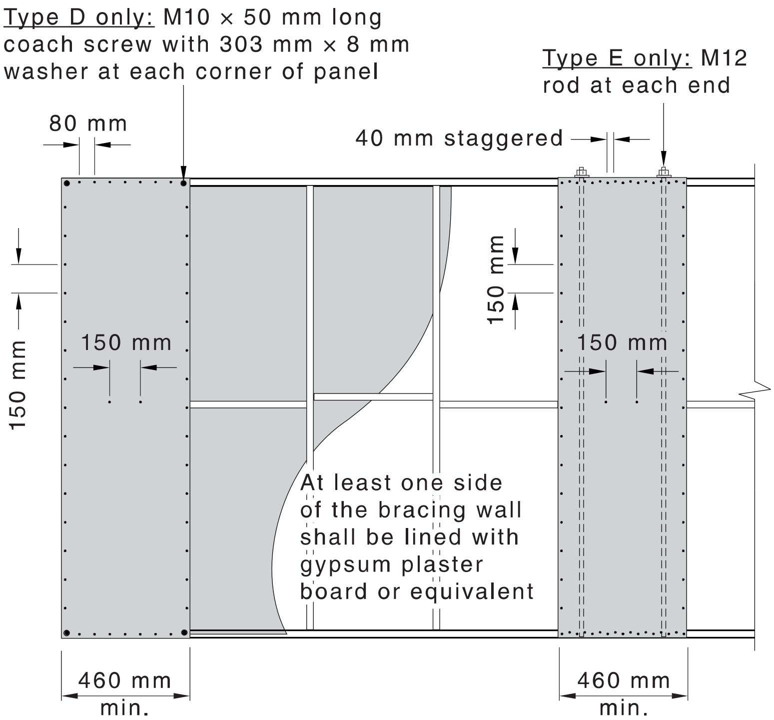
<table>
<tr><th colspan="3">Type of bracing</th><th>Bracing capacity, kN/m</th></tr>
<tr><td rowspan="7">(m) Hardboard Types B and C — Hardboard shall conform to AS/NZS 1859.4. Hardboard shall be nailed to frame using min. 30 mm × 2.8 mm ⌀ galvanized flat-head nails or equivalent. Nails shall be located a min. of 10 mm from the vertical edges and 15 mm from the top and bottom edges. Maximum stud spacing shall be 600 mm. Bracing panel min. width shall be 900 mm.

</td><td colspan="2">Minimum hardboard thickness, 4.8 mm</td><td rowspan="7">Type B 5.0
Type C 7.6</td></tr>
<tr><td colspan="2">Fastener spacing, mm</td></tr>
<tr><td>Top and bottom plates</td><td>40</td></tr>
<tr><td>Vertical edges and nogging</td><td>150</td></tr>
<tr><td>Intermediate studs</td><td>30</td></tr>
<tr><td colspan="2">Fixing of bottom plate to floor frame or slab</td></tr>
<tr><td colspan="2">Type B: Fix bottom plate to floor frame or slab with M10 bolts each end and intermediately at max. 1 200 mm centres
Type C: M12 rods at each end and intermediately at max. 1 800 mm centres</td></tr>
<tr><td colspan="4">NOTE Bolt/rod washer sizes are set out in Table 9.1.</td></tr>
</table>

Table 8.18(n) — Structural wall bracing (maximum wall height 2.7 m)

<table>
<tr><th colspan="3">Type of bracing</th><th>Bracing capacity, kN/m</th></tr>
<tr><td rowspan="7">(n) Hardboard Types D and E — Short wall bracing systems — Hardboard shall conform to AS/NZS 1859.4. Hardboard shall be nailed to frame using min. 30 mm × 2.8 mm ⌀ galvanized flat-head nails or equivalent. Nails shall be located a min. of 10 mm from the vertical edges and 15 mm from the top and bottom edges. Maximum stud spacing shall be 600 mm. Bracing panel min. width shall be 460 mm.

</td><td colspan="2">Minimum hardboard thickness, 4.8 mm</td><td rowspan="7">Type D
2.9

Type E
5.0</td></tr>
<tr><td colspan="2">Fastener spacing, mm</td></tr>
<tr><td rowspan="2">Top and bottom plates</td><td>Type D: 80</td></tr>
<tr><td>Type E: 40</td></tr>
<tr><td>Vertical edges and nogging</td><td>150</td></tr>
<tr><td colspan="2">Fixing of bottom plate to floor frame or slab</td></tr>
<tr><td colspan="2">Type D: Fix bottom plate to floor frame or slab with nominal fixing only (see Table 9.4)

Type E: M12 rods at each end</td></tr>
<tr><td colspan="4">NOTE Bolt/rod washer sizes are set out in Table 9.1.</td></tr>
</table>

8.3.6.4 Wall capacity and height modification

The capacity of bracing walls given in Tables 8.18(a) to 8.18(n) is appropriate to wall heights up to and including 2 700 mm. For wall heights greater than 2 700 mm, the capacity shall be multiplied by the values given in Table 8.19.

Table 8.19 — Bracing wall capacity/height multiplier

Wall height, mm	Multiplier
3 000	0.9
3 300	0.8
3 600	0.75
3 900	0.7

Table 8.19 *(continued)*

Wall height, mm	Multiplier
4 200	0.64

8.3.6.5 Length and capacity for plywood bracing walls

For the bracing capacities given in Tables 8.18(g) to 8.18(i) for plywood, the minimum length of the panels shall be 900 mm, except —

(a) in bracing type given in Table 8.18 (h) for Method A only, the minimum length of the panels may be 600 mm; or

(b) in bracing type given in Table 8.18 (g) —

  (i) for panel length of 600 mm, the bracing capacity shall be half of that for 900 mm; and

  (ii) for panel length between 600 mm and 900 mm, the bracing capacity may be determined by multiplying the respective capacities by 0.5 for 600 mm long varying linearly to 1.0 for 900 mm.

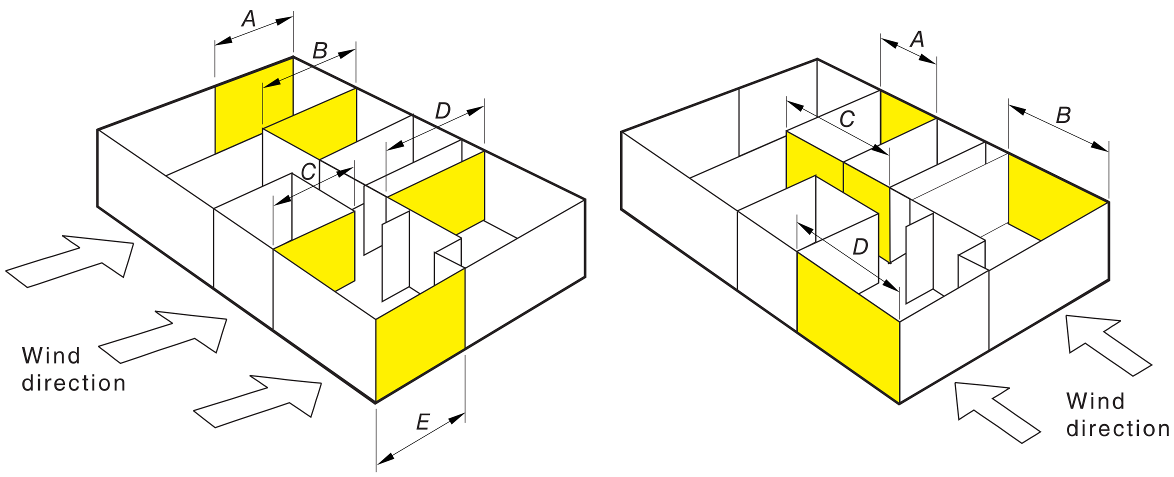
Where plywood fixed to both sides of the wall is used the bracing capacity in Table 8.18(g), (h) and (i) is double the capacity of a single side. Where plywood fixed to both sides of the wall is used the depth of the bottom plate shall be a minimum of 45mm and, the tiedown of the bracing wall shall be double as provided in Tables 8.18(g), (h) and (i) or in accordance with clause 8.3.6.10 for the increased capacity.

8.3.6.6 Location and distribution of bracing

Bracing shall be approximately evenly distributed and provided in both directions, as shown in Figure 8.5.

NOTE See also Examples 1 and 2 given in Appendix D.

Bracing shall initially be placed in external walls and, where possible, at the corners of the building.



(a) Right angles to long side **(b) Right angles to short side**

NOTE 1 *A*, *B*, *C* and *D* are the design strengths of individual bracing walls.

NOTE 2 Total bracing strength = *A* + *B* + *C* + *D*, etc.

Figure 8.5 — Location of bracing

8.3.6.7 Spacing of bracing walls in single storey or upper storey of two storey construction

For single storey or upper storey of two storey construction, the maximum distance between braced walls at right angles to the building length or width shall not exceed 9 000 mm for wind classifications up to N2. For wind classifications greater than N2, spacing shall be in accordance with Table 8.20 and Table 8.21 for the relevant wind classification, ceiling depth and roof pitch.

For the lower storey of a two storey construction, or for subfloors, the spacing of bracing walls (see Figure 8.6) or other bracing systems shall be determined from Clause 8.3.5.9.

NOTE Ceiling depth is measured parallel to the wind direction being considered.

Where bracing cannot be placed in external walls because of openings or similar situations, a structural diaphragm ceiling may be used to transfer racking forces to bracing walls that can support the loads. Alternatively, wall frames may be designed for portal action.

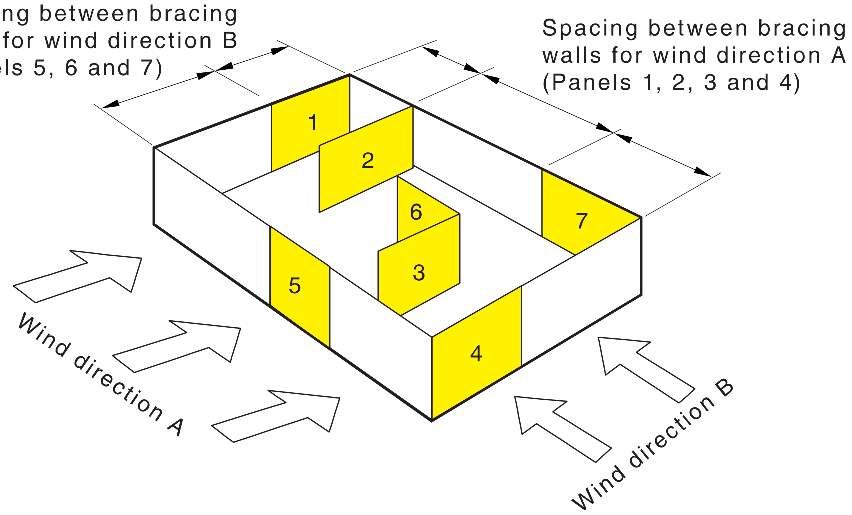


Figure 8.6 — Spacing of bracing

Table 8.20 — Maximum spacing of bracing walls — Wind classification N3

Ceiling depth, m	Maximum bracing wall spacing, m								
	Roof pitch, degrees								
	0	5	10	15	17.5	20	25	30	35
≤ 4	5.9	6.6	7.4	7.5	7	6.4	5.1	4.4	4.2
5	7.4	8.3	9	9	8.6	7.9	6	5	4.7
6	8.9	9	9	9	9	8.8	6.7	5.6	5.1
7	9	9	9	9	9	9	7.1	6.1	5.5
8	9	9	9	9	9	9	7.6	6.7	5.7
9	9	9	9	9	9	9	7.9	7.2	5.9
10	9	9	9	9	9	9	8.4	7.9	6.2
11	9	9	9	9	9	9	8.7	7.9	6.4
12	9	9	9	9	9	9	9	7.9	6.6
13	9	9	9	9	9	9	9	8.1	6.6
14	9	9	9	9	9	9	9	8.3	6.7
15	9	9	9	9	9	9	9	8.4	6.8

Table 8.20 *(continued)*

Ceiling depth, m	Maximum bracing wall spacing, m								
	Roof pitch, degrees								
	0	5	10	15	17.5	20	25	30	35
16	9	9	9	9	9	9	9	8.6	6.9

Table 8.21 — Maximum spacing of bracing walls — Wind classification N4

Ceiling depth, m	Maximum bracing wall spacing, m								
	Roof pitch, degrees								
	0	5	10	15	17.5	20	25	30	35
≤ 4	3.9	4.3	4.9	5	4.6	4.2	3.4	2.9	2.8
5	4.9	5.4	6.1	6.2	5.7	5.2	4	3.3	3.1
6	5.9	6.6	7.3	7.4	6.5	5.8	4.4	3.7	3.4
7	6.9	7.9	8.6	8.3	7.2	6.3	4.7	4	3.7
8	7.9	9	9	9	7.7	6.7	5	4.4	3.8
9	8.8	9	9	9	8.4	7.1	5.2	4.8	3.9
10	9	9	9	9	8.9	7.4	5.5	5.2	4.1
11	9	9	9	9	9	7.7	5.8	5.2	4.2
12	9	9	9	9	9	7.9	5.9	5.2	4.3
13	9	9	9	9	9	8.1	6.1	5.3	4.3
14	9	9	9	9	9	8.2	6.1	5.5	4.4
15	9	9	9	9	9	8.5	6.3	5.5	4.5
16	9	9	9	9	9	8.6	6.5	5.7	4.6

8.3.6.8 External bracing walls under the ends of eaves

External bracing walls under the ends of eaves may be used as bracing walls provided they are suitably connected to the main ceiling diaphragms using appropriate connections such as crossed metal bracing straps to rafter overhangs or sheet bracing to rafter overhangs as shown in Figure 8.7.

Where appropriate, the crossed metal or sheet bracing shall be connected to the bulkhead, to provide continuity of the ceiling diaphragm.

Crossed metal braces in the roofline continue the ceiling diaphragm action to the rafter overhangs.

The same structural requirements that apply to normal external bracing walls shall apply to the external bracing walls under the ends of eaves.

These bracing walls shall be limited to 20 % of the total wall bracing required in each direction.

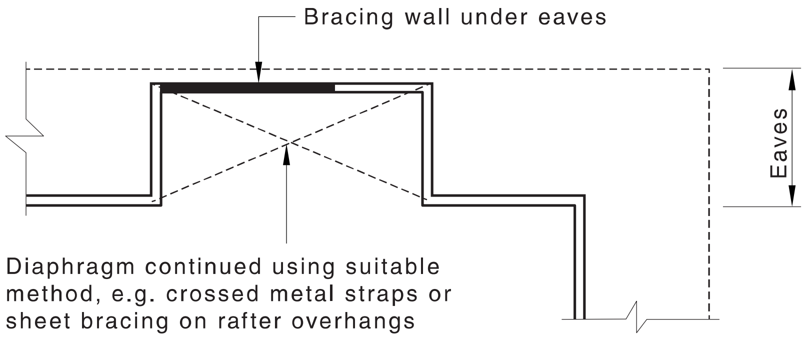


Figure 8.7 — Bracing units under eaves

8.3.6.9 Fixing of top of bracing walls

All internal bracing walls shall be fixed to the floor of lower storey bracing walls, the ceiling or roof frame, and/or the external wall frame, with structural connections of equivalent shear capacity to the bracing capacity of that particular bracing wall.

Nominal and other bracing walls with bracing capacity up to 1.5 kN/m require nominal fixing only, i.e. no additional fixing requirements.

Typical details and shear capacities are specified in Tables 8.22(a) to 8.22(k).

For trussed roofs, where nominal fixings are used, they should permit vertical movement of the trusses, see Tables 8.22(a) and 8.22(i). Where screws or bolts through the top plate are used they shall be placed in holes that permit free vertical movement of the trusses, see Table 8.22 (b).

NOTE 1 The connection required to achieve the necessary shear capacity between bracing walls and the ceiling, roof or external wall frames can be achieved by using individual connections or combinations of connections.

NOTE 2 For an explanation and further information on joint groups (J and JD), as referenced in Tables 8.22(a) to 8.22(k), see Table 9.15, Clause 9.6.5 and Appendix G.

Table 8.22(a) — Fixing of top of bracing walls

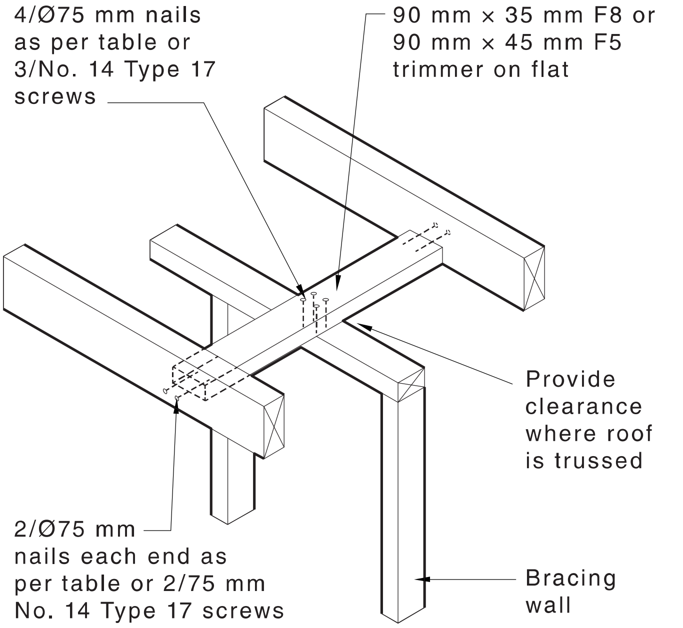
Rafters, joists or trusses to bracing wall		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
		J2	J3	J4	JD4	JD5	JD6
(a) 	Nails						
	3.05	3.0	2.1	1.5	2.1	1.8	1.3
	3.33	3.3	2.4	1.7	2.4	2.0	1.5
	Screws						
	No.14 Type 17	12	8.3	5.9	8.3	5.9	4.3

Table 8.22(b) — Fixing of top of bracing walls

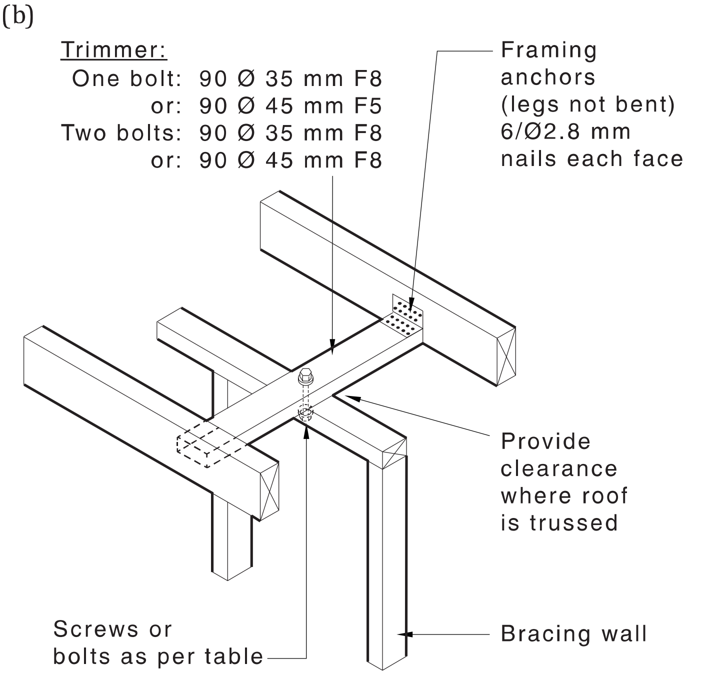
Rafters, joists or trusses to bracing wall		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
		J2	J3	J4	JD4	JD5	JD6
(b) 	Screws						
	1/No.14 Type 17	4.8	3.5	2.5	3.5	2.5	1.8
	2/No.14 Type 17	9.7	6.9	4.9	6.9	4.9	3.6
	3/No.14 Type 17	13	9.3	6.6	9.8	7.4	5.4
	Bolts						
	M10	6.4	4.1	2.6	4.3	3.0	2.0
	M12	7.6	4.9	3.1	5.1	3.6	2.5
	2/M10	12	8.0	5.1	8.4	5.9	4.0
	2/M12	13	9.3	6.1	9.8	7.0	4.9

Table 8.22(c) — Fixing of top of bracing walls

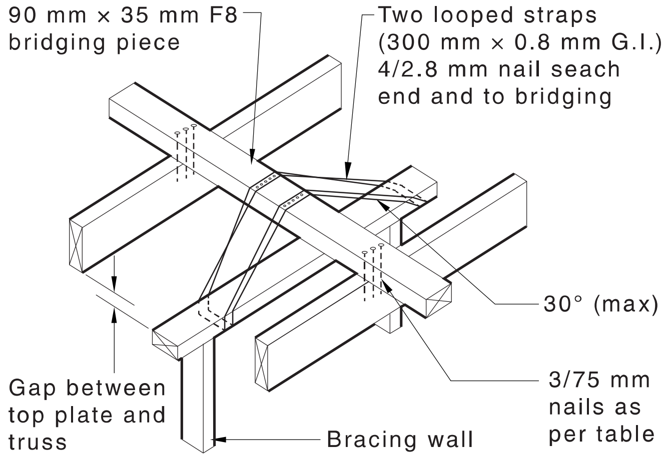
<table>
<tr><th rowspan="3" colspan="2">Rafters, joists or trusses to bracing wall</th><th colspan="6">Shear capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="3">(c)

</td><td colspan="7">Nails</td></tr>
<tr><td>3.05⌀</td><td>6.6</td><td>4.7</td><td>3.4</td><td>5.0</td><td>4.2</td><td>3.1</td></tr>
<tr><td>3.33⌀</td><td>7.4</td><td>5.3</td><td>3.7</td><td>5.5</td><td>4.6</td><td>3.5</td></tr>
</table>

Table 8.22(d) — Fixing of top of bracing walls

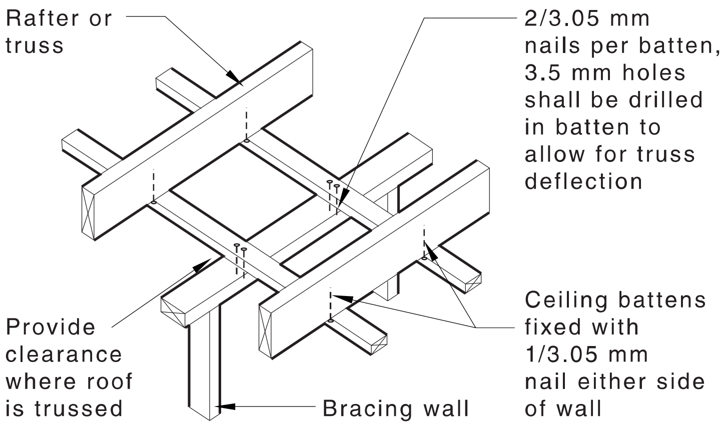
<table>
<tr><th rowspan="3">Rafters, joists or trusses to bracing wall</th><th colspan="6">Shear capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td>(d)

</td><td>2.5</td><td>1.8</td><td>1.3</td><td>1.8</td><td>1.5</td><td>1.1</td></tr>
</table>

Table 8.22(e) — Fixing of top of bracing walls

Rafters, joists or trusses to bracing wall		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
		J2	J3	J4	JD4	JD5	JD6
(e)	Nails						
	4/3.05	5.0	3.6	2.5	3.6	3.0	2.2
	6/3.05	6.6	4.7	3.4	5.0	4.2	3.1
	4/3.33	5.6	4.0	2.8	4.0	3.3	2.5
	6/3.33	7.4	5.3	3.7	5.5	4.6	3.5
	Bolts						
	M10	6.4	4.1	2.6	4.3	3.0	2.0
	M12	7.6	4.9	3.1	5.1	3.6	2.5
	2/M10	13	8.0	5.1	8.4	5.9	4.0
	Screws						
	2/No.14 Type 17	9.7	6.9	4.9	6.9	4.9	3.6
	3/No.14 Type 17	13	9.2	6.6	9.8	7.4	5.4

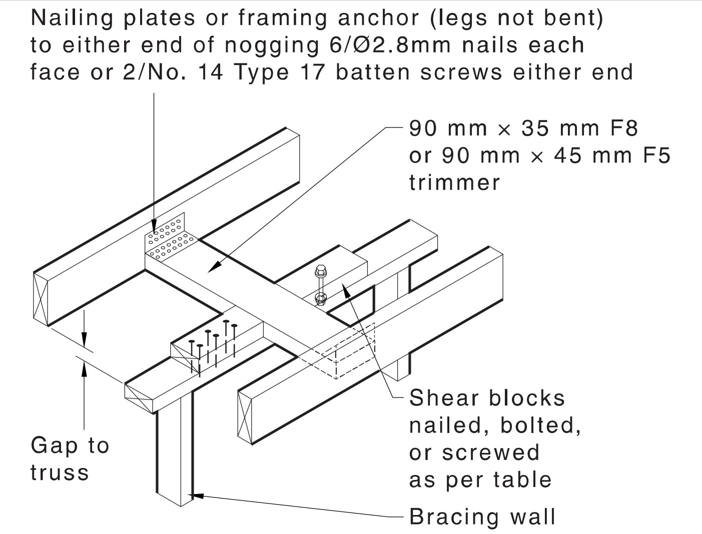


Table 8.22(f) — Fixing of top of bracing walls

Rafters, joists or trusses to bracing wall	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
	J2	J3	J4	JD4	JD5	JD6
(f)	6.5	4.6	3.3	4.9	4	3.1

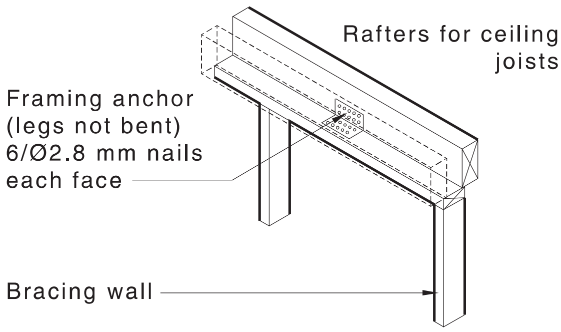
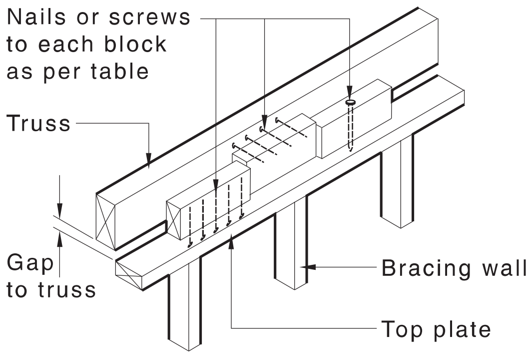


Table 8.22(g) — Fixing of top of bracing walls

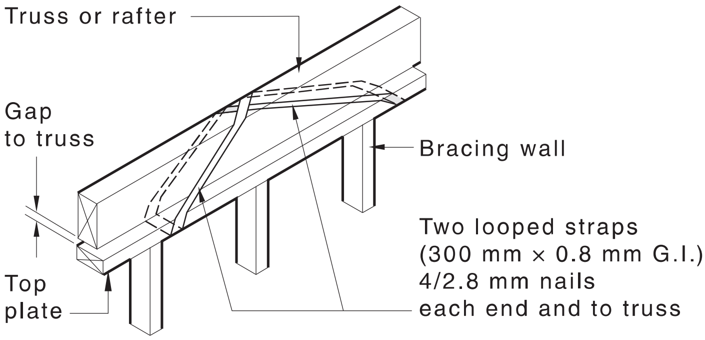
(g)



Rafters, joists or trusses to bracing wall	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
	J2	J3	J4	JD4	JD5	JD6
Nails						
4/3.05	5.0	3.6	2.5	3.6	3.0	2.2
6/3.05	6.6	4.7	3.4	5.0	4.2	3.1
4/3.33	5.6	4.0	2.8	4.0	3.3	2.5
6/3.33	7.4	5.3	3.7	5.5	4.6	3.5
Screws						
2/No.14 Type 17	9.7	6.9	4.9	6.9	4.9	3.6
3/No.14 Type 17	15	10	7.4	10	7.4	5.4

Table 8.22(h) — Fixing of top of bracing walls

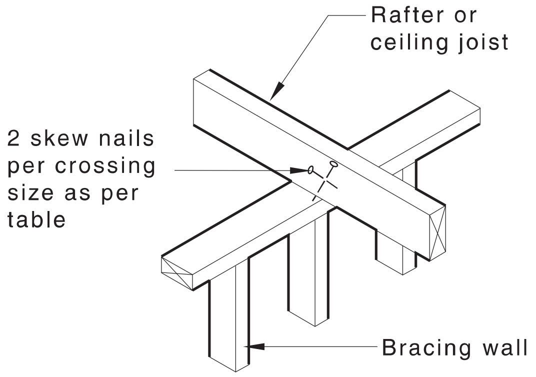
(h)



Rafters, joists or trusses to bracing wall	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
	J2	J3	J4	JD4	JD5	JD6
(h)	8.7	6.2	4.4	6.6	5.4	4.1

Table 8.22(i) — Fixing of top of bracing walls

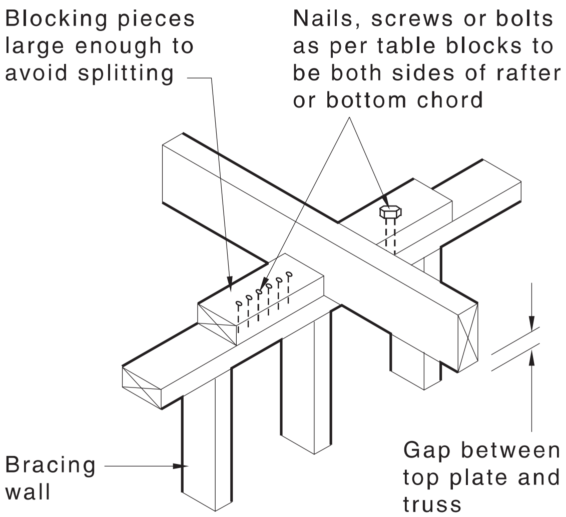
(i)



Rafters, joists or trusses to bracing wall	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
	J2	J3	J4	JD4	JD5	JD6
Nails						
2/3.05	1.4	1.1	0.77	1.1	0.90	0.66
2/3.33	1.7	1.2	0.85	1.2	1.0	0.75

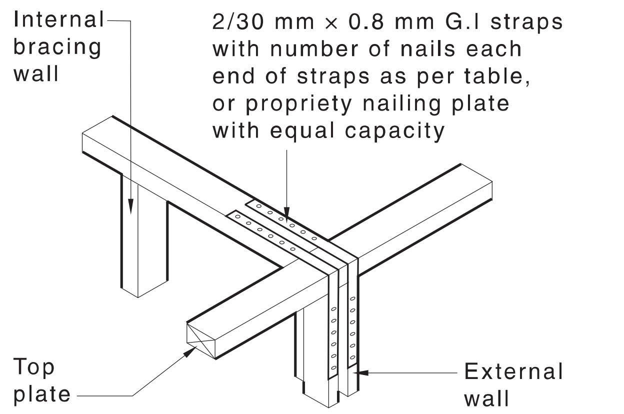
Table 8.22(j) — Fixing of top of bracing walls

(j)



Rafters, joists or trusses to beacing wall	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
	J2	J3	J4	JD4	JD5	JD6
Nails						
4/3.05	5.0	3.6	2.5	3.6	3.0	2.2
6/3.05	6.6	4.7	3.4	5.0	4.2	3.1
4/3.33	5.6	4.0	2.8	4.0	3.3	2.5
6/3.33	7.4	5.3	3.7	5.5	4.6	3.5
Bolts						
M10	6.4	4.1	2.6	4.3	3.0	2.0
M12	7.6	4.9	3.1	5.1	3.6	2.5
2/M10	13	8.0	5.1	8.4	5.9	4.0
Screws						
2/No.14 Type17	9.7	6.9	4.9	6.9	4.9	3.6
3/No.14 Type17	15	10	7.4	10	7.4	5.4

Table 8.22(k) — Fixing of top of bracing walls

<table>
<tr><th colspan="3" rowspan="3">Rafters, joists or trusses to bracing wall</th><th colspan="6">Shear capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="5">(k)

</td><td>Straps</td><td>Nails</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">1</td><td>4/2.8</td><td>4.3</td><td>3.1</td><td>2.2</td><td>3.3</td><td>3.0</td><td>2.1</td></tr>
<tr><td>6/2.8</td><td>6.5</td><td>4.6</td><td>3.3</td><td>4.9</td><td>4.0</td><td>3.1</td></tr>
<tr><td rowspan="2">2</td><td>4/2.8</td><td>8.7</td><td>6.2</td><td>4.4</td><td>6.6</td><td>5.4</td><td>4.1</td></tr>
<tr><td>6/2.8</td><td>13</td><td>9.3</td><td>6.6</td><td>9.8</td><td>8.1</td><td>6.1</td></tr>
</table>

8.3.6.10 Fixing of bottom of bracing walls

The bottom plate of timber-framed bracing walls shall be fixed at the ends of the bracing panel and, if required, intermediately to the floor frame or concrete slab with connections determined from Table 8.18.

NOTE Table 8.18 nominates that bracing systems with a racking capacity up to 3.4 kN/m only require nominal fixing of the bottom plate to the floor frame or slab. This concession is based on outcomes from whole house testing programs together with post-wind damage assessments of the performance of bracing in housing.

Where bottom plate fixing information is not given in Table 8.18, the bottom plates shall be fixed at the ends of each bracing panel using tie-down fixings determined from Table 8.23 and Table 8.24.

For bracing wall systems of capacity 5.2 kN/m or greater given in Table 8.18, which do not specify intermediate bottom plate fixings, additional intermediate bottom plate fixings of a minimum of 1/M10 bolt, or 2/No. 14 Type 17 screws, at max. 1 200 mm centres shall be used.

Details included in Table 9.18 may also be used to fix bottom plates to timber-framed floors where their uplift capacities are appropriate.

The bracing wall tie-down details in Table 9.18 are not required where tie-down walls are provided and the tie-down connections used are equivalent in capacity to those determined for the bracing wall from Table 8.24.

Where bracing systems require more fixings or stronger fixings than determined from Tables 8.23 and 8.24, such systems shall be used.

Nominal bracing walls require nominal fixing only, i.e. no additional fixing requirements.

Table 8.23 — Uplift force at ends of bracing walls

Wall height, mm	Uplift force at ends of bracing walls, kN											
	For bracing walls rated at (kN/m) capacity											
	1	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**8**	**10**
2 400	2.4	3.6	4.8	6.0	7.2	8.4	10	11	12	13	14	19	24
2 700	2.7	4.1	5.4	6.8	8.1	9.5	11	12	14	15	16	22	27
3 000	3.0	4.5	6.0	7.5	9.0	11	12	14	15	17	18	24	30

NOTE 1 Some bracing wall systems require fixings to be full-length anchor rods, i.e. from the top plate to the floor frame or concrete slab.

NOTE 2 The maximum tension load of 8.5 kN given in the Notes to Span Tables for studs in the Supplements is not applicable when considering the uplift force at the ends of bracing walls.

NOTE 3 Where provided, the bottom plate tie-down details given in Table 8.18 may be used in lieu of the details determined from Tables 8.23 and 8.24.

Table 8.24(a) — Fixing of bottom of bracing walls

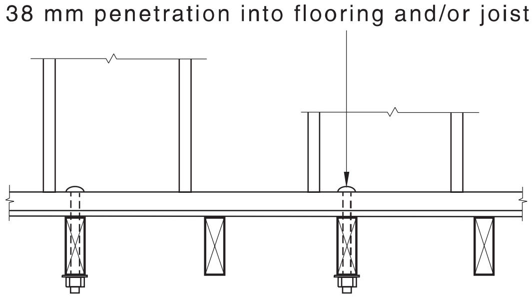
<table>
<tr><th rowspan="3" colspan="2">Fixing details</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="2">(a)
M10 cup-head bolts or No. 14 Type 17 batten screws as per table, with min. 38 mm penetration into flooring and/or joist
</td><td>M10 cuo-head</td><td>16</td><td>14</td><td>10</td><td>10</td><td>7</td><td>5</td></tr>
<tr><td>2/No.14 Type17 screws</td><td>11</td><td>8.4</td><td>4.8</td><td>9.0</td><td>7.2</td><td>5.4</td></tr>
</table>

Table 8.24(b) — Fixing of bottom of bracing walls

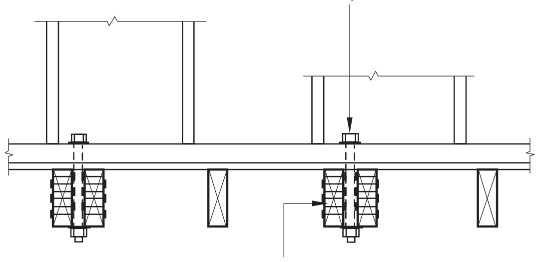
<table>
<tr><th rowspan="3" colspan="2">Fixing details</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="2">(b)
Bolts as per table

Double joist or 450 mm long full depth cleat nailed to joist with 6/75 mm × Ø3.15 mm nails</td><td>M10 bolt</td><td>18</td><td>18</td><td>18</td><td>15</td><td>12</td><td>9</td></tr>
<tr><td>M12 bolt</td><td>27</td><td>27</td><td>26</td><td>20</td><td>16</td><td>12</td></tr>
</table>

Table 8.24(c) — Fixing of bottom of bracing walls

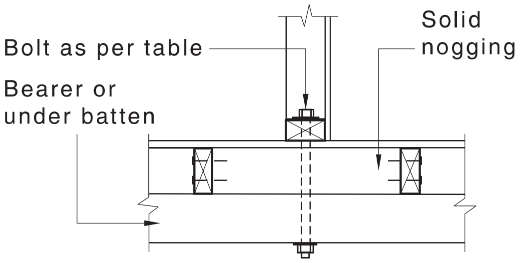
Fixing details		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
		J2	J3	J4	JD4	JD5	JD6
(c) 	M10 bolt	18	18	18	15	12	9.0
	M12 bolt	27	27	26	20	16	12

Table 8.24(d) — Fixing of bottom of bracing walls

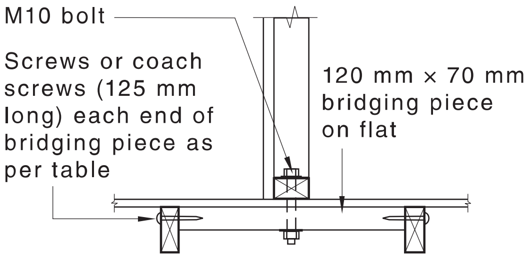
Fixing details		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
		J2	J3	J4	JD4	JD5	JD6
(d) 	2/No. 14 Type 17 screws	12	8.3	5.9	8.3	5.9	4.3
	3/No. 14 Type 17 screws	17	13	9.0	13.	9.0	7.0
	2/M12 coach screws	18	18	13	15	12	9.0

Table 8.24(e) — Fixing of bottom of bracing walls

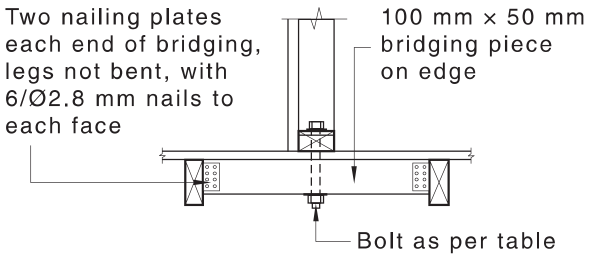
Fixing details		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
		J2	J3	J4	JD4	JD5	JD6
(e) 	M10 bolt	18	16	11	15	12	9
	M12 bolt	22	16	11	18	15	11

Table 8.24(f) — Fixing of bottom of bracing walls

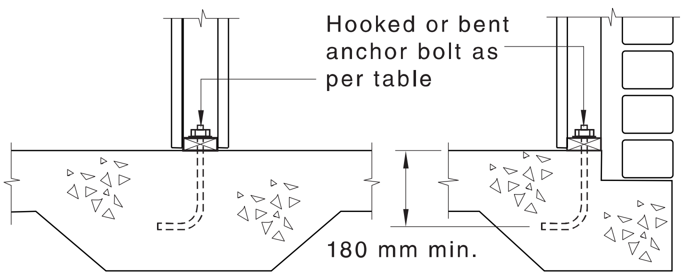
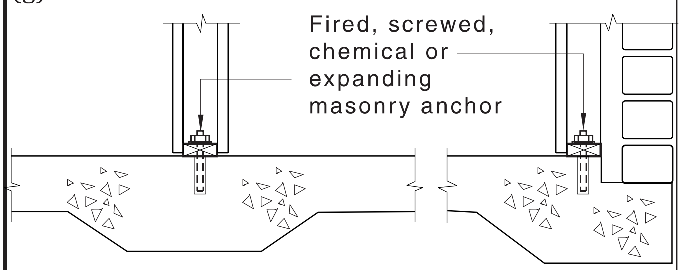
Fixing details		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
		J2	J3	J4	JD4	JD5	JD6
(f) 	M12 bolt	27	27	26	20	16	12

Table 8.24(g) — Fixing of bottom of bracing walls

Fixing details	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
	J2	J3	J4	JD4	JD5	JD6
(g) 	Refer to manufacturer's specifications					

8.3.7 Roof bracing

8.3.7.1 Pitched roofs (coupled and non-coupled roofs)

The following shall apply to the bracing of pitched roofs:

(a) *Hip roofs* — Hip roofs shall not require any specific bracing as they are restrained against longitudinal movement by hips, valleys and similar structures.

(b) *Gable roofs (including cathedral roofs)* — For wind classifications up to N2, gable roof buildings with a roof pitch greater than 10° but less than 25° shall be provided with roof bracing in accordance with Clause 8.3.7.2. Alternatively, for wind classifications up to N4 and roof pitches to 35°, bracing shall be in accordance with Tables 8.25 and 8.26, and the following:

(i) *Ridge to internal wall* — minimum of two timber braces in opposing directions at approximately 45°, see Tables 8.25 and 8.26.

(ii) *Diagonal metal bracing* — single or double diagonal bracing to be designed and installed in accordance with engineering principles.

Table 8.25 — Gable roof bracing — Gable strut size and grade

Wind classification	Stress grade	Width of gable roof, mm											
		6 000			9 000			12 000			15 000		
		Roof pitch, degrees											
		0 to 15	16 to 25	26 to 35	0 to 15	16 to 25	26 to 35	0 to 15	16 to 25	26 to 35	0 to 15	16 to 25	26 to 35
N1/N2	F5 or MGP10	70 × 35	70 × 45	2/90 × 35	70 × 45	2/90 × 45	3/120 × 45	2/90 × 35	3/120 × 35	NS	3/90 × 35	NS	NS
	F14 or MGP15	70 × 35	70 × 35	70 × 45	70 × 35	70 × 45	2/90 × 45	70 × 45	2/90 × 45	3/120 × 35	2/90 × 35	3/120 × 35	NS
N3	F5 or MGP10	70 × 35	70 × 45	2/90 × 45	70 × 45	3/90 × 35	3/120 × 45	2/90 × 45	3/120 × 45	NS	3/90 × 35	NS	NS
	F14 or MGP15	70 × 35	70 × 35	2/70 × 35	70 × 35	2/90 × 35	2/120 × 45	70 × 45	2/120 × 45	3/140 × 45	2/90 × 45	3/90 × 45	NS
N4	F5 or MGP10	70 × 35	2/90 × 35	2/120 × 45	2/70 × 35	3/120 × 35	NS	3/120 × 35	NS	NS	3/120 × 45	NS	NS
	F14 or MGP15	70 × 35	70 × 35	2/90 × 35	70 × 45	2/70 × 45	3/90 × 45	2/70 × 45	3/120 × 35	NS	3/90 × 35	3/140 × 45	NS

NOTE NS = not suitable. Seek engineering advice.

Table 8.26 — Gable roof struts and connections at ends of struts

Stress grade of strut	Strut size, mm	End connection
F5 or MGP10	70 × 35 to 70 × 45	4/3.33 dia. nails or 1/No. 14 Type 17 screw
	2/90 × 35 to 2/90 × 45	3/No.14 Type 17 screws or 2/M10 bolts
	3/90 × 35 to 3/120 × 35	2/M12 bolts
	3/90 × 45 to 3/140 × 45	2/M16 bolts
F14 or MGP15	70 × 35 to 70 × 45	3/No. 14 Type 17 screws or 2/M10 bolts
	2/90 × 35 to 2/90 × 45	2/M12 bolts
	3/90 × 35 to 3/120 × 35	2/M16 bolts
	3/90 × 45 to 3/140 × 45	To be designed

8.3.7.2 Gable roofs (including cathedral roofs) for wind classifications up to N2

The following shall apply for gable roofs:

(a) *General* — For buildings with a gable width (excluding eaves overhangs) up to 12 000 mm and a roof pitch greater than 10° but less than 25°, roof bracing shall be provided in accordance with Table 8.27 and the following (see Figure 8.8):

(i) Gable roofs — using either —

(A) ridge to internal wall — minimum of two timber braces in opposing directions at approximately 45° (see Table 8.27); or

(B) ridge to external wall plates — single diagonal timber brace on both sides of the ridge running at approximately 45° from ridge to wall plate, see Table 8.27.

(ii) Diagonal metal bracing, single or double diagonal — designed and installed in accordance with engineering principles.

(iii) Structural sheet bracing — designed and installed in accordance with engineering principles.

The minimum timber grade for gable roof bracing shall be F5.

(b) *Intersection of timber braces* — Where timber braces intersect, they shall be spliced in accordance with Figure 8.9.

Table 8.27 — Gable roof bracing alternatives

Brace location alternative	Brace specification		
	Length, mm	Minimum size, mm	End connection
(a) Ridge to internal wall in opposing directions	Up to 2 100	70 × 45	5/3.05 nails or 4/3.33 ⌀ nails
	Over 2 100 to 2 400	2/90 × 35	M10 cup-head bolt
	Over 2 400 to 3 000	2/90 × 45	M12 cup-head bolt
	Over 3 000 to 4 200	3/120 × 35	2/M10 cup-head bolts
(b) Ridge to external wall plates on both sides of ridge	As required	90 × 19 or 75 × 25 timber or equivalent metal system	5/3.75 nails each end

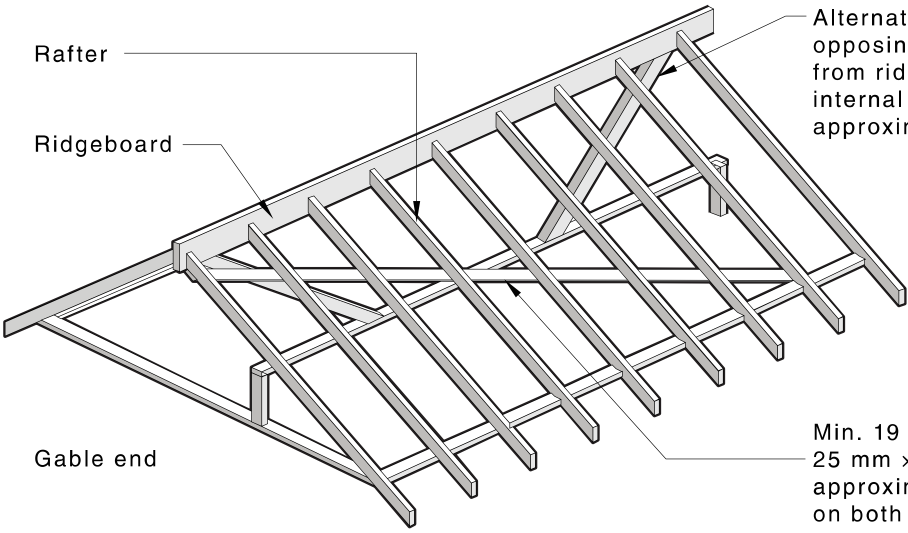


Figure 8.8 — Gable roof bracing

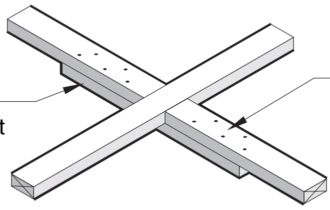


Figure 8.9 — Timber bracing splice

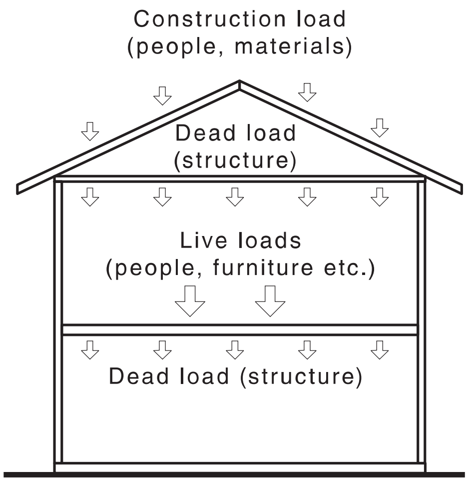
8.3.7.3 Trussed roofs

Bracing requirements for trussed roofs shall be in accordance with AS 4440.

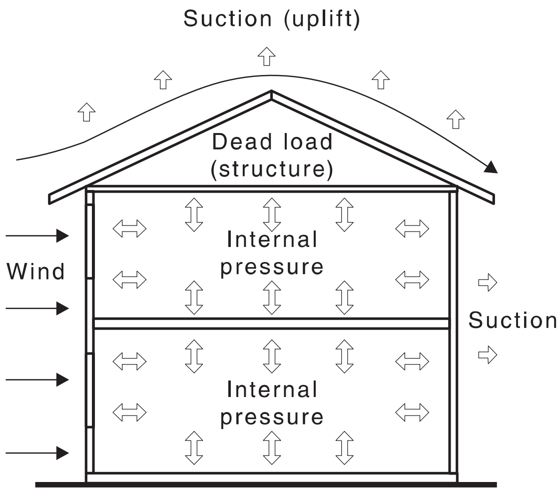
Section 9 Fixings and tie-down design

9.1 General

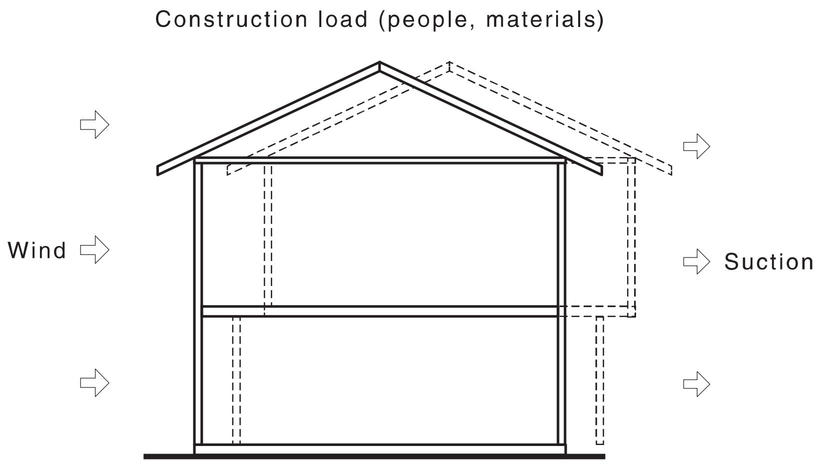
This Section specifies the fixing requirements necessary to ensure the structural adequacy of the interconnection of the various framing members in a house. Figure 9.1 illustrates the typical load actions that are accounted for in this Section.



(a) Gravity loads



(b) Uplift wind loads



(c) Lateral wind loads

Figure 9.1 — Load actions

9.2 General connection requirements

9.2.1 General

The general requirements given in Clauses 9.2.2 to 9.2.9 shall apply to all connections and fixings.

9.2.2 Straps, bolts, screws, coach screws and framing anchors

Straps, bolts, screws, coach screws and framing anchors shall conform to the material requirements of the relevant Australian Standards.

9.2.3 Steel washers

The size of steel washers shall be determined from Table 9.1.

Circular washers of equivalent thickness and with the same net bearing area may also be used to carry the same full design loads. For thinner washers or washers with smaller net bearing areas, the design loads shall be reduced in proportion to the reduction of thickness and net bearing area, i.e. less the hole diameter.

Table 9.1 — Steel washers

Bolt or coach screw diameter, mm	Washer size, mm
M10 cup-head	Standard
M12 cup-head	Standard
M16 cup-head	Standard
M10 bolt or coach screw	38 × 38 × 2.0
M12 bolt or coach screw	50 × 50 × 3.0
M16 bolt or coach screw	65 × 65 × 5.0

9.2.4 Drilling for bolts

Bolt holes in unseasoned timber shall be 2 mm to 3 mm greater in diameter than the bolt diameter, and for seasoned timber they shall be 1 mm to 2 mm greater than the bolt diameter.

Bolt holes in steel shall provide a snug fit, i.e. not more than 0.5 mm greater than the bolt diameter.

9.2.5 Drilling for coach screws

Drilling for coach screws shall be as follows:

(a) Hole for shank — shank diameter + 1 mm.

(b) Hole for thread — root diameter.

9.2.6 Screw and coach screw penetration

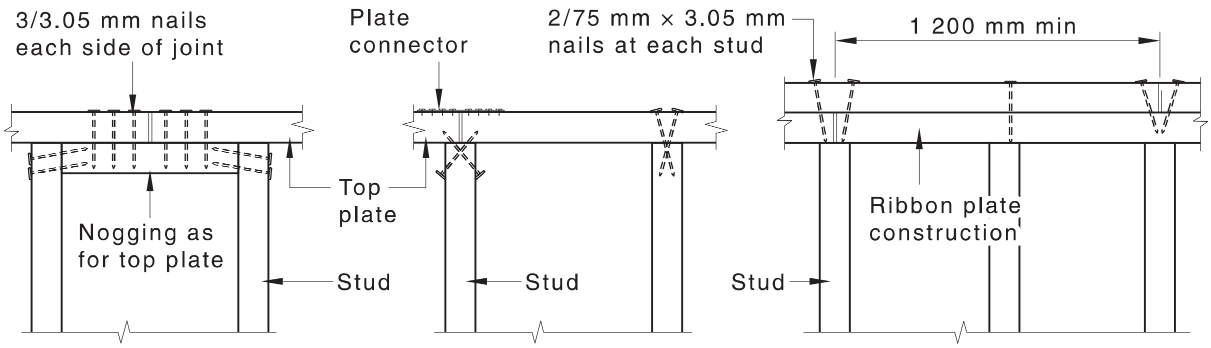
The minimum penetration of the threaded portion of screws and coach screws into the receiving member shall not be less than 35 mm for screws and 5 times the diameter of coach screws, unless otherwise noted.

9.2.7 Framing anchor and strap nails

All nails used for framing anchor and straps shall be corrosion protected flat-head connector nails. Clout shall not be used for this purpose.

9.2.8 Joining of top plates and ring beam

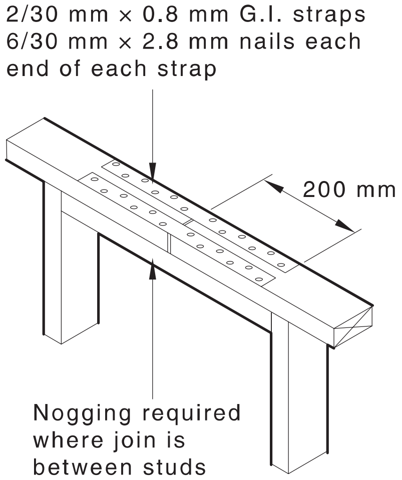
Top plates and ring beam in walls shall be joined by one of the methods shown in Figure 9.2 for the relevant wind classification.



(a) Suitable for wind classifications N1, N2 and N3

(b) Suitable for wind classifications N1 and N2

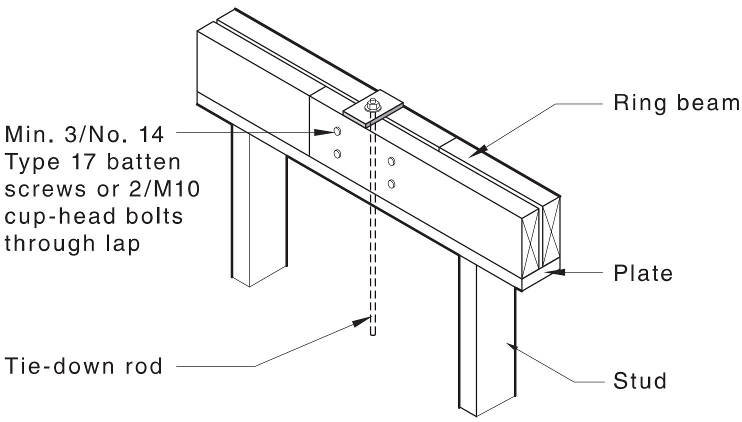
(c) Suitable for wind classifications N1, N2 and N3



(d) Suitable for wind classifications N1 to N4

(e) Suitable for wind classifications N1 to N4

(f) Suitable for wind classifications N1 to N4



(g) Suitable for wind speeds N1 to N4

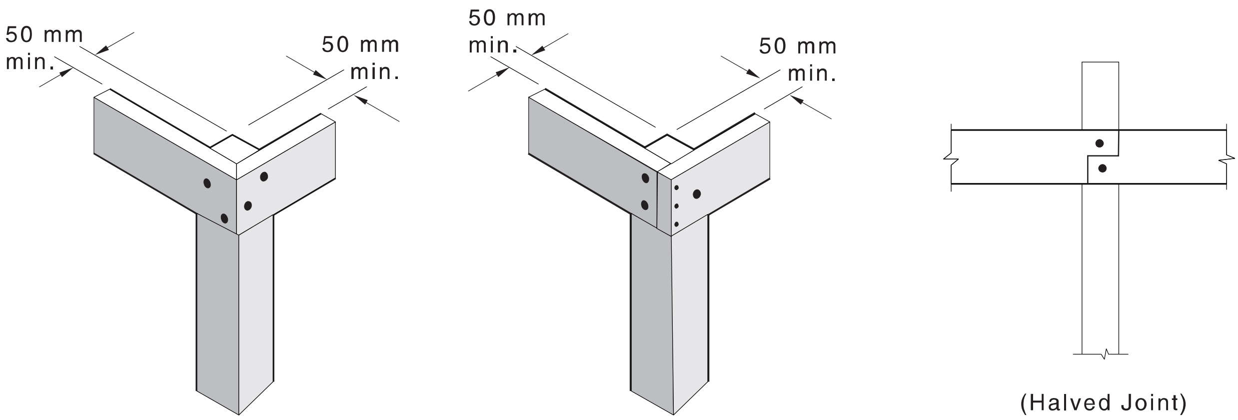
Figure 9.2 — Joining of top plates and ring beams

9.2.9 Tie-down of members joined over supports

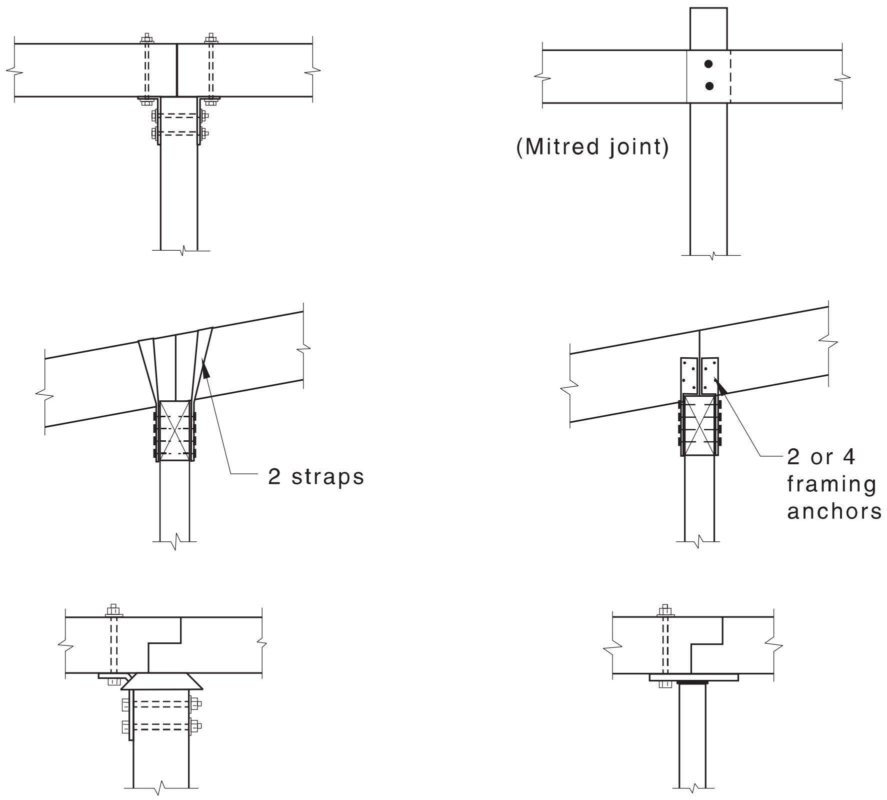
Unless shown or illustrated, the uplift capacities given in the relevant details of Tables 9.16 to 9.25 apply to members that are continuous over supports. Where members are joined over supports, consideration shall be given to the effect of reduced end distances for connectors (bolts, screws, etc.).

Where members are joined over supports, such as shown in Figure 9.3(b), the uplift capacity shall be equal to the uplift capacity as if there were no join over the support as the full strength of the connection is maintained.

NOTE As a general guide, where members are joined over supports, such as shown in Figure 9.3(a), the uplift capacity should be equal to half the uplift for the number of connectors (i.e. bolts) shown as the required end distances are reduced.



(a) Type 1



(b) Type 2

Figure 9.3 — Joining members at supports

9.3 Procedure flow chart

Where required, fixing and tie-down requirements shall be provided in accordance with the procedure set out in Figure 9.4.

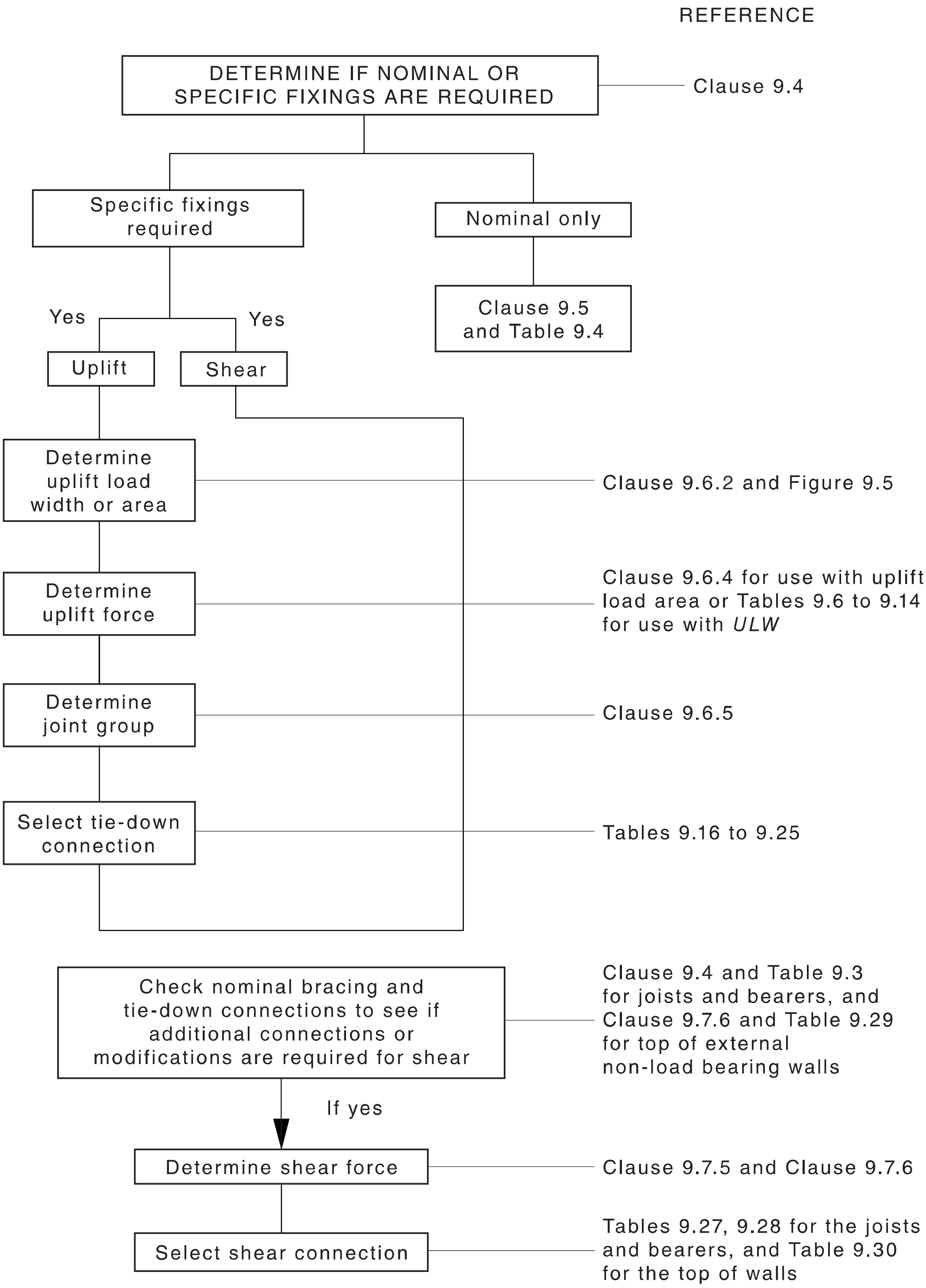


Figure 9.4 — Flow chart showing procedure for tie-down requirements

9.4 Nominal and specific fixing requirements

For all houses and wind speeds, the nominal (minimum) fixing requirements shall be in accordance with Clause 9.5.

As the design gust wind speed increases, additional specific fixings and tie-down connections are required to resist the increased uplift and sliding or lateral forces (shear forces between wall/floor frame and supports) generated by the higher winds. Requirements with respect to resisting racking forces and special fixings for bracing shall be as given in Section 8.

Table 9.2 gives the design situations where either nominal (minimum) fixings or specific fixings are required for a range of wind classifications and various connections in the house with respect to uplift loads.

Table 9.3 gives the design situations where either nominal (minimum) fixings or specific fixings are required for a range of wind classifications and various connections in the house with respect to lateral (shear) loads.

Table 9.2 — Uplift

Connection	Wind classification							
	N1		N2		N3		N4	
	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof
Roof battens to rafters/trusses								
— within 1 200 mm of edges	S	S	S	S	S	S	S	S
— general area	S	S	S	S	S	S	S	
Single or upper storey rafters/trusses to wall frames, floor frame or slab	S	N	S	N	S	S	S	S
Single or upper storey floor frame to supports	N	N	N	N	S	S	S	S
Lower storey wall frame to floor frame or slab	N	N	N	N	S	S	S	S
Lower storey floor frame to supports	N	N	N	N	N	N	S	S

NOTE 1 *N* = nominal (minimum) connection only (see Clause 9.5).

NOTE 2 S = specific connection may be required for uplift forces (see Clause 9.6).

Table 9.3 — Shear

Connection	Wind classification		
	N1 and N2	N3	N4
Bottom plate to slab	N	N	N at 900 mm max. centres
Joists to bearers	N	N	S
Bearers to stumps	N	S	S

NOTE 1 *N* = nominal (minimum) connection only (see Clause 9.5).

NOTE 2 S = specific connection may be required for shear forces (see Clauses 9.7.5 and 9.7.6).

9.5 Nominal fixings (minimum fixings)

Unless otherwise specified, the minimum diameter of machine-driven nails shall be 3.05 mm for hardwood and cypress and 3.33 mm for softwood framing. Machine-driven nails shall be plastic polymer (glue) coated or annular or helical deformed shank nails. Where the nail length is not specified in this standard, the minimum depth of penetration into the final receiving member shall be 10 times the nail diameter where driven into side grain or 15 times the nail diameter where driven into end grain. Unless otherwise specified herein, not less than two nails shall be provided at each joint.

Where plain shank hand-driven nails are used in lieu of machine-driven nails, they shall be a minimum diameter of 3.15 mm for hardwood and cypress and 3.75 mm for softwood and other low-density timber.

Nails used in joints that are continuously damp or exposed to the weather shall be hot-dip galvanized, stainless steel or monel metal. The nominal (minimum) fixings for most joints are given in Table 9.4.

Table 9.4 — Nominal fixings for timber members

Joint		Minimum fixing for each joint
Floor framing		
Bearer to timber stump/post		4/75 mm × 3.33 mm or 5/75 mm × 3.05 mm machine-driven nails plus 1/30 mm × 0.8 mm G.I. strap over bearer and fixed both ends to stump with 4/2.8 mm dia. each end; OR 1/M10 bolt through bearer halved to stump; OR 1/M12 cranked bolt fixed vertically through bearer and bolted to stump plus 4/75 mm × 3.33 mm or 5/75 mm × 3.05 mm machine-driven nails
Bearer to masonry column/wall/pier (excluding masonry veneer construction)		1/M10 bolt or 1/50 mm × 4 mm mild steel bar fixed to bearer with M10 bolt and cast into masonry (to footing)
Bearer to supports (masonry veneer construction)		No requirement
Bearer to concrete stump/post		1/6 mm dia. rod cast into stump, vertically through bearer and bent over
Bearers to steel post		1/M10 coach screw or bolt
Floor joist to bearer		2/75 mm × 3.05 mm dia. nails
Wall framing		
Plates to studs and plates to ring beams at 600 mm max. centres		Plates up to 38 mm thick — 2/75 mm × 3.05 mm nails through plate; Plates 38 mm to 50 mm thick — 2/90 mm × 3.05 mm nails through plate; OR 2/75 mm × 3.05 mm nails skewed through stud into plate
Noggings to studs		2/75 mm × 3.05 mm nail skewed or through nailed
Timber braces to studs or plates/ring beams		2/50 mm × 2.8 mm dia. nails at each joint
Lintel to jamb stud		2/75 mm × 3.05 mm dia. nails at each joint
Bottom plates to joists	Non-loadbearing and non-bracing walls	2/2.8 mm dia. nails at max. 600 mm centres
	Other walls	Plates up to 38 mm thick — 2/75 mm × 3.05 mm nails at max. 600 mm centres Plates 38 to 50 mm thick — 2/90 mm × 3.05 mm nails at max. 600 mm centres
Bottom plates to concrete slab		One 75 mm masonry nail (hand-driven at slab edge), screw or bolt at not more than 1 200 mm centres
Ribbon plate to top plate		See Clause 2.5 and Clause 9.2.8
Multiple studs		1/75 mm × 3.05 mm nail at 600 centres max.
Posts to bearers or joists		1/M12 or 2/M10 bolts (unless otherwise specified)
Roof framing		
Roof trusses to top plates/ring beams	Standard trusses	See Clause 1.12; One framing anchor with three nails to each leg; OR 1/30 mm × 0.8 mm G.I. strap over truss with strap ends fixed to plate with 3/2.8 mm dia. nails plus 2/75 mm skew nails
	Girder trusses	In accordance with Clause 9.6.4
Rafters to top plates/ring beams	Coupled roofs	2/75 mm skew nails plus, where adjoining a ceiling joist of — 38 mm thick — 2/75 mm nails; OR 50 mm thick — 2/90 mm nails, fixing joist to rafter
	Non-coupled roofs	2/75 mm skew nails
Rafter to ridge		2/75 mm skew nails

Table 9.4 *(continued)*

Joint	Minimum fixing for each joint
Ceiling joists to top plates	2/75 mm skew nails
Bottom chord of trusses to top plate for non-load bearing bracing walls with capacity up to 1.5 kN/m	2 "L" partition brackets (one each side of bottom chord) at max. 1 200 mm ctrs
Ceiling joists to rafters	In coupled roof construction, 1/75 mm hand-driven nail; OR 2/75 mm × 3.05 mm dia. machine-driven nails
Collar ties to rafters	1/M10 bolt for ties over 4.2 m or 3/75 mm nails for ties up to 4.2 m long
Verandah beams and roof beams to post	1/M12 or 2/M10 bolts (unless otherwise specified for tie-down)
NOTE Nails that are smaller than the nominated size, or other than those described, may be used provided their performance, as determined by testing, indicates they are not inferior to the nail sizes given above.	

9.6 Specific tie-down fixings

9.6.1 General

This Clause provides details for structural connections to resist uplift and shear forces (lateral loads) in floor framing, wall framing and roof framing. Where specific tie-down fixings provide equal or better resistance to gravity or shear loads, then nominal nailing is not required in addition to the specific tie-down fixing.

Continuity of tie-down shall be provided from the roof sheeting to the foundations. Where appropriate, due allowance for the counterbalancing effects of gravity loads may be considered. Where the gravity loads equal or exceed the uplift loads, nominal (minimum) fixings only shall be required unless otherwise noted for shear or racking loads.

For trussed roofs, AS 4440 does not provide specific tie-down details. The details given in this Clause for specific tie-down fixings for standard trussed roofs satisfy the general requirements of AS 4440, which states that the fixing of trusses to the supporting structure shall be in accordance with the approved specification. For other trusses (e.g. girder, TG), refer to appropriate specification.

9.6.2 Uplift load width (*ULW*)

The wind uplift load width (*ULW*) shall be used to determine the tie-down requirements for each structural joint in floor framing, wall framing and roof framing excluding roof battens, as shown in Figure 9.5.

9.6.3 Application

To determine an appropriate structural tie-down detail, the following general steps shall be followed:

(a) Using Figure 9.5 as a guide, determine the appropriate wind uplift load width (*ULW*) for the member or joint under consideration.

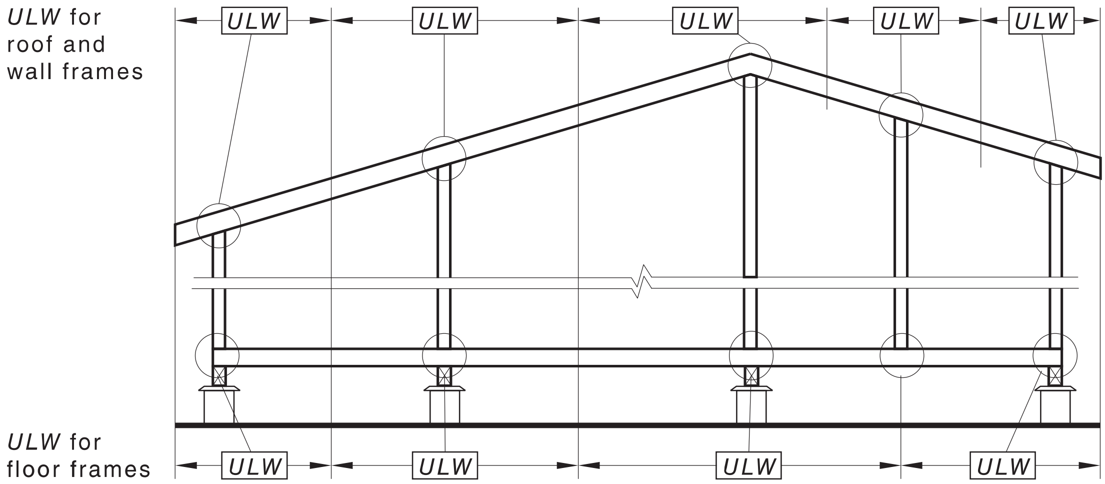
(b) From Table 9.5 or Tables 9.6 to 9.14, determine the uplift forces to be resisted by the joint under consideration.

(c) From Table 9.15 and Figure 9.6, determine the appropriate joint group for the timber in the joint under consideration.

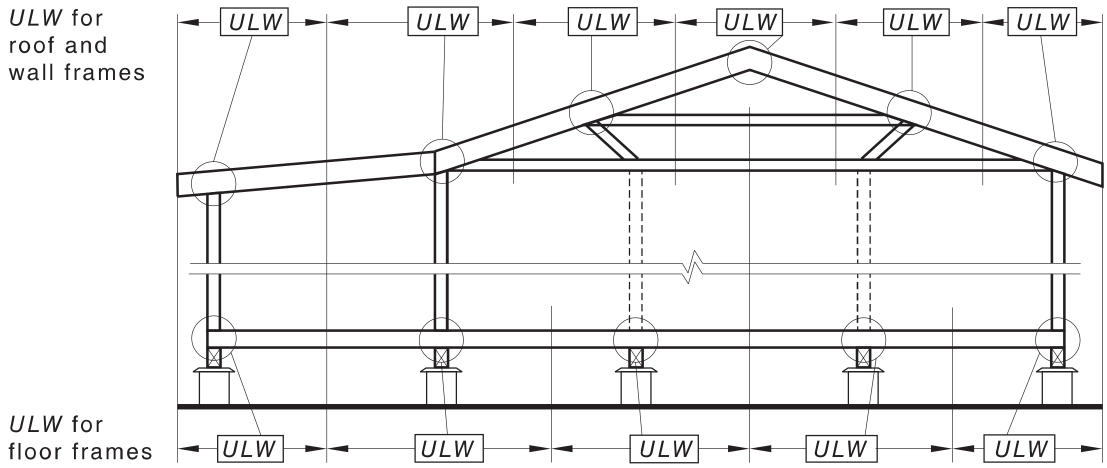
(d) Enter the appropriate design strength from Tables 9.16 to 9.25 and establish a suitable tie-down detail.

NOTE 1 *ULW* for uplift may differ significantly from the *RLW*, *CLW* or *FLW* used for determination of timber member sizes.

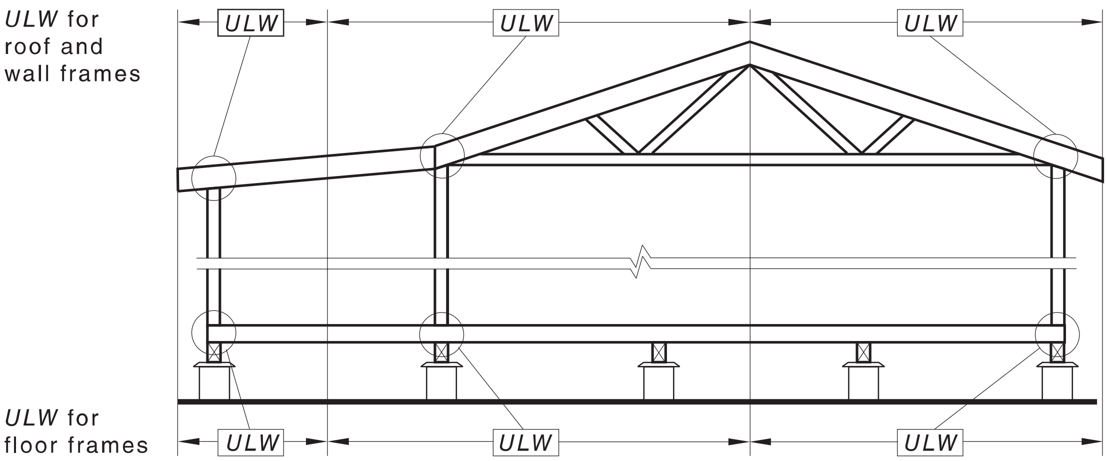
NOTE 2 The tie-down details given in Tables 9.16 to 9.25 are interchangeable for other tie-down positions, i.e. a detail shown for a floor joist to bearer would be equally applicable to use for a rafter to beam connection and vice versa.



(a) Roof beam construction



(b) Traditional raftered construction



(c) Roof truss construction

NOTE 1 To determine *ULW* for floor joists and bearer, consideration should be given to the sharing of uplift load through internal partitions. The *ULW*s shown above for bearers and floor joists illustrate this approximation.

NOTE 2 Circles indicate tie-down points.

NOTE 3 Trusses may be specially designed for tie-down from their ridge or panel points through internal walls.

NOTE 4 For single storey slab on ground construction, the only *ULW*s applicable are those shown for roof and wall frames.

Figure 9.5 — Roof uplift load width (*ULW*) for wind

For wind classifications N1 and N2 coupled sheet roofs, and wind classification N3 coupled tile roofs, roof tie-down may be considered as for trussed roofs with tie-down taken via the roof frame to external walls provided —

(i) collar ties are fixed to rafters with 1/M10 cup-head bolt at max. 1 200 mm centres;

(ii) each pair of rafters is tied together at the ridge using a connection determined using the *ULW* for ridges shown in Figure 9.5(b) and the uplift force determined from Table 9.13;

(iii) each rafter is tied down to the underpurlin using the *ULW* for underpurlins shown in Figure 9.5(b) and the uplift force determined from Table 9.13;

(iv) each rafter is tied down to the external wall frame using the *ULW* for trussed roofs shown in Figure 9.5(c), and the uplift force determined from Table 9.13; and

(v) at hip ends, the rafters supported by the underpurlin shall be tied down to the underpurlin and to the external wall with details similar to the common rafters.

NOTE 3 Tie-down details for rafters to underpurlins and rafters to top plates or wall frame can be selected from any of the appropriate details given in Tables 9.21 or 9.22. Details for tying the rafters together at the ridge can be obtained from Table 9.24(A).

9.6.4 Wind uplift forces

The wind uplift forces that occur at tie-down points may be determined from Table 9.5 by multiplying the net uplift pressure (e.g. allowance for typical dead load deducted) by the area of roof contributing to tie-down at that point, as follows:

Net uplift force = Net uplift pressure × Uplift load width (*ULW*) × Spacing

Alternatively, the forces may be determined directly from Tables 9.6 to 9.14 using roof uplift load width *ULW* (see Figure 9.5) for the respective tie-down positions.

Regarding Table 9.13, where rafters or trusses require specific tie-down, each rafter/truss shall be tied down. Except for openings, the maximum tie-down fixing spacing in wall frames (top plate to bottom plate) shall be 1 800 mm.

Regarding Table 9.14, where ceiling or eaves lining is placed on top of rafters or trusses, or the ceiling or eaves lining does not have sufficient strength to resist internal pressures, or roof cavities are vented to an internal room (e.g. manhole covers not rigidly fixed), the batten to rafter/truss shall be designed for maximum internal pressure. Where ceiling-lining material is structurally sufficient to resist the maximum internal pressure and the ceiling cavity is not vented to internal room pressure, the batten to rafter/truss connection may be designed for partial internal pressure.

Table 9.5 — Net uplift pressure, kPa

Connection/tie-down position	Wind classification							
	N1		N2		N3		N4	
	Sheet	Tile	Sheet	Tile	Sheet	Tile	Sheet	Tile
Roof battens to rafters/trusses								
— within 1 200 mm of edges	1.31	0.91	1.84	1.44	2.92	2.52	4.39	3.99
— general area	0.68	0.28	0.98	0.58	1.57	1.17	2.38	1.98
Single or upper storey rafters/trusses to wall frames and wall plates to studs, floor frame or slab	0.44	—	0.74	0.14	1.33	0.93	2.14	1.74
Single or upper storey bottom plates to floor frame or slab	0.12	—	0.42	—	1.01	0.61	1.82	1.42
Single or upper storey floor frame to supports	—	—	—	—	1.01	0.61	1.82	1.42
Lower storey wall frame to floor frame or slab	—	—	—	—	1.01	0.61	1.82	1.42
Lower storey floor frame to supports	—	—	—	—	—	—	1.0	1.0

NOTE The shaded values make allowance for overturning forces, which dictate rather than direct uplift.

Table 9.6 — Net uplift force — Lower storey bearers — To columns, stumps, piers or masonry supports

Wind uplift load width (*ULW*), mm	Fixing spacing, mm	Uplift force, kN							
		Wind classification							
		N1		N2		N3		N4	
		Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1 500	1 800	N	N	N	N	N	N	2.7	2.7
	2 400	N	N	N	N	N	N	3.6	3.6
	3 000	N	N	N	N	N	N	4.5	4.5
	3 600	N	N	N	N	N	N	5.4	5.4
	4 200	N	N	N	N	N	N	6.3	6.3
3 000	1 800	N	N	N	N	N	N	5.4	5.4
	2 400	N	N	N	N	N	N	7.2	7.2
	3 000	N	N	N	N	N	N	9.0	9.0
	3 600	N	N	N	N	N	N	10	10
	4 200	N	N	N	N	N	N	12	12
4 500	1 800	N	N	N	N	N	N	8.1	8.1
	2 400	N	N	N	N	N	N	10	10
	3 000	N	N	N	N	N	N	13	13
	3 600	N	N	N	N	N	N	16	16
	4 200	N	N	N	N	N	N	18	18
6 000	1 800	N	N	N	N	N	N	10	10
	2 400	N	N	N	N	N	N	14	14
	3 000	N	N	N	N	N	N	18	18
	3 600	N	N	N	N	N	N	21	21
	4 200	N	N	N	N	N	N	25	25
7 500	1 800	N	N	N	N	N	N	13	13
	2 400	N	N	N	N	N	N	18	18
	3 000	N	N	N	N	N	N	22	22
	3 600	N	N	N	N	N	N	27	27
	4 200	N	N	N	N	N	N	31	31

NOTE 1 Interpolation within the Table is permitted.

NOTE 2 *N* = nominal (minimum) connection only, see Clause 9.5.

Table 9.7 — Net uplift force — Floor joists — Lower storey of two storeys — To bearers or supports

Wind uplift load width (*ULW*), mm	Fixing spacing, mm	Uplift force, kN							
		Wind classification							
		N1		N2		N3		N4	
		Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1 500	450	N	N	N	N	N	N	0.68	0.68
	600	N	N	N	N	N	N	0.90	0.90
	900	N	N	N	N	N	N	1.3	1.3
	1 200	N	N	N	N	N	N	1.8	1.8
	1 350	N	N	N	N	N	N	2.0	2.0
3 000	450	N	N	N	N	N	N	1.3	1.3
	600	N	N	N	N	N	N	1.8	1.8
	900	N	N	N	N	N	N	2.7	2.7
	1 200	N	N	N	N	N	N	3.6	3.6
	1 350	N	N	N	N	N	N	4.0	4.0
4 500	450	N	N	N	N	N	N	2.0	2.0
	600	N	N	N	N	N	N	2.7	2.7
	900	N	N	N	N	N	N	4.0	4.0
	1 200	N	N	N	N	N	N	5.4	5.4
	1 350	N	N	N	N	N	N	6.0	6.0
6 000	450	N	N	N	N	N	N	2.7	2.7
	600	N	N	N	N	N	N	3.6	3.6
	900	N	N	N	N	N	N	5.4	5.4
	1 200	N	N	N	N	N	N	7.2	7.2
	1 350	N	N	N	N	N	N	8.1	8.1
7 500	450	N	N	N	N	N	N	3.3	3.3
	600	N	N	N	N	N	N	4.5	4.5
	900	N	N	N	N	N	N	6.7	6.7
	1 200	N	N	N	N	N	N	9.0	9.0
	1 350	N	N	N	N	N	N	10	10

NOTE 1 Interpolation within the Table is permitted.

NOTE 2 *N* = nominal (minimum) connection only, see Clause 9.5.

Table 9.8 — Net uplift force — Wall frame — Lower storey of two storeys — To floor frame or slab

Wind uplift load width (*ULW*), mm	Fixing spacing, mm	Uplift force, kN							
		Wind classification							
		N1		N2		N3		N4	
		Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1 500	450	N	N	N	N	0.41	0.68	0.96	1.2
	600	N	N	N	N	0.55	0.91	1.2	1.6
	900	N	N	N	N	0.82	1.3	1.9	2.4
	1 200	N	N	N	N	1.1	1.8	2.5	3.2
	1 350	N	N	N	N	1.2	2.0	2.8	3.6
	1 800	N	N	N	N	1.6	2.7	3.8	4.9
	3 000	N	N	N	N	2.7	4.5	6.3	8.1
3 000	450	N	N	N	N	0.82	1.3	1.9	2.4
	600	N	N	N	N	1.1	1.8	2.5	3.2
	900	N	N	N	N	1.6	2.7	3.8	4.9
	1 200	N	N	N	N	2.2	3.6	5.1	6.5
	1 350	N	N	N	N	2.4	4.0	5.7	7.3
	1 800	N	N	N	N	3.2	5.4	7.6	9.8
	3 000	N	N	N	N	5.4	9.0	12	16
4 500	450	N	N	N	N	1.2	2.0	2.8	3.6
	600	N	N	N	N	1.6	2.7	3.8	4.9
	900	N	N	N	N	2.4	4.0	5.7	7.3
	1 200	N	N	N	N	3.2	5.4	7.6	9.8
	1 350	N	N	N	N	3.7	6.1	8.6	11
	1 800	N	N	N	N	4.9	8.1	11	14
	3 000	N	N	N	N	8.2	13	19	24
6 000	450	N	N	N	N	1.6	2.7	3.8	4.9
	600	N	N	N	N	2.2	3.6	5.1	6.5
	900	N	N	N	N	3.2	5.4	7.6	9.8
	1 200	N	N	N	N	4.3	7.2	10	13
	1 350	N	N	N	N	4.9	8.1	11	14
	1 800	N	N	N	N	6.5	10	15	19
	3 000	N	N	N	N	10	18	25	32
7 500	450	N	N	N	N	2.0	3.4	4.7	6.1
	600	N	N	N	N	2.7	4.5	6.3	8.1
	900	N	N	N	N	4.1	6.8	9.5	12
	1 200	N	N	N	N	5.4	9.0	12	16
	1 350	N	N	N	N	6.1	10	14	18
	1 800	N	N	N	N	8.2	13	19	24
	3 000	N	N	N	N	13	22	31	40

NOTE 1 Interpolation within the Table is permitted.

NOTE 2 *N* = nominal (minimum) connection only, see Clause 9.5.

Table 9.9 — Net uplift force — Bearers — Single storey or upper storey — To columns, stumps, piers, or masonry supports

Wind uplift load width (*ULW*), mm	Fixing spacing, mm	Uplift force, kN							
		Wind classification							
		N1		N2		N3		N4	
		Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1 500	1 800	N	N	N	N	1.6	2.7	3.8	4.9
	2 400	N	N	N	N	2.2	3.6	5.1	6.5
	3 000	N	N	N	N	2.7	4.5	6.3	8.1
	3 600	N	N	N	N	3.2	5.4	7.6	9.8
	4 200	N	N	N	N	3.8	6.3	8.9	11
3 000	1 800	N	N	N	N	3.2	5.4	7.6	9.8
	2 400	N	N	N	N	4.3	7.2	10	13
	3 000	N	N	N	N	5.4	9.0	12	16
	3 600	N	N	N	N	6.5	10	15	19
	4 200	N	N	N	N	7.6	12	17	22
4 500	1 800	N	N	N	N	4.9	8.1	11	14
	2 400	N	N	N	N	6.5	10	15	19
	3 000	N	N	N	N	8.2	13	19	24
	3 600	N	N	N	N	9.8	16	23	29
	4 200	N	N	N	N	11	19	26	34
6 000	1 800	N	N	N	N	6.5	10	15	19
	2 400	N	N	N	N	8.7	14	20	26
	3 000	N	N	N	N	10	18	25	32
	3 600	N	N	N	N	13	21	30	39
	4 200	N	N	N	N	15	25	35	45
7 500	1 800	N	N	N	N	8.2	13	19	24
	2 400	N	N	N	N	10	18	25	32
	3 000	N	N	N	N	13	22	31	40
	3 600	N	N	N	N	16	27	38	49
	4 200	N	N	N	N	19	31	44	57

NOTE 1 Interpolation within the Table is permitted.

NOTE 2 N = nominal (minimum) connection only, see Clause 9.5.

Table 9.10 — Net uplift force — Floor joists — Single storey or upper storey — To supports

Wind uplift load width (*ULW*), mm	Fixing spacing, mm	Uplift force, kN							
		Wind classification							
		N1		N2		N3		N4	
		Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1 500	450	N	N	N	N	0.41	0.68	0.96	1.2
	600	N	N	N	N	0.55	0.91	1.2	1.6
	900	N	N	N	N	0.82	1.3	1.9	2.4
	1 200	N	N	N	N	1.1	1.8	2.5	3.2
	1 350	N	N	N	N	1.2	2.0	2.8	3.6
3 000	450	N	N	N	N	0.82	1.3	1.9	2.4
	600	N	N	N	N	1.1	1.8	2.5	3.2
	900	N	N	N	N	1.6	2.7	3.8	4.9
	1 200	N	N	N	N	2.2	3.6	5.1	6.5
	1 350	N	N	N	N	2.4	4.0	5.7	7.3
4 500	450	N	N	N	N	1.2	2.0	2.8	3.6
	600	N	N	N	N	1.6	2.7	3.8	4.9
	900	N	N	N	N	2.4	4.0	5.7	7.3
	1 200	N	N	N	N	3.2	5.4	7.6	9.8
	1 350	N	N	N	N	3.7	6.1	8.6	11
6 000	450	N	N	N	N	1.6	2.7	3.8	4.9
	600	N	N	N	N	2.2	3.6	5.1	6.5
	900	N	N	N	N	3.2	5.4	7.6	9.8
	1 200	N	N	N	N	4.3	7.2	10	13
	1 350	N	N	N	N	4.9	8.1	11	14
7 500	450	N	N	N	N	2.0	3.4	4.7	6.1
	600	N	N	N	N	2.7	4.5	6.3	8.1
	900	N	N	N	N	4.1	6.8	9.5	12
	1 200	N	N	N	N	5.4	9.0	12	16
	1 350	N	N	N	N	6.1	10	14	18

NOTE 1 Interpolation within the Table is permitted.

NOTE 2 N = nominal (minimum) connection only, see Clause 9.5.

Table 9.11 — Net uplift force — Bottom plates — Single storey or upper storey — To floor frame or slab

Wind uplift load width (*ULW*), mm	Fixing spacing, mm	Uplift force, kN							
		Wind classification							
		N1		N2		N3		N4	
		Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1 500	450	N	N	N	0.28	0.41	0.68	0.96	1.2
	600	N	N	N	0.38	0.55	0.91	1.2	1.6
	900	N	N	N	0.57	0.82	1.3	1.9	2.4
	1 200	N	N	N	0.76	1.1	1.8	2.5	3.2
3 000	450	N	N	N	0.57	0.82	1.3	1.9	2.4
	600	N	N	N	0.76	1.1	1.8	2.5	3.2
	900	N	N	N	1.1	1.6	2.7	3.8	4.9
	1 200	N	N	N	1.5	2.2	3.6	5.1	6.5
4 500	450	N	N	N	0.85	1.2	2.0	2.8	3.6
	600	N	N	N	1.1	1.6	2.7	3.8	4.9
	900	N	N	N	1.7	2.4	4.0	5.7	7.3
	1 200	N	N	N	2.2	3.2	5.4	7.6	9.8
6 000	450	N	N	N	1.1	1.6	2.7	3.8	4.9
	600	N	N	N	1.5	2.2	3.6	5.1	6.5
	900	N	N	N	2.2	3.2	5.4	7.6	9.8
	1 200	N	N	N	3.0	4.3	7.2	10	13
7 500	450	N	N	N	1.4	2.0	3.4	4.7	6.1
	600	N	N	N	1.8	2.7	4.5	6.3	8.1
	900	N	N	N	2.8	4.1	6.8	9.5	12
	1 200	N	N	N	3.7	5.4	9.0	12	16

NOTE 1 Interpolation within the Table is permitted.

NOTE 2 *N* = nominal (minimum) connection only, see Clause 9.5.

NOTE 3 Fixing spacing = distance between bottom plate tie-down points.

Table 9.12 — Net uplift force — Underpurlins, ridgeboards, and hip rafters — To tie-down walls or floors

Wind uplift load width (*ULW*), mm	Fixing spacing, mm	Uplift force, kN							
		Wind classification							
		N1		N2		N3		N4	
		Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1 500	1 800	N	1.1	N	2.0	2.5	3.5	4.7	5.7
	2 400	N	1.5	N	2.6	3.3	4.7	6.2	7.7
	3 000	N	1.9	N	3.3	4.1	5.9	7.8	9.6
	3 600	N	2.3	N	4.0	5.0	7.1	9.4	11
3 000	1 800	N	2.3	N	4.0	5.0	7.1	9.4	11
	2 400	N	3.1	N	5.3	6.7	9.5	12	15
	3 000	N	3.9	N	6.6	8.3	11	15	19
	3 600	N	4.7	N	7.9	10	14	18	23
4 500	1 800	N	3.5	N	5.9	7.5	10	14	17
	2 400	N	4.7	N	7.9	10	14	18	23
	3 000	N	5.9	N	9.9	12	17	23	28
	3 600	N	7.1	N	11	15	21	28	34
6 000	1 800	N	4.7	N	7.9	10	14	18	23
	2 400	N	6.3	N	10	13	19	25	30
	3 000	N	7.9	N	13	16	23	31	38
	3 600	N	9.5	N	15	20	28	37	46

NOTE 1 Interpolation within the Table is permitted.

NOTE 2 *N* = nominal (minimum) connection only, see Clause 9.5.

NOTE 3 Fixing spacing = spacing of straps or tie-down bolts along hip, ridge or underpurlin.

Table 9.13 — Net uplift force — On rafters/trusses, beams or lintels to wall frame and wall plate to studs, floor frame or slab — Single storey or upper storey

Wind uplift load width (*ULW*), mm	Fixing spacing, mm	Uplift force, kN							
		Wind classification							
		N1		N2		N3		N4	
		Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1 500	450	N	0.30	N	0.50	0.63	0.90	1.1	1.4
	600	N	0.40	N	0.67	0.84	1.2	1.5	1.9
	900	N	0.59	N	1.0	1.2	1.8	2.3	2.8
	1 200	N	0.79	N	1.3	1.6	2.3	3.1	3.8
	1 350	N	0.89	N	1.5	1.8	2.6	3.5	4.3
	1 800	N	1.1	N	2.0	2.5	3.5	4.7	5.7
	3 000	N	1.9	N	3.3	4.1	5.9	7.8	9.6
3 000	450	N	0.59	N	1.0	1.2	1.8	2.3	2.8
	600	N	0.79	N	1.3	1.6	2.3	3.1	3.8
	900	N	1.1	N	2.0	2.5	3.5	4.7	5.7
	1 200	N	1.5	N	2.6	3.3	4.7	6.2	7.7
	1 350	N	1.7	N	3.0	3.7	5.3	7.0	8.6
	1 800	N	2.3	N	4.0	5.0	7.1	9.4	11
	3 000	N	3.9	N	6.6	8.3	11	15	19
4 500	450	N	0.89	N	1.5	1.8	2.6	3.5	4.3
	600	N	1.1	N	2.0	2.5	3.5	4.7	5.7
	900	N	1.7	N	3.0	3.7	5.3	7.0	8.6
	1 200	N	2.3	N	4.0	5.0	7.1	9.4	11
	1 350	N	2.6	N	4.5	5.6	8.0	10	13
	1 800	N	3.5	N	5.9	7.5	10	14	17
	3 000	N	5.9	N	9.9	12	17	23	28
6 000	450	N	1.1	N	2.0	2.5	3.5	4.7	5.7
	600	N	1.5	N	2.6	3.3	4.7	6.2	7.7
	900	N	2.3	N	4.0	5.0	7.1	9.4	11
	1 200	N	3.1	N	5.3	6.7	9.5	12	15
	1 350	N	3.5	N	5.9	7.5	10	14	17
	1 800	N	4.7	N	7.9	10	14	18	23
	3 000	N	7.9	N	13	16	23	31	38
7 500	450	N	1.4	N	2.5	3.1	4.4	5.8	7.2
	600	N	1.9	N	3.3	4.1	5.9	7.8	9.6
	900	N	2.9	N	5.0	6.2	8.9	11	14
	1 200	N	3.9	N	6.6	8.3	11	15	19
	1 350	N	4.4	N	7.4	9.4	13	17	21
	1 800	N	5.9	N	9.9	12	17	23	28
	3 000	N	9.9	N	16	20	29	39	48

NOTE 1 Interpolation within the Table is permitted.

NOTE 2 *N* = nominal (minimum) connection only, see Clause 9.5.

NOTE 3 Fixing spacing = rafter/truss, beams, lintels, stud or bottom plate fixing-spacing.

Table 9.14 — Net uplift force on roof battens

Rafter or truss spacing, mm	Batten spacing, mm	Uplift force, kN Wind classification							
		N1		N2		N3		N4	
		General area	Edges	General area	Edges	General area	Edges	General area	Edges
Tile roof									
450	330	0.04	0.14	0.09	0.21	0.17	0.37	0.29	0.59
600	330	0.06	0.18	0.11	0.29	0.23	0.50	0.39	0.79
900	330	0.08	0.27	0.17	0.43	0.35	0.75	0.59	1.1
1 200	330	0.12	0.36	0.22	0.58	0.46	1.0	0.78	1.6
Sheet roof									
600	370	0.15	0.29	0.22	0.41	0.35	0.65	0.53	0.97
	450	0.18	0.35	0.26	0.50	0.42	0.79	0.64	1.1
	600	0.24	0.47	0.35	0.66	0.57	1.0	0.86	1.5
	750	0.31	0.59	0.44	0.83	0.71	1.3	1.0	1.9
	900	0.37	0.71	0.53	1.0	0.85	1.5	1.2	2.3
	1 200	0.49	0.94	0.71	1.3	1.1	2.1	1.7	3.1
900	370	0.23	0.44	0.33	0.61	0.52	0.97	0.79	1.4
	450	0.28	0.53	0.40	0.75	0.64	1.1	0.96	1.7
	600	0.37	0.71	0.53	1.0	0.85	1.5	1.2	2.3
	750	0.46	0.88	0.66	1.2	1.0	1.9	1.6	2.9
	900	0.55	1.0	0.79	1.5	1.2	2.3	1.9	3.5
	1 200	0.73	1.4	1.0	2.0	1.7	3.1	2.5	4.7
1 200	370	0.30	0.58	0.44	0.82	0.70	1.3	1.0	1.9
	450	0.37	0.71	0.53	1.0	0.85	1.5	1.2	2.3
	600	0.49	0.94	0.71	1.3	1.1	2.1	1.7	3.1
	750	0.61	1.1	0.88	1.7	1.4	2.6	2.1	3.9
	900	0.73	1.4	1.0	2.0	1.7	3.1	2.5	4.7
	1 200	0.98	1.8	1.4	2.6	2.2	4.2	3.4	6.3

NOTE 1 Tile roof also includes concrete or terracotta tiles. Sheet roof also includes metal or other “lightweight” tiles or other sheet material.

NOTE 2 General area also includes any roof area that is greater than 1 200 mm away from the edges of a roof. Edges include edges, hips, ridges, fascias and barges.

NOTE 3 Roofing manufacturers may require batten spacings to be reduced at or near edges to reduce uplift forces and, therefore, permit use of lower strength connections.

NOTE 4 Interpolation within the Table is permitted.

9.6.5 Joint group

“Joint group” shall mean a rating assigned to a piece or parcel of timber to indicate, for purposes of joint design, a design capacity grouping appropriate to that timber for a range of connectors, refer to AS 1720.1. Joint group is designated in the form of a number preceded by the letters “J” or “JD” indicating unseasoned or seasoned timber respectively, see Table 9.15.

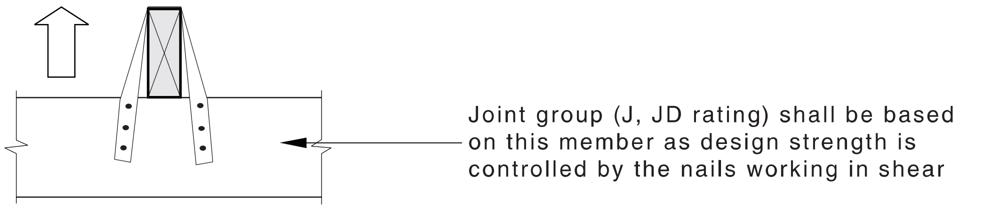
Table 9.15 — Joint groups

Species or species group		Joint group
Seasoned softwood (radiata, slash and other plantation pines)	Seasoned — Free of heart-in material (e.g. MGP12, F8)	JD4
	Seasoned — Heart-in material included (e.g. MGP10, F5)	JD5
Australian hardwood (non-ash type from Qld, NSW, WA, etc.)	Unseasoned	J2
	Seasoned	JD2
Australian hardwood (ash type eucalyptus from Vic, TAS, etc.)	Unseasoned	J3
	Seasoned	JD3
Cypress	Unseasoned	J3
Douglas fir (oregon) from North America	Unseasoned	J4
	Seasoned	JD4
Douglas fir (oregon) from elsewhere	Unseasoned	J5
	Seasoned	JD5
Hem-fir	Seasoned	JD5
Scots pine (Baltic)	Seasoned	JD5
Softwood, imported unidentified	Seasoned	JD6
Spruce pine fir (SPF)	Seasoned	JD6

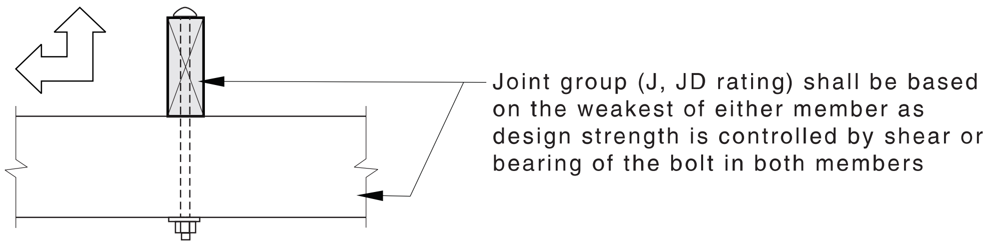
NOTE 1 The appropriate joint group for a single timber species can be determined by reference to Table G.1 or AS 1720.2.

NOTE 2 For timber with a joint group of JD2 or JD3, the values given in this Standard for J2 may be used.

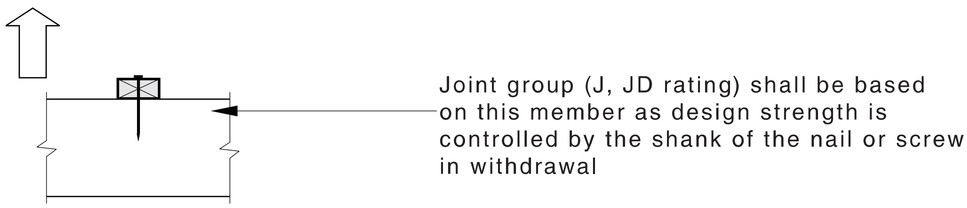
Where a timber joint comprises two or more different species, the joint group allocated to that joint generally shall be that appropriate to the weakest material in that joint. Where timbers of differing joint groups are used in a single connection, recognition shall be given to the end or part of the connection that controls the strength of the joint, as specified in Figure 9.6.



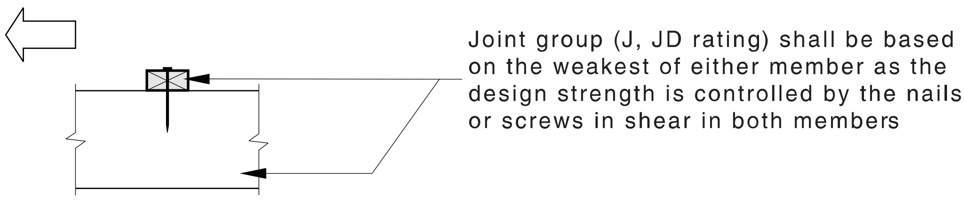
(a) Joint type 1



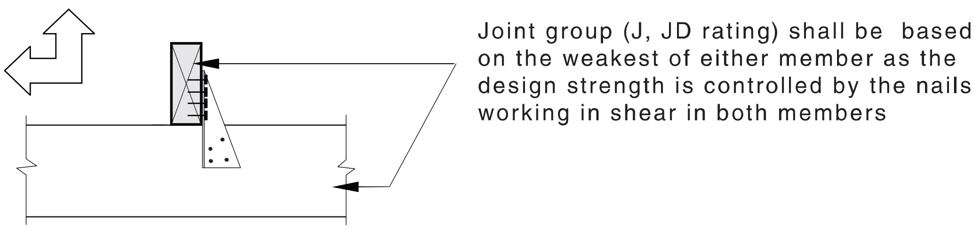
(b) Joint type 2



(c) Joint type 3



(d) Joint type 4



(e) Joint type 5

NOTE Large arrows indicate direction of load.

Figure 9.6 — Joint group selection

The uplift capacity of tie-down connections for unseasoned and seasoned timber are set out in Tables 9.16 to 9.25.

Table 9.16(a) — Uplift capacity of bearer tie-down connections

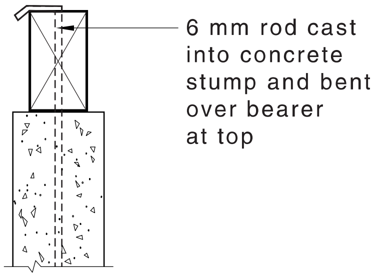
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	J2	J3	J4	JD4	JD5	JD6
(a) 	1.0	1.0	1.0	1.0	1.0	1.0

Table 9.16(b) — Uplift capacity of bearer tie-down connections

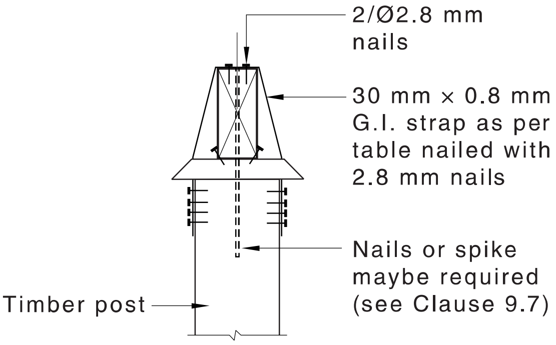
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	J2	J3	J4	JD4	JD5	JD6
(b) 	1 strap with 4 nails each end					
	9.9	7.1	5.0	7.1	5.8	4.4
	2 strap with 4 nails each end					
	17	12	8.4	12	9.7	7.4
	1 strap with 6 nails each end					
	13	9.3	6.6	9.3	7.6	5.8
	2 strap with 6 nails each end					
	23	17	12	17	14	10

Table 9.16(c) — Uplift capacity of bearer tie-down connections

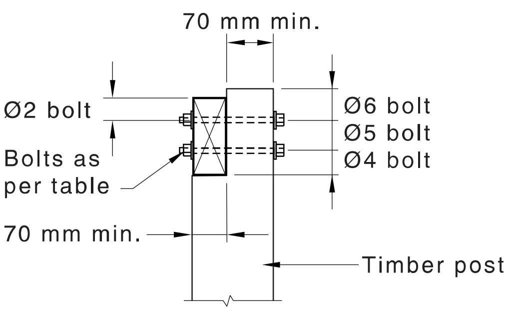
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		J2	J3	J4	JD4	JD5	JD6
(c) 	No. of bolts						
	1/M10	5.7	5.2	3.6	5.2	4.5	3.9
	1/M12	8.1	6.8	4.7	7.4	6.4	5
	2/M10	13	10	7.3	12	11	8.3
	2/M12	17	14	9.4	17	14	10
	2/M16	26	20	14	27	20	13

Table 9.16(d) — Uplift capacity of bearer tie-down connections

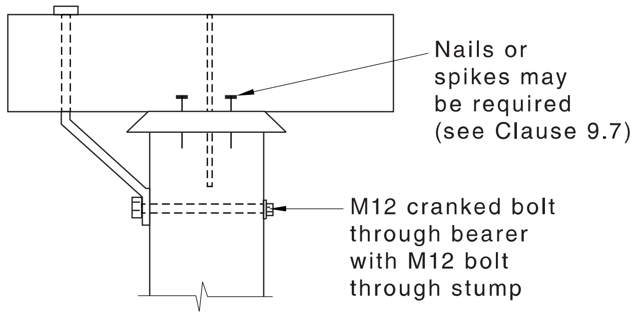
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(d) 	2	2	2	2	2	2

Table 9.16(e) — Uplift capacity of bearer tie-down connections

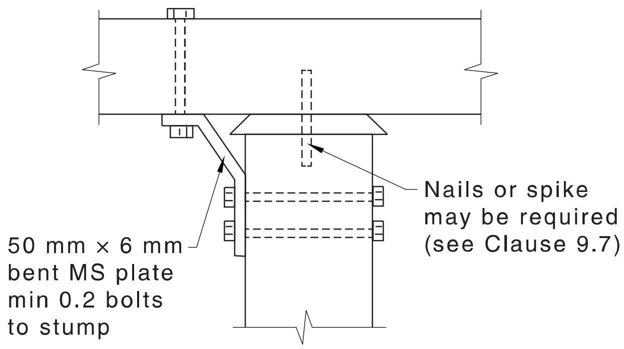
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(e) 	2	2	2	2	2	2

Table 9.16(f) — Uplift capacity of bearer tie-down connections

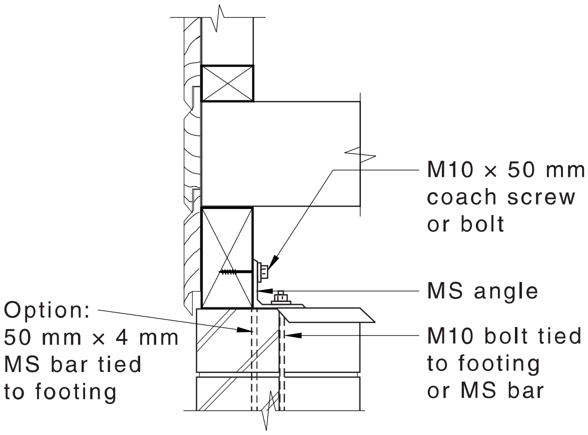
<table>
<tr><th rowspan="2">Position of tie-down connection</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>Bearers to stumps, posts, piers</th><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td>(f)

</td><td>5.5</td><td>3.1</td><td>1.6</td><td>3.2</td><td>1.8</td><td>1</td></tr>
</table>

Table 9.16(g) — Uplift capacity of bearer tie-down connections

<table>
<tr><th colspan="2" rowspan="2">Position of tie-down connection</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th colspan="2">Bearers to stumps, posts, piers</th><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
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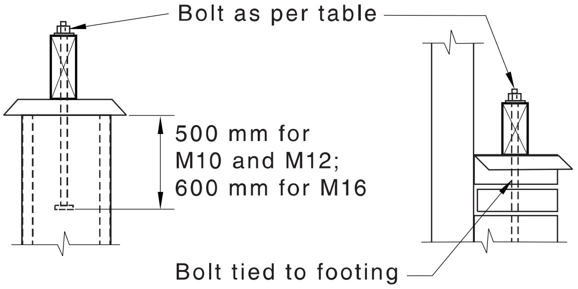

</td><td colspan="7">Bolts</td></tr>
<tr><td>M10</td><td>18</td><td>18</td><td>18</td><td>15</td><td>12</td><td>9</td></tr>
<tr><td>M12</td><td>27</td><td>27</td><td>26</td><td>20</td><td>16</td><td>12</td></tr>
<tr><td>M16</td><td>50</td><td>50</td><td>46</td><td>35</td><td>28</td><td>21</td></tr>
</table>

Table 9.16(h) — Uplift capacity of bearer tie-down connections

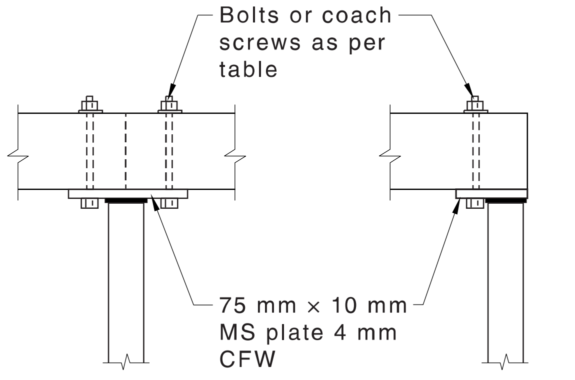
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		J2	J3	J4	JD4	JD5	JD6
(h) 	No. of bolts						
	1/M10	18	18	18	15	12	9
	1/M12	27	27	26	20	16	12
	2/M10	36	36	36	30	24	18
	2/M12	54	54	52	40	32	24
	No. of coach screw (75 mm min.)						
	1/M10	7.5	5.5	3.7	4.7	3.6	2.6
	1/M12	8.2	6.0	4.0	5.0	4.2	3.0
	2/M10	15	11	7.4	9.4	7.2	5.2
	2/M12	16	12	8.0	10	8.4	6.0

Table 9.16(i) — Uplift capacity of bearer tie-down connections

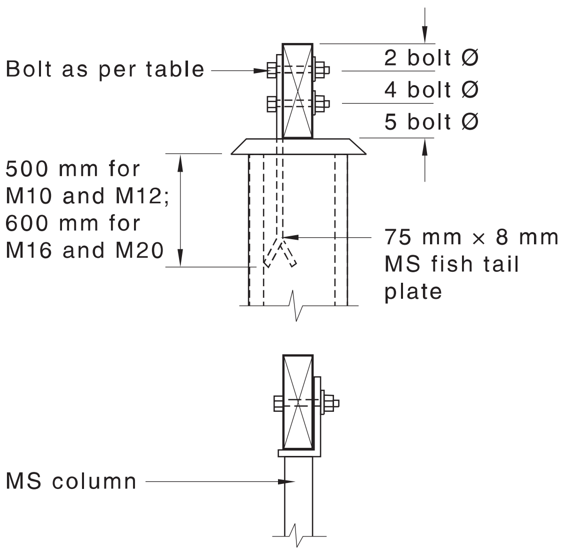
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		J2	J3	J4	JD4	JD5	JD6
(i) 	Bolts						
	1/M10	7.7	6.2	4.4	7.9	6.3	5.0
	1/M12	10	8.2	5.7	10	8.3	6.0
	1/M16	16	12	8.6	16	12	8.0
	2/M10	15	12	8.8	16	13	9.9
	2/M12	21	16	11	21	17	12
	2/M16	32	24	17	32	24	16

Table 9.16(j) — Uplift capacity of bearer tie-down connections

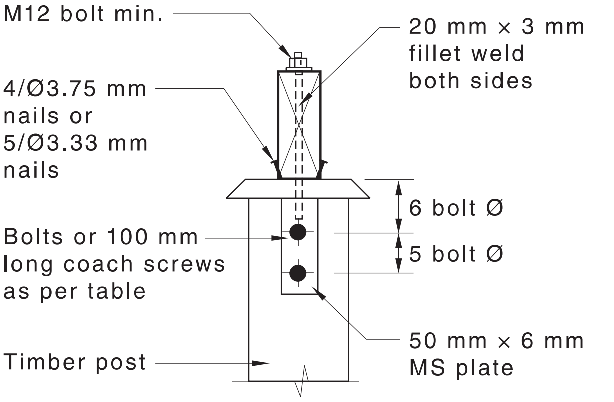
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(j) 	No. of bolts						
	1/M10	9.1	8.3	6.6	8.3	7.3	6.2
	1/M12	13	12	9.5	12	10	9.1
	2/M10	18	17	13	17	15	12
	2/M12	26	24	19	20	16	12
	2/M16	27	27	26	20	16	12
	No. of coach screws						
	1/M10	9.1	8.3	6.6	8.3	7.3	5.1
	1/M12	13	12	7.9	12	8.5	6.3
	2/M10	18	17	13	17	15	10
	2/M12	26	24	16	20	16	12
	2/M16	27	27	21	20	16	12

Table 9.16(k) — Uplift capacity of bearer tie-down connections

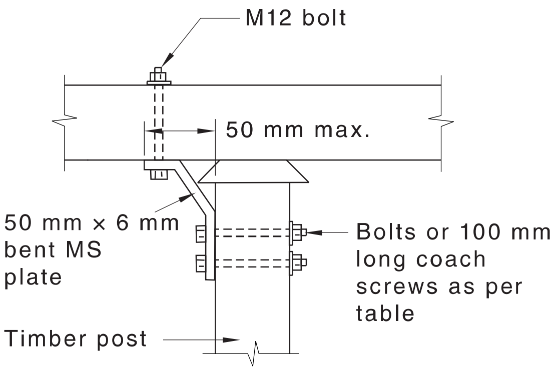
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(k) 	No. of bolts						
	1/M10	9.1	8.3	6.6	8.3	7.3	6.2
	1/M12	13	12	9.5	12	10	9.1
	2/M10	18	17	13	17	15	12
	2/M12	26	24	19	20	16	12
	2/M16	27	27	26	20	16	12
	No. of coach screws						
	1/M10	9.1	8.3	6.6	8.3	7.3	5.1
	1/M12	13	12	7.9	12	8.5	6.3
	2/M10	18	17	13	17	15	10
	2/M12	26	24	16	20	16	12
	2/M16	27	27	21	20	16	12

Table 9.16(l) — Uplift capacity of bearer tie-down connections

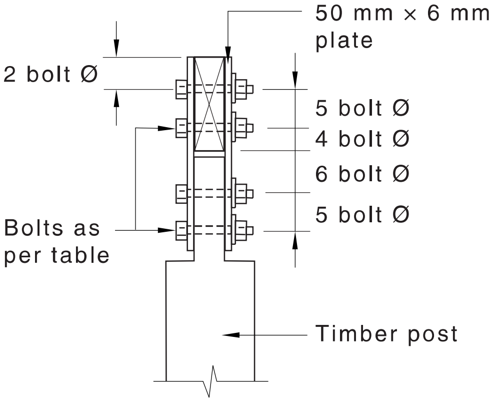
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(l) 	No. of bolts						
	2/M10	31	20	13	20	14	9.8
	2/M12	36	23	15	24	17	12
	2/M16	49	31	20	33	23	16

Table 9.16(m) — Uplift capacity of bearer tie-down connections

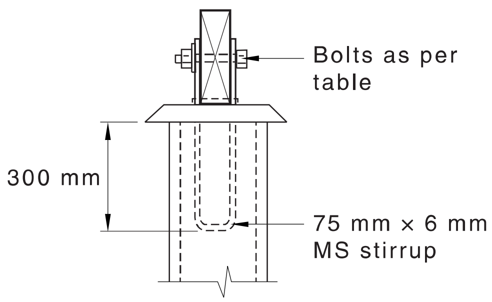
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(m) 	No. of bolts						
	M10	14	9.8	6.3	10	7.3	4.9
	M12	18	12	7.5	12	8.7	6.1
	M16	24	16	9.8	17	12	8

Table 9.17(a) — Uplift capacity of floor joist tie-down connections

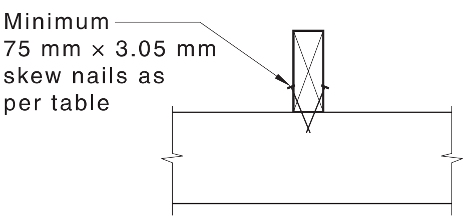
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Floor joists to bearers or top plates		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(a) 	No. of nails						
	2	1.5	1.2	1.1	0.77	0.50	0.36
	3	2.2	1.8	1.6	1.1	0.75	0.55
	4	3.0	2.4	2.2	1.5	1.0	0.72
	Glue-coated or deformed shank machine-driven nails shall be used.						

Table 9.17(b) — Uplift capacity of floor joist tie-down connections

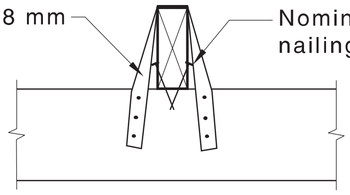
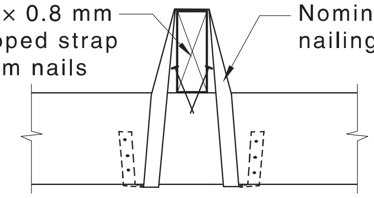
<table>
<tr><th rowspan="2">Position of tie-down connection</th><th colspan="7">Uplift capacity, kN</th></tr>
<tr><th colspan="4">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>Floor joists to bearers or top plates</th><th></th><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="3">(b)

</td><td colspan="7">No. of straps</td></tr>
<tr><td>1</td><td>6.5</td><td>4.7</td><td>3.3</td><td>4.7</td><td>3.8</td><td>2.9</td></tr>
<tr><td>2</td><td>12</td><td>8.4</td><td>5.9</td><td>8.4</td><td>6.9</td><td>5.2</td></tr>
</table>

Table 9.17(c) — Uplift capacity of floor joist tie-down connections

<table>
<tr><th rowspan="2">Position of tie-down connection</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>Floor joists to bearers or top plates</th><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td>(c)


Nails required for each end of looped strap:
3/Ø2.8 mm for J2
4/Ø2.8 mm for J3 and JD4
5/Ø2.8 mm for J4, JD5 and JD6</td><td>13</td><td>13</td><td>13</td><td>13</td><td>13</td><td>13</td></tr>
</table>

Table 9.17(d) — Uplift capacity of floor joist tie-down connections

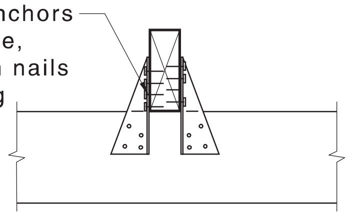
<table>
<tr><th rowspan="2">Position of tie-down connection</th><th colspan="7">Uplift capacity, kN</th></tr>
<tr><th colspan="4">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>Floor joists to bearers or top plates</th><th></th><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="5">(d)

</td><td colspan="7">No. of framing anchors</td></tr>
<tr><td>1</td><td>4.9</td><td>3.5</td><td>2.5</td><td>3.5</td><td>2.9</td><td>2.2</td></tr>
<tr><td>2</td><td>8.3</td><td>5.9</td><td>4.2</td><td>5.9</td><td>4.9</td><td>3.7</td></tr>
<tr><td>3</td><td>12</td><td>8.4</td><td>5.9</td><td>8.4</td><td>6.9</td><td>5.2</td></tr>
<tr><td>4</td><td>15</td><td>11</td><td>7.7</td><td>11</td><td>8.9</td><td>6.8</td></tr>
</table>

Table 9.17(e) — Uplift capacity of floor joist tie-down connections

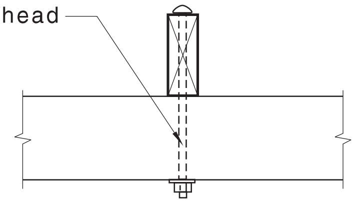
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Floor joists to bearers or top plates	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(e) 	16	14	10	10	7.0	5.0

Table 9.17(f) — Uplift capacity of floor joist tie-down connections

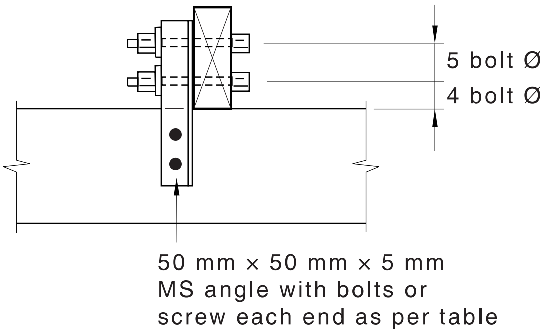
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Floor joists to bearers or top plates		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(f) 	No. of bolts						
	2/M10	14	9.2	5.9	10	7.3	4.9
	2/M12	18	11	7.0	12	8.7	6.1
	Coach screws						
	2/M10	7	4.6	3.0	5	3.6	2.5

Table 9.17(g) — Uplift capacity of floor joist tie-down connections

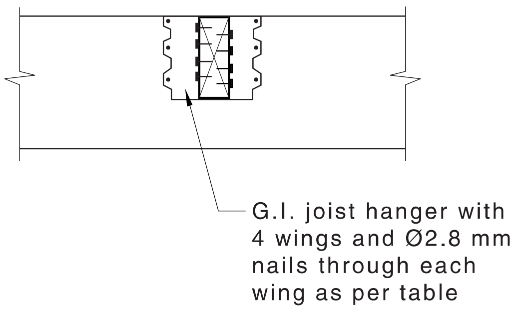
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Floor joists to bearers or top plates		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(g) 	No. of nails per wing						
	3	6.5	4.7	3.3	4.7	3.8	2.9
	4	8.3	5.9	4.2	5.9	4.9	3.7
	5	9.9	7.1	5	7.1	5.8	4.4
	6	12	8.4	5.9	8.4	6.9	5.2

Table 9.18(a) — Uplift capacity of bottom plate tie-down connections

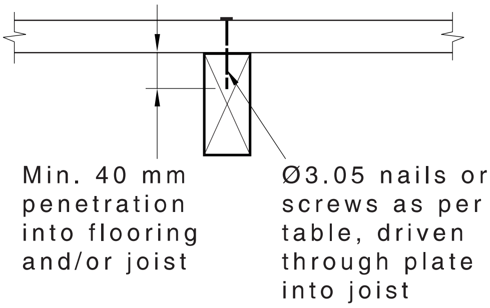
<table>
<tr><th colspan="2" rowspan="3">Position of tie-down connection</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="6">(a)

</td><td colspan="7">No. of nails</td></tr>
<tr><td>2</td><td>1.3</td><td>1.1</td><td>0.95</td><td>0.68</td><td>0.45</td><td>0.32</td></tr>
<tr><td>3</td><td>1.9</td><td>1.6</td><td>1.4</td><td>1.0</td><td>0.67</td><td>0.48</td></tr>
<tr><td></td><td colspan="6">2/No. 14 Type 17 screws</td></tr>
<tr><td></td><td>11</td><td>8.4</td><td>4.8</td><td>9.0</td><td>7.2</td><td>5.4</td></tr>
<tr><td colspan="7"></td></tr>
</table>

Table 9.18(b) — Uplift capacity of bottom plate tie-down connections

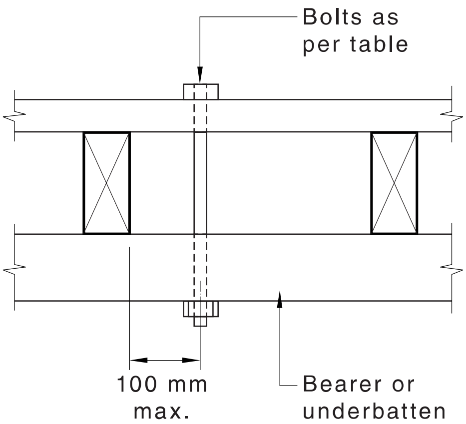
<table>
<tr><th colspan="3" rowspan="3">Position of tie-down connection</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="12">(b)

</td><td colspan="8">Bolts</td></tr>
<tr><td colspan="2">M10 cup-head</td><td>16</td><td>14</td><td>10</td><td>10</td><td>7.0</td><td>5.0</td></tr>
<tr><td colspan="2">M10</td><td>18</td><td>18</td><td>18</td><td>15</td><td>12</td><td>9.0</td></tr>
<tr><td colspan="2">M12</td><td>27</td><td>27</td><td>26</td><td>20</td><td>16</td><td>12</td></tr>
<tr><td>Axial load in bolt, kN</td><td colspan="7">Underbatten size (depth × breadth), mm</td></tr>
<tr><td></td><td>F5</td><td colspan="2">F8</td><td colspan="2">F14</td><td colspan="2">F17</td></tr>
<tr><td>6</td><td>70 × 70</td><td colspan="2">45 ×70</td><td colspan="2">45 ×70</td><td colspan="2">35 ×70</td></tr>
<tr><td>10</td><td>90 ×70</td><td colspan="2">70 ×70</td><td colspan="2">70 ×70</td><td colspan="2">45 ×70</td></tr>
<tr><td>15</td><td>90 ×70</td><td colspan="2">90 ×70</td><td colspan="2">70 ×70</td><td colspan="2">70 ×70</td></tr>
<tr><td>20</td><td>120 ×70</td><td colspan="2">90 ×70</td><td colspan="2">70 ×70</td><td colspan="2">70 ×70</td></tr>
<tr><td>30</td><td>140 ×70</td><td colspan="2">120 ×70</td><td colspan="2">90 ×70</td><td colspan="2">90 ×70</td></tr>
<tr><td>50</td><td>190 ×70</td><td colspan="2">170 ×70</td><td colspan="2">140 ×70</td><td colspan="2">120 ×70</td></tr>
</table>

Table 9.18(c) — Uplift capacity of bottom plate tie-down connections

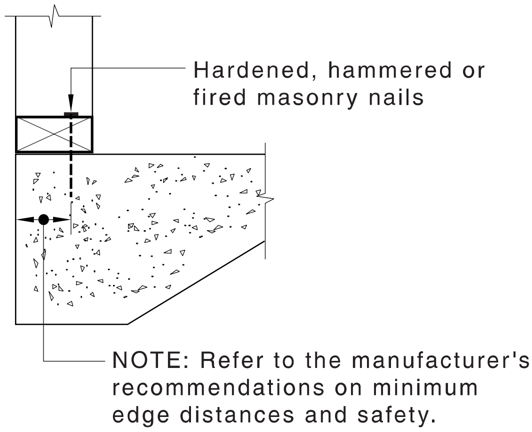
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
		J2	J3	J4	JD4	JD5	JD6
(c) 	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 9.18(d) — Uplift capacity of bottom plate tie-down connections

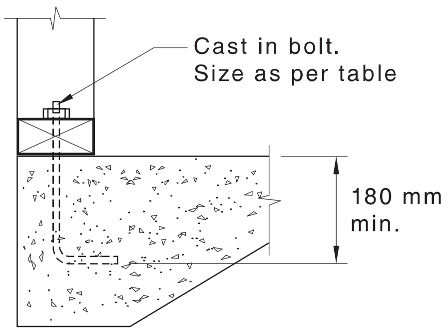
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
		J2	J3	J4	JD4	JD5	JD6
(d) 	Bolts						
	M10	18	18	18	15	12	9.0
	M12	27	27	26	20	16	12

Table 9.18(e) — Uplift capacity of bottom plate tie-down connections

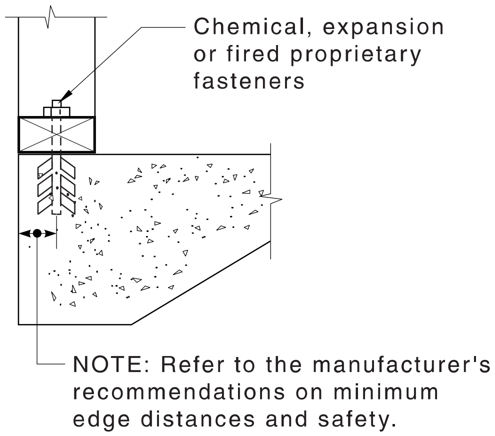
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
	J2	J3	J4	JD4	JD5	JD6
(e) 	Refer to manufacturer's specifications. The strength of their proprietary fasteners with respect to the strength of the fastener in the timber bottom plate needs to be considered.					

Table 9.19(a) — Uplift capacity of wall frame tie-down connections

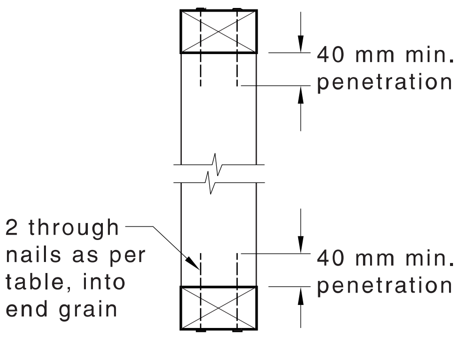
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Studs to plates	J2	J3	J4	JD4	JD5	JD6
(a) 	Hand-driven nail dia.					
2/3.15	0.32	0.27	0.24	0.17	0.11	0.08
2/3.75	0.37	0.32	0.29	0.22	0.13	0.10
	Glue-coated or deformed shank machine-driven nail dia.					
2/3.05	0.48	0.41	0.36	0.26	0.17	0.12
2/3.33	0.56	0.48	0.43	0.33	0.20	0.14

Table 9.19(b) — Uplift capacity of wall frame tie-down connections

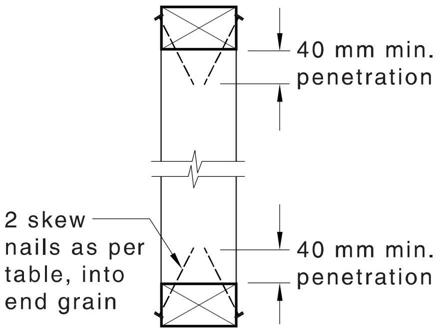
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Studs to plates		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(b) 	Hand-driven nail dia.						
	2/3.15	0.78	0.65	0.57	0.41	0.27	0.19
	2/3.75	0.9	0.78	0.69	0.53	0.32	0.23
	Glue-coated or deformed shank machine-driven nail dia.						
	2/3.05	1.2	0.98	0.86	0.61	0.4	0.29
	2/3.33	1.4	1.2	1.0	0.8	0.48	0.34

Table 9.19(c) — Uplift capacity of wall frame tie-down connections

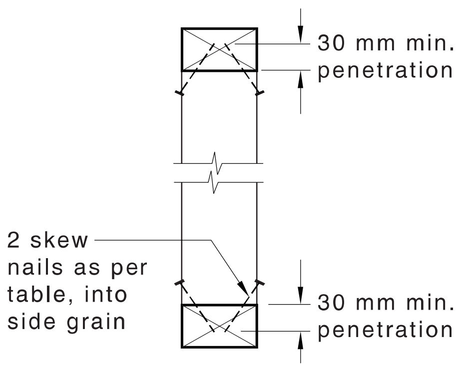
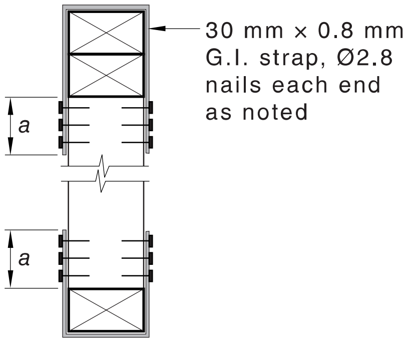
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Studs to plates		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(c) 	Hand-driven nail dia.						
	2/3.15	0.97	0.82	0.71	0.51	0.34	0.24
	2/3.75	1.1	0.97	0.87	0.66	0.4	0.29
	Glue-coated or deformed shank machine-driven nail dia.						
	2/3.05	1.5	1.2	1.1	0.77	0.5	0.36
	2/3.33	1.7	1.5	1.3	0.99	0.6	0.43

Table 9.19(d) — Uplift capacity of wall frame tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Studs to plates		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(d) 	No. of nails						
	2	4.9	3.5	2.5	3.5	2.9	2.2
	3	6.5	4.7	3.3	4.7	3.8	2.9
	4	8.3	5.9	4.2	5.9	4.9	3.7
	6	12	8.4	5.9	8.4	6.9	5.2

NOTE *a* = 100 mm or longer to prevent splitting for number of nails used.

Table 9.19(e) — Uplift capacity of wall frame tie-down connections

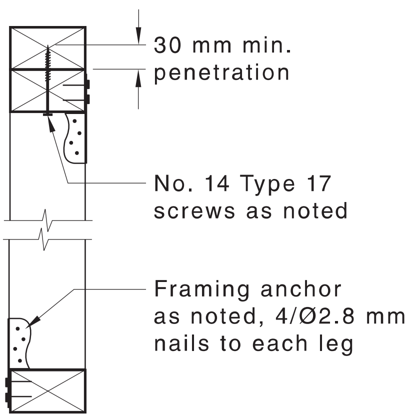
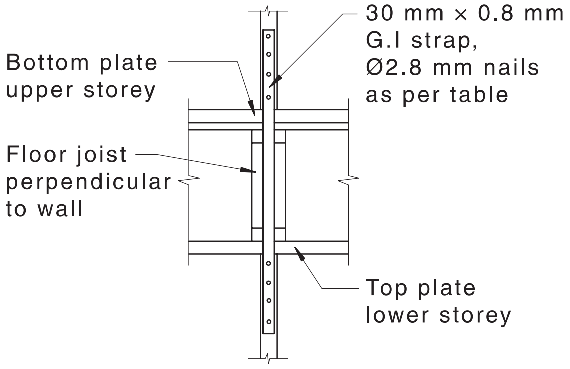
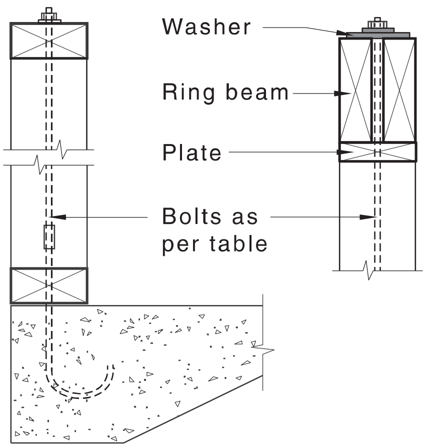
Position of tie-down connection			Uplift capacity, kN					
			Unseasoned timber			Seasoned timber		
Studs to plates			**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(e) 	No. of screws	No. of anchors						
	1/75 mm	1	4.9	3.5	2.5	3.5	2.9	2.2
	2/75 mm	2	8.3	5.9	4.2	5.9	4.9	3.7

Table 9.19(f) — Uplift capacity of floor joist tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Floor joists to bearers or top plates		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(f) 	No. of nails each end of strap	Straps nailed to timber framing					
	4	4.9	3.5	2.5	3.5	2.9	2.2
	6	6.5	4.7	3.3	4.7	3.8	2.9
	8	6.5	5.9	4.2	5.9	4.9	3.7
	12	6.5	6.5	5.9	6.5	6.5	5.2

NOTE 6.5 kN is the maximum tensile capacity of the steel strap.

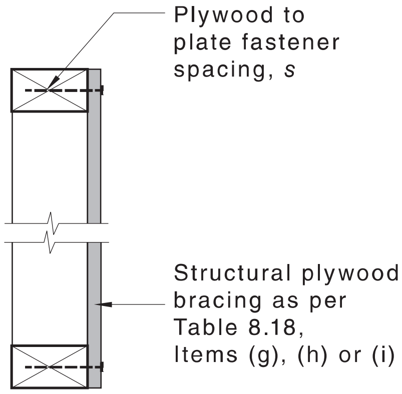
Table 9.19(g) — Uplift capacity of wall frame tie-down connections

Position of tie-down connection			Uplift capacity, kN					
			Unseasoned timber			Seasoned timber		
Studs to plates			**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(g) 	Bolt	M10	18	18	18	15	15	9.0
		M12	27	27	26	20	16	12
		M16	50	50	46	35	28	21
	Tie-down rods or bolts				M10 or M12		M16	
	Plate size, mm				75 × 75		90 × 75	
	Washer thickness, mm				6		8	

NOTE This detail is also suitable for tie-down of ring beam.

Table 9.19(h) — Uplift capacity of wall frame tie-down connections

Position of tie-down connections	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
	J2	J3	J4	JD4	JD5	JD6

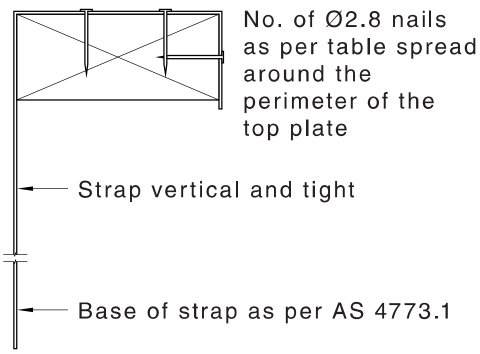
(h)	Fastener spacing (*s*), mm	Uplift capacity, kN/rafter
	50	16.7
	150	10.4
	Rafters or trusses shall be fixed a minimum of 300 mm away from stud at either end of sheathed section. Bottom plate to subfloor fixing capacity shall be at least 13 kN, tie-down every 1 200 mm. Minimum plywood panel width shall be 900 mm.	

NOTE 1 This detail is suitable for rafter spacings of 600 mm, 900 mm or 1 200 mm.

NOTE 2 This detail is not applicable for tie-down at sides of the openings. The details for tie-down at sides of the openings are given in Table 9.20.

NOTE 3 See Table 9.20(p) for full details.

Table 9.19(i) — Uplift capacity of wall frame tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Plates to walls including masonry straps in accordance with AS 4773.1		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(i) 	No. of nails						
	3	6.5	4.8	3.9	4.8	3.9	3.9
	4	6.5	6.5	5.2	6.5	5.2	5.2
	5	6.5	6.5	6.5	6.5	6.5	6.5

NOTE Capacity may be limited by the connection capacity in AS 4773.1.

Table 9.20(a) — Uplift capacity of beam/lintel tie-down connections

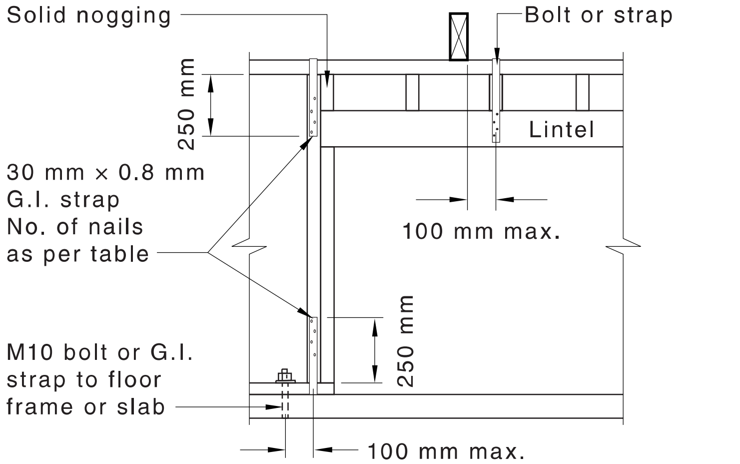
<table>
<tr><th rowspan="2">Position of tie-down connection</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>Beams/lintels/ring beams to studs/posts/floor</th><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="5">(a)

</td><td colspan="6">4/2.8 mm ⌀ nails each end of strap</td></tr>
<tr><td>8.3</td><td>5.9</td><td>4.2</td><td>5.9</td><td>4.9</td><td>3.7</td></tr>
<tr><td colspan="6">6/2.8 mm ⌀ nails each end of strap</td></tr>
<tr><td>12</td><td>8.4</td><td>5.9</td><td>8.4</td><td>6.9</td><td>5.2</td></tr>
<tr><td colspan="6">The top plate shall be fixed or tied to the lintel within 100 mm of each rafter/truss, or the rafter/truss fixed directly to the lintel with a fixing of equivalent tie-down strength to that required for the rafter/truss.</td></tr>
</table>

Table 9.20(b) — Uplift capacity of beam/lintel tie-down connections

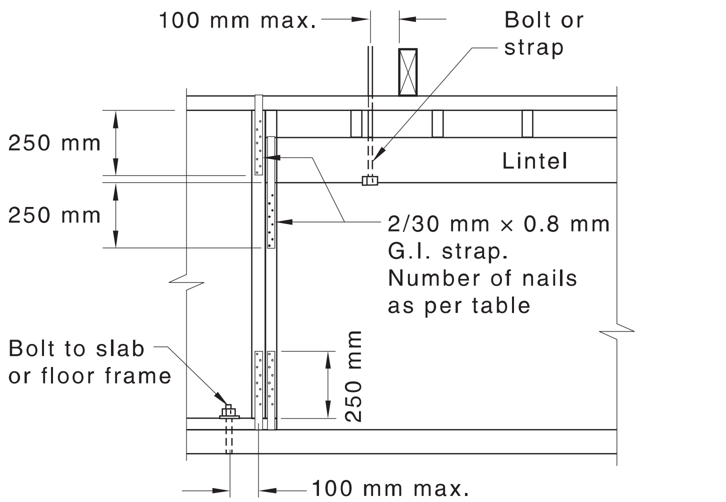
<table>
<tr><th rowspan="2">Position of tie-down connection</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>Beams/lintels/ring beams to studs/posts/floor</th><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="5">(b)

</td><td colspan="6">4 nails each end of strap M10 bolt to floor</td></tr>
<tr><td>17</td><td>12</td><td>8.4</td><td>12</td><td>9.8</td><td>7.4</td></tr>
<tr><td colspan="6">6 nails each end of strap M12 bolt to floor</td></tr>
<tr><td>17</td><td>17</td><td>12</td><td>17</td><td>14</td><td>10</td></tr>
<tr><td colspan="6">The top plate shall be fixed or tied to the lintel within 100 mm of each rafter/truss, or the rafter/truss fixed directly to the lintel with a fixing of equivalent tie-down strength to that required for the rafter/truss.</td></tr>
</table>

Table 9.20(c) — Uplift capacity of beam/lintel tie-down connections

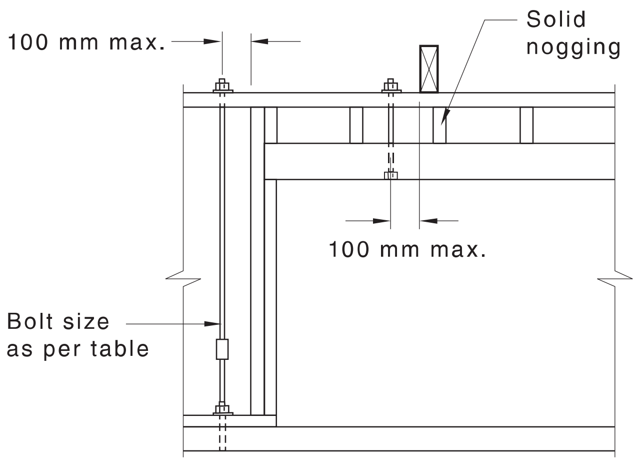
Position of tie-down connection		**Uplift capacity, kN**					
		Unseasoned timber			**Seasoned timber**		
Beams/lintels/ring beams to studs/posts/floor		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(c) 	Bolt						
	M10	18	18	18	15	12	9.0
	M12	27	27	26	20	16	12
	The top plate shall be fixed or tied to the lintel within 100 mm of each rafter/truss, or the rafter/truss fixed directly to the lintel with a fixing of equivalent tie-down strength to that required for the rafter/truss. For an M16 bolt, the detail in Table 9.20(d) or 9.20(e) shall be used.						

Table 9.20(d) — Uplift capacity of beam/lintel tie-down connections

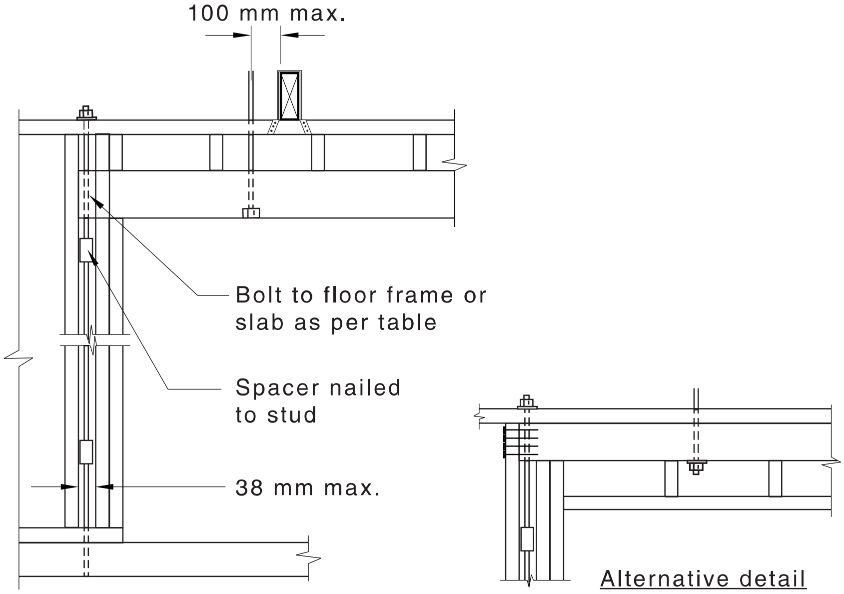
Position of tie-down connection		**Uplift capacity, kN**					
		Unseasoned timber			**Seasoned timber**		
Beams/lintels/ring beams to studs/posts/floor		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(d)	Bolt size						
The top plate shall be fixed or tied to the lintel within 100 mm of each rafter/truss, or the rafter/truss fixed directly to the lintel with a fixing of equivalent tie-down strength to that required for the rafter/truss.	M12	27	27	26	20	16	12
	M16	50	50	46	35	28	21
							

Table 9.20(e) — Uplift capacity of beam/lintel tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(e)	Bolt size						
The top plate shall be fixed or tied to the lintel within 100 mm of each rafter/truss, or the rafter/truss fixed directly to the lintel with a fixing of equivalent tie-down strength to that required for the rafter/truss.	M10	18	18	18	15	12	9.0
	M12	27	27	26	20	16	12
	M16	50	50	46	35	28	21

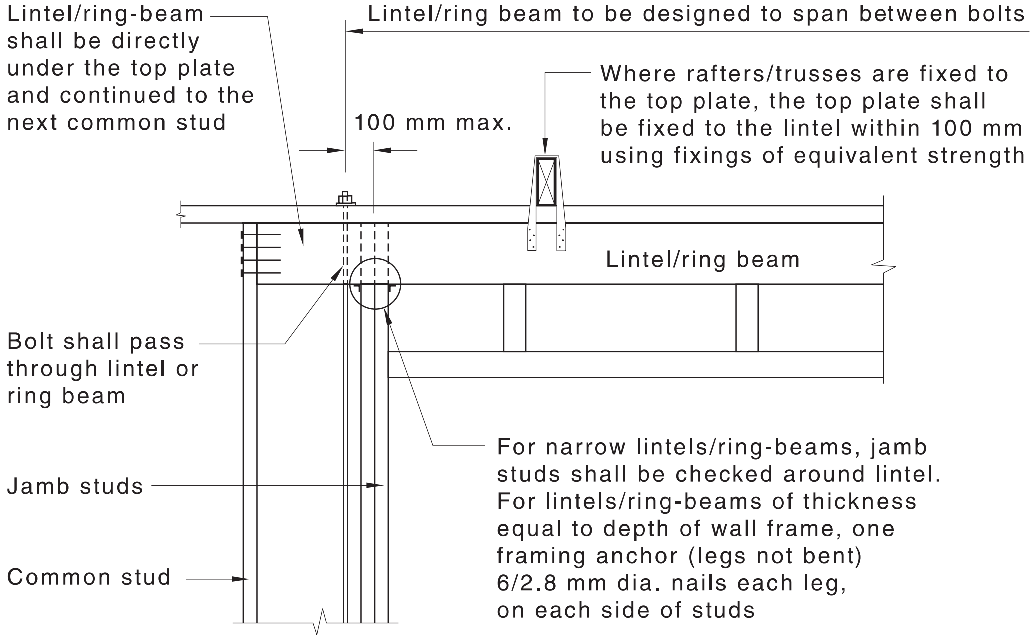
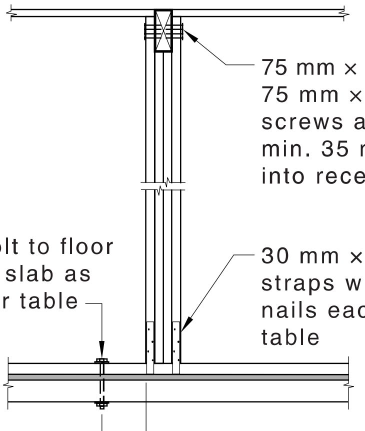


Table 9.20(f) — Uplift capacity of beam/lintel tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor		J2	J3	J4	JD4	JD5	JD6
(f) 	No. of nails to each stud						
	4	8.1	5.7	4.1	5.7	4.8	3.5
	6	12	8.6	6.2	8.6	7.2	5.3
	8	16	11	8.2	11	9.6	7.1
	No. of screws to each stud						
	2	15	11	7.8	11	7.8	5.7
	4	31	22	16	22	16	11
	6	46	33	23	33	23	17
	4 nails each end of strap						
	M10 bolt to floor	17	12	8.4	12	9.8	7.4
	6 nails each end of strap						
	M12 bolt to floor	17	17	12	17	14	10

NOTE The uplift capacity of the detail will be governed by the lowest of the capacities at either the top or bottom of post or the bottom plate to floor frame or slab.

Table 9.20(g) — Uplift capacity of beam/lintel tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor		J2	J3	J4	JD4	JD5	JD6
(g)	Bolts						
	2/M10	17	15	9.8	17	12	8.2
	2/M12	17	17	12	17	14	10

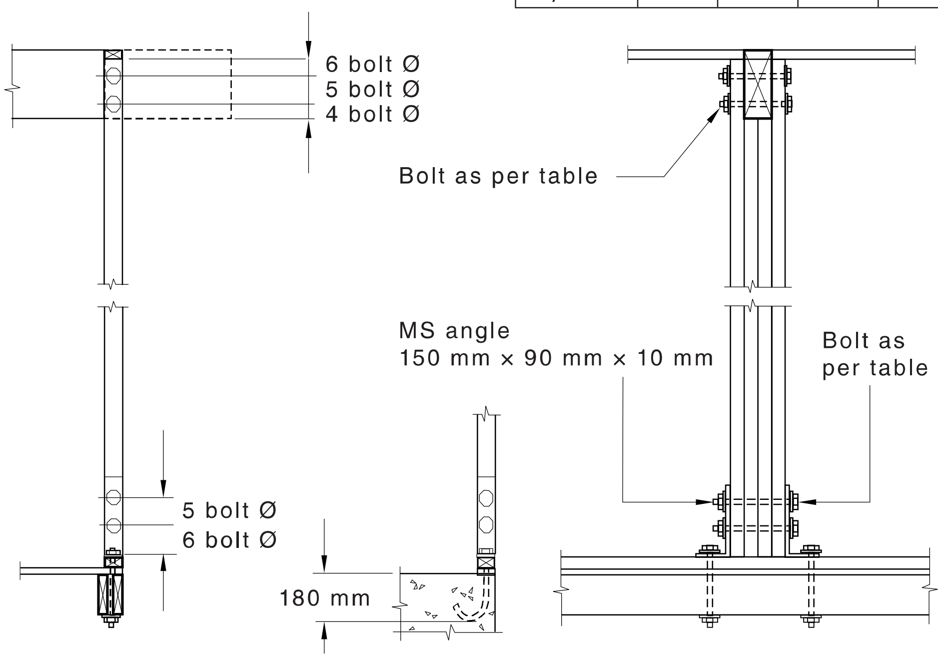


Table 9.20(h) — Uplift capacity of beam/lintel tie-down connections

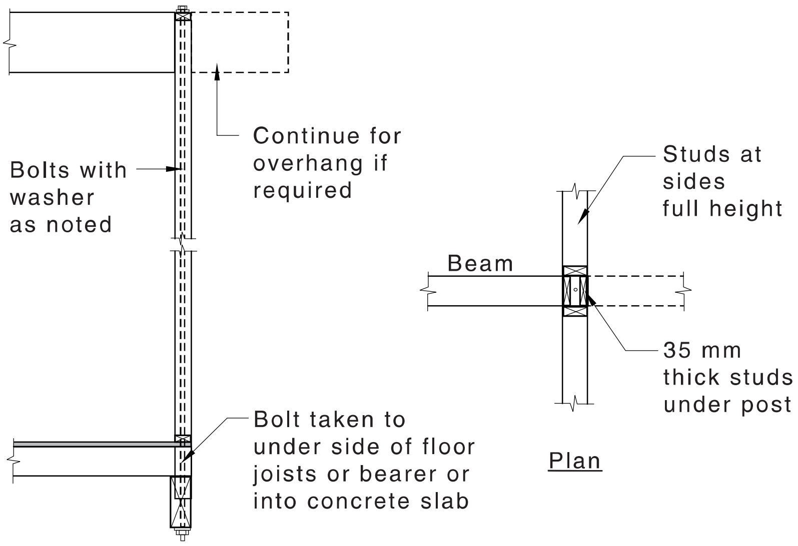
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor		J2	J3	J4	JD4	JD5	JD6
(h) 	Bolts						
	M10	18	18	18	15	12	9.0
	M12	27	27	26	20	16	12
	M16	50	50	46	35	28	21

Table 9.20(i) — Uplift capacity of beam/lintel tie-down connections

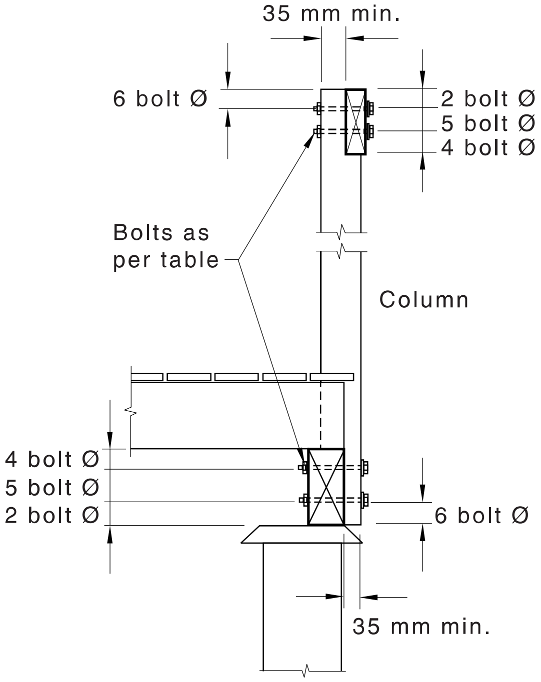
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor		J2	J3	J4	JD4	JD5	JD6
(i) 	No. 14 Type 17 screws (min. 35 mm penetration into receiving member)						
	2	7.7	5.5	3.9	5.5	3.9	2.8
	4	15	11	7.8	11	7.8	5.7
	Bolts						
	1/M10 cup-head	3.9	2.3	1.5	2.6	1.8	1.2
	1/M12 cup-head	4.4	2.7	1.8	3.0	2.2	1.5
	1/M16 cup-head	5.7	3.7	2.3	4.2	2.9	2.0
	2/M10 cup-head	7.7	4.6	2.9	5.2	3.6	2.5
	2/M12 cup-head	8.8	5.5	3.5	6.1	4.3	3.0
	2/M16 cup-head	11	7.3	4.6	8.3	5.7	4.0
	1/M10	5.7	3.8	2.5	4.3	3.6	2.1
	1/M12	7.3	4.5	2.9	5.1	3.6	2.5
	1/M16	9.5	6.1	3.8	6.9	4.8	3.3
	2/M10	11	7.6	4.9	8.6	6.1	4.1
	2/M12	15	9.1	5.8	10	7.2	5.1
	2/M16	19	12	7.6	14	9.6	6.6

Table 9.20(j) — Uplift capacity of beam/lintel tie-down connections

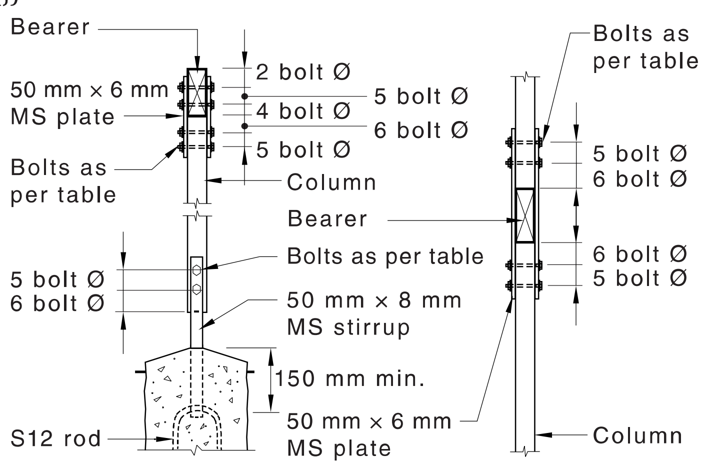
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor		J2	J3	J4	JD4	JD5	JD6
(j) 	Bolts						
	1/M10	11	7.6	4.9	8.6	6.1	4.1
	1/M12	15	9.1	5.8	10	7.2	5.1
	2/M10	23	15	9.8	17	12	8.2
	2/M12	29	18	12	20	14	10
	2/M16	38	24	15	28	19	13

Table 9.20(k) — Uplift capacity of beam/lintel tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor		J2	J3	J4	JD4	JD5	JD6
(k)	Bolts						
	1/M12	22	20	16	20	17	15
	2/M12	43	39	32	39	34	30
	1/M16	38	35	27	35	30	24
	2/M16	76	71	53	71	60	49
NOTE The same or an equivalent detail is required at the bottom of the post.							

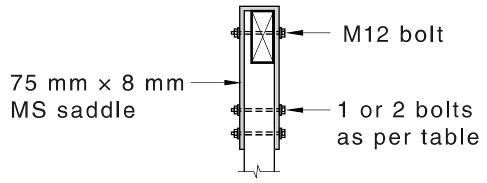


Table 9.20(l) — Uplift capacity of beam/lintel tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor		J2	J3	J4	JD4	JD5	JD6
(l)	Bolts						
	2/M10	36	36	36	30	24	18
	2/M12	54	54	52	40	32	24
	2/M16	100	100	92	70	56	42

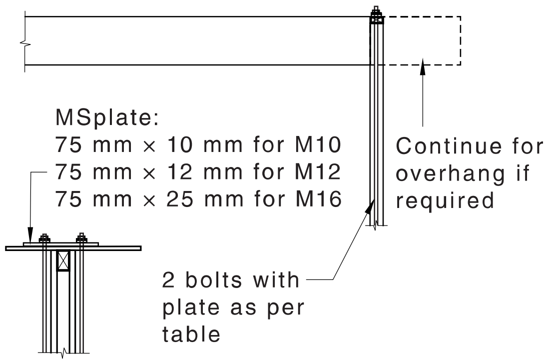


Table 9.20(m) — Uplift capacity of beam/lintel tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor	J2	J3	J4	JD4	JD5	JD6
(m)	106	85	55	85	69	55

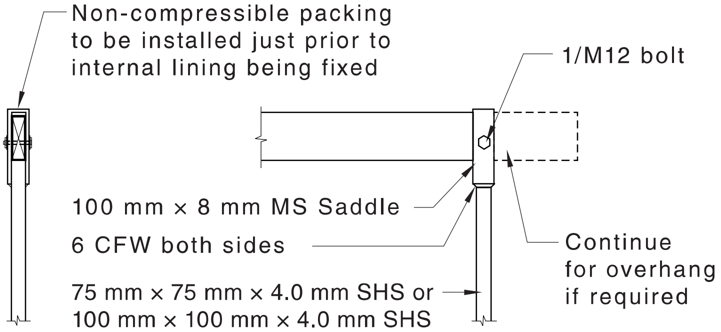
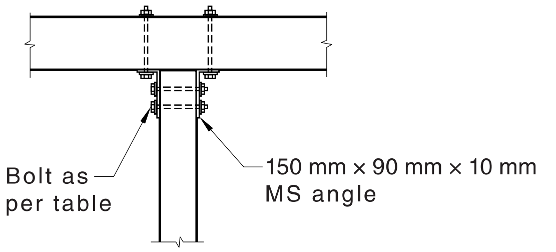
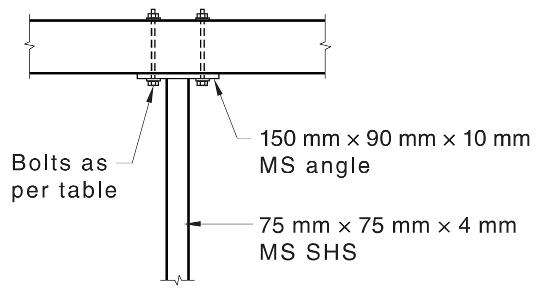


Table 9.20(n) — Uplift capacity of beam/lintel tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor		J2	J3	J4	JD4	JD5	JD6
(n) 	Bolts						
	2/M10	23	21	16	24	21	18
	2/M12	33	30	24	35	30	27
	2/M16	57	53	40	62	53	43

NOTE The same or an equivalent detail is required at the bottom of the post.

Table 9.20(o) — Uplift capacity of beam/lintel tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor		J2	J3	J4	JD4	JD5	JD6
(o) 	Bolts						
	2/M10	36	36	36	30	24	18
	2/M12	54	54	52	40	32	24
	2/M16	100	100	92	70	56	42

NOTE The same or an equivalent detail is required at the bottom of the post.

Table 9.20(p) — Uplift capacity of beam/lintel tie-down connections

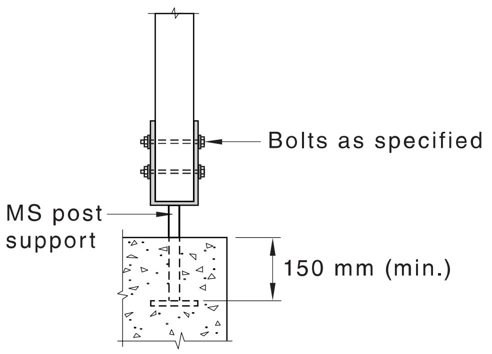
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Beams/lintels/ring beams to studs/posts/floor	J2	J3	J4	JD4	JD5	JD6
(p) 	Refer to manufacturer's specifications.					

Table 9.21(a) — Uplift capacity of rafter and truss tie-down connections

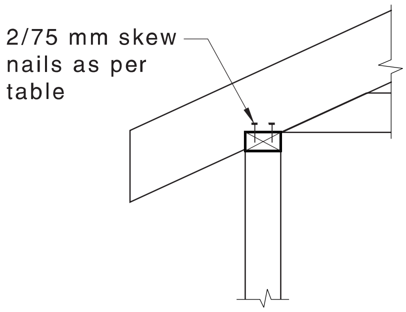
<table>
<tr><th rowspan="2" colspan="2">Position of tie-down connection</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th colspan="2">Rafters/trusses to wall frame or floor frame</th><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="7">(a)

</td><td colspan="7">Hand-driven nail dia.</td></tr>
<tr><td>3.15</td><td>0.97</td><td>0.82</td><td>0.71</td><td>0.51</td><td>0.34</td><td>0.24</td></tr>
<tr><td>3.75</td><td>1.1</td><td>0.97</td><td>0.87</td><td>0.66</td><td>0.40</td><td>0.29</td></tr>
<tr><td colspan="7">Glue-coated or deformed shank machine-driven nail dia.</td></tr>
<tr><td>3.05</td><td>1.5</td><td>1.2</td><td>1.1</td><td>0.77</td><td>0.50</td><td>0.36</td></tr>
<tr><td>3.33</td><td>1.7</td><td>1.5</td><td>1.3</td><td>0.99</td><td>0.60</td><td>0.43</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="8">NOTE The uplift capacities given in this Item are applicable to the joint, not individual nails.</td></tr>
</table>

Table 9.21(b) — Uplift capacity of rafter and truss tie-down connections

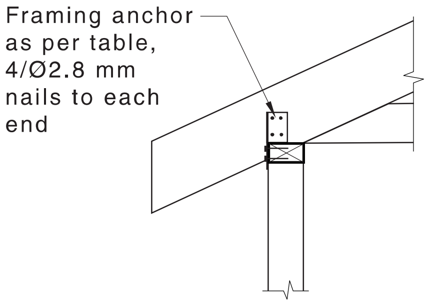
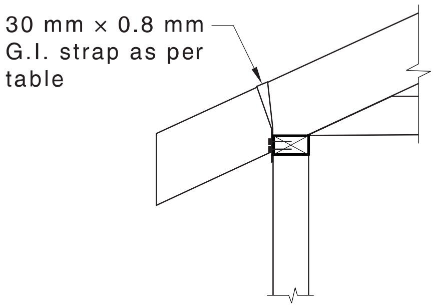
<table>
<tr><th rowspan="2" colspan="2">Position of tie-down connection</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th colspan="2">Rafters/trusses to wall frame or floor frame</th><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="4">(b)

</td><td colspan="7">No. of anchors</td></tr>
<tr><td>1</td><td>4.9</td><td>3.5</td><td>2.5</td><td>3.5</td><td>2.9</td><td>2.2</td></tr>
<tr><td>2</td><td>8.3</td><td>5.9</td><td>4.2</td><td>5.9</td><td>4.9</td><td>3.7</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="8">NOTE For ribbon plate construction, nails are to be equally located in both the upper and lower plate, or more in the lower plate.</td></tr>
</table>

Table 9.21(c) — Uplift capacity of rafter and truss tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters/trusses to wall frame or floor frame		J2	J3	J4	JD4	JD5	JD6
(c) 	No. of straps with 2/2.8 dia nails each end						
	1	4.9	3.5	2.5	3.5	2.9	2.2
	2	8.3	5.9	4.2	5.9	4.9	3.7
	No. of straps with 3/2.8 dia nails each end						
	1	6.5	4.7	3.3	4.7	3.8	2.9
	2	12	8.4	5.9	8.4	6.9	5.2

NOTE For ribbon plate construction, nails are to be equally located in both the upper and lower plate, or more in the lower plate.

Table 9.21(d) — Uplift capacity of rafter and truss tie-down connections

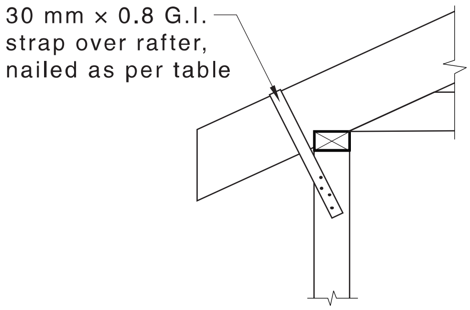
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters/trusses to wall frame or floor frame		J2	J3	J4	JD4	JD5	JD6
(d) 	No. of 2.8 dia nails each end						
	2	4.9	3.5	2.5	3.5	2.9	2.2
	3	6.5	4.7	3.3	4.7	3.8	2.9
	4	8.3	5.9	4.2	5.9	4.9	3.7
	6	12	8.4	5.9	8.4	6.9	5.2

Table 9.21(e) — Uplift capacity of rafter and truss tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters/trusses to wall frame or floor frame		J2	J3	J4	JD4	JD5	JD6
(e)	No. of looped straps						
	1	13	13	13	13	13	13
	2	25	25	25	25	25	25

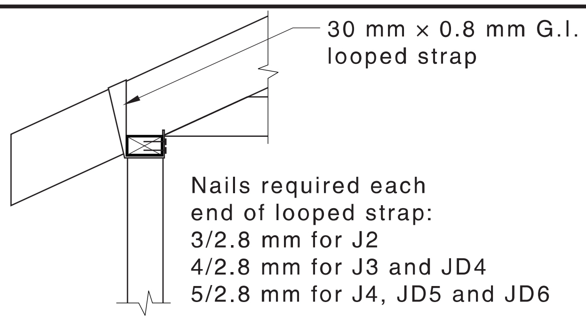


Table 9.21(f) — Uplift capacity of rafter and truss tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters/trusses to wall frame or floor frame		J2	J3	J4	JD4	JD5	JD6
(f)	M10	16	14	10	10	7	5
	Minimum roof batten size shall be 35 mm × 70 mm for up to F7 and 38 mm × 50 mm for F8 and above.						

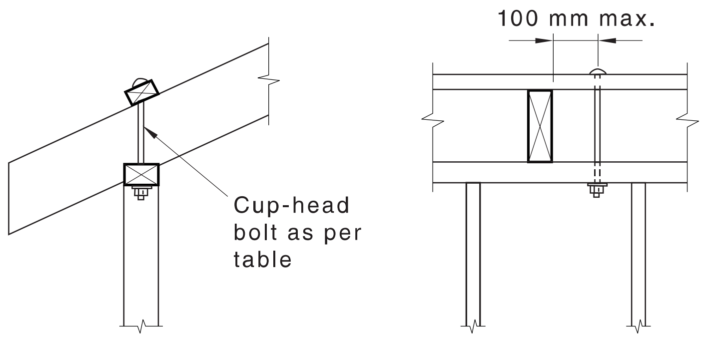


Table 9.21(g) — Uplift capacity of rafter and truss tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters/trusses to wall frame or floor frame		J2	J3	J4	JD4	JD5	JD6
(g)	No. of bolts						
	M10	18	18	18	15	12	9.0
	M12	27	27	26	20	16	12
	M16	50	50	46	35	28	21
	2/M10	36	36	36	30	24	18
	2/M12	54	54	52	40	32	24
	Where bolts are connected to top plates, the top plate shall be designed for uplift.						

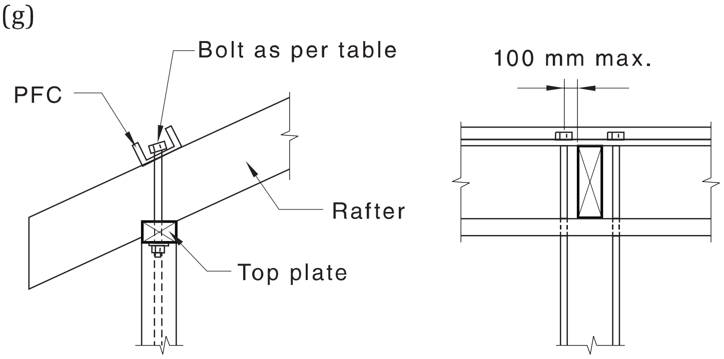


Table 9.21(h) — Uplift capacity of rafter and truss tie-down connections

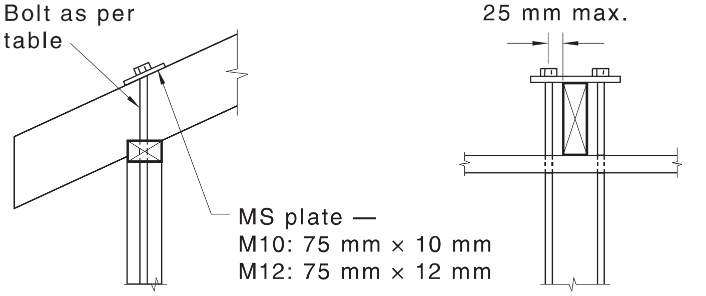
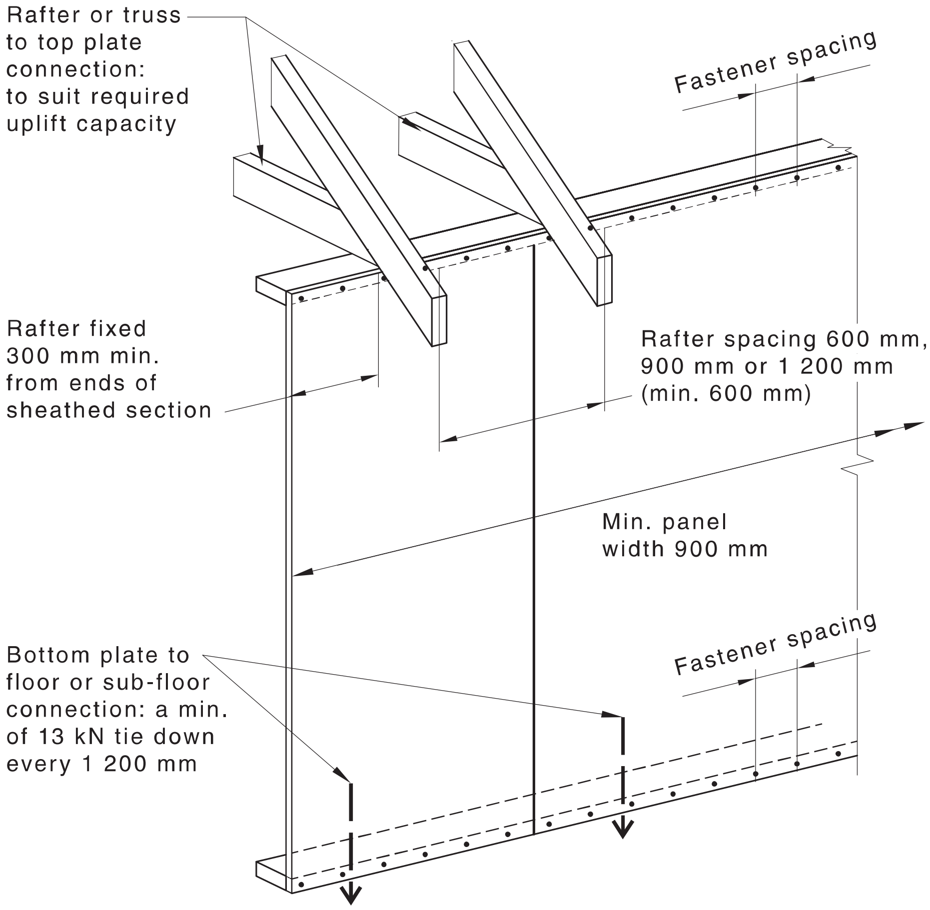
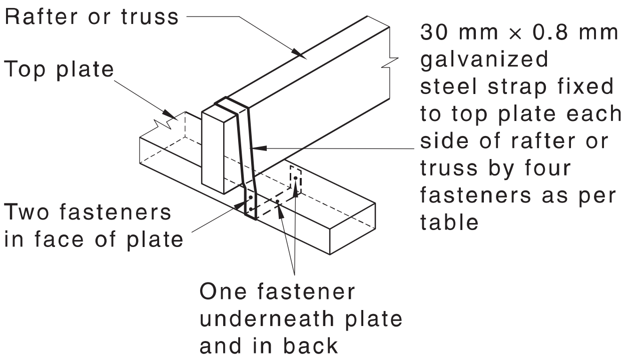
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters/trusses to wall frame or floor frame		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(h) 	No. of bolts						
	2/M10	36	36	36	30	24	18
	2/M12	54	54	52	40	32	24

Table 9.21(i) — Uplift capacity of rafter and truss tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters/trusses to wall frame or floor frame	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**

(i) *Plywood sheathed wall system*



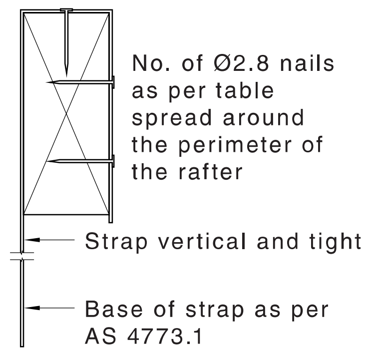


Fastener spacing, mm		Uplift capacity, kN/rafter
Hand or machine-driven nails	Staples	
50	33	16.7
150	100	10.4

NOTE This detail is not applicable for tie-down at sides of openings.

Table 9.21(j) — Uplift capacity of rafter and truss tie-down connections

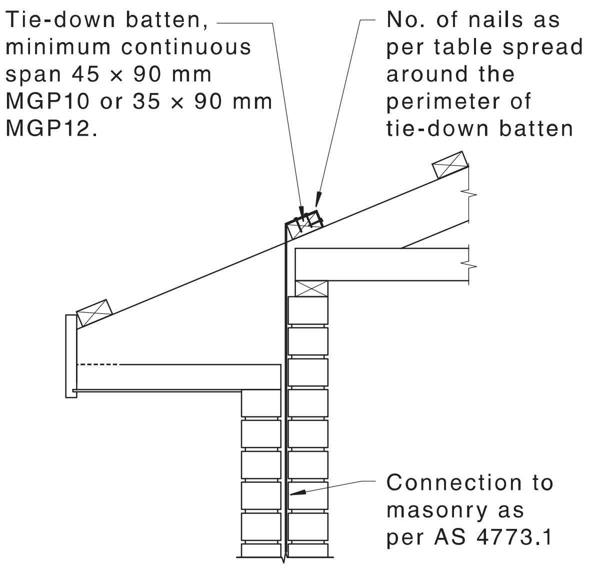
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters/truss to walls including masonry straps in accordance with AS 4773.1	J2	J3	J4	JD4	JD5	JD6
(j)	No. of nails					
3	6.5	4.8	3.9	4.8	3.9	3.9
4	6.5	6.5	5.2	6.5	5.2	5.2
5	6.5	6.5	6.5	6.5	6.5	6.5



NOTE Capacity may be limited by the connection capacity in AS 4773.1.

Table 9.21(k) — Uplift capacity of rafter and truss tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to walls and tie-down batten to masonry wall including masonry straps in accordance with AS 4773.1	J2	J3	J4	JD4	JD5	JD6
(k) No. of nails						
3	6.5	4.8	3.9	4.8	3.9	3.9
4	6.5	6.5	5.2	6.5	5.2	5.2
5	6.5	6.5	6.5	6.5	6.5	6.5



NOTE 1 Capacity may be limited by the connection capacity in AS 4773.1.

NOTE 2 Battens of an alternative material and/or size to the above should be designed in accordance with AS 1720.1.

Table 9.22(a) — Uplift capacity of rafter tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	J2	J3	J4	JD4	JD5	JD6
(a)	No. of framing anchors					
1	4.9	3.5	2.5	3.5	2.9	2.2
2	8.3	5.9	4.2	5.9	4.9	3.7
4	15	11	7.7	11	9.0	6.8

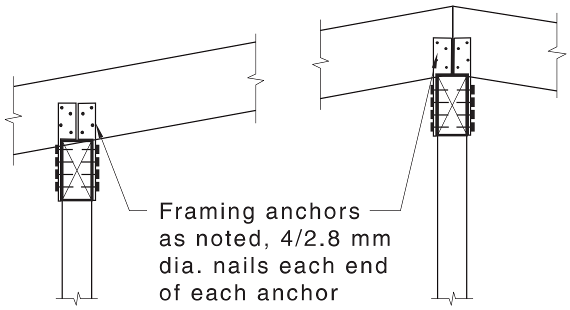


Table 9.22(b) — Uplift capacity of rafter tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	J2	J3	J4	JD4	JD5	JD6
(b)	No. of straps					
1	8.3	5.9	4.2	5.9	4.9	3.7
2	15	11	7.7	11	9.0	6.8

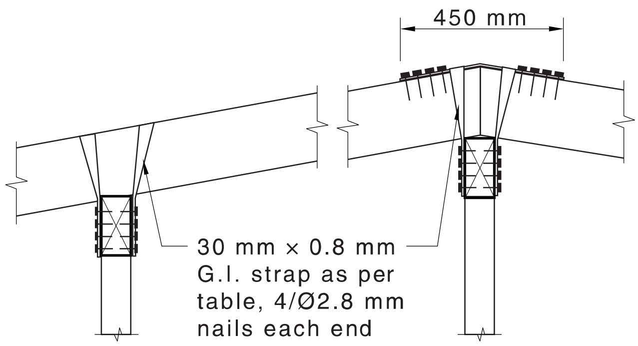


Table 9.22(c) — Uplift capacity of rafter tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	J2	J3	J4	JD4	JD5	JD6
(c)	No. of straps					
1	13	13	13	13	13	13
2	25	25	25	25	25	25

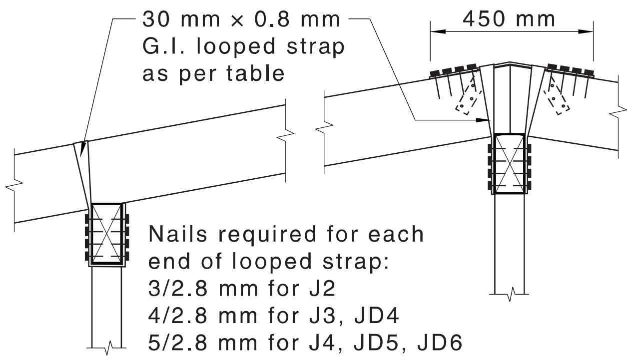


Table 9.22(d) — Uplift capacity of rafter tie-down connections

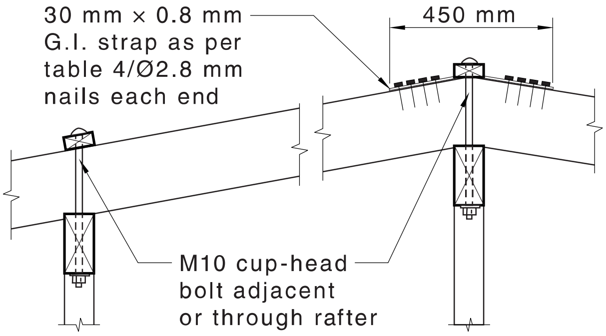
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams		J2	J3	J4	JD4	JD5	JD6
(d) 	No. of bolts						
	1	16	14	10	10	7.0	5.0
	Minimum roof batten size shall be 35 mm × 70 mm for up to F7 and 38 mm × 50 mm for F8 and above.						

Table 9.22(e) — Uplift capacity of rafter tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams		J2	J3	J4	JD4	JD5	JD6
(e)	No. of bolts						

Table 9.22(e) *(continued)*

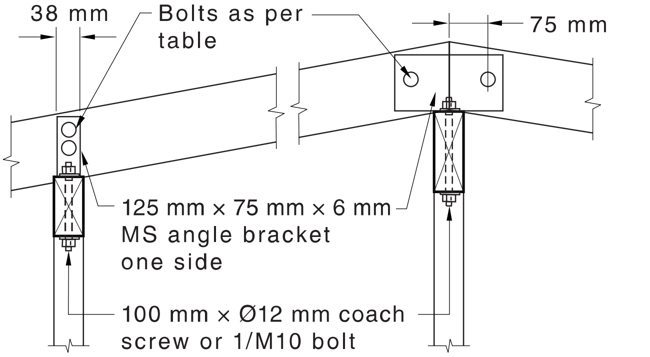
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
	2/M10	14	9.2	5.9	8.8	7.2	4.9
	2/M12	14	11	7.0	8.8	7.2	5.1

Table 9.22(f) — Uplift capacity of rafter tie-down connections

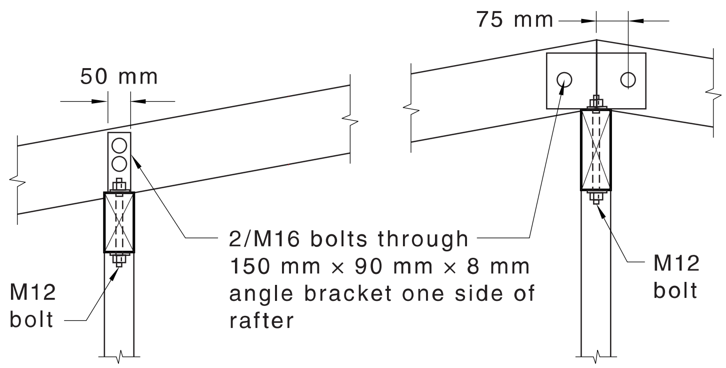
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(f) 	23	15	9.2	17	12	8.0

Table 9.22(g) — Uplift capacity of rafter tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	J2	J3	J4	JD4	JD5	JD6
(g)	Coach screw or bolts					
12 mm dia. coach screw	11	7.9	5.2	6.6	5.4	3.8
M10 bolt	18	18	18	15	12	9.0
M12 bolt	27	27	26	20	16	12

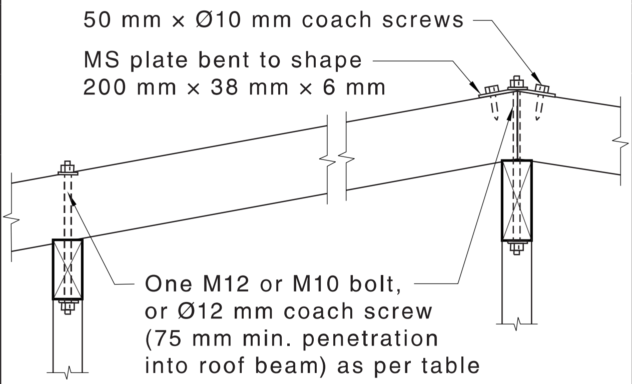


Table 9.22(h) — Uplift capacity of rafter tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	J2	J3	J4	JD4	JD5	JD6
(h)	14	11	6.4	8.0	5.2	3.6

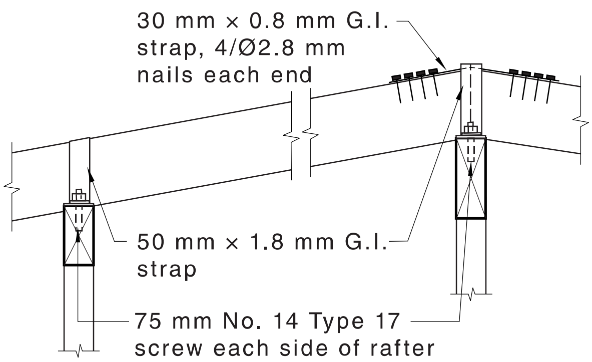


Table 9.22(i) — Uplift capacity of rafter tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	J2	J3	J4	JD4	JD5	JD6
(i)	Bolts					
2/M10	14	9.2	5.9	10	7.3	4.9
2/M12	18	11	7.0	12	8.7	6.1
Screws						
2/40 mm No.14	12	8.3	5.9	8.3	5.9	4.3

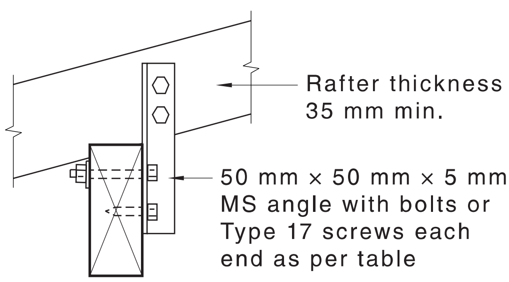


Table 9.22(j) — Uplift capacity of rafter tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams		J2	J3	J4	JD4	JD5	JD6
(j)	No. of screws						
	1	5.8	4.2	2.9	4.2	2.9	2.1
	2	12	8.3	5.6	8.3	5.9	4.3
	Bolt to rafter						
	1/ M10	7.2	4.6	2.9	5.1	3.6	2.5

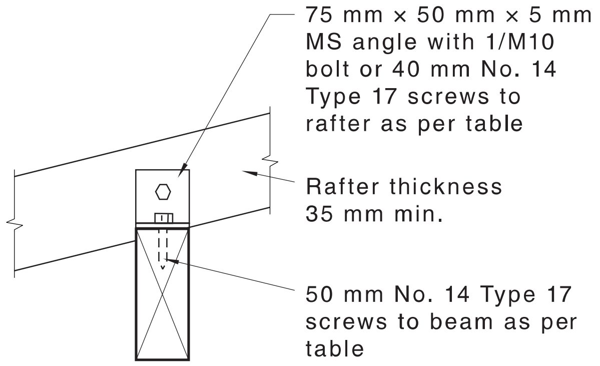


Table 9.22(k) — Uplift capacity of rafter tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams		J2	J3	J4	JD4	JD5	JD6
(k)	Bolts						
	M8	5.2	3.6	2.2	4	2.9	2
	M10	7.2	4.6	2.9	5.1	3.6	2.5
	M12	8.8	5.5	3.5	6.1	4.3	3
	M16	11	7.3	4.6	8.3	5.7	4
	Beams shall be a minimum of 70 mm thick for M16 bolts.						

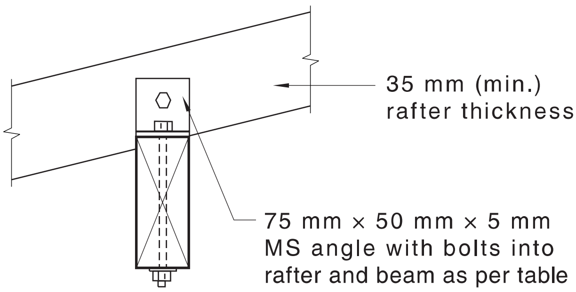


Table 9.22(l) — Uplift capacity of rafter tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	J2	J3	J4	JD4	JD5	JD6
(l)	14	11	7	8.8	7.2	5.1

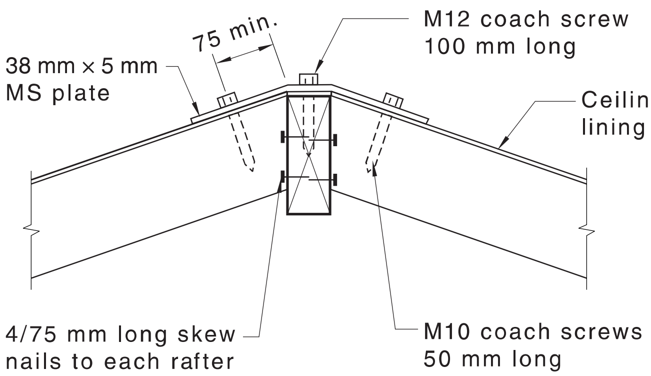


Table 9.22(m) — Uplift capacity of rafter tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	J2	J3	J4	JD4	JD5	JD6
(m)	3.05 mm dia. nails					

Table 9.22(m) *(continued)*

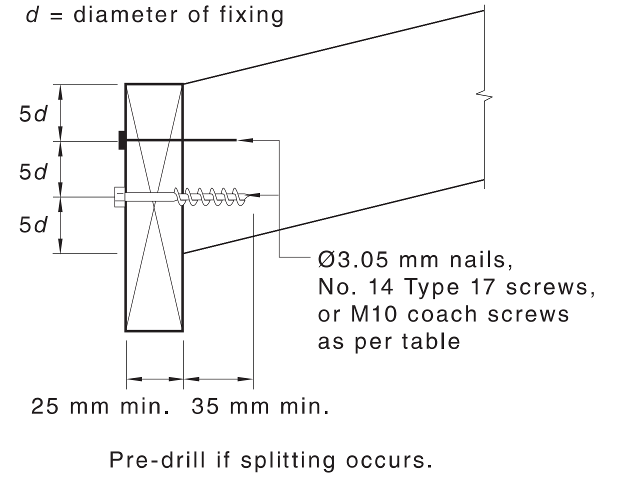
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams		J2	J3	J4	JD4	JD5	JD6
	2	1.5	1.1	0.77	1.1	0.90	0.66
	3	2.3	1.6	1.2	1.6	1.4	0.99
	4	3.0	2.2	1.5	2.2	2.0	1.3
	Type 17 screws						
	2/No14	5.8	4.2	2.9	4.2	2.9	2.2
	3/No14	8.7	6.2	4.4	6.2	4.4	3.2
	4/No14	12	8.3	5.9	8.3	5.9	4.3
	Coach screws						
	2/M10	8.2	5.2	3.3	5.8	4.1	2.8
	3/M10	12	7.8	5.0	8.8	6.2	4.2

Table 9.22(n) — Uplift capacity of rafter tie-down connections

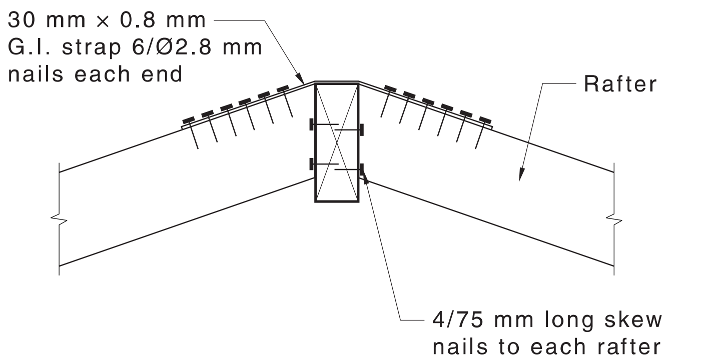
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	J2	J3	J4	JD4	JD5	JD6
(n) 	3.0	2.2	1.5	2.2	2.0	1.3

Table 9.22(o) — Uplift capacity of rafter tie-down connections

Table 9.22(o) *(continued)*

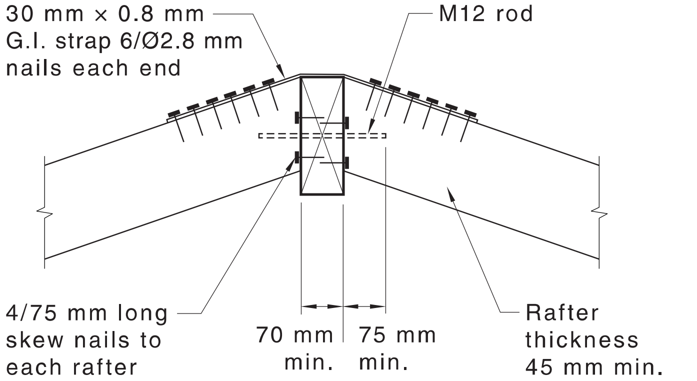
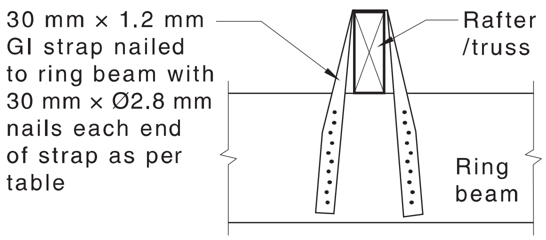
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(o) 	9.0	5.5	3.5	6.0	4.3	3.1

Table 9.22(p) — Uplift capacity of rafter tie-down connections

Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams		J2	J3	J4	JD4	JD5	JD6
(p)	No. of nails						
	6	12	8.4	5.9	8.4	6.9	5.2
	8	15	11	7.6	11	8.8	6.7
	10	18	13	9.3	13	11	8.3



NOTE See also Tables 9.21 (d) and 9.21(e).

Table 9.23 — Uplift capacity of underpurlin tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Underpurlins to strutting beams/walls	J2	J3	J4	JD4	JD5	JD6
Looped straps or bolts						
1 looped strap	13	13	13	13	13	13
2 looped straps	25	25	25	25	25	25
1/M10 bolt	18	18	18	15	12	9
1/M12 bolt	27	27	26	20	16	12
Nails required for each end of looped strap shall be: 3/2.8 mm ⌀ for J2; 4/2.8 mm ⌀ for J3 and JD4; and 5/2.8 mm ⌀ for J4, JD5 and JD6. The top plate shall be tied down to floor frame.						

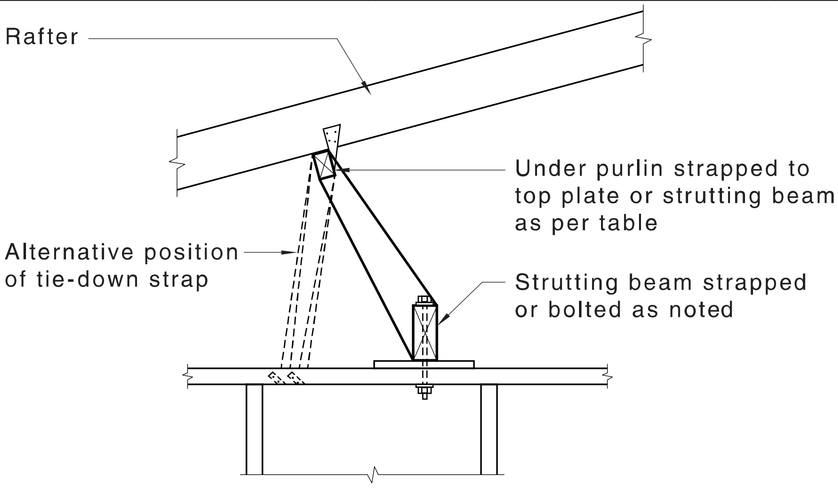


Table 9.24(A) — Uplift capacity of rafters to rafters at ridge tie-down connections

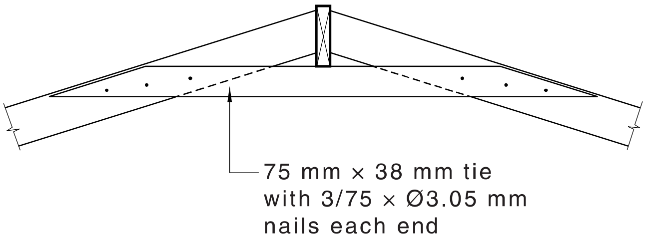
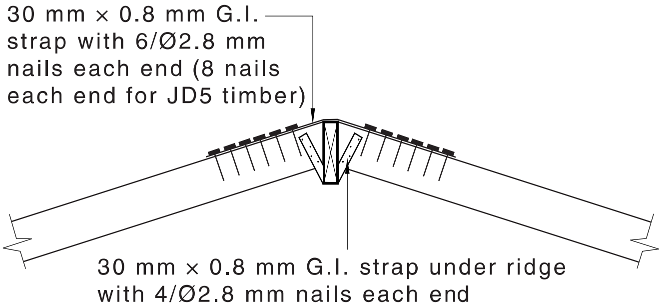
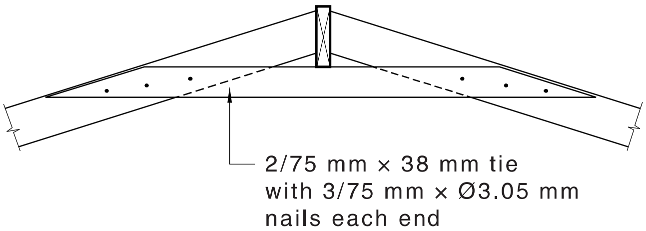
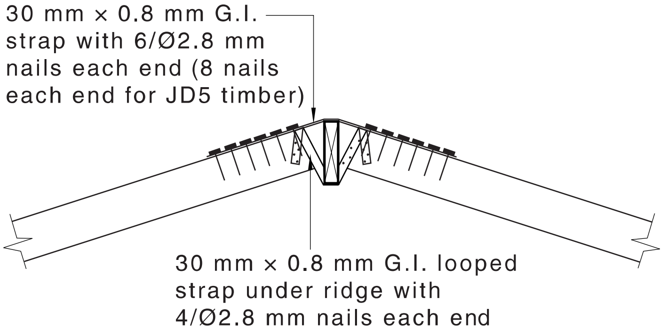
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to rafters at ridge	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(a) 	7.0	5.0	3.6	5.0	4.2	3.1
(b) 	9.8	7.0	5.0	7.0	5.8	4.4
(c) 	14	10	7.2	10	8.4	6.2
(d) 	13	13	10	13	11.6	8.8

Table 9.24(A) *(continued)*

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to rafters at ridge	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**

NOTE Regarding Item (b) above, for N1 and N2, a metal ridge cap screwed down with No. 14 Type 17 screws at max. 450 mm centres may be used in lieu of the G.I. strap over the rafters.

Table 9.24(B) — Uplift capacity of ridgeboard and hip rafter tie-down connections

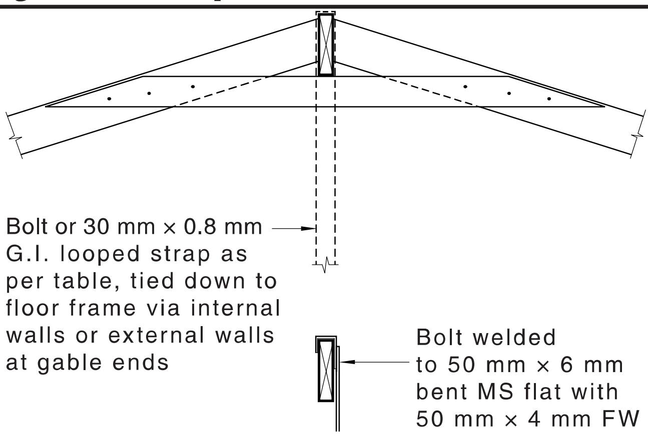
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Ridgeboards and hip rafters to walls		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
	1 looped strap	13	13	13	13	13	13
	2 looped straps	25	25	25	25	25	25
	1/M10 bolt	18	18	18	15	12	9
	1/M12 bolt	27	27	26	20	16	12

Table 9.25(a) — Uplift capacity of roof batten tie-down connections

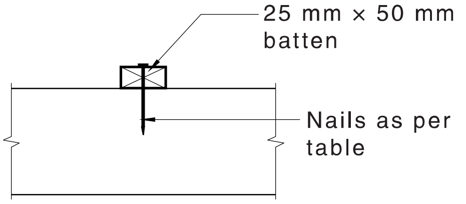
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses		J2	J3	J4	JD4	JD5	JD6
(a) 	Plain shank (length × diameter - mm)						
	1/50 × 2.8⌀	0.36	0.30	0.28	0.20	0.13	0.09
	1/65 × 2.8⌀	0.58	0.48	0.44	0.32	0.20	0.14
	1/65 × 3.05⌀	0.65	0.54	0.48	0.34	0.22	0.16
	1/75 × 3.05⌀	0.81	0.68	0.60	0.43	0.28	0.20
	Deformed shank						
	1/65 × 3.05	1.3	1.1	0.95	0.68	0.45	0.32
	1/75 × 3.05	1.6	1.4	1.2	0.85	0.56	0.40

Table 9.25(b) — Uplift capacity of roof batten tie-down connections

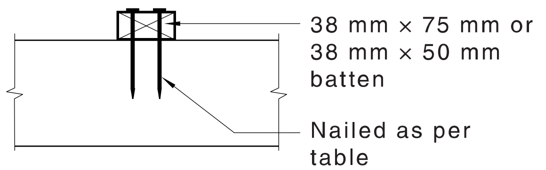
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses		J2	J3	J4	JD4	JD5	JD6
(b) 	Plain shank (length × diameter - mm)						
	1/75 × 3.05	0.61	0.52	0.45	0.32	0.21	0.15
	2/75 × 3.05	1.2	1.0	0.90	0.64	0.42	0.30
	Deformed shank						
	1/75 × 3.05	1.2	1.0	0.90	0.65	0.43	0.30
	2/75 × 3.05	2.5	2.1	1.8	1.3	0.86	0.60
	2/75 × 3.75	2.8	2.5	2.2	1.7	1.0	0.72

Table 9.25(c) — Uplift capacity of roof batten tie-down connections

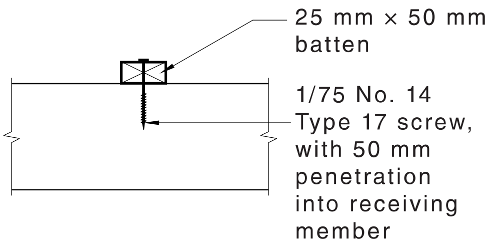
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses	J2	J3	J4	JD4	JD5	JD6
(c) 	7.4	5.5	3.2	6.0	4.7	3.6

Table 9.25(d) — Uplift capacity of roof batten tie-down connections

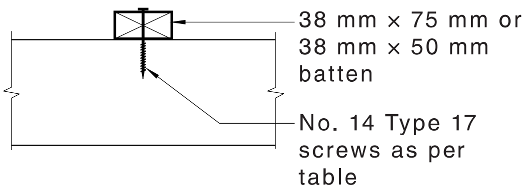
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(d)  Two screws shall be used only with 75 mm wide batten	Screws (length)						
	1/75 mm long	5.7	4.2	2.4	4.5	3.6	2.7
	1/90 mm long	7.4	5.5	3.2	6.0	4.7	3.6
	2/75 mm long	11	8.4	4.8	9.0	7.2	5.4
	2/90 mm long	15	11	6.4	12	9.4	7.2

Table 9.25(e) — Uplift capacity of roof batten tie-down connections

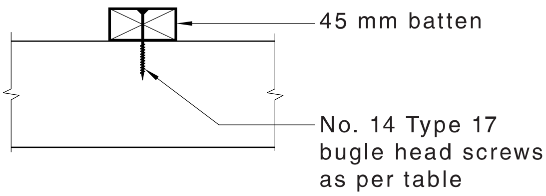
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(e)  Two screws shall be used only with 75 mm wide batten	Screws (length)						
	1/75 mm	4.2	3.1	1.8	3.4	2.7	2.1
	1/90 mm	5.9	4.4	2.5	4.7	3.7	2.9
	2/75 mm	8.5	6.3	3.6	6.8	5.4	4.2
	2/90 mm	11.7	8.7	5.0	9.4	7.4	5.8

Table 9.25(f) — Uplift capacity of roof batten tie-down connections

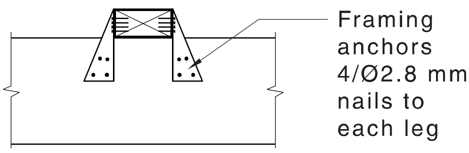
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(f) 	Framing anchors						
	1	4.9	3.5	2.5	3.5	2.9	2.2
	2 placed on alt. sides of batten	8.3	5.9	4.2	5.9	4.9	3.7

Table 9.25(g) — Uplift capacity of roof batten tie-down connections

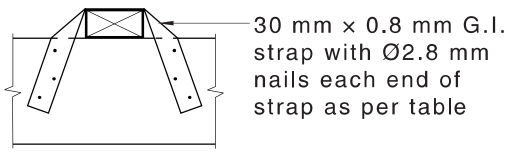
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(g) 	No. of nails each end of strap						
	3	6.5	4.7	3.3	4.7	3.8	2.9
	4	8.3	5.9	4.2	5.9	4.9	3.7

Table 9.25(h) — Uplift capacity of roof batten tie-down connections

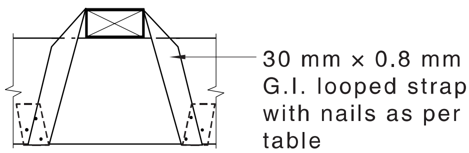
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(h) 		13	13	13	13	13	13
Timber	No. of 2.8 mm dia. nails each end of strap						
J2	3						
J3 aqnd JD4	4						
JD4, JD5, JD6	5						

Table 9.25(i) — Uplift capacity of roof batten tie-down connections

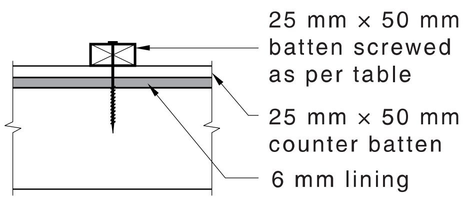
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(i) 	No. 14 Type 17 screws						
	1/90 mm long	4.9	3.6	2.1	3.9	3.1	2.4
	1/100 mm long	6.4	4.8	2.7	5.1	4.0	3.1

Table 9.25(j) — Uplift capacity of roof batten tie-down connections

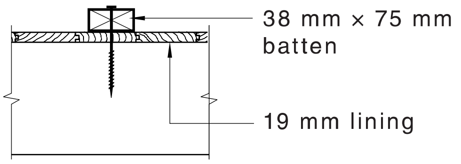
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses		J2	J3	J4	JD4	JD5	JD6
(j) 	No. 14 Type 17 screws						
	1/100 mm long	6.4	4.8	2.7	5.1	4.0	3.1

Table 9.25(k) — Uplift capacity of roof batten tie-down connections

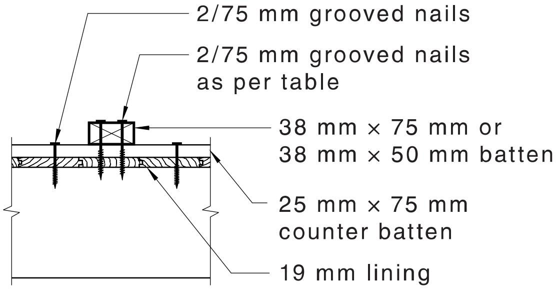
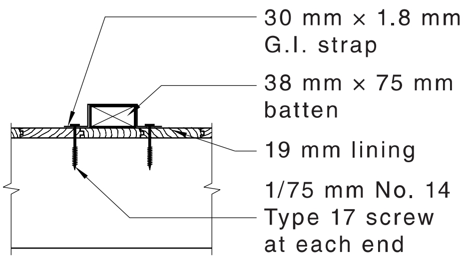
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses		J2	J3	J4	JD4	JD5	JD6
(k) 	Deformed shank nails						
	2/3.06 mm	2.5	2.1	1.8	1.3	0.86	0.6
	2/3.75 mm	2.8	2.5	2.2	1.7	1.0	0.72

Table 9.25(l) — Uplift capacity of roof batten tie-down connections

Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Roof battens to rafters/trusses	J2	J3	J4	JD4	JD5	JD6
(l) 	15	11	6.4	12	9.4	7.2

9.7 Shear forces

9.7.1 General

Shear forces (lateral wind forces) shall be resisted by connections at each level of the house to prevent "sliding".

For masonry veneer construction for wind classifications up to N3, specific connections to resist shear forces are not required.

For most other situations, the provisions of nominal fixings and/or specific tie-down connections, and the connection of bracing walls to the ceiling, floor or subfloor are adequate to resist the shear forces.

Where these connections are not adequate, additional connections shall be provided in accordance with Clauses 9.7.2 to 9.7.6.

9.7.2 Bottom plate to concrete slab

For wind classifications N1 to N3, nominal fixings only shall be provided in accordance with Table 9.4.

For wind classification N4, bottom plates shall be fixed to concrete slabs using hammered, fired, screwed or expansion masonry anchors at 900 mm centres maximum along all bottom plates.

9.7.3 Floor joists to bearers/walls

For wind classifications N1 to N3, nominal fixings only shall be provided in accordance with Table 9.4.

For wind classification N4, see Clause 9.7.5 and Tables 9.26 and 9.27. These additional connections are not required where connections provided for tie-down also provide the necessary shear capacity.

9.7.4 Bearers to supports

For wind classifications N1 and N2, nominal fixings only shall be provided in accordance with Table 9.4.

For wind classifications N3 and N4, see Clause 9.7.5, and Tables 9.26 and 9.28. These additional connections are not required where connections provided for tie-down also provide the necessary shear capacity.

9.7.5 Shear forces on joists and bearers

The shear force required to be resisted by joists or bearers may be calculated using the following procedure:

(a) Determine the shear wind force at the floor line from Table 9.26 for the relevant joist spacing or bearer span.

(b) Multiply this force by the projected height of the house (ridge to relevant floor level) and divide this by the number of lines of connection (bearers, walls or supporting stumps, piers, etc.) across the width of the house.

The resultant value shall be resisted by one of the details given in Table 9.27 and Table 9.28.

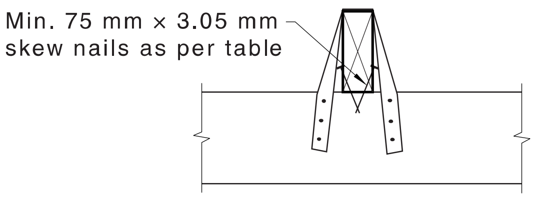
NOTE An example of the application of this Clause is given in Appendix D.

Table 9.26 — Shear force of projected height at the floor line

Wind classification	Lateral load[a] of projected height at the floor line, kN/m									
	Joist spacings or bearer spans, mm									
	300	450	600	1 200	1 800	2 400	3 000	3 600	4 500	6 000
N3	0.42	0.63	0.84	1.7	2.5	3.4	4.2	5.0	6.3	8.4
N4	0.63	0.95	1.3	2.5	3.8	5.0	6.3	7.6	9.5	13

[a] Interpolation is permitted.

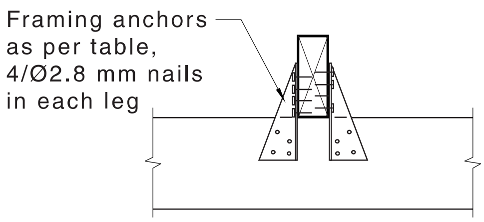
Table 9.27(a) — Shear connections for floor joists

Position of shear connection		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
Floor joists to bearers or top plates		J2	J3	J4	JD4	JD5	JD6
(a) 	No. of nails						
	2	1.4	1.1	0.77	1.1	0.90	0.66
	3	2.1	1.6	1.2	1.6	1.4	1.0
	4	2.8	2.1	1.5	2.1	1.8	1.3

NOTE 1 This connection does not provide rotational restraint to the top of the bearers.

NOTE 2 The same lateral strength applies, whether joists are strapped or not strapped to the bearers or supports.

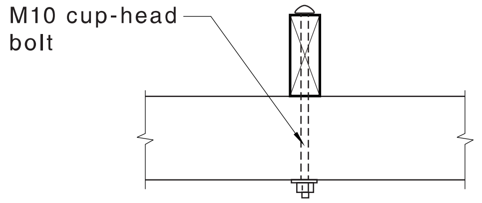
Table 9.27(b) — Shear connections for floor joists

Position of shear connection		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
Floor joists to bearers or top plates		J2	J3	J4	JD4	JD5	JD6
(b) 	No. of framing anchors						
	1	2.4	2.4	2.4	2.4	2.2	2.0
	2	4.8	4.8	4.8	4.8	4.3	3.9
	3	7.2	7.2	7.2	7.2	6.5	5.9
	4	9.6	9.6	9.6	9.6	8.6	7.8

NOTE This connection does provide rotational restraint to the top of bearers.

Table 9.27(c) — Shear connections for floor joists

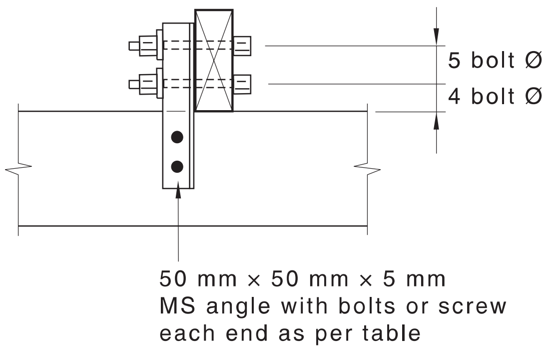
Position of shear connection		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
Floor joists to bearers or top plates		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(c)	M10 cup-head	6.0	3.8	2.4	4.3	3.0	2.0



NOTE This connection does provide rotational restraint to the top of bearers.

Table 9.27(d) — Shear connections for floor joists

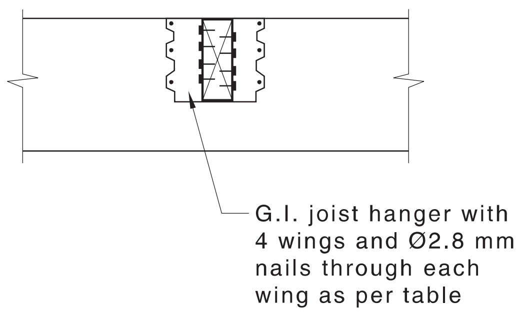
Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Floor joists to bearers or top plates	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(d) No. of bolts						
2/M10	14	9.2	5.9	10	7.3	4.9
2/M12	18	11	7.0	12	8.7	6.1



NOTE This connection does provide rotational restraint to the top of bearers.

Table 9.27(e) — Shear connections for floor joists

Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Floor joists to bearers or top plates	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(e) No. of nails per wing						
3	6.5	4.7	3.3	4.7	3.8	2.9
4	8.3	5.9	4.2	5.9	4.9	3.7
5	9.9	7.1	5	7.1	5.8	4.4
6	12	8.4	5.9	8.4	6.9	5.2



NOTE This connection does provide rotational restraint to the top of bearers.

Table 9.28(a) — Shear connections for bearers

Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(a)	Bearer not restrained by joist					
	0.5	0.5	0.5	0.5	0.5	0.5
	Bearer restrained by joist					
	3.0	2.4	1.7	3.0	2.5	1.8

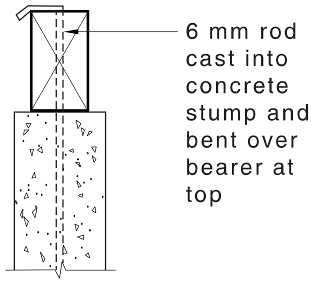


Table 9.28(b) — Shear connections for bearers

Position of shear connection		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(b)	Nails						
	2/75 × 3.05	1.4	1.1	0.77	1.1	0.90	0.66
	4/75 × 3.05	2.8	2.1	1.5	2.1	1.8	1.3
	4/75 × 3.33	3.3	2.4	1.7	2.4	2.0	1.5
	Spike						
	1/M10	6.4	5.2	3.4	6.0	4.3	2.9
	1/M12	7.7	5.9	3.7	6.5	4.7	3.2
	1/M16	11	6.9	4.4	7.9	5.5	3.8
NOTE Values apply irrespective of joist connection.							

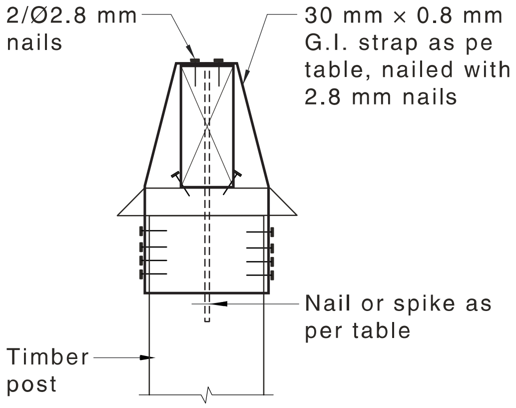


Table 9.28(c) — Shear connections for bearers

Position of shear connection		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(c)	No. of bolts						
	1/M10	6.4	4.1	2.6	4.3	3.0	2.0
	1/M12	7.6	4.9	3.1	5.1	3.6	2.5
	2/M10	12	8.2	5.3	8.6	6.0	4.1
	2/M12	12	9.8	6.2	10	7.2	5.1
	2/M16	12	12	8.2	12	9.6	6.6
NOTE Values apply irrespective of joist connection.							

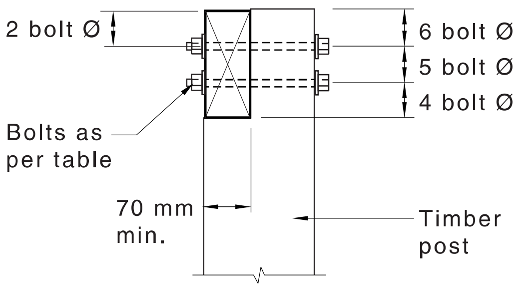


Table 9.28(d) — Shear connections for bearers

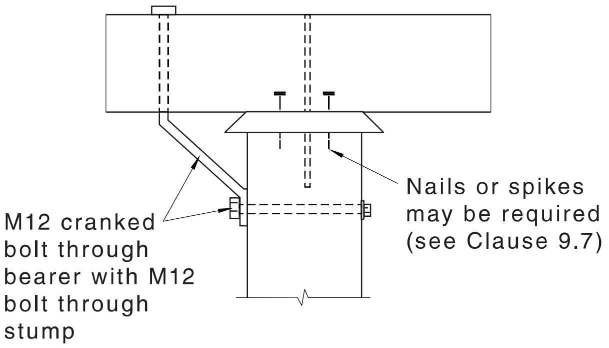
Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(d) 						
Bearer not restrained by joist						
Nails						
2/75 × 3.05	1.4	1.1	0.77	1.1	0.90	0.66
4/75 × 3.05	2.8	2.1	1.5	2.1	1.8	1.3
4/75 × 3.33	3.3	2.4	1.7	2.4	2.0	1.5
Spike						
1/M10	3.2	2.6	1.7	3.0	2.1	1.5
1/M12	3.9	2.9	1.8	3.2	2.3	1.6
1/M16	5.3	3.4	2.2	3.9	2.8	1.9
Bearer restrained by joist						
Spike						
1/M10	6.4	5.2	3.4	6.0	4.3	2.9
1/M12	7.7	5.9	3.7	6.5	4.7	3.2
1/M16	10.5	6.9	4.4	7.9	5.5	3.8

Table 9.28(e) — Shear connections for bearers

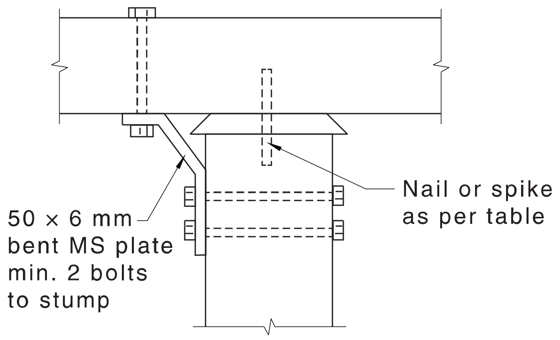
Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(e) 						
Bearer not restrained by joist						
Bolts						
1/M10	3.2	2.6	1.7	3.0	2.1	1.5
1/M12	3.9	2.9	1.8	3.2	2.3	1.6
1/M16	5.3	3.4	2.2	3.9	2.8	1.9
Bearer restrained by joist						
Bolts						
1/M10	6.4	5.2	3.4	6.0	4.3	2.9
1/M12	7.7	5.9	3.7	6.5	4.7	3.2
1/M16	11	6.9	4.4	7.9	5.5	3.8

Table 9.28(f) — Shear connections for bearers

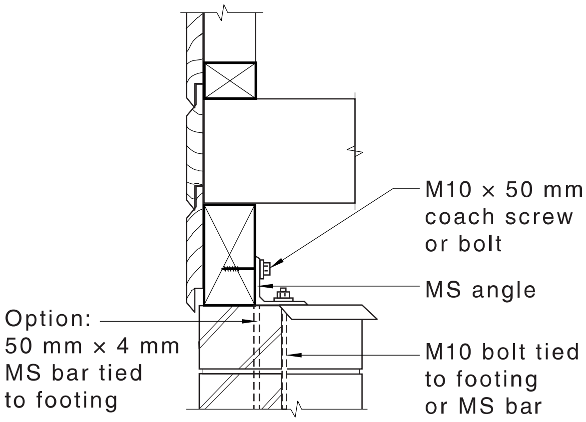
Position of shear connection		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		J2	J3	J4	JD4	JD5	JD6
(f) 	M10 coach screw	5.1	3.8	2.6	3.3	2.5	1.8
	M10 bolt	9.1	8.3	6.6	8.3	7.3	6.2
NOTE Values apply irrespective of joist connection.							

Table 9.28(g) — Shear connections for bearers

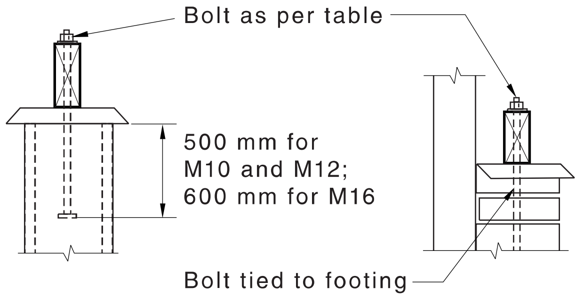
Position of shear connection		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		J2	J3	J4	JD4	JD5	JD6
(g) 	Bearer not restrained by joist						
	Bolts						
	M10	4.8	3.9	2.6	4.5	3.2	2.2
	M12	5.8	4.4	2.8	4.9	3.5	2.4
	M16	7.9	5.1	3.3	5.9	4.2	2.9
	M20	9	5.7	3.6	6.4	4.5	3.1
	Bearer restrained by joist						
	Bolts						
	M10	6.4	5.2	3.4	6.0	4.3	2.9
	M12	7.7	5.9	3.7	6.5	4.7	3.2
	M16	11	6.9	4.4	7.9	5.5	3.8
	M20	12	7.6	4.8	8.5	6.0	4.2

Table 9.28(h) — Shear connections for bearers

Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	J2	J3	J4	JD4	JD5	JD6
(h)	Bearer not restrained by joist					
Bolts						
1/M10	4.8	3.9	2.6	4.5	3.2	2.2
1/M12	5.8	4.4	2.8	4.9	3.5	2.4
2/M10	10	7.8	5.1	9	6.4	4.4
2/M12	12	9	5.5	10	7.0	4.7
	Bearer restrained by joist					
Bolts						
1/M10	6.4	5.2	3.4	6.0	4.3	2.9
1/M12	7.7	5.9	3.7	6.5	4.7	3.2
2/M10	13	10	6.8	12	8.6	5.9
2/M12	15	12	7.4	13	9.3	6.3

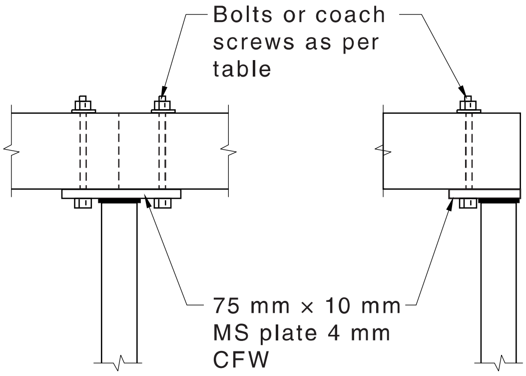
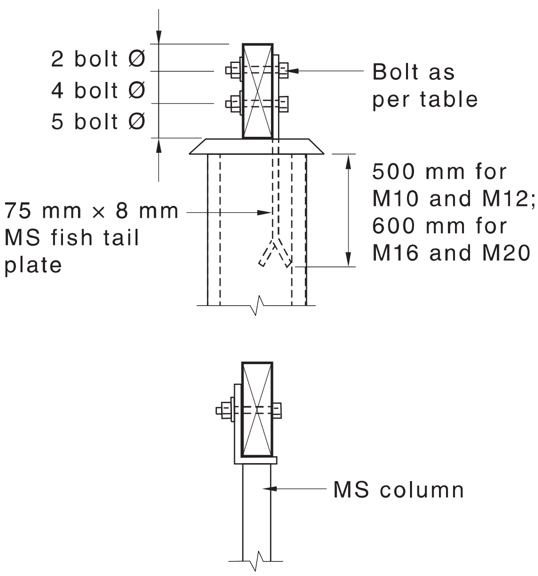


Table 9.28(i) — Shear connections for bearers

Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	J2	J3	J4	JD4	JD5	JD6
(i) Bolts						
1/M10	7.7	6.2	4.4	7.9	6.3	5.0
1/M12	10	8.2	5.7	10	8.3	6.0
1/M16	16	12	8.6	16	12	8.0
2/M10	15	12	8.8	16	13	9.9
2/M12 or 2/M16	21	16	11	21	17	12



NOTE Values apply irrespective of joist connection.

Table 9.28(j) — Shear connections for bearers

Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	J2	J3	J4	JD4	JD5	JD6
(j) Bearer not restrained by joist						
Nails						
2/75 × 3.05	1.4	1.1	0.77	1.1	0.90	0.66
4/75 × 3.05	2.8	2.1	1.5	2.1	1.8	1.3
4/75 × 3.33	3.3	2.4	1.7	2.4	2.0	1.5
Bolts						
1/M10	3.2	2.6	1.7	3.0	2.1	1.5
1/M12	3.9	2.9	1.8	3.2	2.3	1.6
1/M16	5.3	3.4	2.2	3.9	2.8	1.9
Bolts (bearer restrained by joist)						
1/M10	6.4	5.2	3.4	6.0	4.3	2.9
1/M12	7.7	5.9	3.7	6.5	4.7	3.2
1/M16	11	6.9	4.4	7.9	5.5	3.8

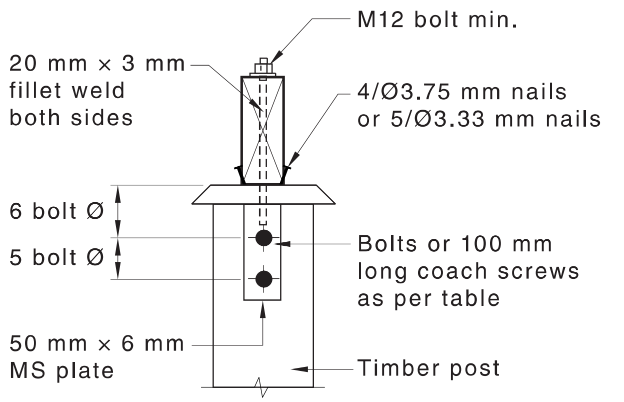


Table 9.28(k) — Shear connections for bearers

Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	J2	J3	J4	JD4	JD5	JD6
(k) Bearer not restrained by joist						
Bolts						
M10	4.8	3.9	2.6	4.5	3.2	2.2
M12	5.8	4.4	2.8	4.9	3.5	2.4
M16	7.9	5.1	3.3	5.9	4.2	2.9
Bolts (bearer restrained by joist)						
M10	6.4	5.2	3.4	6.0	4.3	2.9
M12	7.7	5.9	3.7	6.5	4.7	3.2
M16	11	6.9	4.4	7.9	5.5	3.8

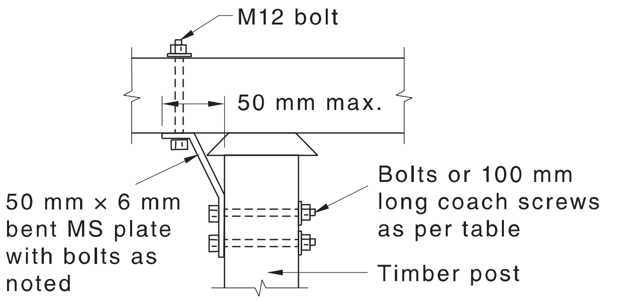


Table 9.28(l) — Shear connections for bearers

Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	J2	J3	J4	JD4	JD5	JD6
(l) No. of bolts						
2/M10	31	20	13	20	14	9.8
2/M12	36	23	15	24	17	12
2/M16	49	31	20	33	23	16

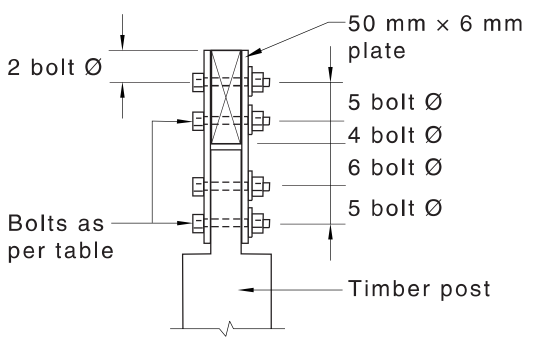
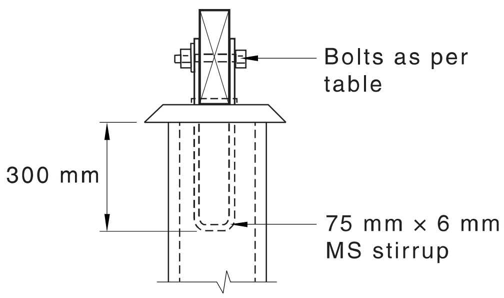


Table 9.28(l) *(continued)*

Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
NOTE Values apply irrespective of joist connection.						

Table 9.28(m) — Shear connections for bearers

Position of shear connection		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(m) 	No. of bolts						
	M10	14	9.8	6.3	10	7.3	4.9
	M12	18	12	7.5	12	8.7	6.1
	M16	24	16	9.8	17	12	8
NOTE Values apply irrespective of joist connection.							

9.7.6 Shear forces on external non-loadbearing walls

Non-loadbearing external walls, such as gable end walls and verandah walls (where trusses are pitched off verandah beams or other beams), shall be restrained laterally at their tops at a maximum of 3 000 mm, see Clause 6.2.5.

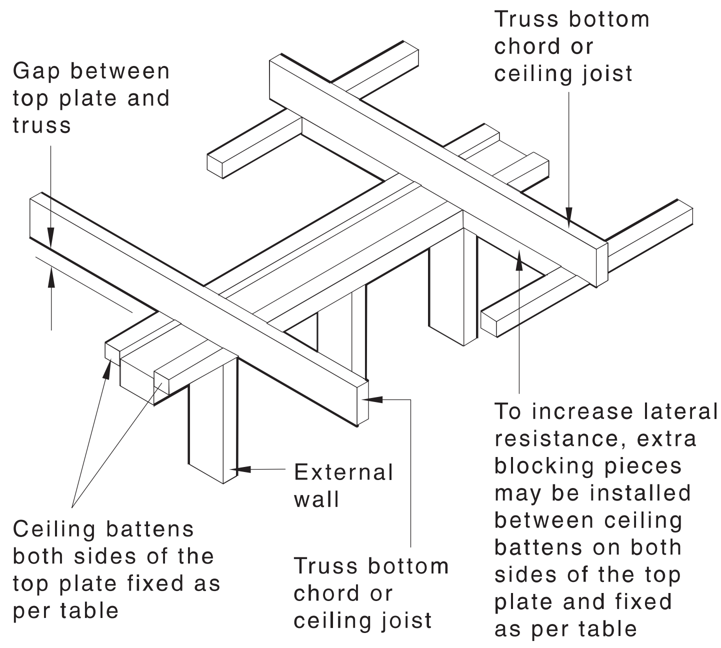
Where lateral restraint for these walls is not provided by the usual means using binders, intersecting walls, strutting, hanging or other roof beams or ceiling joists or ceiling battens or similar members, the walls shall be restrained laterally in accordance with Table 9.29 and Table 9.30, where applicable, or the relevant details given in Table 8.22 for the fixing of the top of bracing walls.

NOTE Lateral restraint in accordance with this Clause is not required where bracing walls are connected to the ceiling or roof framing in accordance with Clause 8.3.5.8 or where tie-down details are structurally adequate to provide also the lateral restraint.

Table 9.29 — Shear wind forces at the top of external walls up to 2 700 mm high

Wind classification	Shear force per metre length of external wall, kN/m	Shear resistance required, kN						
		Connections spacing along the wall, mm						
		450	**600**	**900**	**1 200**	**1 800**	**2 400**	**3 000**
N1	0.94	0.42	0.56	0.85	1.1	1.7	2.3	2.8
N2	1.3	0.58	0.78	1.2	1.6	2.3	3.1	3.9
N3	2.0	0.9	1.2	1.8	2.4	3.6	4.8	6.0
N4	3.0	1.4	1.8	2.7	3.6	5.4	7.2	9.0
NOTE 1 For 2 400 mm high external walls, multiply the above values by 0.91.								
NOTE 2 For 3 000 mm high external walls, multiply the above values by 1.1.								

Table 9.30 — Shear support for external non-loadbearing walls

<table>
<tr><th rowspan="2">Shear connection of external</th><th colspan="7">Shear capacity, kN</th></tr>
<tr><th colspan="4">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>Non-loadbearing walls</th><th></th><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><td rowspan="10">


Spacing between nails in blocking shall be greater than 60 mm
</td><td colspan="7">Capacity per batten fixing</td></tr>
<tr><td>1 nail per batten</td><td>1.3</td><td>0.90</td><td>0.64</td><td>0.90</td><td>0.75</td><td>0.56</td></tr>
<tr><td>1 screw per batten</td><td>4.8</td><td>3.5</td><td>2.5</td><td>3.5</td><td>2.5</td><td>1.8</td></tr>
<tr><td colspan="7">Additional capacity per block</td></tr>
<tr><td>2 nails per block</td><td>2.5</td><td>1.8</td><td>1.3</td><td>1.8</td><td>1.5</td><td>1.1</td></tr>
<tr><td>3 nails per block</td><td>3.7</td><td>2.7</td><td>1.9</td><td>2.7</td><td>2.3</td><td>1.7</td></tr>
<tr><td>4 nails per block</td><td>5.0</td><td>3.6</td><td>2.5</td><td>3.6</td><td>3.0</td><td>2.2</td></tr>
<tr><td>1 screw per block</td><td>4.8</td><td>3.5</td><td>2.5</td><td>3.5</td><td>2.5</td><td>1.8</td></tr>
<tr><td>2 screws per block</td><td>9.6</td><td>7.0</td><td>5.0</td><td>7.0</td><td>5.0</td><td>3.6</td></tr>
</table>

Appendix A
(informative)

Determination of roof mass

A.1 Mass of roof and ceiling components

Tables A.1.1 and A.1.2 can be used to determine the mass of individual roof and ceiling components, with respect to the use of the relevant Span Tables given in the Supplements.

Clause A.2 provides worked examples of the determination of roof masses.

Table A.1.1 — Mass of typical roof constructions

Mass of roof[a], kg/m^2	Material
10	Steel sheet roofing 0.50 mm thick and battens
20	Metal sheet tiles or medium gauge steel sheet roofing, battens, 12 mm softwood ceiling lining, sarking and lightweight insulation
30[b]	Steel sheet roofing 0.75 mm thick, 13 mm plaster ceiling, roof and ceiling battens, sarking and lightweight insulation
40	Steel sheet roofing 0.75 mm thick, battens, graded purlins and high density fibreboard ceiling lining
60	Terracotta or concrete tiles and battens
75[b]	Terracotta or concrete tiles, roofing and ceiling battens, 10 mm plasterboard, sarking and insulation
90	Terracotta or concrete tiles, purlins, roofing and ceiling battens, 19 mm hardwood ceiling lining, sarking and insulation

a The mass of the member being considered has been included in the calculations for the Span Tables in the Supplements.

b Interpolation within tables is required, see Section 1.

Table A.1.2 — Guide for determination of typical building construction mass

Material examples		Approximate mass/unit area, kg/m^2
Roofing		
Steel sheet	— 0.50 mm	5.0
	— 0.75 mm	10.0
Aluminium sheet	— 1.2 mm	5.0
Tiles	— Terracotta	58.0
	— Concrete	54.0
	— Metal sheet	7.5
Battens or purlins		
Unseasoned hardwood		
	100 mm × 38 mm at 600 mm spacing	7.0
	100 mm × 50 mm at 450 mm spacing	12.0
	50 mm × 2 mm at 330 mm spacing	4.0

Table A.1.2 *(continued)*

Material examples			Approximate mass/unit area, kg/m²
		38 mm × 50 mm at 600 mm spacing	3.0
		38 mm × 50 mm at 900 mm spacing	2.0
		38 mm × 75 mm at 900 mm spacing	3.5
	Seasoned hardwood	35 mm × 42 mm at 900 mm spacing	1.3
		90 mm × 35 mm at 600 mm spacing	4.0
	Seasoned softwood	32 mm × 32 mm at 330 mm spacing	2.0
		90 mm × 35 mm at 900 mm spacing	2.0
		38 mm × 50 mm at 450 mm spacing	2.5
		38 mm × 50 mm at 600 mm spacing	2.0
	Unseasoned softwood	150 mm × 38 mm at 900 mm spacing	4.0
		200 mm × 50 mm at 1 000 mm spacing	6.5
Boards and lining			
	Tongued and grooved lining boards/decking	12 mm softwood	6.5
		19 mm softwood	10.5
		35 mm softwood	19.0
		12 mm hardwood	8.0 to 10.0
		19 mm hardwood	12.0 to 16.0
	Plywood	12 mm softwood	6.5
		8 mm hardwood	5.0
	Plasterboard	10 mm	7.5
		13 mm	10.0
	Hardboard	4.8 mm	5.0
		5.5 mm	5.5
	Fibreboard	50 mm low density	10.0
		50 mm high density	20.0
	Fibre cement sheet	4.5 mm	7.0
		6.0 mm	9.0
Insulation			
	Lightweight insulation plus sarking		1.0

A.2 Examples — Determination of roof mass

The following examples provide guidance on the determination of roof mass:

(a) *Example 1* — Determine the mass of roof input for a rafter supporting concrete tiles on 50 mm × 25 mm unseasoned hardwood battens (330 mm centres), 13 mm plaster ceiling lining with 50 mm × 38 mm unseasoned hardwood ceiling battens at 600 mm centres, sarking (*RFL*) and bulk insulation.

The masses are listed in Table A.2.1.

Table A.2.1 — Masses for example 1

Material	Mass, kg/m^2	Source of information
Concrete tiles	54.0	Table A.1.2
Tile battens	4.0	Table A.1.2
Plaster ceiling	10.0	Table A.1.2
Ceiling battens	3.5	Table A1.2 (half value for 100 mm × 38 mm)
Sarking and insulation	1.0	Table A.1.2
Total	72.5	Adopt 75 kg/m^2
NOTE Similarly, using Table A.1.1, a mass of 75 kg/m^2 would be appropriate.		

(b) *Example 2* — Determine the mass of roof input for an underpurlin supporting unseasoned hardwood rafters with 35 mm × 90 mm seasoned softwood battens at 900 mm centres, 0.53 mm sheet roofing and reflective foil (*RFL*).

The masses are listed in Table A.2.2.

Table A.2.2 — Masses for example 2

Material	Mass, kg/m^2	Source of information
Rafters	—	No input required
Battens	2.0	Table A.1.2
Sheet roofing	5.0	Manufacturer's specification
Sarking	about 0.5	Table A.1.2
Total	7.5	Adopt 10 kg/m^2
NOTE Similarly, using Table A.1.1, a mass of 10 kg/m^2 would be appropriate.		

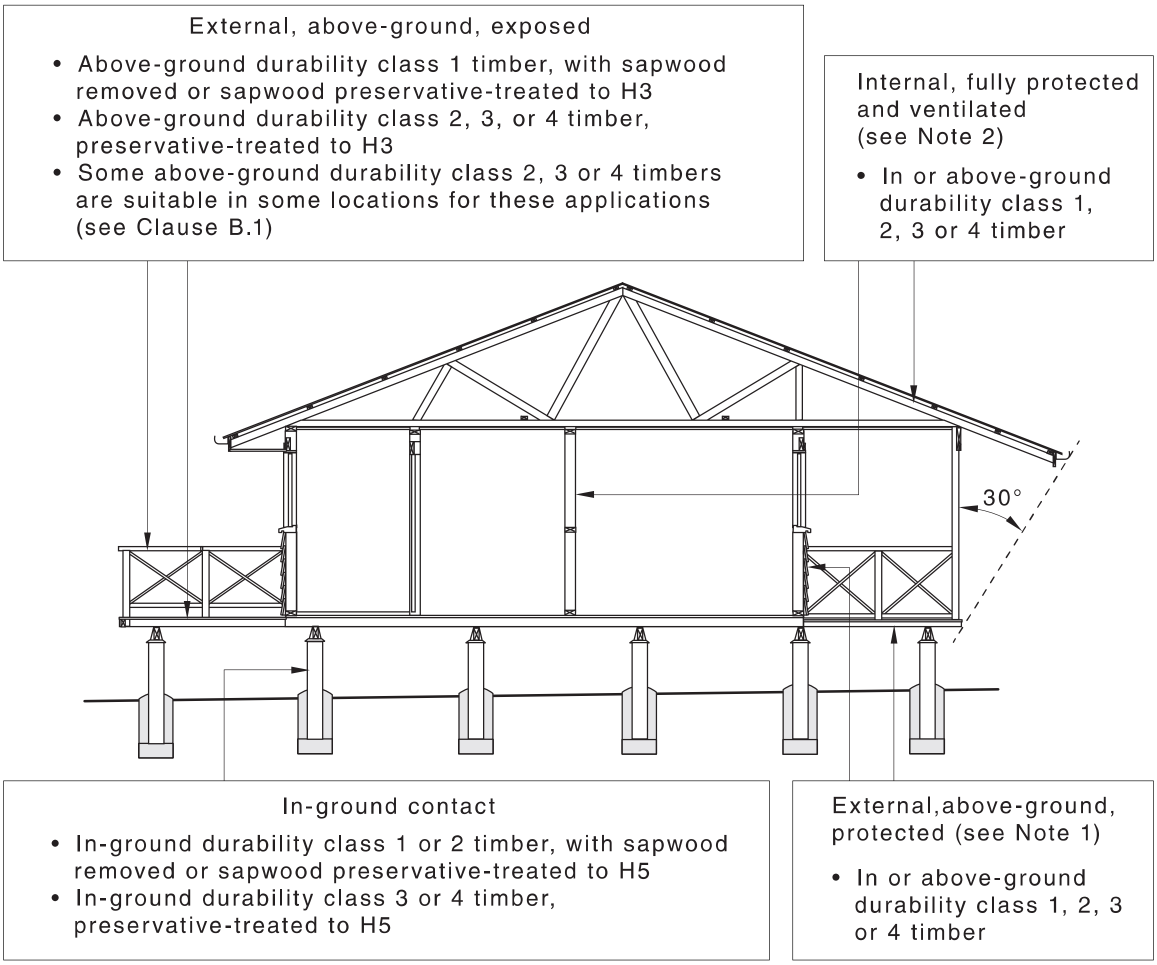
Appendix B
(informative)

Durability

B.1 Durability

Timber used for house construction should have the level of durability appropriate for the relevant climate and expected service life and conditions, i.e. exposure to insect attack or to moisture, which could cause decay. Figure B.1 gives general guidance on the natural durability class or appropriate level of preservative treatment (hazard level) required to give an acceptable service life for various applications. For specific guidance, see Clause B.7.

In some situations, the climatic conditions (colder, dryer, etc.) or the lower risk of insect attack or the careful detailing of joints and application and maintenance of protective coatings may be such that a lower durability to that listed in Figure B.1 could be used.



NOTE 1 External timbers are regarded as protected if they are covered by a roof projection (or similar) at 30° to the vertical and they are well detailed and maintained (painted or stained and kept well ventilated).

NOTE 2 Framing in extremely damp or unventilated locations should have the durability required for external above-ground situations.

Figure B.1 — Species selection for durability

B.2 Natural durability

The heartwood of timber has natural durability characteristics. Species are given an in-ground durability rating from class 1 (the most durable) through to class 4 (the least durable), and a separate above-ground durability rating from class 1 (the most durable) through to class 4 (the least durable).

NOTE See Appendix G for timber species durability ratings.

The sapwood of all species is not durable (regarded as durability class 4); however, sapwood can generally be treated with preservatives to increase its durability. Untreated sapwood should be protected from weather exposure and the ingress of moisture.

B.3 Hazard level

The level of exposure to insects or decay is classified by a hazard level and is given an H number. This number refers to the level of exposure (H1 for low hazards and H6 for high hazards) to service conditions and possible hazards, particularly with respect to preservative treatment required, see Table B.1.

Table B.1 — Hazard class selection guide

Hazard class	Exposure	Specific service conditions	Biological hazard	Typical uses
H1	Inside, above-ground	Completely protected from the weather and well ventilated, and protected from termites	Lyctid borers	Susceptible framing, flooring, furniture, interior joinery
H2	Inside, above-ground	Protected from wetting. Nil leaching	Borers and termites	Framing, flooring, and similar, used in dry situations
H3	Outside, above-ground	Subject to periodic moderate wetting and leaching	Moderate decay, borers and termites	Weatherboard, fascia, pergolas (above-ground), window joinery, framing and decking
H4	Outside, in-ground	Subject to severe wetting and leaching	Severe decay, borers and termites	Fence posts, garden wall less than 1 m high, greenhouses, pergolas (in-ground) and landscaping timbers
H5	Outside, in-ground contact with or in fresh water	Subject to extreme wetting and leaching and/or where the critical use requires a higher degree of protection	Very severe decay, borers and termites	Retaining walls, piling, house stumps, building poles, cooling tower fill
H6	Marine waters	Subject to prolonged immersion in sea water	Marine wood borers and decay	Boat hulls, marine piles, jetty cross-bracing, landing steps, and similar

NOTE 1 Examples shown in this table are not exhaustive. Reference should be made to AS 1604.1.

NOTE 2 Where treated timber is to be used in a marine situation, refer to AS 1604.1 Section 7 on hazard class H6.

NOTE 3 The minimum hazard class level appropriate to the specific exposure and service conditions should be nominated.

B.4 Preservative treatment

Preservative treatment of timber involves the introduction of chemicals into the cellular structure, which protect the timber from fungal decay and insects.

Plantation softwoods contain a wide band of sapwood, which can readily accept preservatives and, therefore, increase durability. Hardwoods have a relatively narrow band of treatable sapwood. Hardwood heartwood cannot be effectively treated and, therefore, its natural durability cannot be increased. Cypress sapwood cannot be effectively treated.

B.5 Weathering

All timber should be protected against the weathering process by the application and proper maintenance of coatings such as paints, stains, water-repellent preservatives, and similar coatings.

Clear finishes may provide limited protection against weathering, as many finishes deteriorate when exposed to sunlight.

Weathering is essentially a surface effect (not decay), causing aesthetic rather than structural problems.

NOTE Appendix H gives guidelines on the storage and handling of timber products.

B.6 Service life

The service life of timber can be improved by reducing exposure to hazards. External timber should be shielded from weather, using roof overhangs, screens, capping and flashing, fascias and barges, see Figure B.2. Timber should be isolated from potential moisture sources, e.g. contact with ground, concrete and masonry.

Subfloor areas, roof spaces and wall cavities should be ventilated, see Clause 3.3.

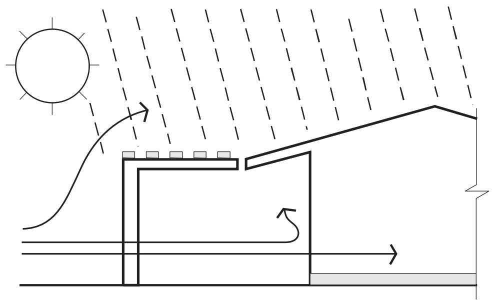
B.7 Specific durability design

Design for durability requires knowledge of the performance requirements of a particular application (structural reliability, cost of failure and initial and ongoing maintenance costs) versus the hazards or natural environment conditions that have to be addressed in conjunction with the materials resistance to these.

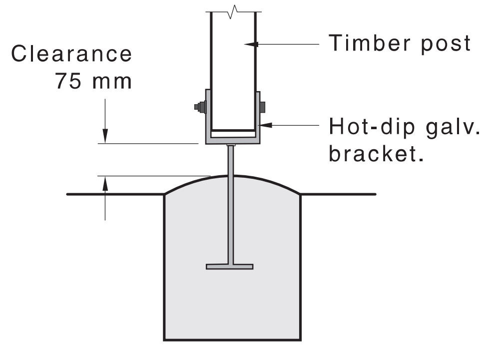
For detailed information on designing for durability, refer to the following:

(a) Mackenzie CE, Wang C-H, Leicester RH, Foliente GC and Nguyen MN, *Timber Service Life Design Guide*, Forest and Wood Products Australia, December 2007.

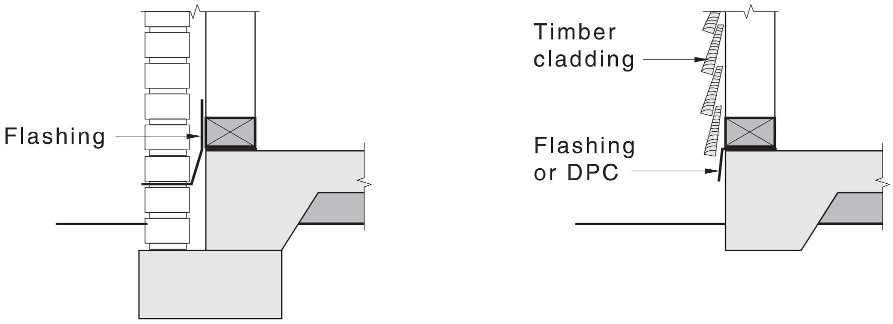
(b) Department of Agriculture and Fisheries, *Construction Timbers in Queensland*, Queensland Government, 2018.



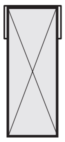
(a) Screens and pergolas (reduce exposure and allow air circulation)



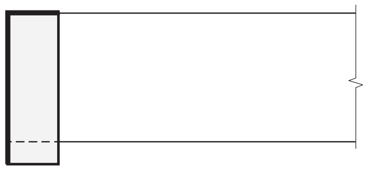
(b) Above-ground posts (isolation from moisture and termites)



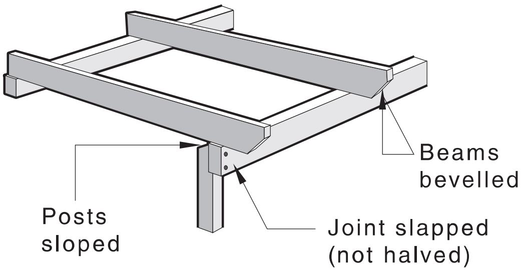
(c) Flashings or damp proof course (isolation from moisture)



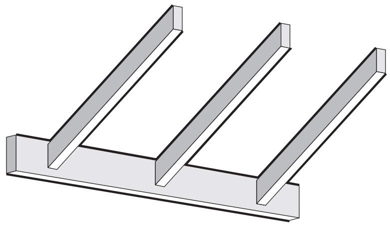
(d) Beam capping (protecting horizontal surface and joints)



(e) Protecting end grain



(f) Reducing end grain exposure



(g) Fascias and bargeboards (protecting end grain)

Figure B.2 — Improving durability

Appendix C
(normative)

Interpolation

C.1 Interpolation

Throughout this Standard, including the Span Tables in the Supplements, direct linear interpolation shall be used to obtain table values for spacings, spans, stud heights, roof load width (*RLW*), roof masses, and similar parameters, intermediate to those listed.

C.2 Example — Span and overhang

Interpolate to obtain the permissible span and overhang for a rafter at a spacing of 600 mm, for a roof mass of 80 kg/m^2 using MGP10 seasoned pine, see Table C.1.

Table C.1 — Rafters — Interpolation

Beam size depth × breadth, mm	Mass of roof, kg/m^2	Rafter spacing, mm							
		450		600		900		1 200	
		Maximum rafter span and overhang, mm							
		Span	Overhang	Span	Overhang	Span	Overhang	Span	Overhang
140 × 35	10	5 300	1 200	5 000	1 150	4 300	900	3 800	800
	20	4 500	1 200	4 200	1 150	3 700	900	3 400	800
	40	3 700	1 200	3 400	1 050	3 000	850	2 700	750
	60	3 300	1 200	3 000	1 000	2 600	800	2 400	700
	80			2 730	930				
	90	2 900	1 100	2 600	900	2 300	750	2 100	650

The interpolation is as follows:

$$\text{Span required} = \frac{90-80}{90-60} \times \left(3000-2600\right) = 2730$$

$$\text{Overhang} = \frac{90-80}{90-60} \times \left(1000-900\right) + 900 = 930$$

Appendix D
(informative)

Examples — Foundation bearing area, distribution of bracing and shear force

D.1 General

This Appendix provides worked examples showing the calculation of foundation bearing area, distribution of bracing and shear force.

D.2 Foundation bearing area

Calculate the bearing area required for a stump supporting the following roof and floor areas for a Class M site. Assume a two storey house with the following criteria:

(a) The allowable bearing capacity determined from a geotechnical investigation of the site has been determined as 180 kPa.

(b) Supported areas are as follows:

   (i) Area of tile roof supported — 5 m^2.

   (ii) Area of upper floor supported — 9 m^2.

   (iii) Area of lower floor supported — 3 m^2.

(c) Total permanent loads (G) are determined as follows (see Clause 3.6.4.2):

   (i) Roof — 5 × 0.9 = 4.5 kN.

   (ii) Upper floor — 9 × 0.5 = 4.5 kN.

   (iii) Lower floor — 3 × 0.3 = 0.9 kN.

   (iv) Walls — (9 + 3) × 0.4 = 4.8 kN.

   (v) Permanent loads G — 14.7 kN.

(d) Floor live load (Q) is determined as follows (see Clause 3.6.4.3):

   Q (upper and lower floors) = (9 + 3) × 1.5 = 18.0 kN

(e) The total load combination (P) is determined as follows (see Clause 3.6.5):

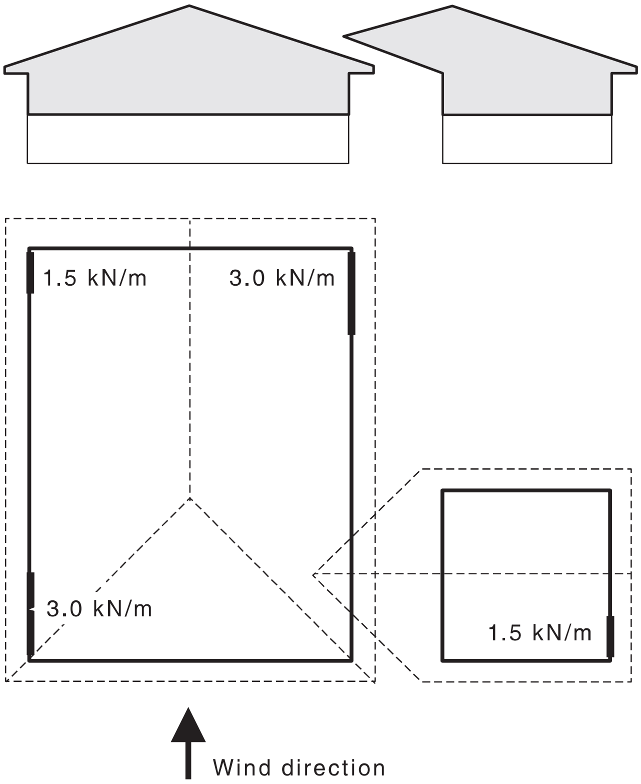
   $P = G + 0.5\ Q = 14.7 + 0.5 \times 18 = 14.7 + 9 = 23.7$ kN

(f) The area of footing required, A (m^2) is determined as follows (Clause 3.6.6):

   $A = P/180 = 23.7/180 = 0.13$ m^2 410 mm diameter

D.3 Even distribution of bracing

Figure D.1 provides examples of how the strength of bracing should be approximately evenly distributed in proportion to the racking forces that occur on the house, relevant to the area of elevation.



NOTE 1 The sections of the house have been separated to illustrate the distribution required.

NOTE 2 The projected area of eaves up to 1 000 mm wide may be ignored in the calculation of area of elevation.

Figure D.1 — Example of even distribution of bracing

D.4 Shear force

D.4.1 Example 1 — Floor joists

Floor joists are spaced at 450 mm centres, in wind classification N4 area, see Figure D.2.

The shear force is calculated as follows:

Shear force = 0.95 × 3.6

= 3.42 (kN per joist)

For joists connected to 4 rows of bearers, the shear force per joist connection is calculated as follows:

Shear force = 3.42/4

= 0.86 (kN per joist connection)

Need 2/3.05 dia. skew nails (1.1 kN capacity, JD4), see Table 9.27.

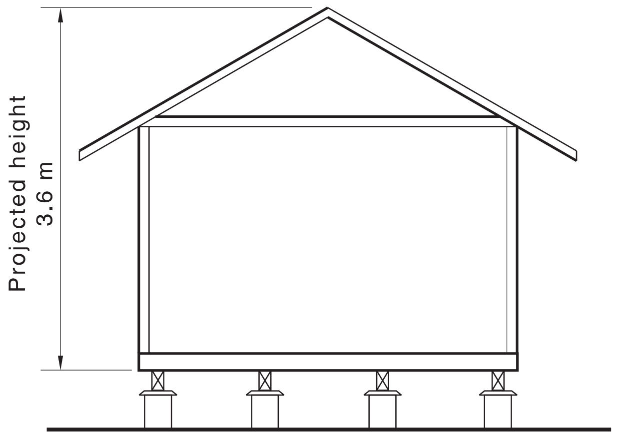


Figure D.2 — Shear force — Example 1

D.4.2 Example 2 — Bearers to stumps

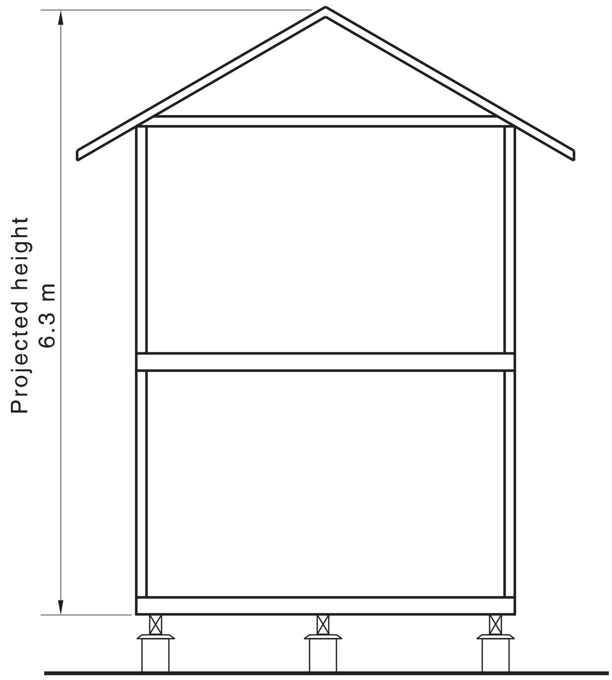
Bearer spans 3 600 mm, in wind classification N3 area, see Figure D.3.

The shear force is calculated as follows:

Shear force = 5.0 × 6.3 m

= 31.5 (kN per row of stumps)

For bearers connected to 3 rows of stumps, the shear force per bearer connection is calculated as follows:



Shear force = 31.5/3

= 10.5 (kN per bearer connection)

Figure D.3 — Shear force — Example 2

Appendix E
(informative)

Moisture content and shrinkage

E.1 Moisture content

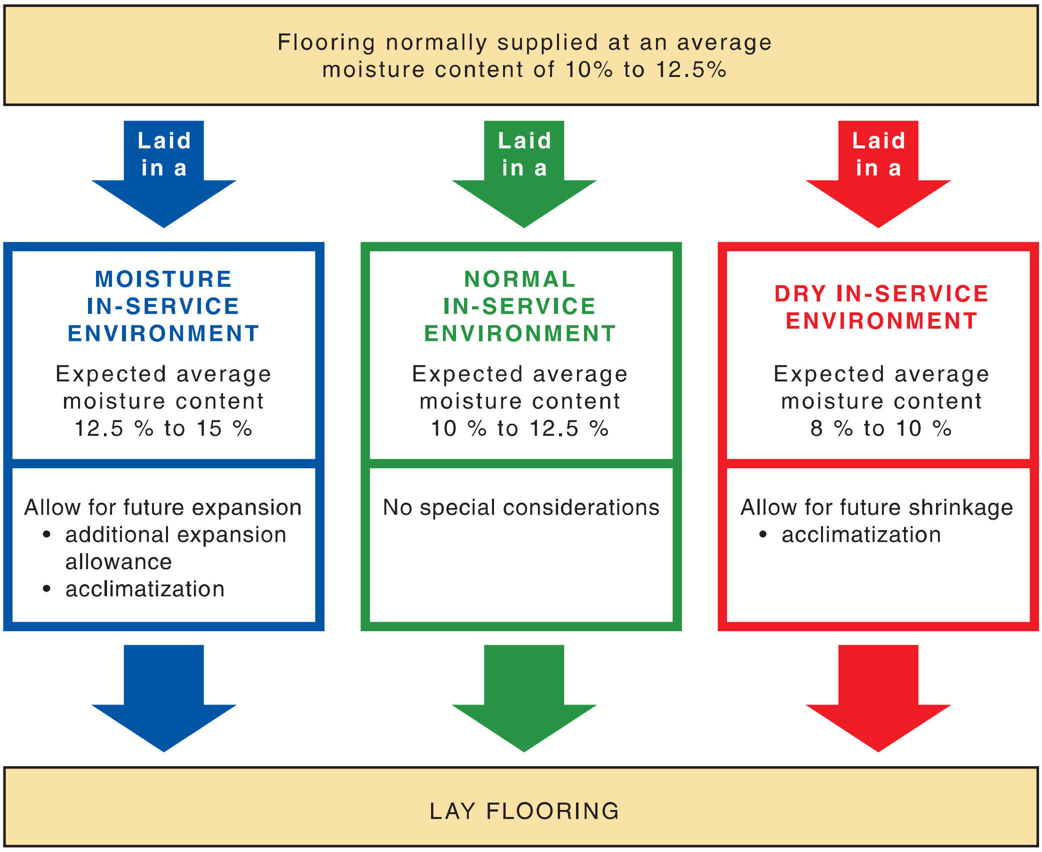
Timber should have a moisture content appropriate to its use.

Structural timber may be either seasoned (moisture content 15 % or less) or unseasoned (moisture content greater than 15 %). Milled products (flooring, joinery, etc.) should be seasoned.

Timber flooring should be installed at an average moisture content appropriate to the average internal equilibrium moisture content (EMC) for the location. EMC is the moisture content that timber approaches under set conditions of humidity and temperature, with values indicated in Table E.1. Guidance on allowing for in-service movement (shrinkage or swelling) due to differences in supplied average moisture content to the expected in-service moisture content is provided in Figure E.1.

Table E.1 — Equilibrium moisture content

	Equilibrim moisture content at various relative humidities and temperatures																		
Relative humidity	**5 %**	**10 %**	**15 %**	**20 %**	**25 %**	**30 %**	**35 %**	**40 %**	**45 %**	**50 %**	**55 %**	**60 %**	**65 %**	**70 %**	**75 %**	**80 %**	**85 %**	**90 %**	**95 %**
Temperature 0 °C	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.4	11.3	12.4	13.5	14.9	16.5	18.5	21.0	24.3
Temperature 10 °C	1.4	2.6	3.6	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.3	11.2	12.3	13.4	14.8	16.4	18.4	20.9	24.3
Temperature 20 °C	1.3	2.5	3.6	4.5	5.4	6.2	7.0	7.7	8.5	9.3	10.1	11.0	12.0	13.1	14.5	16.0	18.0	20.5	23.9
Temperature 30 °C	1.2	2.4	3.4	4.3	5.2	6.0	6.7	7.5	8.2	9.0	9.8	10.6	11.6	12.7	14.0	15.5	17.5	20.0	23.4
Temperature 40 °C	1.1	2.2	3.2	4.1	5.0	5.7	6.4	7.1	7.1	8.6	9.4	10.2	12.2	12.2	13.4	15.0	16.8	19.3	22.7



[SOURCE: AUSTRALIASIAN TIMBER FLOORING ASSOCIATION. *Solid Timber Flooring Industry Standard*. Version 3, 2016]

NOTE 1 Acclimatization is the process of re-stacking flooring in the installation environment to allow air humidity to adjust the moisture content of the flooring prior to laying to be closer to the expected in-service moisture content. This is to reduce post-installation movement (shrinkage or swelling) but relies on appropriate humidity during the process.

NOTE 2 Average EMCs in air-conditioned or heated buildings are often approximately 9 % with a range from 7 % to 12 %.

NOTE 3 Where long-term average temperature and humidity data for a location is obtained from the Bureau of Meteorology (an average of 9:00 am and 3:00 pm data should be used), these apply to ambient external conditions. Internal EMCs in non-conditioned buildings are often 1 % to 2 % lower than ambient external EMCs.

Figure E.1 — Allowing for in-service movement

E.2 Dimensional stability

Allowance should be made for timber movement.

See Clause E.3 for guidance on the use of unseasoned timber and Appendix G for shrinkage rates of various timber species.

Wet, green or unseasoned timber will release moisture until it stabilizes at the EMC of the surrounding atmosphere. At this point, moisture content of the timber will only change (increase or decrease) if there is a change in the surrounding atmospheric humidity or temperature.

With the use of unseasoned timber, shrinkage can be expected to occur as the wood moisture content reduces.

E.3 Allowance for shrinkage

Allowance should be made for the effects of shrinkage where any one of the following conditions applies:

(a) Unseasoned members are used.

(b) Materials with different shrinkage characteristics are combined.

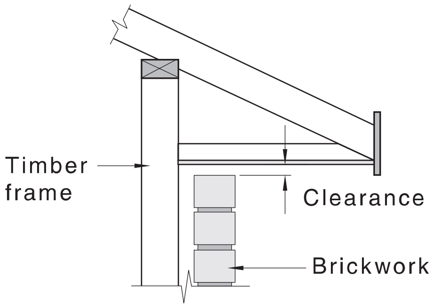
(c) Unseasoned timber is used in conjunction with seasoned timber or other non-timber products.

(d) Openings occur in external brick veneer.

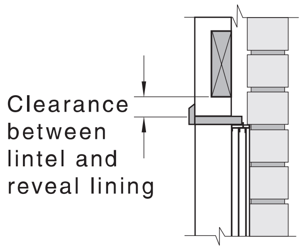
(e) In multistorey construction.

(f) In multi-residential timber-framed fire-rated construction.

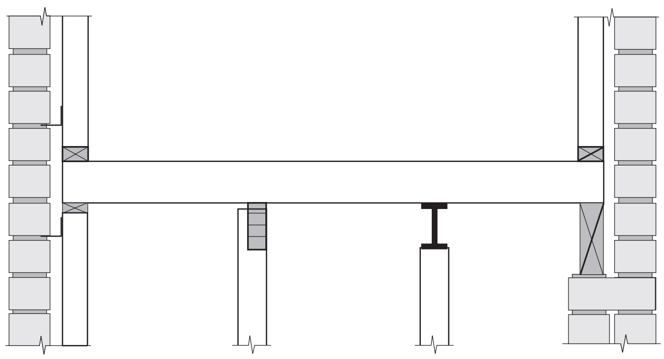
Clearance should be provided at lintels, eaves lining in brick veneer construction, windowsill and floor framing, see Figure E.2.



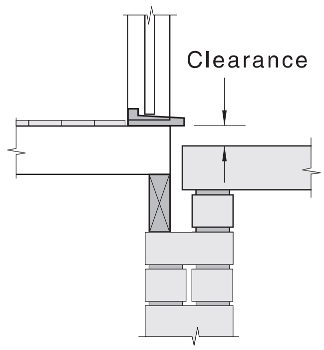
(a) Brick veneer to be kept clear of unseasoned framing



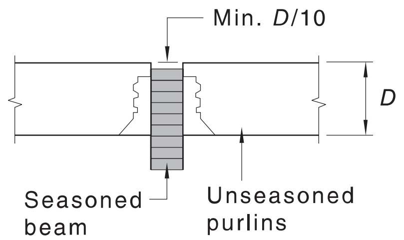
(b) Clearance at door and window heads



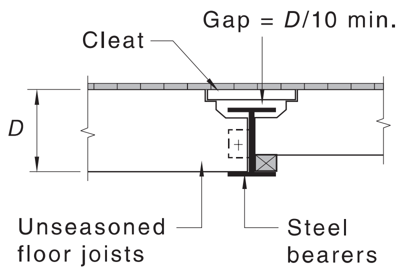
(c) Using material with different shrinkage characteristics cause uneven floors, etc.



(d) Clearance at concrete patio



(e) Allowance for different shrinkage of unseasoned and seasoned members



(f) Allowance for shrinkage of unseasoned timber in combined steel and timber construction

Figure E.2 — Allowance for shrinkage

Unseasoned timber can be expected to shrink as its moisture content reduces. Although this shrinkage can be regarded as insignificant in terms of the structural performance of timber framing members, due consideration of the secondary effects of shrinkage (movement, moisture penetration, and similar effects) is necessary. Typical shrinkage rates are shown in Table E.2.

Bolt holes in unseasoned timber should be 15 % greater in diameter than the bolt diameter. Bolts that restrain timber across the grain should be avoided.

Table E.2 — Typical shrinkage rates

Member	Depth, mm	Typical shrinkage, mm		
		Unseasoned softwood	Unseasoned hardwood	Seasoned timber
Top plates	2 at 35	2.8	5.6	0
Lintel	1 at 250	10	20	0
Bottom plate	2 at 45	3.6	7.2	0
Floor joist	1 at 200	8	16	0

NOTE 1 The shrinkage values given in this Table are based on typical values for softwood of 4 % and typical values for hardwood of 8 %.

Table E.2 *(continued)*

Member	Depth, mm	Typical shrinkage, mm		
		Unseasoned softwood	Unseasoned hardwood	Seasoned timber
NOTE 2 Lintel shrinkage will be local to the position of the lintel and may not be reflected in total shrinkage for the full height of the building.				

Appendix F
(normative)

Racking forces — Alternative procedure

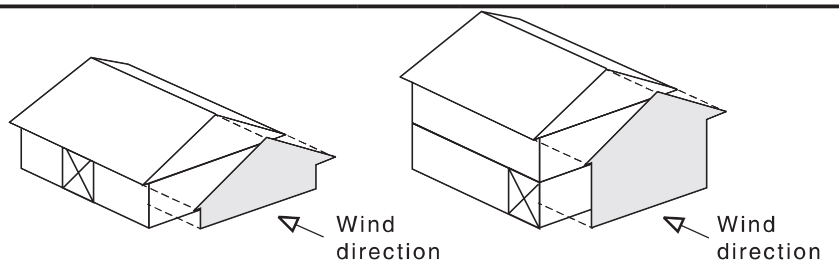
Racking forces determined from Tables F.1(A) to F.4(C) for wind classifications N1 to N4 respectively may be used as an alternative to the racking forces derived from Clause 8.3.4 for hip or gable roofs only. For skillion roofs, see Section 8.

All the other provisions of Section 8 shall apply for the use of the racking forces determined from this Appendix.

Tables F.1(A) to F.4(C) are only applicable to a maximum wall height of 2 700 mm. For wall heights exceeding 2 700 mm up to 3 000 mm, the forces shall be increased by 15 %.

Interpolation of the values given in Tables F.1(A) to F.4(C) is permitted.

Table F.1(A) — Wind classification N1 — Wind force (kN) to be resisted by gable ends

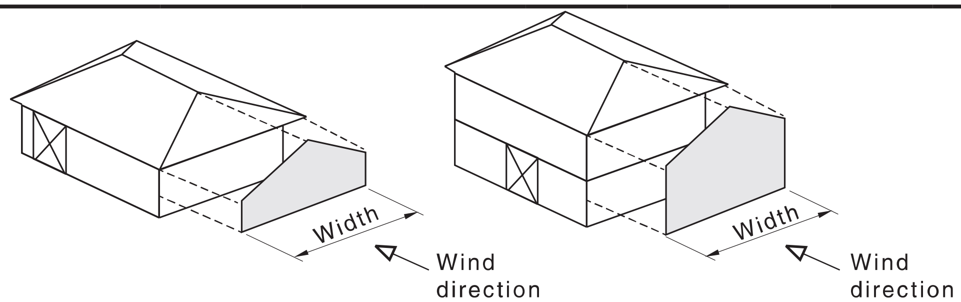


Level of applied racking force	Building width, m	Wind force to be resisted by gable ends, kN							
		Roof slope, degrees							
		0	5	10	15	20	25	30	35
Single or upper storey	4	3.4	3.7	3.9	4.1	4.4	4.6	4.9	5.2
	6	5.2	5.7	6.2	6.7	7.3	7.9	8.5	9.2
	8	6.9	7.8	8.7	9.6	11	12	13	14
	10	8.6	10	11	13	14	16	18	20
	12	10	12	14	17	19	21	24	26
	14	12	15	18	20	23	27	30	34
	16	14	17	21	25	29	33	37	42
Subfloor of single storey (max. 1 000 mm off ground)	4	9.1	9.3	9.6	9.8	10	10	11	11
	6	14	14	15	15	16	16	17	18
	8	18	19	20	21	22	23	24	26
	10	23	24	26	27	29	31	32	34
	12	27	29	32	34	36	39	41	44
	14	32	35	38	41	44	47	51	55
	16	36	40	44	48	52	56	61	66

Table F.1(A) *(continued)*

Subfloor of single storey (max. 1 800 mm off ground)	4	10	10	11	11	11	11	12	12
	6	15	16	16	17	17	18	19	19
	8	20	21	22	23	24	25	26	28
	10	25	27	28	30	31	33	35	37
	12	31	33	35	37	39	42	44	47
	14	36	38	41	44	47	51	54	58
	16	41	44	48	52	56	61	65	71
Lower storey of two storeys or highset	4	12	12	12	12	13	13	13	13
	6	17	18	18	19	20	20	21	22
	8	23	24	25	26	27	28	29	31
	10	29	30	32	33	35	37	39	41
	12	35	37	39	41	43	46	49	52
	14	41	43	46	49	52	56	59	63
	16	46	50	54	58	62	66	71	76
Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	17	17	18	18	18	18	19	19
	6	26	26	27	27	28	28	29	30
	8	34	35	36	37	38	39	40	42
	10	43	44	46	47	49	51	52	54
	12	51	53	56	58	60	62	65	68
	14	60	63	66	69	72	75	79	83
	16	68	72	76	80	84	88	93	98
Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	18	18	19	19	19	19	20	20
	6	27	28	28	29	29	30	31	31
	8	36	37	38	39	40	41	42	44
	10	45	47	48	50	51	53	55	57
	12	54	57	59	61	63	66	68	71
	14	64	66	69	72	75	79	82	86
	16	73	76	80	84	88	93	97	102

Table F.1(B) — Wind classification N1 — Wind force (kN) to be resisted by hip ends

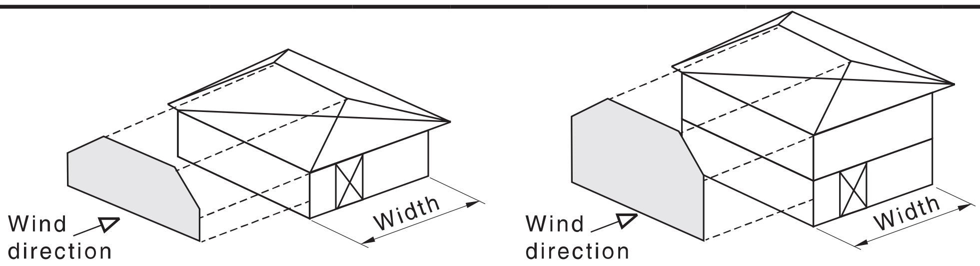


Level of applied racking force	Building width, m	Wind force to be resisted by gable ends, kN							
		Roof slope, degrees							
		0	**5**	**10**	**15**	**20**	**25**	**30**	**35**

Table F.1(B) *(continued)*

Single or upper storey	4	3.6	3.6	3.6	3.7	4.0	4.4	4.6	4.9
	6	5.4	5.4	5.5	5.7	6.6	7.3	7.8	8.6
	8	7.2	7.2	7.2	8.1	9.6	11	12	13
	10	9.0	9.0	9.0	11	13	15	16	19
	12	11	11	11	13	17	19	21	25
	14	13	13	13	16	21	24	27	32
	16	14	14	14	19	25	29	33	39
Subfloor of single storey (max. 1 000 mm off ground)	4	9.1	9.1	9.1	9.2	9.4	9.7	10	10
	6	14	14	14	14	15	15	16	17
	8	18	18	18	19	20	22	22	24
	10	23	23	23	24	26	28	30	32
	12	27	27	27	30	33	35	37	41
	14	32	32	32	35	40	43	46	51
	16	36	36	36	41	47	51	55	61
Subfloor of single storey (max. 1 800 mm off ground)	4	10	10	10	10	10	11	11	11
	6	15	15	15	15	16	17	18	18
	8	20	20	21	21	22	24	24	26
	10	25	25	26	26	29	31	32	34
	12	31	31	31	32	36	38	40	44
	14	36	36	36	38	43	47	49	54
	16	41	41	41	45	51	55	59	65
Lower storey of two storeys or highset	4	12	12	12	12	12	12	13	13
	6	17	17	17	18	18	19	20	20
	8	23	23	23	24	25	26	27	29
	10	29	29	29	30	32	34	35	38
	12	35	35	35	36	39	42	44	47
	14	41	41	41	43	47	51	54	58
Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	17	17	17	17	17	18	18	18
	6	26	26	26	26	26	27	28	28
	8	34	34	34	35	35	37	38	39
	10	43	43	43	43	45	47	49	51
	12	51	51	52	52	55	58	61	64
	14	60	60	60	61	66	70	72	77
	16	68	68	69	71	77	82	85	91
Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	18	18	18	18	18	19	19	19
	6	27	27	27	27	28	29	30	30
	8	36	36	36	37	37	39	40	41
	10	45	45	46	46	48	50	52	54
	12	54	54	55	55	58	61	64	67
	14	64	64	64	65	69	73	76	81
	16	73	73	73	75	81	86	89	95

Table F.1(C) — Wind classification N1 — Wind force per unit length (kN/m) to be resisted at right angles to building length (hip or gable end buildings)

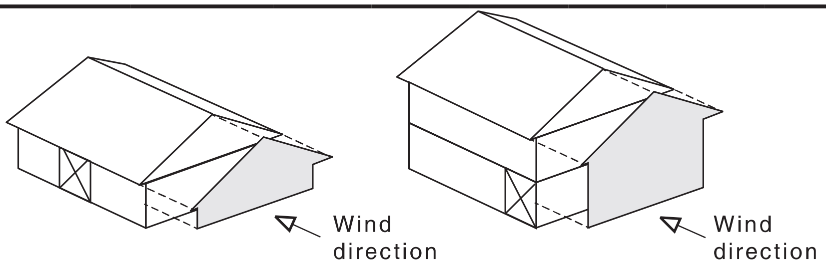


Level of applied racking force	Building width, m	Wind force to be resisted by building length, kN/m Total force = length (m) × force (kN/m)							
		Roof slope, degrees							
		0	5	10	15	20	25	30	35
Single or upper storey	4	0.8	0.8	0.8	0.8	1.0	1.2	1.4	1.5
	6	0.8	0.8	0.8	0.9	1.2	1.5	1.6	1.9
	8	0.8	0.8	0.8	1.0	1.4	1.7	1.9	2.3
	10	0.8	0.8	0.8	1.1	1.5	2.0	2.2	2.7
	12	0.8	0.8	0.8	1.2	1.7	2.2	2.5	3.1
	14	0.8	0.8	0.8	1.3	1.9	2.4	2.8	3.5
Subfloor of single storey (max. 1 000 mm off ground)	4	2.1	2.1	2.1	2.1	2.2	2.6	2.8	2.9
	6	2.1	2.1	2.1	2.2	2.4	2.9	3.0	3.3
	8	2.1	2.1	2.1	2.2	2.6	3.1	3.3	3.7
	10	2.1	2.1	2.1	2.3	2.8	3.4	3.6	4.1
	12	2.1	2.1	2.1	2.5	3.0	3.6	3.9	4.5
	14	2.1	2.1	2.1	2.6	3.2	3.9	4.3	5.0
	16	2.1	2.1	2.1	2.7	3.4	4.1	4.6	5.4
Subfloor of single storey (max. 1 800 mm off ground)	4	2.3	2.3	2.4	2.4	2.5	2.9	3.1	3.2
	6	2.3	2.3	2.4	2.4	2.6	3.1	3.3	3.5
	8	2.3	2.3	2.4	2.4	2.8	3.3	3.6	3.9
	10	2.3	2.3	2.4	2.5	3.0	3.6	3.8	4.3
	12	2.3	2.3	2.4	2.6	3.2	3.9	4.2	4.7
	14	2.3	2.3	2.4	2.7	3.4	4.1	4.5	5.2
	16	2.3	2.3	2.3	2.9	3.6	4.4	4.8	5.6
Lower storey of two storeys or highset	4	2.7	2.7	2.7	2.7	2.8	3.2	3.4	3.5
	6	2.7	2.7	2.7	2.7	2.9	3.4	3.7	3.8
	8	2.7	2.7	2.7	2.7	3.0	3.6	3.9	4.2
	10	2.7	2.7	2.7	2.8	3.2	3.9	4.2	4.6
	12	2.7	2.7	2.7	2.9	3.4	4.2	4.5	5.0
	14	2.7	2.7	2.7	3.0	3.6	4.4	4.8	5.4
	16	2.7	2.7	2.7	3.1	3.8	4.7	5.1	5.9

Table F.1(C) *(continued)*

Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	3.9	3.9	3.9	3.9	4.0	4.6	4.8	4.9
	6	3.9	3.9	3.9	4.0	4.1	4.7	5.0	5.2
	8	3.9	3.9	4.0	4.0	4.2	5.0	5.3	5.6
	10	3.9	3.9	4.0	4.0	4.4	5.2	5.6	5.9
	12	3.9	3.9	4.0	4.1	4.6	5.5	5.8	6.3
	14	3.9	3.9	4.0	4.1	4.8	5.7	6.1	6.7
	16	3.9	3.9	4.0	4.3	5.0	6.0	6.4	7.2
Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	4.2	4.2	4.2	4.2	4.3	4.9	5.1	5.2
	6	4.2	4.2	4.2	4.2	4.3	5.0	5.3	5.5
	8	4.2	4.2	4.2	4.2	4.4	5.2	5.6	5.8
	10	4.2	4.2	4.2	4.3	4.6	5.4	5.8	6.2
	12	4.2	4.2	4.2	4.3	4.8	5.7	6.1	6.6
	14	4.2	4.2	4.2	4.4	5.0	6.0	6.3	7.0
	16	4.2	4.2	4.2	4.4	5.2	6.2	6.6	7.4

Table F.2(A) — Wind classification N2 — Wind force (kN) to be resisted by gable ends

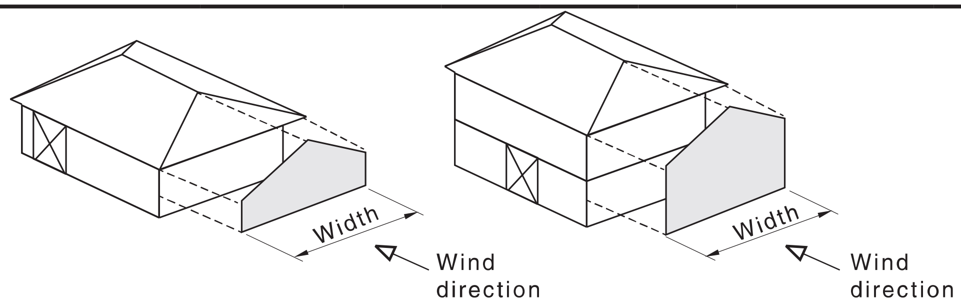


Level of applied racking force	Building width, m	Wind force to be resisted by gable ends, kN							
		Roof slope, degrees							
		0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
Single or upper storey	4	5.0	5.3	5.6	6.0	6.3	6.7	7.1	7.6
	6	7.5	8.2	8.9	9.7	10	11	12	13
	8	10	11	13	14	15	17	18	20
	10	12	14	17	19	21	23	26	29
	12	15	18	21	24	27	30	34	38
	14	17	21	25	30	34	38	43	49
	16	20	25	30	36	41	47	54	61
Subfloor of single storey (max. 1 000 mm off ground)	4	13	13	13	14	14	14	15	15
	6	19	20	20	21	22	23	24	25
	8	25	27	28	29	31	32	34	36
	10	32	34	36	38	40	42	45	48
	12	38	41	44	47	50	53	57	61
	14	44	48	52	56	61	65	70	76
	16	50	56	61	66	72	78	84	92

Table F.2(A) *(continued)*

Subfloor of single storey (max. 1 800 mm off ground)	4	14	14	15	15	15	16	16	17
	6	21	22	23	23	24	25	26	27
	8	28	29	31	32	34	35	37	38
	10	35	37	39	41	44	46	49	51
	12	42	45	48	51	54	58	61	65
	14	49	53	57	61	66	70	75	81
	16	56	61	67	72	78	84	90	98
Lower storey of two storeys or highset	4	16	16	17	17	17	18	18	19
	6	24	25	26	26	27	28	29	30
	8	32	33	35	36	37	39	41	42
	10	40	42	44	46	48	51	53	56
	12	48	51	54	57	60	64	67	71
	14	56	60	64	68	73	77	82	88
	16	64	69	75	80	86	92	98	105
Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	24	24	24	25	25	25	26	26
	6	36	36	37	38	39	39	40	41
	8	47	49	50	51	53	54	56	58
	10	59	61	63	65	68	70	72	75
	12	71	74	77	80	83	86	90	94
	14	83	87	91	95	99	104	109	114
	16	95	100	105	110	116	122	129	136
Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	25	25	26	26	26	27	27	28
	6	38	38	39	40	41	42	43	44
	8	50	52	53	54	56	57	59	61
	10	63	65	67	69	71	74	76	79
	12	75	78	81	84	87	91	95	99
	14	88	92	96	100	104	109	114	120
	16	101	106	111	116	122	128	135	142

Table F.2(B) — Wind classification N2 — Wind force (kN) to be resisted by hip ends

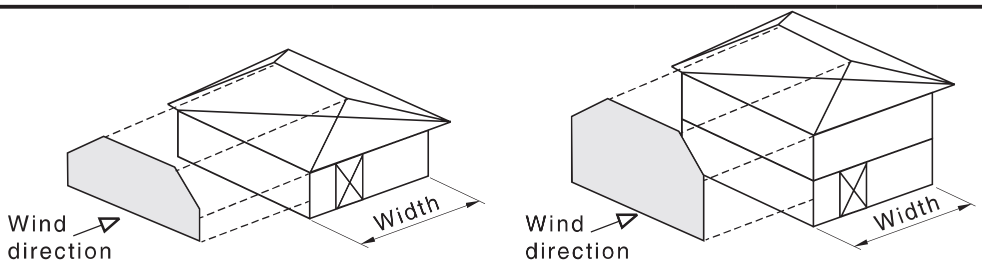


Level of applied racking force	Building width, m	Wind force to be resisted by gable ends, kN							
		Roof slope, degrees							
		0	**5**	**10**	**15**	**20**	**25**	**30**	**35**

Table F.2(B) *(continued)*

Single or upper storey	4	5.0	5.0	5.0	5.1	5.5	6.0	6.4	6.8
	6	7.5	7.5	7.6	7.9	9.1	10	11	12
	8	10	10	10	11	13	15	16	18
	10	12	12	12	15	18	20	22	26
	12	15	15	15	19	23	27	29	34
	14	17	17	17	22	28	33	37	44
	16	20	20	20	26	34	41	45	54
Subfloor of single storey (max. 1 000 mm off ground)	4	13	13	13	13	13	13	14	14
	6	19	19	19	19	20	21	22	23
	8	25	25	25	26	28	30	31	33
	10	32	32	32	33	36	39	41	44
	12	38	38	38	41	45	49	52	57
	14	44	44	44	49	55	60	63	70
	16	50	50	50	57	65	71	76	85
Subfloor of single storey (max. 1 800 mm off ground)	4	14	14	14	14	14	15	16	16
	6	21	21	21	21	22	23	24	25
	8	28	28	28	29	31	33	34	36
	10	35	35	36	36	40	42	44	47
	12	42	42	43	45	49	53	56	60
	14	49	49	50	53	59	64	68	75
	16	56	56	56	62	70	77	81	90
Lower storey of two storeys or highset	4	16	16	16	16	16	17	17	18
	6	24	24	24	24	25	26	27	28
	8	32	32	32	33	34	36	38	39
	10	40	40	40	41	44	47	49	52
	12	48	48	49	50	54	59	61	66
	14	56	56	57	59	65	71	74	81
	16	64	64	65	69	77	84	88	97
Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	24	24	24	24	24	25	25	25
	6	36	36	36	36	36	37	39	39
	8	47	47	48	48	49	51	53	54
	10	59	59	60	60	63	66	68	71
	12	71	71	71	72	77	81	84	88
	14	83	83	83	85	91	97	100	107
	16	95	95	95	98	106	114	118	127
Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	25	25	25	25	25	26	27	27
	6	38	38	38	38	38	40	41	42
	8	50	50	50	51	52	54	56	57
	10	63	63	63	64	66	69	72	74
	12	75	75	76	77	81	85	88	92
	14	88	88	89	90	96	102	105	111
	16	101	101	101	103	112	119	123	132

Table F.2(C) — Wind classification N2 — Wind force per unit length (kN/m) to be resisted at right angles to building length (hip or gable end building)

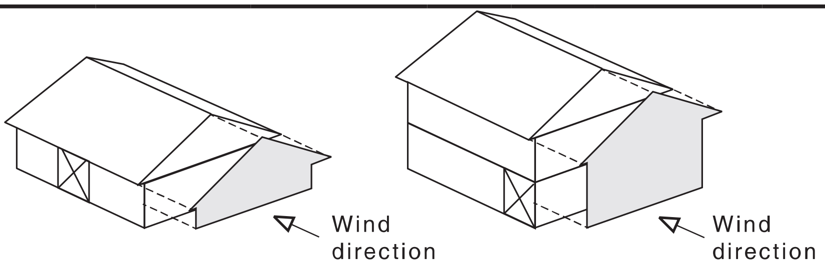


Level of applied racking force	Building width, m	Wind force to be resisted by building length, kN/m Total force = length (m) × force (kN/m)							
		Roof slope, degrees							
		0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
Single or upper storey	4	1.1	1.1	1.2	1.2	1.4	1.8	2.0	2.2
	6	1.1	1.1	1.2	1.3	1.7	2.1	2.3	2.7
	8	1.1	1.1	1.2	1.5	2.0	2.5	2.8	3.3
	10	1.1	1.1	1.1	1.6	2.2	2.8	3.2	3.9
	12	1.1	1.1	1.1	1.8	2.5	3.2	3.6	4.5
	14	1.1	1.1	1.1	1.9	2.7	3.5	4.0	5.0
	16	1.1	1.1	1.1	2.0	2.9	3.8	4.4	5.5
Subfloor of single storey (max. 1 000 mm off ground)	4	2.9	2.9	2.9	2.9	3.1	3.6	3.9	4.0
	6	2.9	2.9	2.9	3.0	3.3	3.9	4.2	4.6
	8	2.9	2.9	2.9	3.1	3.6	4.3	4.6	5.1
	10	2.9	2.9	2.9	3.2	3.8	4.7	5.0	5.7
	12	2.9	2.9	2.9	3.4	4.1	5.0	5.5	6.3
	14	2.9	2.9	2.9	3.6	4.4	5.4	5.9	6.9
	16	2.9	2.9	2.9	3.7	4.7	5.7	6.3	7.5
Subfloor of single storey (max. 1 800 mm off ground)	4	3.2	3.2	3.3	3.3	3.4	4.0	4.2	4.4
	6	3.2	3.2	3.3	3.3	3.6	4.3	4.6	4.9
	8	3.2	3.2	3.3	3.4	3.8	4.6	4.9	5.4
	10	3.2	3.2	3.3	3.5	4.1	5.0	5.3	6.0
	12	3.2	3.2	3.3	3.6	4.4	5.3	5.8	6.6
	14	3.2	3.2	3.3	3.8	4.7	5.7	6.2	7.2
	16	3.2	3.2	3.2	4.0	4.9	6.0	6.6	7.7
Lower storey of two storeys or highset	4	3.7	3.7	3.7	3.7	3.8	4.4	4.7	4.9
	6	3.7	3.7	3.7	3.7	4.0	4.7	5.1	5.3
	8	3.7	3.7	3.7	3.8	4.2	5.0	5.4	5.9
	10	3.7	3.7	3.7	3.9	4.5	5.4	5.8	6.4
	12	3.7	3.7	3.7	4.0	4.7	5.7	6.2	6.9
	14	3.7	3.7	3.7	4.1	5.0	6.1	6.6	7.5
	16	3.7	3.7	3.7	4.3	5.3	6.5	7.1	8.1

Table F.2(C) *(continued)*

Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	5.4	5.4	5.5	5.5	5.6	6.3	6.6	6.8
	6	5.4	5.4	5.5	5.5	5.7	6.6	7.0	7.2
	8	5.4	5.4	5.5	5.5	5.8	6.9	7.3	7.7
	10	5.4	5.4	5.5	5.6	6.1	7.2	7.7	8.2
	12	5.4	5.4	5.5	5.7	6.4	7.6	8.0	8.8
	14	5.4	5.4	5.5	5.7	6.6	7.9	8.4	9.3
	16	5.4	5.4	5.5	5.9	6.9	8.3	8.9	9.9
Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	5.8	5.8	5.8	5.8	5.9	6.7	7.0	7.1
	6	5.8	5.8	5.8	5.8	6.0	6.9	7.3	7.6
	8	5.8	5.8	5.8	5.8	6.1	7.2	7.7	8.0
	10	5.8	5.8	5.8	5.9	6.4	7.5	8.1	8.6
	12	5.8	5.8	5.8	6.0	6.6	7.9	8.4	9.1
	14	5.8	5.8	5.9	6.0	6.9	8.2	8.8	9.6
	16	5.8	5.8	5.9	6.1	7.1	8.6	9.1	10

Table F.3(A) — Wind classification N3 — Wind force (kN) to be resisted by gable ends

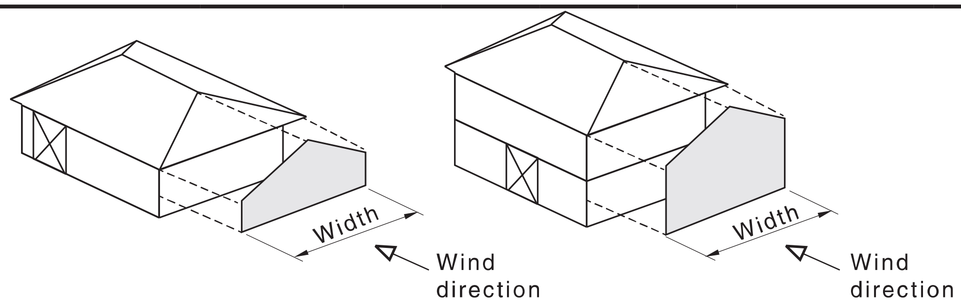


Level of applied racking force	Building width, m	Wind force to be resisted by gable ends, kN							
		Roof slope, degrees							
		0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
Single or upper storey	4	7.8	8.3	8.8	9.3	9.9	10	11	12
	6	12	13	14	15	16	18	19	21
	8	16	18	20	22	24	26	29	32
	10	19	23	26	29	33	36	40	45
	12	23	28	32	37	42	48	53	60
	14	27	33	40	46	53	60	68	77
	16	31	39	47	56	65	74	84	96
Subfloor of single storey (max. 1 000 mm off ground)	4	20	20	21	21	22	22	23	24
	6	30	31	32	33	34	36	37	39
	8	39	41	43	46	48	50	53	56
	10	49	52	56	59	62	66	70	74
	12	59	64	68	73	78	83	89	95
	14	69	75	81	88	95	102	110	118
	16	79	87	95	103	112	122	132	143

Table F.3(A) *(continued)*

Subfloor of single storey (max. 1 800 mm off ground)	4	22	23	23	24	24	25	25	26
	6	33	34	35	36	38	39	40	42
	8	44	46	48	50	52	55	57	60
	10	55	58	61	65	68	72	76	80
	12	66	71	75	80	85	90	96	102
	14	77	83	89	96	103	110	118	126
	16	88	96	104	113	122	131	141	153
Lower storey of two storeys or highset	4	25	26	26	27	27	28	28	29
	6	38	39	40	41	42	44	45	47
	8	50	52	54	56	58	61	63	66
	10	63	66	69	72	76	79	83	88
	12	75	80	84	89	94	99	105	111
	14	88	94	100	107	113	121	128	137
	16	100	108	116	125	134	143	153	165
Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	37	37	38	39	39	40	40	41
	6	55	57	58	59	60	62	63	65
	8	74	76	78	80	82	85	87	90
	10	92	96	99	102	106	109	113	118
	12	111	115	120	125	130	135	141	147
	14	129	136	142	148	155	162	170	179
	16	148	156	164	173	181	191	201	212
Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	39	40	40	41	41	42	43	43
	6	59	60	61	62	64	65	66	68
	8	79	81	83	85	87	89	92	95
	10	98	101	105	108	111	115	119	123
	12	118	122	127	132	137	142	148	154
	14	137	144	150	156	163	170	178	187
	16	157	165	173	182	191	200	210	222

Table F.3(B) — Wind classification N3 — Wind force (kN) to be resisted by hip ends



Level of applied racking force	Building width, m	Wind force to be resisted by gable ends, kN							
		Roof slope, degrees							
		0	5	10	15	20	25	30	35
Single or upper storey	4	7.8	7.8	7.9	8.0	8.6	9.4	10	11
	6	12	12	12	12	14	16	17	19
	8	16	16	16	18	21	23	25	29
	10	19	19	19	23	28	32	35	40

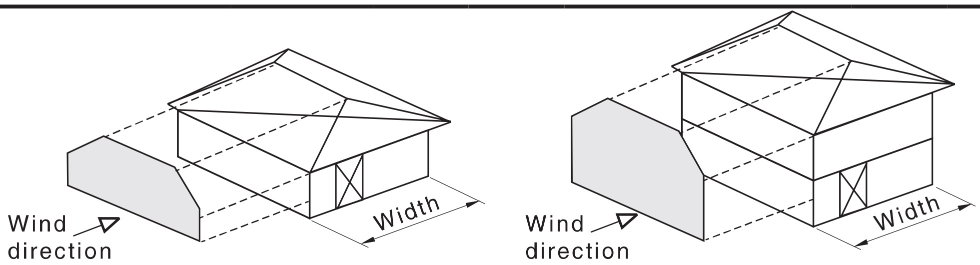
Table F.3(B) *(continued)*

	12	23	23	23	29	36	41	46	54
	14	27	27	27	35	44	52	58	68
	16	31	31	31	41	53	63	71	85
Subfloor of single storey (max. 1 000 mm off ground)	4	20	20	20	20	20	21	22	22
	6	30	30	30	30	32	33	35	36
	8	39	39	40	40	44	47	48	52
	10	49	49	50	52	57	61	64	69
	12	59	59	59	64	71	77	81	88
	14	69	69	69	76	86	93	99	110
	16	79	79	79	89	101	111	119	133
Subfloor of single storey (max. 1 800 mm off ground)	4	22	22	22	22	23	23	24	25
	6	33	33	33	33	35	36	38	39
	8	44	44	44	45	48	51	53	56
	10	55	55	55	57	62	66	69	74
	12	66	66	66	70	77	83	87	95
	14	77	77	77	83	93	101	106	117
	16	88	88	88	97	109	120	127	141
Lower storey of two storeys or highset	4	25	25	25	25	26	26	27	28
	6	38	38	38	38	39	41	43	44
	8	50	50	50	51	53	57	59	62
	10	63	63	63	64	69	73	76	81
	12	75	75	76	78	85	91	95	103
	14	88	88	88	93	102	111	116	126
	16	100	100	101	108	120	131	138	152
Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	37	37	37	37	38	38	39	40
	6	55	55	56	56	57	58	60	62
	8	74	74	74	75	77	80	83	85
	10	92	92	93	94	98	103	106	111
	12	111	111	112	113	120	126	131	138
	14	129	129	130	133	142	151	157	167
	16	148	148	149	154	166	178	185	198

Table F.3(B) *(continued)*

Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	39	39	39	39	40	41	42	42
	6	59	59	59	59	60	62	64	65
	8	79	79	79	79	81	84	87	89
	10	98	98	99	99	103	108	112	116
	12	118	118	119	120	126	133	138	144
	14	137	137	139	140	150	159	165	174
	16	157	157	158	162	174	186	193	206

Table F.3(C) — Wind classification N3 — Wind force per unit length (kN/m) to be resisted at right angles to building length (hip or gable end buildings)

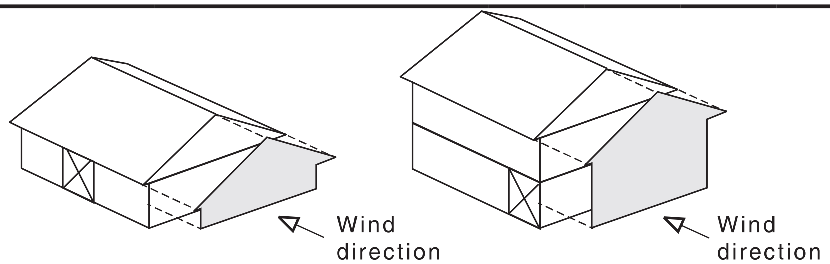


Level of applied racking force	Building width, m	Wind force to be resisted by building length, kN/m Total force = length (m) × force (kN/m) Roof slope, degrees							
		0	5	10	15	20	25	30	35
Single or upper storey	4	1.8	1.8	1.8	1.9	2.2	2.8	3.1	3.4
	6	1.8	1.8	1.8	2.0	2.6	3.3	3.6	4.3
	8	1.8	1.8	1.8	2.3	3.1	3.9	4.3	5.2
	10	1.8	1.8	1.8	2.5	3.5	4.4	5.0	6.1
	12	1.8	1.8	1.8	2.7	3.9	5.0	5.7	7.0
	14	1.8	1.8	1.8	2.9	4.2	5.5	6.3	7.8
	16	1.8	1.8	1.8	3.1	4.6	6.0	6.9	8.7
Subfloor of single storey (max. 1 000 mm off ground)	4	4.5	4.5	4.6	4.6	4.8	5.6	6.0	6.3
	6	4.5	4.5	4.6	4.7	5.2	6.2	6.6	7.1
	8	4.5	4.5	4.6	4.8	5.6	6.7	7.2	8.0
	10	4.5	4.5	4.6	5.0	6.0	7.3	7.8	8.9
	12	4.5	4.5	4.6	5.3	6.5	7.8	8.5	9.8
	14	4.5	4.5	4.5	5.6	6.9	8.4	9.2	11
	16	4.5	4.5	4.5	5.8	7.3	9.0	9.9	12
Subfloor of single storey (max. 1 800 mm off ground)	4	5.0	5.0	5.1	5.1	5.3	6.2	6.6	6.8
	6	5.0	5.0	5.1	5.2	5.6	6.7	7.2	7.6
	8	5.0	5.0	5.1	5.3	6.0	7.2	7.7	8.5
	10	5.0	5.0	5.1	5.4	6.4	7.8	8.3	9.3
	12	5.0	5.0	5.1	5.7	6.8	8.3	9.0	10
	14	5.0	5.0	5.1	5.9	7.3	8.9	9.7	11
	16	5.0	5.0	5.1	6.2	7.7	9.4	10	12

Table F.3(C) *(continued)*

Lower storey of two storeys or highset	4	5.7	5.7	5.8	5.8	6.0	6.9	7.4	7.6
	6	5.7	5.7	5.8	5.8	6.2	7.3	7.9	8.3
	8	5.7	5.7	5.8	5.9	6.6	7.9	8.5	9.1
	10	5.7	5.7	5.8	6.0	7.0	8.4	9.0	10
	12	5.7	5.7	5.9	6.2	7.4	9.0	9.6	11
	14	5.7	5.7	5.8	6.4	7.8	9.5	10	12
	16	5.7	5.7	5.8	6.7	8.2	10	11	13
Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	8.5	8.5	8.5	8.5	8.7	9.9	10	11
	6	8.5	8.5	8.5	8.6	8.9	10	11	11
	8	8.5	8.5	8.6	8.6	9.1	11	11	12
	10	8.5	8.5	8.6	8.7	9.5	11	12	13
	12	8.5	8.5	8.6	8.8	9.9	12	13	14
	14	8.5	8.5	8.6	8.9	10	12	13	15
	16	8.5	8.5	8.6	9.2	11	13	14	15
Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	9.0	9.0	9.0	9.1	9.3	10	11	11
	6	9.0	9.0	9.1	9.1	9.4	11	11	12
	8	9.0	9.0	9.1	9.1	9.6	11	12	13
	10	9.0	9.0	9.1	9.2	10	12	13	13
	12	9.0	9.0	9.1	9.3	10	12	13	14
	14	9.0	9.0	9.2	9.4	11	13	14	15
	16	9.0	9.0	9.2	9.6	11	13	14	16

Table F.4(A) — Wind classification N4 — Wind force (kN) to be resisted by gable ends



Level of applied racking force	Building width, m	Wind force to be resisted by gable ends, kN							
		Roof slope, degrees							
		0	5	10	15	20	25	30	35
Single or upper storey	4	12	12	13	14	15	16	17	18
	6	17	19	21	23	24	26	28	31
	8	23	26	29	32	36	39	43	47
	10	29	34	38	43	48	54	60	66
	12	35	41	48	55	63	71	79	89
	14	41	50	59	69	79	89	101	114
	16	46	58	70	83	96	110	125	142

Table F.4(A) *(continued)*

Subfloor of single storey (max. 1 000 mm off ground)	4	30	31	32	32	33	34	35	36
	6	45	47	48	50	52	54	56	59
	8	60	63	66	69	72	76	80	84
	10	75	80	84	89	95	100	106	113
	12	90	97	104	111	118	126	135	144
	14	105	114	124	133	143	154	166	179
	16	120	132	144	157	170	184	199	216
Subfloor of single storey (max. 1 800 mm off ground)	4	33	34	35	36	37	37	38	39
	6	50	52	54	55	57	59	61	64
	8	67	70	73	76	79	83	87	91
	10	84	88	93	98	103	109	115	121
	12	100	107	114	121	128	136	145	154
	14	117	126	136	145	155	166	178	191
	16	134	146	158	170	184	198	213	230
Lower storey of two storeys or highset	4	37	38	39	40	40	41	42	43
	6	56	58	59	61	63	65	67	69
	8	75	78	81	84	87	91	94	99
	10	93	98	103	108	113	118	124	131
	12	112	119	125	133	140	148	156	166
	14	131	140	149	159	169	179	191	204
	16	149	161	173	186	199	213	228	245
Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	55	56	57	57	58	59	60	61
	6	83	84	86	88	90	92	94	96
	8	110	113	116	119	123	126	130	134
	10	138	142	147	152	157	163	169	175
	12	165	172	179	186	193	201	210	219
	14	193	202	211	221	231	242	253	266
	16	220	232	244	257	270	284	299	316
Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	58	59	60	61	62	62	63	64
	6	88	89	91	93	95	97	99	101
	8	117	120	123	126	129	133	137	141
	10	146	151	156	161	166	171	177	184
	12	175	182	189	196	203	211	220	229
	14	205	214	223	233	243	254	265	278
	16	234	246	258	271	284	298	313	330

Table F.4(B) — Wind classification N4 — Wind force (kN) to be resisted by hip ends

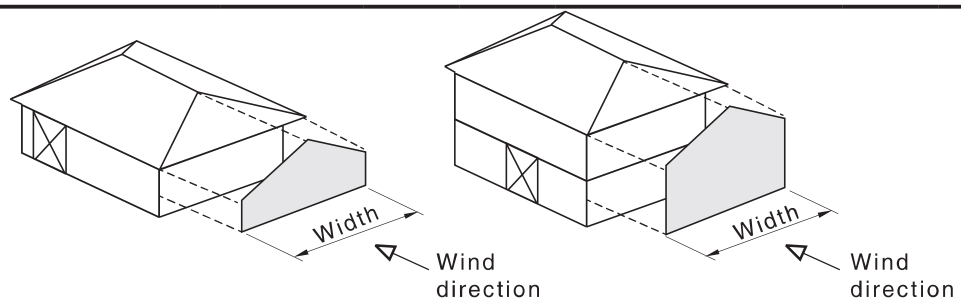


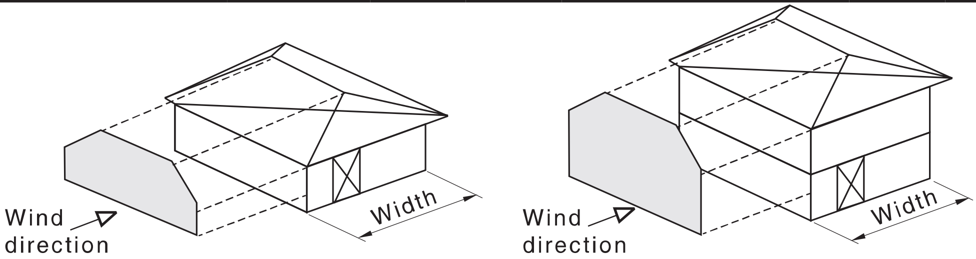
Table F.4(B) *(continued)*

Level of applied racking force	Building width, m	Wind force to be resisted by hip ends, kN							
		Roof slope, degrees							
		0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
Single or upper storey	4	12	12	12	12	13	14	15	16
	6	17	17	18	18	21	24	25	28
	8	23	23	23	26	31	35	37	42
	10	29	29	29	35	42	48	52	60
	12	35	35	35	43	53	62	68	80
	14	41	41	41	52	66	77	86	102
	16	46	46	46	62	80	94	106	126
Subfloor of single storey (max. 1 000 mm off ground)	4	30	30	30	30	31	32	33	34
	6	45	45	45	46	48	51	52	55
	8	60	60	61	62	66	71	73	78
	10	75	75	75	79	86	93	97	104
	12	90	90	90	97	107	116	122	134
	14	105	105	105	116	130	141	150	165
	16	120	120	120	135	153	168	179	200
Subfloor of single storey (max. 1 800 mm off ground)	4	33	33	34	34	34	35	37	37
	6	50	50	50	51	53	55	58	60
	8	67	67	67	68	72	77	80	84
	10	84	84	84	86	94	100	104	112
	12	100	100	101	106	116	125	131	143
	14	117	117	118	126	140	152	161	176
	16	134	134	134	147	165	181	192	212
Lower storey of two storeys or highset	4	37	37	37	37	38	39	41	41
	6	56	56	56	56	58	61	63	65
	8	75	75	75	76	80	84	88	92
	10	93	93	94	95	102	109	114	121
	12	112	112	113	116	126	136	142	153
	14	131	131	131	138	152	165	173	188
	16	149	149	150	161	179	195	206	226
Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	55	55	55	55	56	57	58	59
	6	83	83	83	83	84	87	90	92
	8	110	110	111	111	114	119	123	127
	10	138	138	138	140	145	153	158	165
	12	165	165	166	168	178	188	195	205
	14	193	193	194	197	212	225	233	248
	16	220	220	222	229	247	264	275	294

Table F.4(B) *(continued)*

Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	58	58	59	59	59	60	62	62
	6	88	88	88	88	89	92	95	97
	8	117	117	117	118	120	125	130	133
	10	146	146	147	148	153	161	167	173
	12	175	175	177	178	187	198	205	215
	14	205	205	206	209	223	236	245	259
	16	234	234	236	241	259	277	287	306

Table F.4(C) — Wind classification N4 — Wind force per unit length (kN/m) to be resisted at right angles to building length (hip or gable end buildings)



Level of applied racking force	Building width, m	Wind force to be resisted by building length, kN/m Total force = length (m) × force (kN/m)							
		Roof slope, degrees							
		0	5	10	15	20	25	30	35
Single or upper storey	4	2.7	2.7	2.7	2.8	3.3	4.1	4.5	5.1
	6	2.7	2.7	2.7	3.0	3.9	4.9	5.4	6.3
	8	2.7	2.7	2.7	3.4	4.6	5.8	6.5	7.7
	10	2.7	2.7	2.7	3.8	5.2	6.6	7.5	9.1
	12	2.7	2.7	2.7	4.1	5.8	7.4	8.5	10
	14	2.7	2.7	2.7	4.3	6.3	8.1	9.4	12
	16	2.7	2.7	2.7	4.6	6.8	8.9	10	13
Subfloor of single storey (max. 1 000 mm off ground)	4	6.9	6.9	6.9	7.0	7.3	8.5	9.2	9.5
	6	6.9	6.9	7.0	7.1	7.9	9.3	10	11
	8	6.9	6.9	7.0	7.3	8.4	10	11	12
	10	6.9	6.9	7.0	7.6	9.1	11	12	13
	12	6.9	6.9	6.9	8.0	9.7	12	13	15
	14	6.9	6.9	6.9	8.4	10	13	14	16
	16	6.9	6.9	6.9	8.8	11	13	15	18
Subfloor of single storey (max. 1 800 mm off ground)	4	7.7	7.7	7.7	7.8	8.1	9.4	10	10
	6	7.7	7.7	7.8	7.9	8.5	10	11	12
	8	7.7	7.7	7.8	8.0	9.1	11	112	13
	10	7.7	7.7	7.8	8.2	9.7	12	13	14
	12	7.7	7.7	7.8	8.6	10	13	14	15
	14	7.7	7.7	7.7	9.0	11	13	15	17
	16	7.7	7.7	7.7	9.3	12	14	16	18

Table F.4(C) *(continued)*

Lower storey of two storeys or highset	4	8.5	8.5	8.6	8.6	8.9	10	11	11
	6	8.5	8.5	8.6	8.7	9.2	11	12	12
	8	8.5	8.5	8.7	8.8	9.8	12	13	14
	10	8.5	8.5	8.7	9.0	10	13	13	15
	12	8.5	8.5	8.7	9.2	11	13	14	16
	14	8.5	8.5	8.7	9.6	12	14	15	18
	16	8.5	8.5	8.7	10	12	15	16	19
Subfloor of two storeys or highset (max. 1 000 mm off ground)	4	13	13	13	13	13	15	15	16
	6	13	13	13	13	13	15	16	17
	8	13	13	13	13	14	16	17	18
	10	13	13	13	13	14	17	18	19
	12	13	13	13	13	15	18	19	20
	14	13	13	13	13	15	18	20	22
	16	13	13	13	14	16	19	21	23
Subfloor of two storeys or highset (max. 1 800 mm off ground)	4	13	13	13	13	14	16	16	17
	6	13	13	13	14	14	16	17	18
	8	13	13	14	14	14	17	18	19
	10	13	13	14	14	15	17	19	20
	12	13	13	14	14	15	18	20	21
	14	13	13	14	14	16	19	20	22
	16	13	13	14	14	17	20	21	24

Appendix G
(informative)

Timber species and properties

G.1 General

Table G.2 lists the most common timber species available in Australia. Where a species group has been included, the properties listed are based on that of the lowest rated species in the group.

NOTE The data given in Table G.2 are based on data given in AS 1720.2. Any changes to AS 1720.2 should be taken to supersede the data cited herein.

G.2 Notes to the Table

G.2.1 Column 1 — Standard trade name

The standard trade names are defined in AS/NZS 1148.

G.2.2 Column 2 — Botanical name

The botanical names are defined in AS/NZS 1148.

G.2.3 Column 3 — Strength group

Strength groups are given for unseasoned (US) and seasoned (S) timber in accordance with AS/NZS 2878.

G.2.4 Column 4 — Joint group

The joint group given for unseasoned (US) and seasoned (S) timber is a classification of the strength of a species in joint design.

G.2.5 Column 5 — Density

Density is given for unseasoned (US) and seasoned (S) timber. The seasoned density is based on a moisture content of 12 %. The unseasoned density is approximate, as it will depend on the moisture content at the time of measurement. It has been provided only as a guide to determine the self-weight of an unseasoned member.

G.2.6 Column 6 — Hardness

Hardness is a measure of a species' resistance to indentation. It is measured in kN and is determined by the Janka hardness test.

G.2.7 Column 7 — Toughness

Toughness is a measure of the unseasoned (US) and seasoned (S) timber's ability to resist shocks and blows, and is synonymous with impact strength. It is measured in Nm but for the purpose of this Standard, the following simplified classifications have been adopted:

(a) L (light) — up to 15.

(b) M (medium) — 15 to 25.

(c) H (high) — 25 and above.

Specific toughness classifications are specified in AS 1720.2.

G.2.8 Column 8 — Tangential shrinkage

Average percentage shrinkage values for the tangential direction only are given as these are normally about double that of the radial shrinkage. Shrinkage is the measure of the percentage reduction in dimension from the unseasoned to 12 % moisture content condition.

G.2.9 Column 9 — Unit tangential movement (%)

The unit tangential movement is the percentage dimensional change for each 1 % moisture content change between about 3 % moisture content and the fibre saturation point for the particular species.

G.2.10 Column 10 — Natural durability class of heartwood

The classification system is based on the average life expectancy (in years) for a species, as given in Table G.1 used both in-ground and above-ground, refer to AS 5604.

NOTE Consideration should be given to the fact that the classification is very broad and it is not intended to distinguish between the relative merits of species in the same classification.

Table G.1 — Natural durability — Probable life expectancy

Class	Probable in-ground life expectancy (years)	Probable above-ground life expectancy (years)
1	Greater than 25	Greater than 40
2	15 to 25	15 to 40
3	5 to 15	7 to 15
4	0 to 5	0 to 7

G.2.11 Column 11 — Lyctid susceptibility of sapwood

Lyctid susceptibility of sapwood is classified as follows:

(a) S — Susceptible.

(b) NS — Not susceptible.

NOTE 1 The Lyctid susceptibility of alpine ash timber shows a consistent variation depending on its origin as Tasmania — S, New South Wales — S, Victoria — NS. If the origin of the timber is not known with certainty, the timber should be regarded as susceptible.

NOTE 2 Refer also to AS 5604.

G.2.12 Column 12 — Termite-resistance of heartwood

Termite resistance of heartwood is classified as follows:

(a) R — Resistant to termite.

(b) NR — Not resistant to termite.

NOTE Refer also to AS 5604.

Other species not listed, or where there is no rating given (designated as "—"), should be assumed to be not resistant to termite unless evidence to the contrary is provided.

G.2.13 Column 13 — Early fire hazard indices

The early fire hazard is classified as follows:

(a) Ignitability index — Scale 0 to 20.

(b) Spread of flame index — Scale 0 to 10.

(c) Smoke developed index — Scale 0 to 10.

G.2.14 Column 14 — Colour

The colour of seasoned heartwood can vary between species and often within a species. The information here should be used as a general guide only.

In most cases, the colour of sapwood is either a lighter shade of the heartwood or a white/cream colour, as follows:

(a) W = white, yellow, pale straw to light brown.

(b) *P* = pink, to pink brown.

(c) R = light to dark red.

(d) B = brown, chocolate, mottled or streaky.

Table G.2 — Timber species and properties

1	2	3		4		5		6	7		8	9	10		11	12	13			14
Standard trade name	Botanical name	Strength group		Joint group		Density, kg/m³		Hard-ness	Tough-ness		Tang-ntial shrink age, %	Unit tangential movemet, %	Natural durability class		Lyctid suscepti -bility	Termite-resistance	Early fire hazard			Colour
		US	S	US	S	US	S	S	US	S			In-ground contact	Outside above-ground			Ignitabi-lity	Spread of flame	Smoke develop ment	
ash, alpine	Eucalyptus delegatensis	S4	SD4	J3	JD3	1050	650	5.0	M	M	8.5	0.35	4	3	a	NR	14	8	3	W
ash, crows	Flindersia australis	S2	SD3	J1	JD1	1050	950	11.0	M	M	4.2	—	1	1	S	R	—	—	—	W
ash, mountain	Eucalyptus regnans	S4	SD3	J3	JD3	1050	650	4.9	M	M	13.3	0.36	4	3	NS	NR	14	8	3	W
ash, silvertop	Eucalyptus sieberi	S3	SD3	J2	JD2	1100	850	9.8	M	M	10.6	0.36	3	2	NS	NR	—	6	3	W-P
balau (selangan batu)	Shorea spp.	S2	SD3	J2	JD2	1150	900	—	—	—	7.0	—	2	1	S	NR	—	—	—	R
Bangkirai	Shorea laevifolia	—	SD3	—	—	—	850	—	—	—	5.0	—	2	—	S	—	—	—	—	W
beech, myrtle	Nothof-agus cunning-hamii	S4	SD5	J3	JD3	1100	700	5.9	—	—	4.7	0.32	4	3	S	NR	—	—	—	P
Blackbutt	Eucalyptus pilularis	S2	SD2	J2	JD2	1150	900	8.9	M	M	7.3	0.37	2	1	NS	R	13	7	3	W
Blackbutt, New England	Eucalyptus andrewsii	S3	SD3	J2	JD2	1150	850	9.2	M	M	11.4	0.36	2	1	S	R	—	6	3	W
Blackbutt, W.A.	Eucalyptus patens	S4	SD5	J2	JD2	1100	850	6.9	L	L	10.0	—	2	1	S	R	—	—	—	B
Blackwood	Acacia melanoxylan	S4	SD4	J3	JD3	1050	650	4.9	—	—	3.9	0.27	3	—	S	—	13	9	3	B
box, brush	Lophoste-man confert-us	S3	SD3	J2	JD2	1100	900	9.1	M	M	9.7	0.38	3	3	NS	R	14	7	3	B
box, grey, coast	Eucalyptus bosistoana	S1	SD1	J1	JD1	1200	1100	13.1	H	H	8.2	0.42	1	1	S	R	—	4	3	W
Brownb-arrell	Eucalyptus fastigata	S4	SD4	J3	JD3	1100	750	5.5	M	M	11.8	0.34	4	3	S	NR	—	8	3	W
Calantas (kalantas)	Toona calantas	S6	SD7	—	JD4	—	500	—	L	L	7.0	—	2	—	S	—	—	—	—	R
Candlebark	Eucalyptus rubida	S5	SD5	J3	JD3	1100	750	5.9	M	L	12.2	0.34	3	3	S	NR	—	—	—	P

Table G.2 *(continued)*

1	2	3		4		5		6	7		8	9	10		11	12	13			14
Standard trade name	Botanical name	Strength group		Joint group		Density, kg/m^3		Hard-ness	Tough-ness		Tang-ntial shrinkage, %	Unit tangential movemet, %	Natural durability class		Lyctid suscepti-bility	Termite-resistance	Early fire hazard			Colour
		US	S	US	S	US	S	S	US	S			In-ground contact	Outside above-ground			Ignitabi-lity	Spread of flame	Smoke develop ment	
cedar, western red	Thuja plicata	S7	SD8	—	JD6	—	350	—	L	L	3.0	—	3	2	NS	R	15	10	4	W-B
cedar, yellow	Chamaec-yparis nootkat-ensis	S6	SD6	—	—	640	480	—	L	L	6.0	—	1	1	NS	R	—	—	—	W
fir, Douglas (oregon)	Pseudotsuga menziesii	S5	SD5	J4	JD4	710	550	3.0	L	L	4.0	—	4	4	NS	NR	14	9	3	W
gum, blue, southern	Eucalyptus globulus	S3	SD2	J2	JD2	1150	1000	11.5	M	H	7.7	0.40	3	2	S	NR	—	—	—	W
gum, blue, Sydney	Eucalyptus saligna	S3	SD3	J2	JD2	1100	850	8.1	M	M	9.5	0.35	3	2	S	NR	—	6	3	P
gum, grey	Eucalyptus propinqua	S1	SD2	J1	JD1	1250	1050	14.0	M	M	7.0	—	1	1	NS	R	—	—	—	R
gum, grey, mountain	Eucalyptus cypellocarpa	S3	SD2	J2	JD2	1100	900	10.3	M	M	11.9	0.39	3	2	S	NR	—	0	3	P
gum, manna	Eucalyptus viminalis	S4	SD4	J3	JD2	1100	800	5.8	M	M	12.0	0.34	4	3	S	NR	—	—	—	P
gum, mountain	Eucalyp-tus darymp-leana	S4	SD5	J3	JD3	1100	700	5.7	M	M	11.5	0.35	4	3	S	NR	—	—	—	P
gum, red, forest	Eucalyptus tereticornis	S3	SD4	J1	JD1	1150	1000	11.3	M	M	8.6	0.34	1	1	NS	R	—	—	—	R
gum, red, river	Eucalyp-tus camaldu-lensis	S5	SD5	J2	JD2	1150	900	9.7	M	L	8.9	0.31	2	1	S	R	—	3	3	R
gum, rose	Eucalyptus grandis	S3	SD4	J2	JD2	1100	750	7.3	M	M	7.5	0.30	3	2	NS	NR	—	7 8[b]	3	P
gum, shining	Eucalyptus nitens	S4	SD4	J3	JD3	1100	700	5.8	M	M	9.4	0.33	4	3	S	NR	—	8	4	W
gum, spotted	Eucalyptus maculata	S2	SD2	J1	JD1	1200	1100	10.1	H	H	6.1	0.38	2	1	S	R	13 7[b]	3	3	B
Hardwood, Johnstone River	Backhousia bancroftii	S2	SD3	J1	JD1	1150	950	—	—	—	6.4	0.39	3	2	S	NR	—	—	—	B

Table G.2 *(continued)*

1	2	3		4		5		6	7		8	9	10		11	12	13			14
Standard trade name	Botanical name	Strength group		Joint group		Density, kg/m³		Hard-ness	Tough-ness		Tang-ntial shrinkage, %	Unit tangential movemet, %	Natural durability class		Lyctid suscepti-bility	Termite-resistance	Early fire hazard			Colour
		US	S	US	S	US	S	S	US	S			In-ground contact	Outside above-ground			Ignitabi-lity	Spread of flame	Smoke develop ment	
Hemlock, western	Tsuga heterophylla	S6	SD6	J4	JD4	800	500	2.7	L	L	5.0	—	4	4	NS	NR	14	9	3	W
Ironbark, grey	Eucalyptus paniculata	S1	SD1	J1	JD1	1250	1100	16.3	H	H	7.5	0.39	1	1	NS	R	—	0	3	WRB
Ironbark, red	Eucalyptus sideroxylon	S2	SD3	J1	JD1	1200	1100	11.9	H	M	6.3	0.37	1	1	S	R	—	5	3	R
Jarrah	Eucalyptus marginata	S4	SD4	J2	JD2	1100	800	8.5	L	L	7.4	0.30	2	2	S	R	13	6	3	R
Kapur	Dryob-alanops spp.	S3	SD4	J2	JD2	1100	750	5.4	L	M	6.0	—	3	2	NS	NR	13	7	3	WPR
Karri	Eucalyptus diversicolor	S3	SD2	J2	JD2	1150	900	9.0	M	M	9.9	0.40	3	2	NS	NR	13	7	3	P
Keruing	Diptero-carpus spp.	S3	SD3	J2	JD2	950	750	4.6	H	H	9.5	—	3	3	S	NR	—	—	—	R
kwila (merbau)	Intsia bijuga	S2	SD3	J2	JD2	1150	850	8.8	M	M	2.5	—	3	2	S	R	—	0	5	R
Mahogany, Philippine, red, dark	Shorea spp.	S5	SD6	—	JD3	—	650	3.2	—	—	4.0	—	3	—	S	—	—	—	—	R
Mahogany, Philippine, red, light	Shorea, Pentacme, Parashorea spp.	S6	SD7	—	JD4	—	550	2.6	—	—	6.5	—	4	4	S	NR	—	—	—	W
Mahogany, red	Eucalyptus resinifera	S2	SD3	J1	JD1	1200	950	12.0	M	M	6.3	0.34	2	1	S	R	—	5	3	R
Mahogany, southern	Eucalyptus botryoides	S2	SD3	J2	JD2	1100	900	9.2	M	M	9.8	0.37	3	2	NS	R	—	—	—	R
Meranti, red, light	Shorea spp.	S6	SD7	—	JD5	—	400	2.4	—	—	4.4	—	4	3	S	NR	14	9	4	P
Messmate	Eucalyptus obliqua	S3	SD3	J3	JD3	1100	750	7.4	M	M	11.3	0.36	3	3	S	NR	13	5	3	W
Messmate, Gympie	Eucalyptus cloeziana	S2	SD3	J1	JD1	—	955	—	—	—	6.0	—	1	1	NS	R	—	—	—	W
oak, American	Quercus spp.	S6	SD6	—	—	—	750	—	—	—	5.0	—	4	—	S	NR	—	—	—	W
Peppermint, narrow-leaved	Eucalyptus australiana	S4	SD4	J3	JD2	1100	800	7.5	L	L	13.2	0.36	4	3	S	NR	—	—	—	P

Table G.2 *(continued)*

1	2	3		4		5		6	7		8	9	10		11	12	13			14
Standard trade name	Botanical name	Strength group		Joint group		Density, kg/m³		Hard-ness	Tough-ness		Tang-ntial shrink age, %	Unit tangential movemet, %	Natural durability class		Lyctid suscepti -bility	Termite-resistance	Early fire hazard			Colour
		US	S	US	S	US	S	S	US	S			In-ground contact	Outside above-ground			Ignitabi-lity	Spread of flame	Smoke develop ment	
pine, caribbean	Pinus caribaea	S6	SD6	J4	JD5[c]	—	550	—	—	—	5.0	0.34	4	4	NS	R	—	—	—	W
pine, celery- top	Phyllodadus asplenifolius	S4	SD5	J3	JD3	1050	650	4.5	—	—	3.1	0.19	4	2	NS	R	—	—	—	W
cypress, white	Callitris glaucophylla	S5	SD6	J3	JD3	850	700	6.1	L	L	2.5	0.26	2	1	NS	R	13	8	3	WB
pine, hoop	Arauca ria cunning-ghamii	S6	SD5	J4	JD4	800	550	3.4	L	L	3.8	0.23	4	4	NS	NR	14	7 9[b]	2 3[b]	W
pine, radiata	Pinus radiata	S6	SD6	J4	JD5[c]	800	550	3.3	M	L	5.1	0.27	4	4	NS	NR	14	8	3	W
pine, slash	Pinus elliottii	S5	SD5	J4	JD5[c]	850	650	3.4	L	L	4.2	0.30	4	4	NS	R	—	8	3	W
pine, Scots	Pinus sylvestris	S7	SD6	—	JD5	—	510	—	L	L	—	—	4	4	NS	NR	—	—	—	W
Ramin	Gonystylus spp.	S4	SD4	—	JD3	—	650	5.8	—	—	5.5	—	4	—	S	NR	14	7	3	W
Satinay	Syncarpia hillii	S3	SD3	J2	JD2	1100	800	8.3	M	L	10.0	0.35	2	2	NS	R	—	—	—	R
Stringybark, Blackdown	Eucalyp-tus sphaer-ocarpa	S3	SD3	J1	JD1	—	1000	—	—	—	7.0	—	2	1	NS	R	—	—	—	B
Stringbark, brown	Eucalyptus baxteri	S3	SD3	J2	JD2	1100	850	7.5	M	M	10.4	0.33	3	2	NS	NR	—	—	—	B
Stringbark, white	Eucalyptus eugenioides	S3	SD3	J2	JD2	1100	1000	9.0	M	M	10.6	0.36	3	2	NS	R	—	—	—	P
Stringbark, yellow	Eucalyptus muellerana	S3	SD3	J2	JD2	1150	900	8.6	M	M	7.5	0.37	6	3	NS	R	—	—	—	W
Tallowwood	Eucalyptus microcorys	S2	SD2	J1	JD2	1200	1000	8.6	M	M	6.1	0.37	1	1	S	R	12	5	4	W
Taun	Pometia pinnata	S4	SD4	—	JD3	—	700	—	—	—	5.5	—	3	2	S	NR	—	—	—	R
Turpentine	Syncarpia glomulifera	S3	SD3	J2	JD2	1050	950	11.6	M	M	13.0	0.35	5	3	NS	R	—	—	—	PB
Commercial species groups																				

Table G.2 *(continued)*

1	2	3		4		5		6	7		8	9	10		11	12	13			14
Standard trade name	Botanical name	Strength group		Joint group		Density, kg/m³		Hard-ness	Tough-ness		Tang-ntial shrinkage, %	Unit tangential movemet, %	Natural durability class		Lyctid suscepti-bility	Termite-resistance	Early fire hazard			Colour
		US	S	US	S	US	S	S	US	S			In-ground contact	Outside above-ground			Ignitabi-lity	Spread of flame	Smoke develop ment	
ash, Victorian oak, Australian oak, Tasmanian	Eucalyptus spp.	-	SD4	J3	JD3	1050	650	4.9	M	M	13.3	0.36	4	—	S	—	—	—	—	W
Hardwood, mixed (Qld/Nth. NSW)	Eucalyptus spp.	S3	SD3	J2	JD2	1150	750	—	M	M	—	—	3	—	S	—	—	—	—	WPRB
Hemfir	—	—	SD7	—	JD5	—	—	—	L	L	—	—	4	—	NS	—	—	—	—	W
Softwoods, imported (uniden-tified)	—	S7	SD8	J6	JD6	850	400	—	L	L	—	—	4	—	NS	—	—	—	—	W
Softwoods, mixed Australian grown pinus spp.	—	—	SD7	—	JD5[c]	850	550	—	L	L	—	—	4	—	NS	—	—	—	—	W
Spruce pine fir (SPF)	—	—	SD7	—	JD6	—	—	—	L	L	—	—	4	—	NS	—	—	—	—	W
European spruce	Picea abies	—	SD5	—	JD5	—	—	—	—	—	—	—	4	—	NS	—	—	—	—	W

[a] Refer to AS 5604.

[b] The value is for plywood.

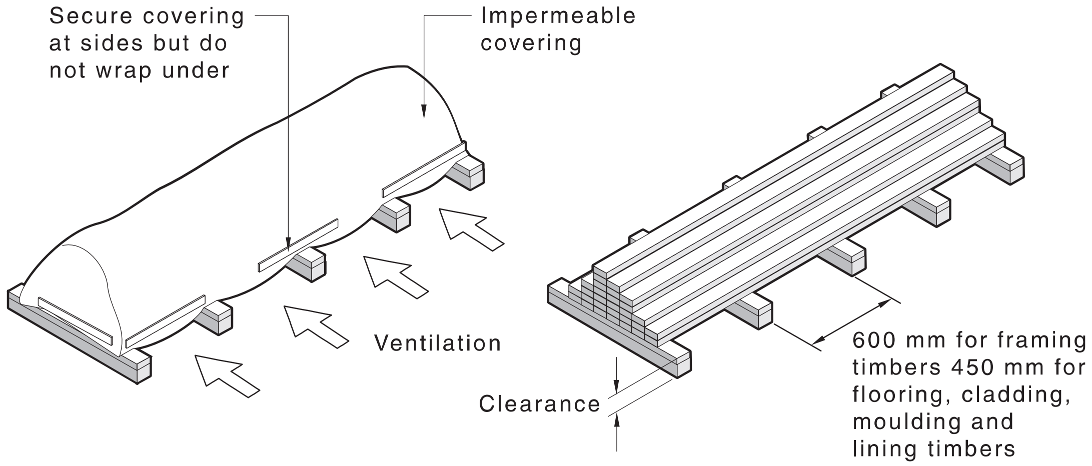
[c] Where the timber does not contain heart-in material, the joint group may be rated JD4.

Appendix H
(informative)

Storage and handling

Timber or timber products should be stored and handled in such manner as to allow for their satisfactory performance when fabricated into the building.

Seasoned or unseasoned framing materials should be stacked as shown in Figure H.1. Unseasoned scantling may be stacked on the ground on impervious sheeting, to protect the lower timbers from dirt and stains, provided the site is reasonably level and timber is clear of any ponding water.



(a) Weather protection **(b) Stacking**

NOTE 1 150 mm clearance for seasoned framing and flooring, cladding, moulding and lining timbers.

NOTE 2 Unseasoned framing may be stacked on impervious sheeting if ground is reasonably level.

Figure H.1 — Storage

Seasoned milled products, such as flooring, moulding, lining timbers, and similar products, should not be delivered until they can be "built-in", or alternatively stored under cover where they should be block-stacked on a flat surface or on closely spaced bearers (gluts).

Prefabricated wall frames and trusses should be stored at least 150 mm above the ground level on suitable bearers to prevent contact with ground or water. Trusses should be stored either —

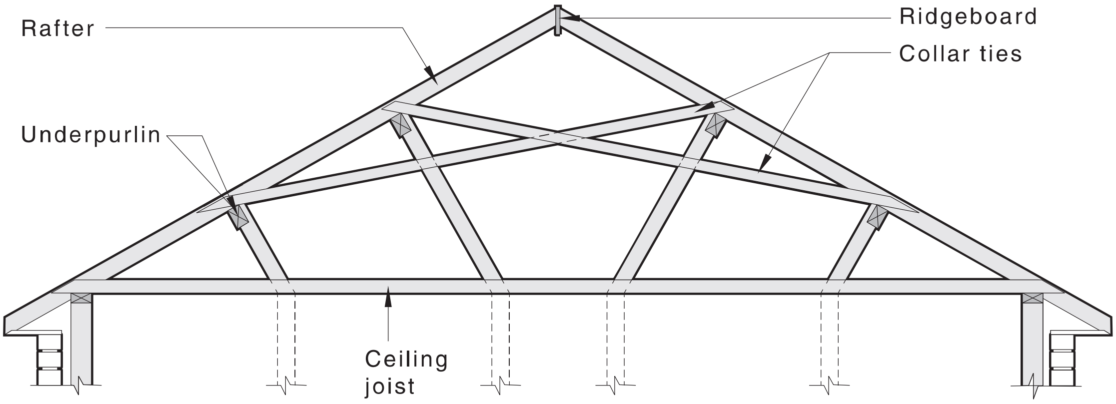
(a) vertically and supported at truss points and prevented from overturning; or

(b) horizontally stacked with sufficient bearers (approximately 2.0 m centres) to prevent bending of the trusses.

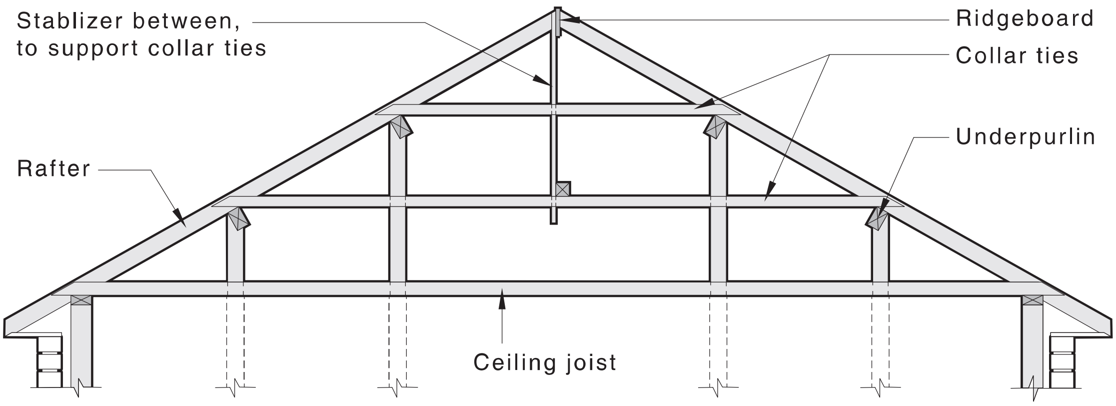
Appendix I
(normative)

Collar ties with multiple rows of underpurlins

This Appendix specifies typical fixing details for collar ties with multiple rows of underpurlins, which are given in Figure I.1. Collar ties that exceed 4.2 m in length shall be fixed in accordance with Figure I.1, as specified in Clause 7.2.16.



(a) Typical method of fixing scissor collar ties when two underpurlins are required on a roof with equal pitches



(b) Typical method of fixing conventional collar ties when two underpurlins are required on a roof with equal or unequal pitches

NOTE Collar tie may be spliced as for ceiling joist, see Clause 7.1.2.1.

Figure I.1 — Fixing of collar ties with multiple rows of underpurlins

Appendix J
(informative)

Building practices for engineered wood products (EWPs)

J.1 General

This Appendix provides general guidance on building practices that are common to a range of manufactured EWPs.

NOTE 1 Manufacturer specifications may have additional requirements or different installation and building practices from the guidelines outlined herein. Where they differ, the manufacturer's specification should apply.

NOTE 2 Additional requirements may also apply where manufacturer product-specific span tables are available for the application and use of their EWPs for bracing and tie-down purposes.

J.2 Vertical nail lamination

In situations where rectangular beams manufactured from EWPs are vertically laminated together using nails, screws or bolts, the requirements of Clause 2.3, applicable to sawn timber, are generally inadequate. As such, fabrication of mechanically laminated members utilizing EWPs, such as laminated veneer lumber (LVL), should be undertaken in accordance with the manufacturer's specification.

J.3 Floor framing

J.3.1 Cuts, holes and notches in bearers and joists

Details for solid, rectangular EWPs (such as LVL, glued laminated timber and laminated strand lumber [LSL]) used in bearer and joist applications should be the same as those specified for solid timber members.

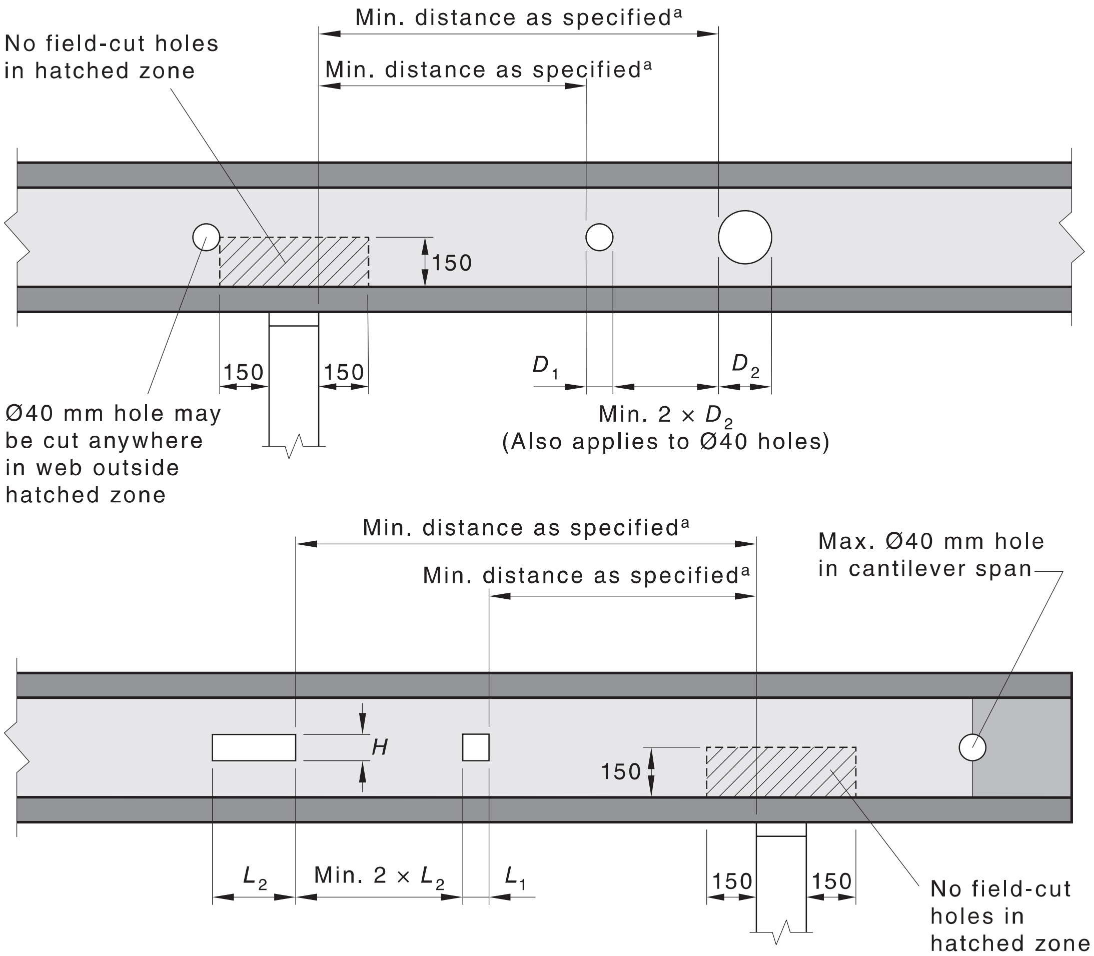
Penetrations such as holes, cuts or notches should not be made in either the flanges or the webs of I-section EWPs used as floor bearers.

Penetrations (such as holes, cuts or notches) should not be made in the flanges of I-section EWPs used as floor joists (I-joists). Penetrations in the webs of I-joists should be as given in Table J.1 and as shown in Figure J.1.

Table J.1 — Maximum hole sizes in webs of I-joists

Nominal depth of I-joist, mm	Max. diameter for circular holes, mm	Max. height for rectangular holes, (*H*)	Max. length for rectangular holes, (*L*)
200	125	125	250
240	165	165	330
300	225	225	400
360	285	285	500
400	325	325	600

Dimensions in millimetres



[a] Minimum distances from supports are product specific, and should be determined in accordance with the manufacturer's specifications.

NOTE All distances to be read from Table J.1.

Figure J.1 — Penetrations in webs of I-joists

J.3.2 Bearers

Details for solid, rectangular EWPs (such as LVL, glued laminated timber and LSL) that are used as floor bearers should be the same as those specified for solid timber members.

End bearing of rectangular section EWPs that are used as floor bearers should be at least 50 mm, unless specifically noted otherwise in the manufacturer's specification.

I-section EWPs that are used in bearer applications should be designed and installed in accordance with the manufacturer's specification.

J.3.3 Joists

J.3.3.1 Solid section

Details for solid, rectangular EWPs (such as LVL, glued laminated timber and LSL) that are used as floor joists should be the same as those specified for solid timber members.

The end bearing of rectangular section EWPs that are used as floor joists should be the same as that specified for solid timber members with the same span.

J.3.3.2 I-joists

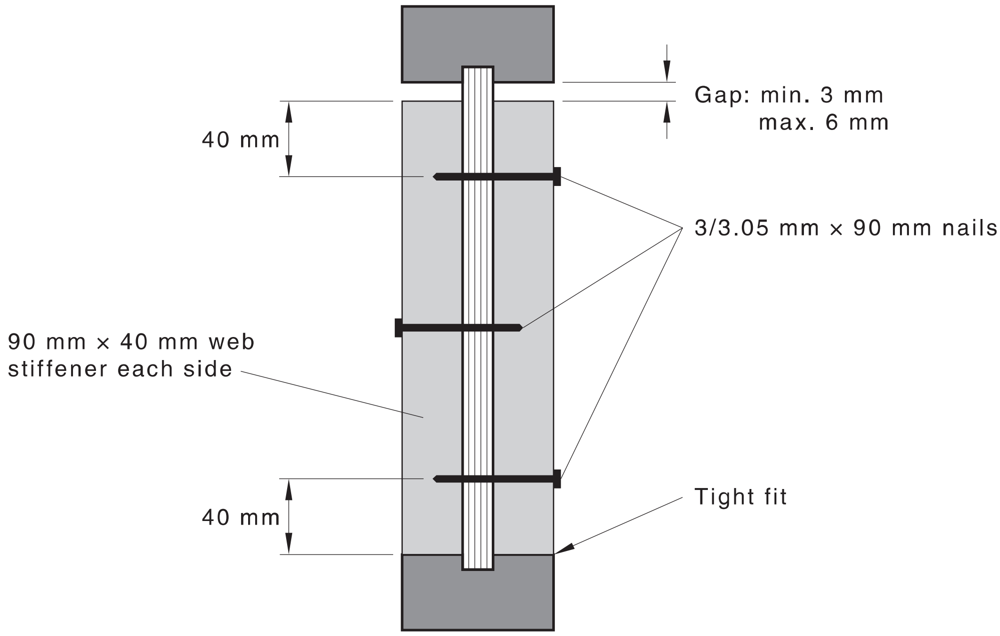
Installation details for I-section members that are used as floor joists should be in accordance with Clauses J.3.3 to J.3.6.

The end bearing of I-section floor joists should be as given in Table J.2.

Table J.2 — Minimum bearing for I-section floor joists

Load type	Joist spacing 450 mm centres	Joist spacing 600 mm centres	Joist spacing 600 mm centres with web stiffeners[a]
End bearing — no load transfer from upper walls	30	30	30
Intermediate bearing — no load transfer from upper walls	45	65	45
End bearing — sheet roof	45	65	45
End bearing — tiled roof	65	90	65

[a] Web stiffeners should be installed over the supports in accordance with the manufacturer's specification. An example of typical web stiffening is shown in Figure J.2.



NOTE Example shown is for an I-joist with 90 mm nominal flange width.

Figure J.2 — Typical web stiffener arrangement

J.3.4 Notching and cutting over bearing points

The location and size of any web penetrations should be in accordance with Clause J.3.1. Web penetrations should not occur over bearing or support points.

The following provisions also apply:

(a) Flanges should not be notched, see Figure J.3. Where notching of the bottom flange is permitted by the manufacturer's specification, over-cutting and splitting should not occur.

(b) Taper or bevel cuts should occur only within the width of a support wall, see Figure J.4.

(c) End splitting of flanges, similar to that shown in Figure J.5, should not occur. Nailing using a minimum nail diameter of 3.05 mm and a maximum of 3.15 mm should be as shown in Figure J.5.

(d) Connections to steel support beams should be constructed as shown in Figures J.6, J.7 and J.8, or as noted otherwise in the manufacturer's specification.

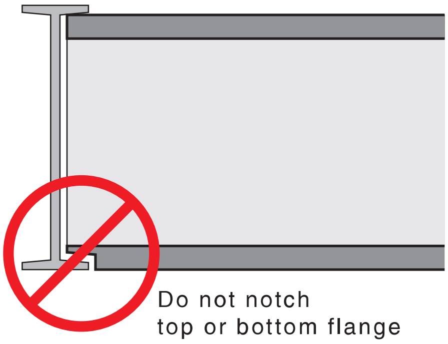


Figure J.3 — Flanges not to be notched

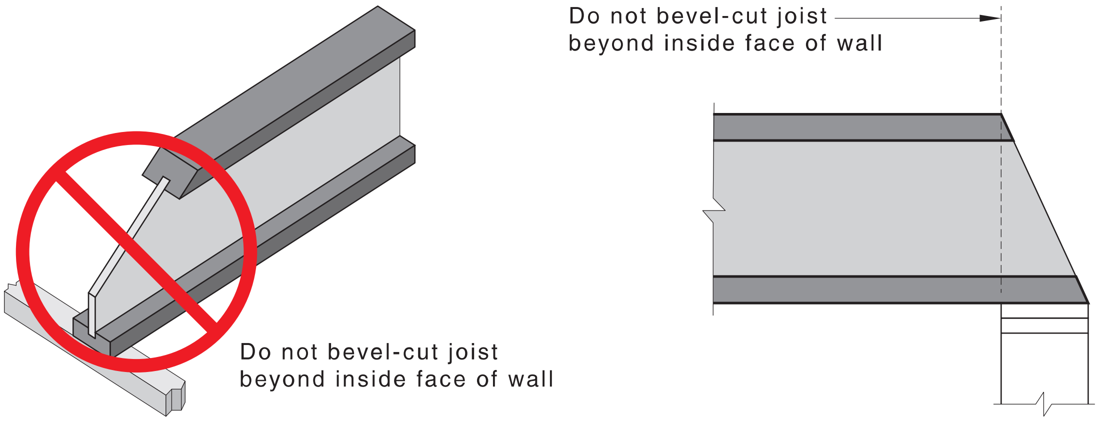


Figure J.4 — Bevel cuts only occur within the width of supports

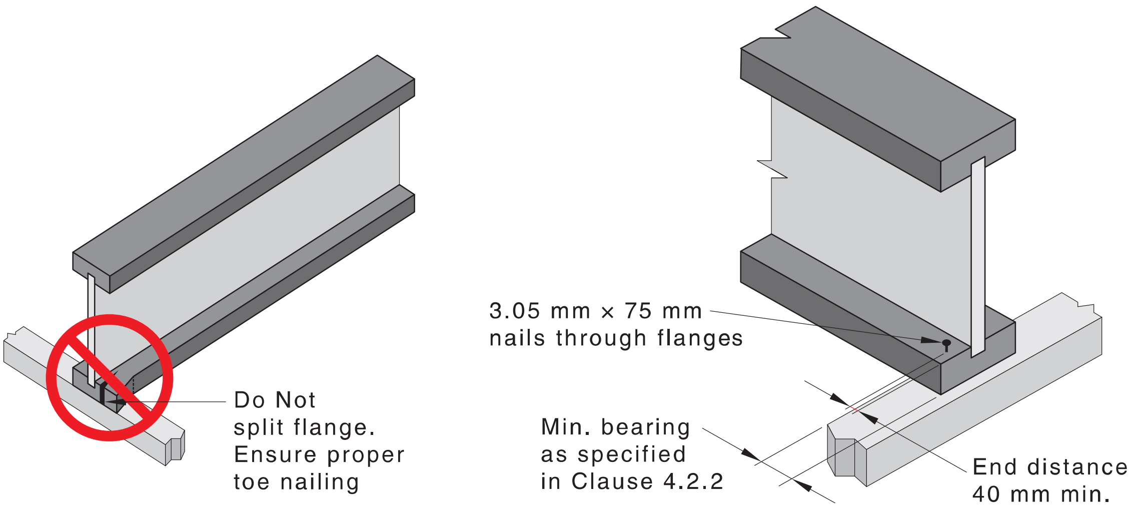


Figure J.5 — Nailing at supports

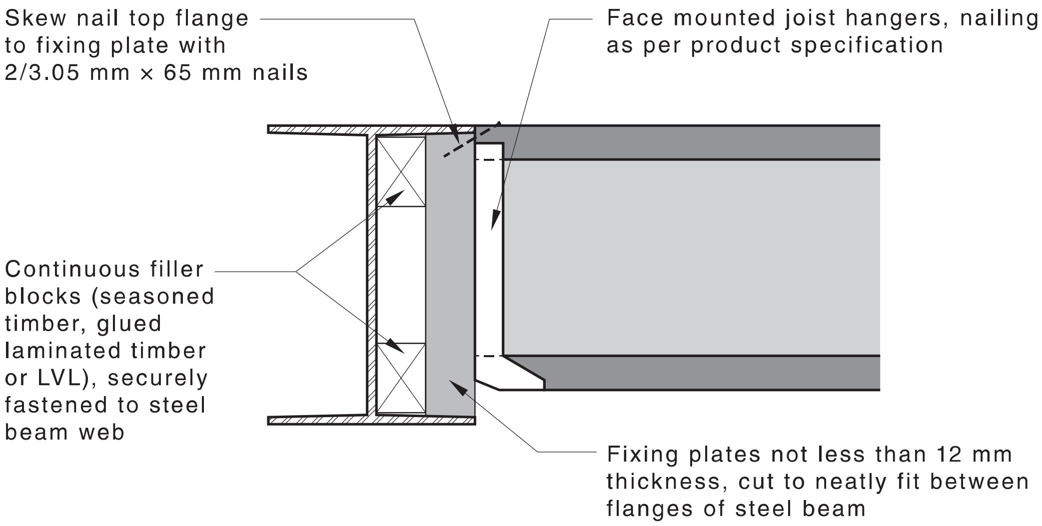


Figure J.6 — Connection of I-joists to a steel beam — Method 1

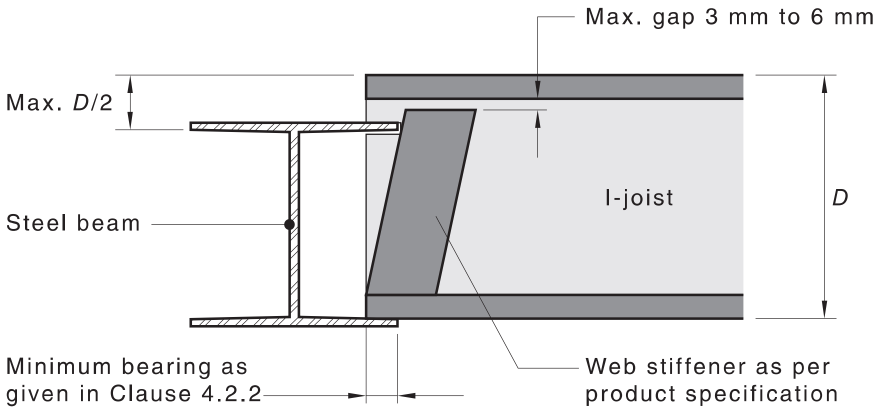


Figure J.7 — Connection of I-joists to a steel beam — Method 2

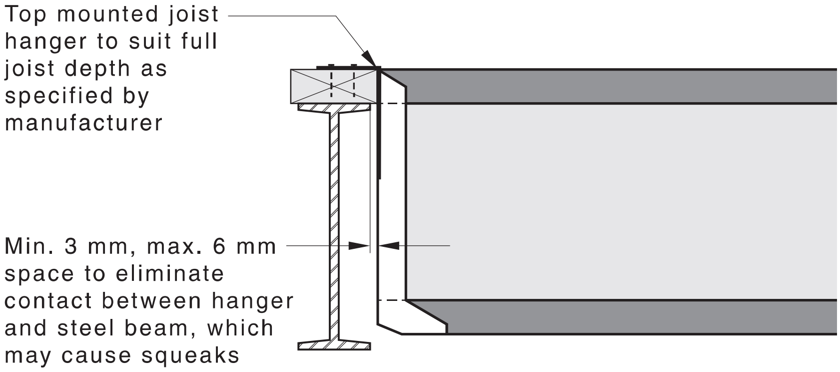


Figure J.8 — Connection of I-joists to a steel beam — Method 3

J.3.5 Bearing points for concentrated loads

Compression blocks and/or web stiffeners should be used at all locations where concentrated loads from wall studs or posts occur. They should be constructed as shown in Figures J.2 and J.9, or as noted otherwise in the manufacturer's specification.

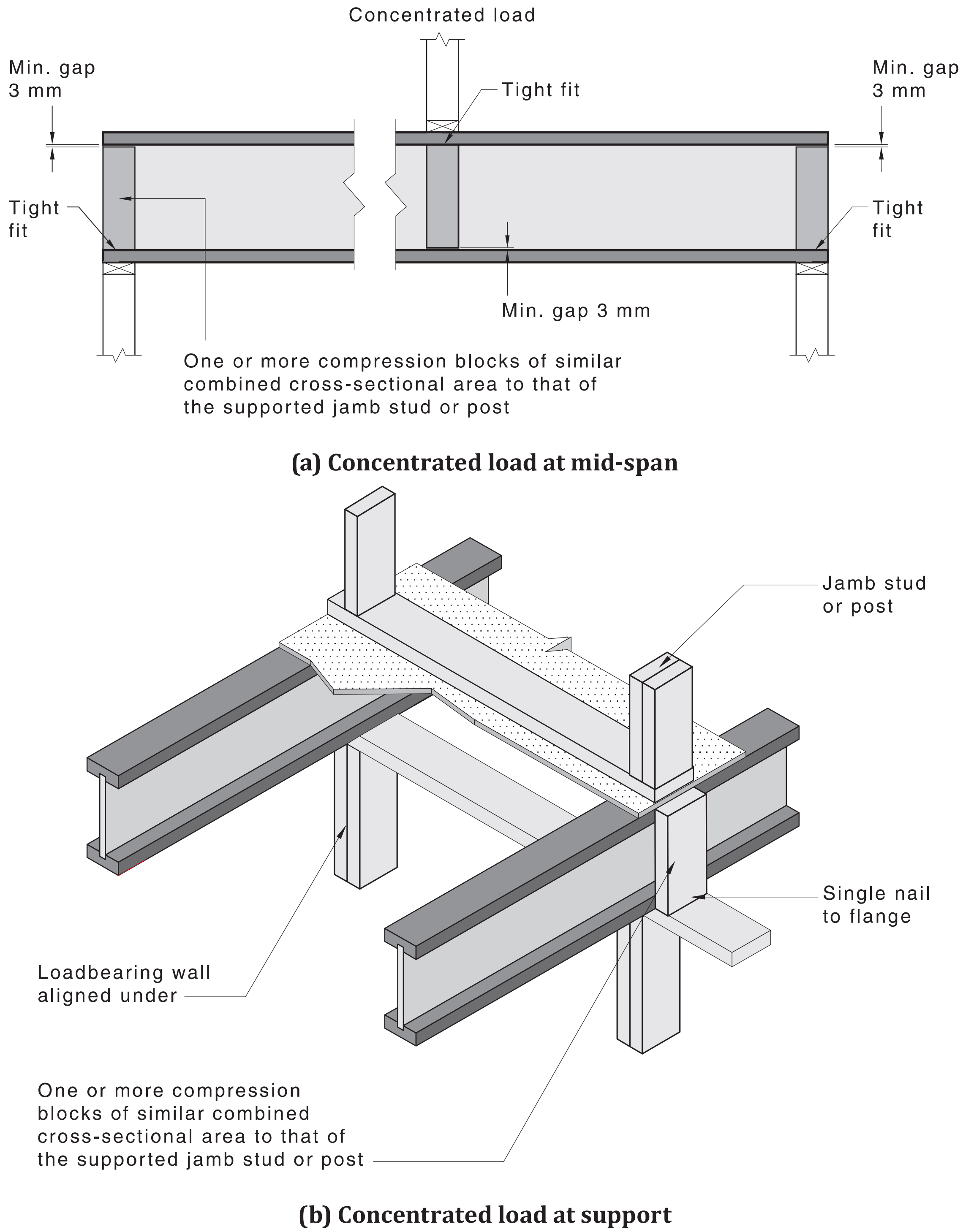
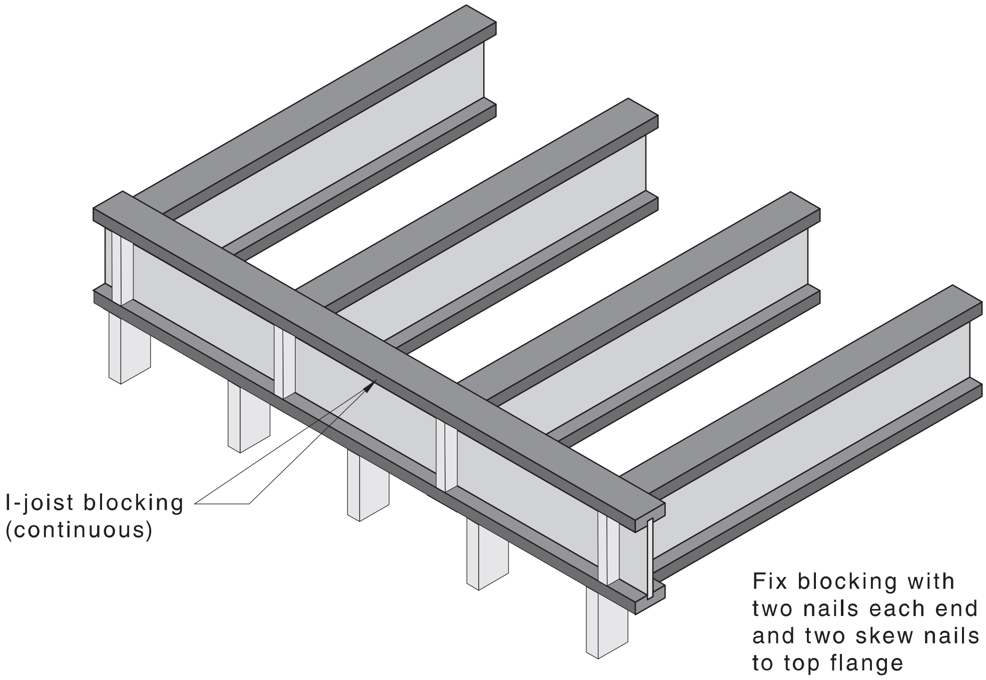


Figure J.9 — Bearing at points of concentrated load

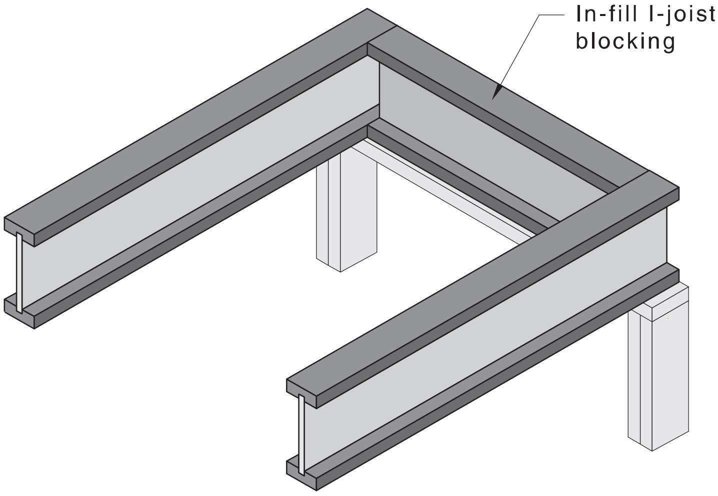
J.3.6 Deep joists — Lateral restraint

J.3.6.1 Blocking and rim boards

Blocking for all joists that are less than 200 mm deep should be installed in accordance with the requirements given in Clause 4.2.2.3 for solid timber. Where the joists are 200 mm or more in depth, lateral restraint should be provided using blocking and/or rim board as shown in Figures J.10 and J.11.



(a) Continuous I-joist blocking



(b) Infill I-joist blocking

Figure J.10 — Blocking of I-joists — Using I-joist

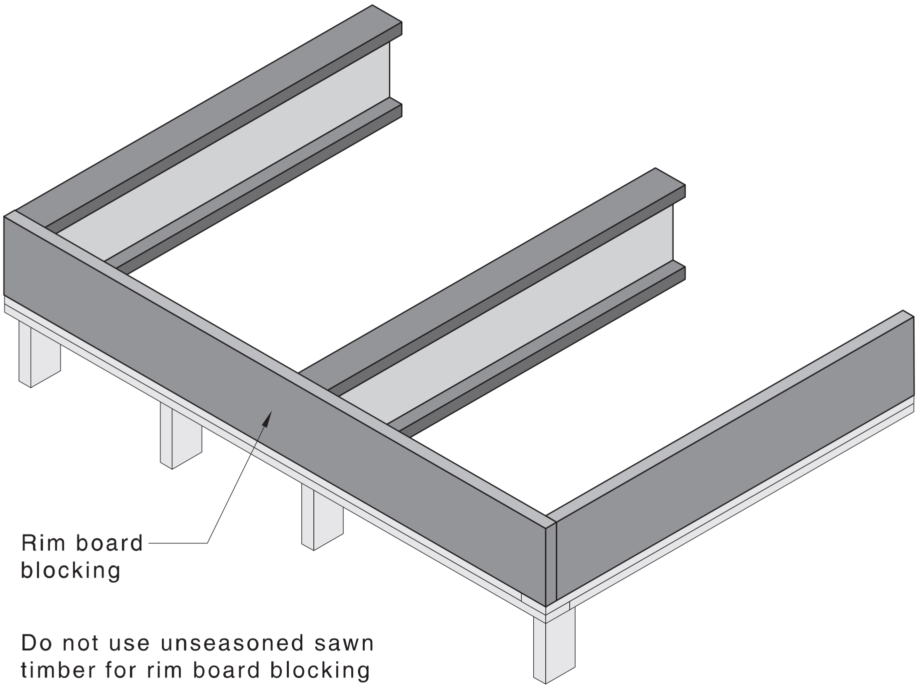


Figure J.11 — Blocking of I-joists — Using rim board

Rim boards and blocking should be constructed from seasoned timber to minimize the effects of shrinkage. Rim boards may be used in conjunction with blocking on external walls.

Where the lateral restraint members assist to provide bracing (transfer of racking loads from the upper storey to the lower storey) due to wind and earthquake events, structural ply bracing should be installed as shown in Figure J.12.

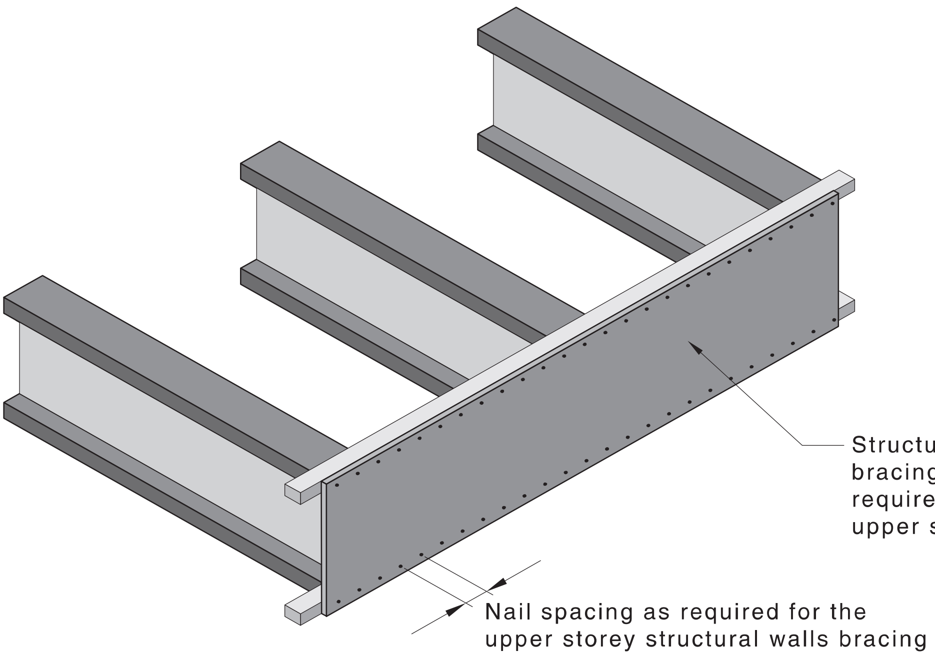
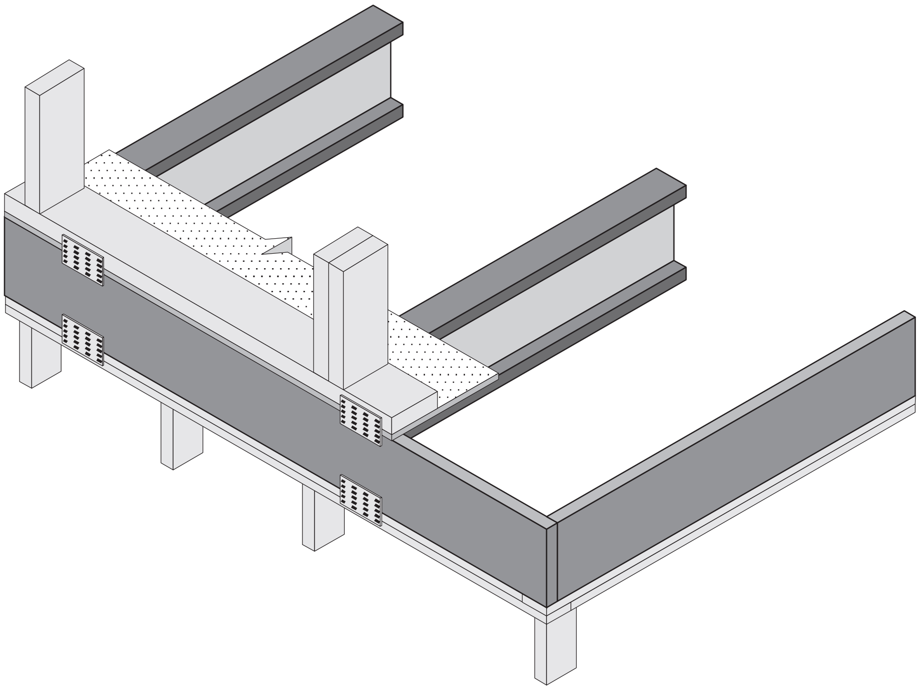


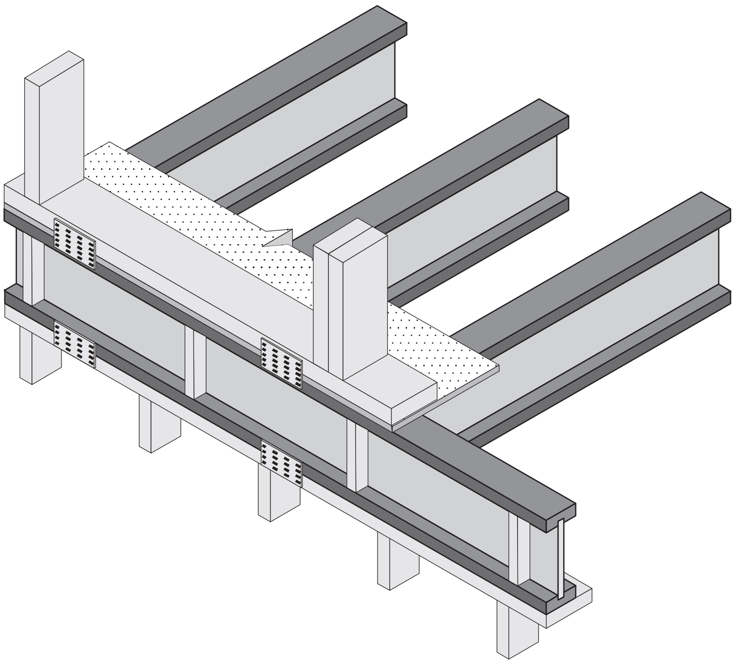
Figure J.12 — Plywood lateral bracing of I-joists — Combined blocking and racking load transfer

J.3.6.2 Nailplate connectors

Where it is not practicable to install adequate structural plywood bracing to transfer lateral loads as shown in Figures J.11 and J.12, nailplate connectors may be used, as shown in Figure J.13(a) or J.13(b), to transfer the lateral loads through the floor provided sufficient connectors are installed in accordance with the manufacturer's specification.



(a) Supported by LVL or similar



(b) Supported by I-joists

Figure J.13 — Equivalent nailplate detail to transfer bracing forces through external walls

J.3.6.3 Intermediate blockings

Non-continuous or intermediate blocking, as shown in Figure J.14, should be designed to resist lateral loads. It should only be used where permitted by the manufacturer's specification.

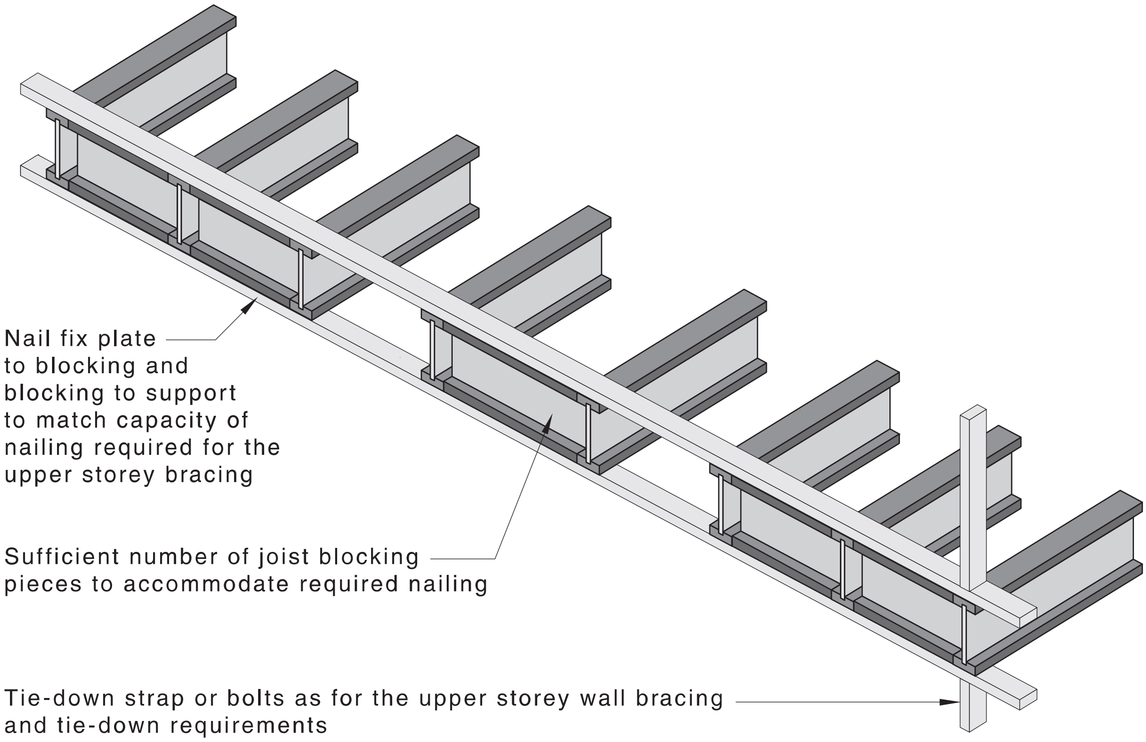


Figure J.14 — Example of non-continuous blocking of I-joists

J.4 Roof framing

J.4.1 Roof bracing

Roof bracing details should be installed in accordance with the requirements for timber trussed roof given in AS 4440.

J.4.2 Rafters

In general, rafter details for solid timber joists may be used with I-beams. Rafters should be in accordance with the requirements of Clause 7.3.13. Birdsmouth cuts for seating rafters should be as shown in Figure J.15 and are permitted only on the lower end of the rafter.

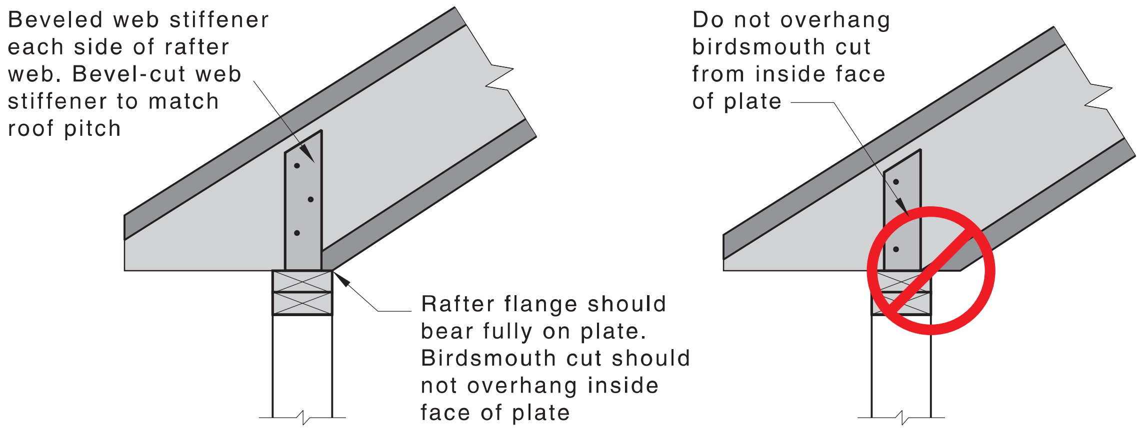


Figure J.15 — Detail for birdsmouth seating of I-beam rafters

Ventilation holes may be used for blocking provided lateral restraints to I-beams are used as rafters, and they do not exceed the size and location limitations shown in Figure J.16.

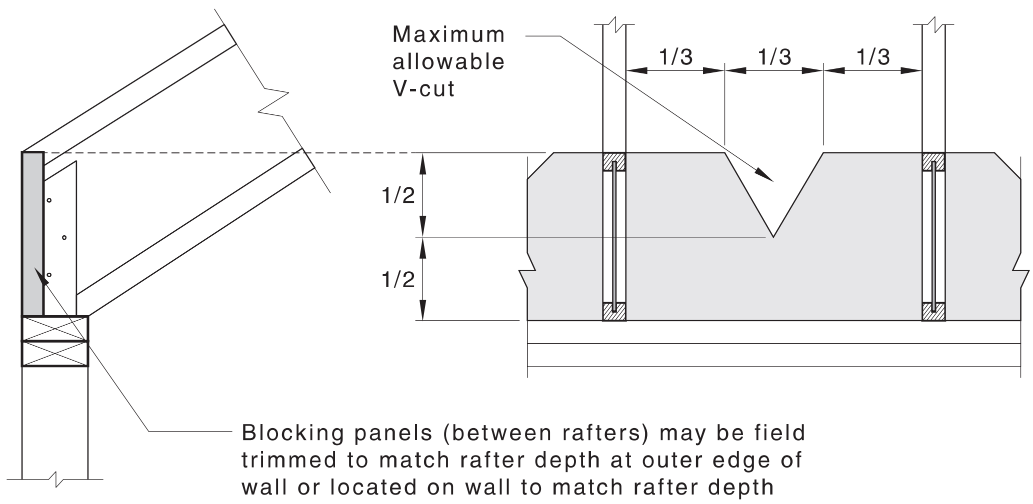
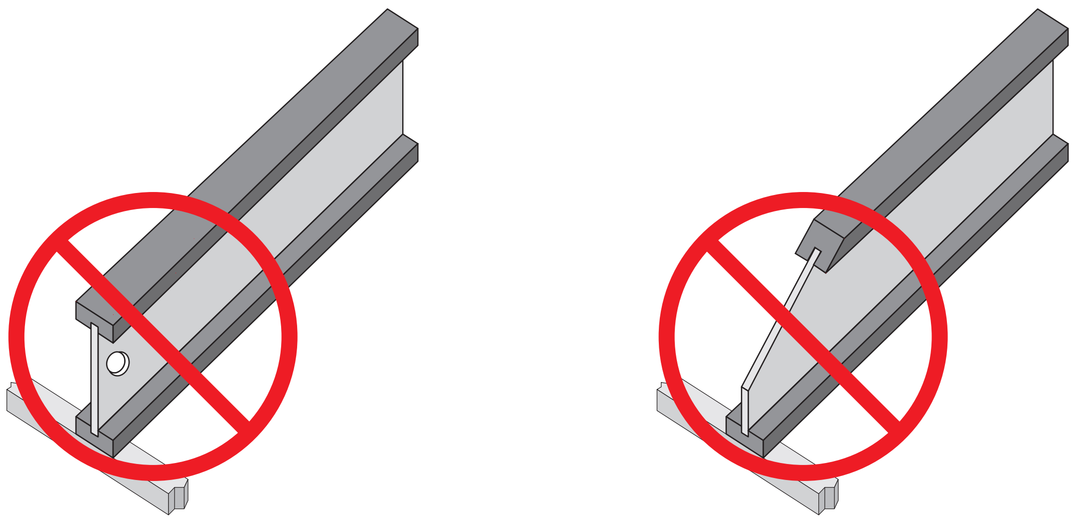


Figure J.16 — Ventilation holes in rafter blocking

General restrictions on rafter cuts are shown in Figure J.17.



(a) Do not cut holes too close to support

(b) Do not bevel cut joist beyond inside face of wall

Figure J.17 — General restrictions on cuts and penetrations to ends of rafters

J.4.3 Ceiling joists

In general, ceiling joist details for solid timber joists may be used with I-beams. Ceiling joists should be in accordance with the requirements given in Clause 7.3.6. Bevel cuts for ceiling joists should not go beyond the internal face of the supporting wall, see Figure J.18.

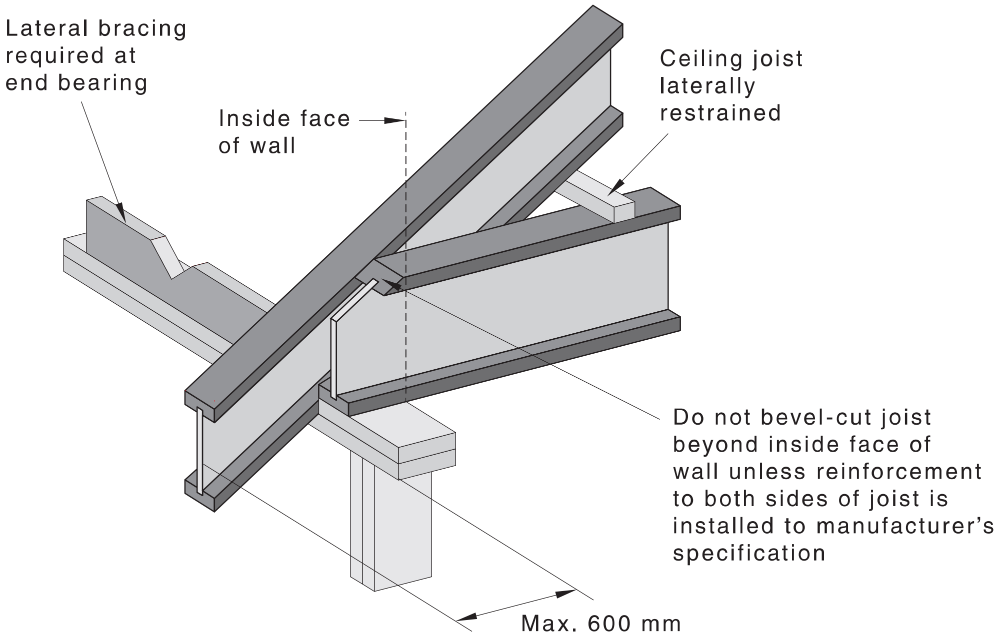


Figure J.18 — Bevel cuts on ceiling joists

J.5 Bracing details and shear forces for internal walls

Where bracing is provided in internal walls, the lateral forces should be transferred in a similar manner to that shown in Table 8.22 (b) and Figure J.19.

For internal walls supporting I-joists, an equivalent detail using Z-clips is shown in Figure J.20. The fixings of the nogging to the top plate and the Z-clips to the I-joists should have equivalent lateral load capacity to those fixings given in Figure J.19.

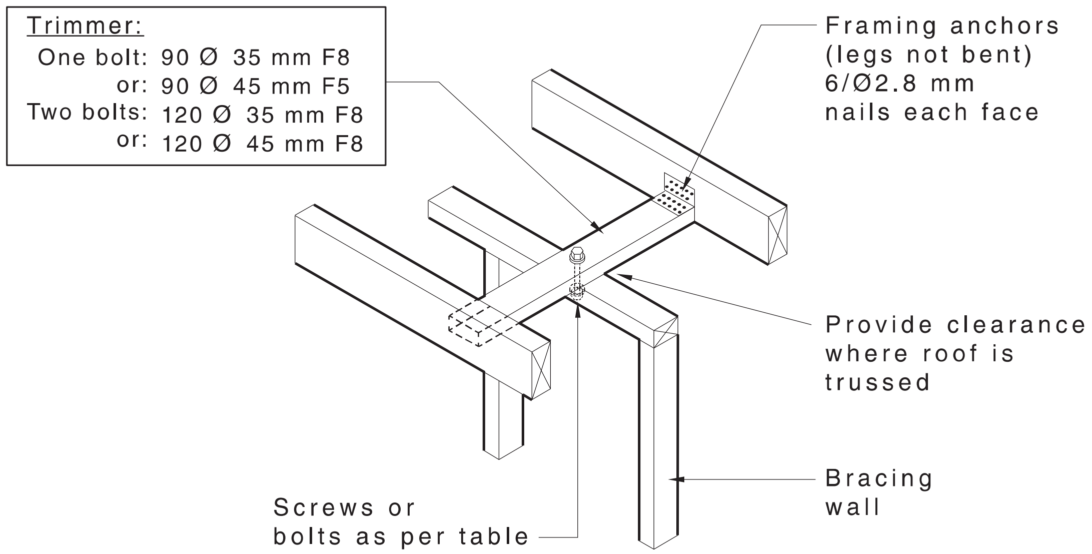


Figure J.19 — Bracing detail for I-joist to internal wall

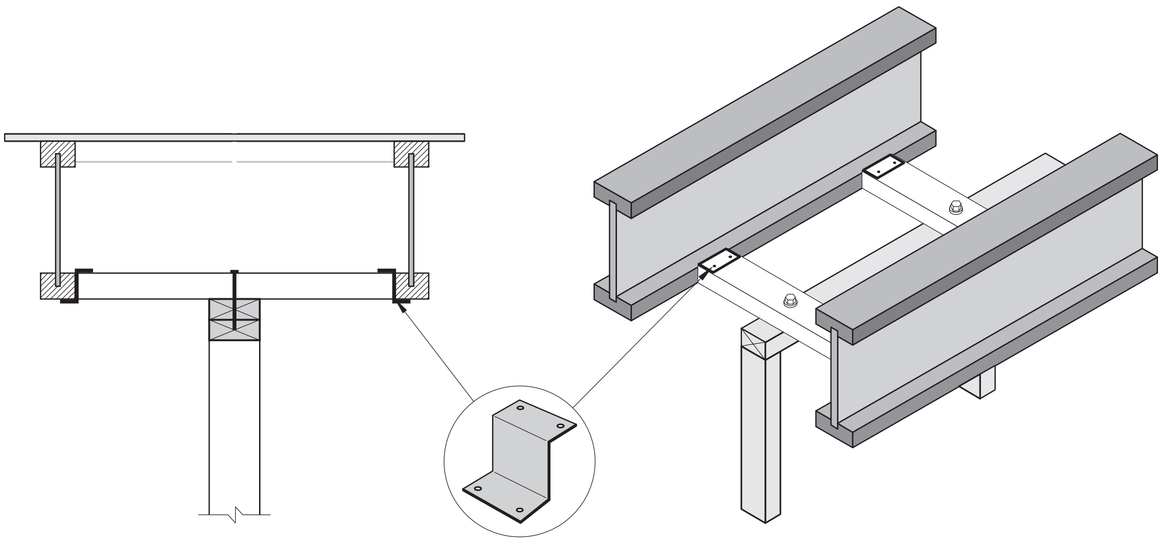


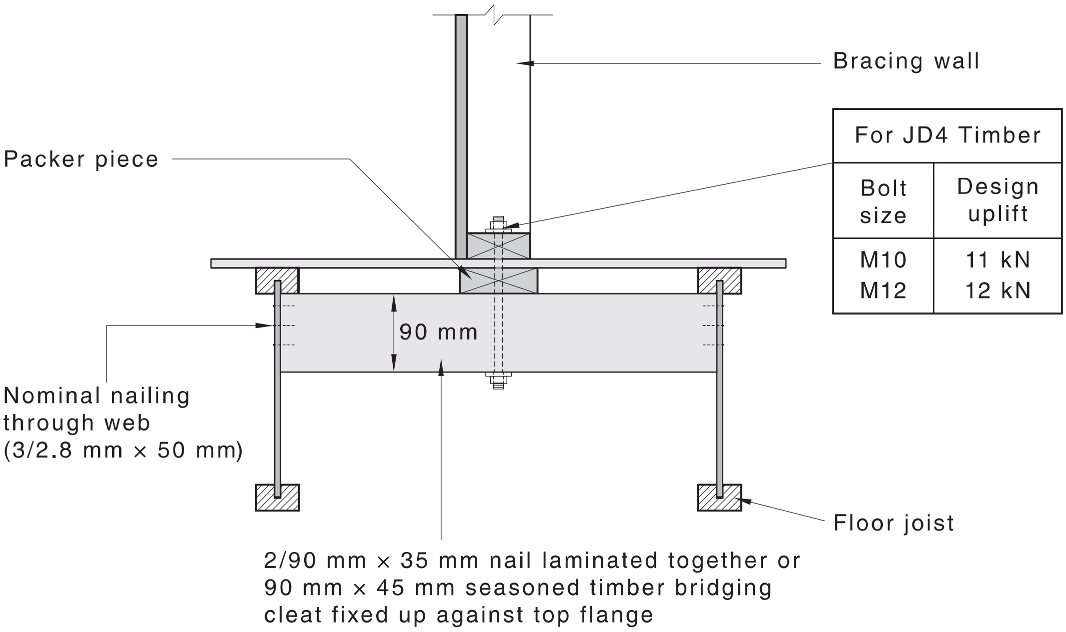
Figure J.20 — Equivalent z-clip detail to transfer bracing forces through internal walls

J.6 Fixings and tie-down design

In general, tie-down details for solid timber joists may be used with I-beams. These should be in accordance with the requirements given in Section 9. However, bolting through the depth of I-beams used as joists should not occur.

In some cases, it will be necessary to provide a tie-down that is not continuous between the roof and the foundations. An example of a suitable detail for transferring tie-down forces through an I-joist floor is shown in Figure J.21.

Dimension in millimetres



NOTE 1 Unless joist is fully supported along its length, the flange should not be drilled through.

NOTE 2 Joists should be tied down at the supports.

Figure J.21 — Detail for discontinuous tie-downs

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