AS 1684.3—2010

Residential timber-framed construction

(Incorporating Amendment No. 1)

Part 3: Cyclonic Areas

Australian STANDARD

AS

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- Australian Building Codes Board
- Australian Institute of Building
- Building Research Association of New Zealand
- CSIRO Manufacturing and Infrastructures Technology
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- Engineers Australia
- Forest Industries Federation (WA)
- Frame and Truss Manufacturers Association Australia
- Housing Industry Association
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- New Zealand Timber Industry Federation
- Scion
- South Australian Housing Trust
- Timber and Building Materials Association, NSW
- Timber Development Association, NSW
- Timber Queensland

Additional Interests:

- Mr Peter Juniper

This Standard was issued in draft form for comment as DR AS 1684.3.

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

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AS 1684.3—2010
(Incorporating Amendment No. 1)

Australian Standard®

Residential timber-framed construction

Part 3: Cyclonic areas

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PREFACE

This Standard was prepared by the Joint Standards Australian/Standards New Zealand Committee TM-002, Timber Framing, to supersede AS 1684.3—2006.

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

This Standard incorporates Amendment No. 1 (June 2012). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

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 construction in cyclonic areas.

The objectives of this revision are to—

(a) include editorial amendments and some technical changes to correct mistakes, clarify interpretation and enhance the application of the document;

(b) incorporate the outcomes of recent research projects that considered the role and function of wall noggings (Clause 6.2.1.5) and alternative simplified tie-down systems for higher wind areas in particular using ring beam construction methods;

(c) include information on generic building practices for EWPs (engineered wood products), which are being widely used in timber-framed construction (see Appendix J); and

(d) provide some adjustments to the Span Table values in Supplements for stress grades MGP 10, MGP 12 and MGP 15 in response to changes to the design characteristic values for these stress grades in AS 1720.1.

    NOTE:These adjustments have been made recognizing that MGP stress grades represent the major product usage in the marketplace. Further work is required to assess and more fully respond to existing and expected changes to the related loading, design, and design criteria Standards, and this may result in a future revision of Span Tables in the Supplements for all stress grades.

The increased scope and application of this Standard to cater for these conditions has also led to the need to perform a more rigorous design check on a wider range of members and construction practices including windowsill trimmers and roof bracing.

This Standard is a companion publication to the following:

AS
1684 Residential timber-framed construction
1684.1 Part 1: Design criteria
1684.2 Part 2: Non-cyclonic areas
1684.4 Part 4: Simplified—Non-cyclonic areas

It should also be noted that AS 1684.4 includes additional differences to AS 1684.2 and 1684.3.

The following Supplements form an integral part of, and must be used in conjunction with, this Standard:

Supplement	0	General introduction and index
C1 Supp.	1	Wind classification C1—Seasoned softwood—Stress grade F5
C1 Supp.	2	Wind classification C1—Seasoned softwood—Stress grade F7
C1 Supp.	3	Wind classification C1—Seasoned softwood—Stress grade F8
C1 Supp.	4	Wind classification C1—Seasoned softwood—Stress grade MGP 10
C1 Supp.	5	Wind classification C1—Seasoned softwood—Stress grade MGP 12
C1 Supp.	6	Wind classification C1—Seasoned softwood—Stress grade MGP 15
C1 Supp.	7	Wind classification C1—WA seasoned hardwood—Stress grade F14
C1 Supp.	8	Wind classification C1—Seasoned hardwood—Stress grade F17
C1 Supp.	9	Wind classification C1—Seasoned hardwood—Stress grade F27
C1 Supp.	10	Wind classification C1—Unseasoned softwood—Stress grade F5
C1 Supp.	11	Wind classification C1—Unseasoned softwood—Stress grade F7
C1 Supp.	12	Wind classification C1—Unseasoned hardwood—Stress grade F8
C1 Supp.	13	Wind classification C1—Unseasoned hardwood—Stress grade F11
C1 Supp.	14	Wind classification C1—Unseasoned hardwood—Stress grade F14
C1 Supp.	15	Wind classification C1—Unseasoned hardwood—Stress grade F17
C2 Supp.	1	Wind classification C2—Seasoned softwood—Stress grade F5
C2 Supp.	2	Wind classification C2—Seasoned softwood—Stress grade F7
C2 Supp.	3	Wind classification C2—Seasoned softwood—Stress grade F8
C2 Supp.	4	Wind classification C2—Seasoned softwood—Stress grade MGP 10
C2 Supp.	5	Wind classification C2—Seasoned softwood—Stress grade MGP 12
C2 Supp.	6	Wind classification C2—Seasoned softwood—Stress grade MGP 15
C2 Supp.	7	Wind classification C2—WA seasoned hardwood—Stress grade F14
C2 Supp.	8	Wind classification C2—Seasoned hardwood—Stress grade F17
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C2 Supp.	13	Wind classification C2—Unseasoned hardwood—Stress grade F11
C2 Supp.	14	Wind classification C2—Unseasoned hardwood—Stress grade F14
C2 Supp.	15	Wind classification C2—Unseasoned hardwood—Stress grade F17
C3 Supp.	1	Wind classification C3—Seasoned softwood—Stress grade F5
C3 Supp.	2	Wind classification C3—Seasoned softwood—Stress grade F7
C3 Supp.	3	Wind classification C3—Seasoned softwood—Stress grade F8
C3 Supp.	4	Wind classification C3—Seasoned softwood—Stress grade MGP 10
C3 Supp.	5	Wind classification C3—Seasoned softwood—Stress grade MGP 12
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C3 Supp.	13	Wind classification C3—Unseasoned hardwood—Stress grade F11
C3 Supp.	14	Wind classification C3—Unseasoned hardwood—Stress grade F14
C3 Supp.	15	Wind classification C3—Unseasoned hardwood—Stress grade F17

Span tables in Supplements for unseasoned hardwood F8 and F11 may be used for unseasoned F8 and F11 softwood as well.

A CD-ROM, which contains the above Supplements, is attached to this Standard.

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

Statements expressed in mandatory terms in Notes to tables and figures 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.

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

The terms 'normative' and 'informative' have been used in this Standard to define the application of the appendix 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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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 Building Code of Australia 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.

NOTES:

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

2 Whilst 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.

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

1.2 COMPANION DOCUMENTS

This Standard is a companion publication to the following:

AS
1684 Residential timber-framed construction
1684.1 Part 1: Design criteria
1684.2 Part 2: Non-cyclonic areas
1684.4 Part 4: Simplified—Non-cyclonic areas

1.3 NORMATIVE REFERENCES

The following are the normative documents referenced in this Standard:

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

AS
1170 Structural design actions
1170.4 Part 4: Earthquake actions in Australia

1214 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)

1397 Steel sheet and strip—Hot-dip zinc-coated or aluminium/zinc-coated

1684 Residential timber-framed construction
1684.1 Part 1: Design criteria

1691 Domestic oil-fired appliances—Installation

1720 Timber structures
1720.1 Part 1: Design methods
1720.2 Part 2: Timber properties

1810 Timber—Seasoned cypress pine—Milled products

1860 Particleboard flooring
1860.2 Part 2: Installation

2796 Timber—Hardwood—Sawn and milled products
2796.1 Part 1: Product specification

2870 Residential slabs and footings—Construction

3700 Masonry structures

4055 Wind loads for housing

4440 Installation of nailplated timber trusses

4785 Timber—Softwood—Sawn and milled products
4785.1 Part 1: Product specification

5604 Timber—Natural durability ratings

AS/NZS
1170 Structural design actions
1170.1 Part 1: Permanent, imposed and other actions
1170.2 Part 2: Wind actions

1604 Specification for preservative treatment (all Parts)

1859 Reconstituted wood-based panels—Specifications
1859.4 Part 4: Wet-processed fibreboard

1860 Particleboard flooring
1860.1 Part 1: Specifications

2269 Plywood—Structural
2269.0 Part 0: Specifications

2918 Domestic solid fuel burning appliances—Installation

4534 Zinc and zinc/aluminium-alloy coatings on steel wire

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

ABCB
BCA Building Code of Australia

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 1.1.

1.4.2 Wind classification

For wind loads, the simplified wind classifications for cyclonic areas C1 to C3, 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.

NOTES:

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.

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

TABLE 1.1

MAXIMUM DESIGN GUST WIND SPEED

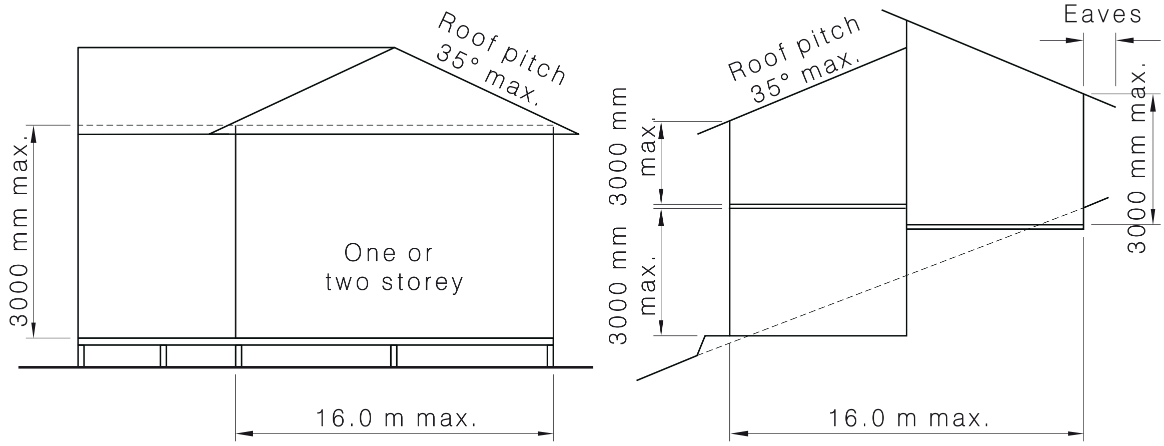
Wind classification regions A and B	Maximum design gust wind speed, m/s		
	Permissible stress method (V_p)	Serviceability limit state (V_s)	Ultimate limit state (V_u)
C1	41 (W41C)	32	50
C2	50 (W50C)	39	61
C3	60 (W60C)	47	74

1.4.3 Plan

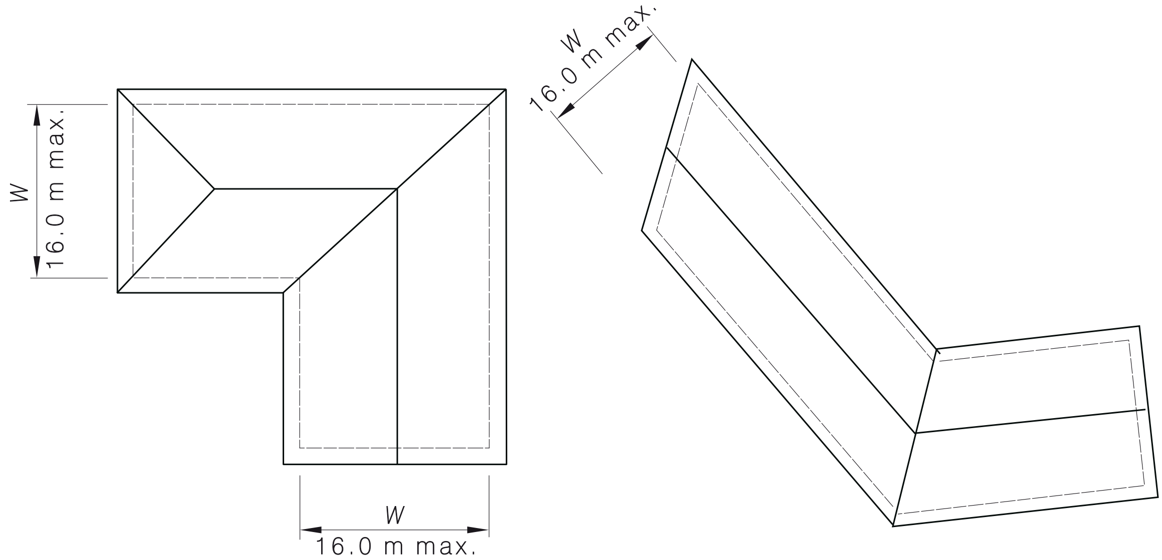
Building shapes shall be essentially rectangular, square, L-shaped or a combination of rectangular elements including splayed-end and boomerang-shaped buildings.

1.4.4 Number of storeys of timber framing

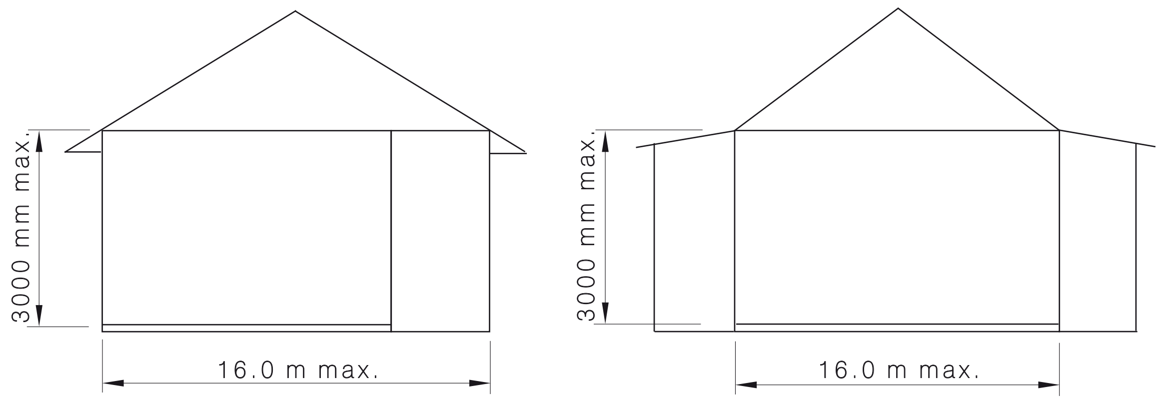
The maximum number of storeys of timber framing shall not exceed two (see Section 2).



(a) Sections



(b) Plan



(c) Verandahs

NOTES:

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

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

FIGURE 1.1 GEOMETRIC BUILDING PARAMETERS

1.4.5 Width

The maximum width of a building shall be 16 000 mm, excluding eaves (see Figure 1.1).

1.4.6 Wall height

The maximum wall height shall be 3000 mm [floor to ceiling, as measured at common external walls, that is, not gable or skillion ends (see Figure 1.1)].

NOTES:

1 The Span Tables for studs given in the Supplements provide for stud heights in excess of 3000 mm to cater for gable, skillion and some other design situations where wall heights, other than those of common external walls, may exceed 3000 mm.

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

3 The provisions contained in this Standard may also be applicable to houses with external wall heights up to 3600 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.

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 9000 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 certified 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 recommended in AS/NZS 1170.1, AS/NZS 1170.2 and AS 4055 were taken into account in the member computations, with appropriate allowances for the distribution of concentrated or localized loads over a number of members where relevant (see also Clause 1.4.2).

NOTE: 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.

NOTES:

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

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

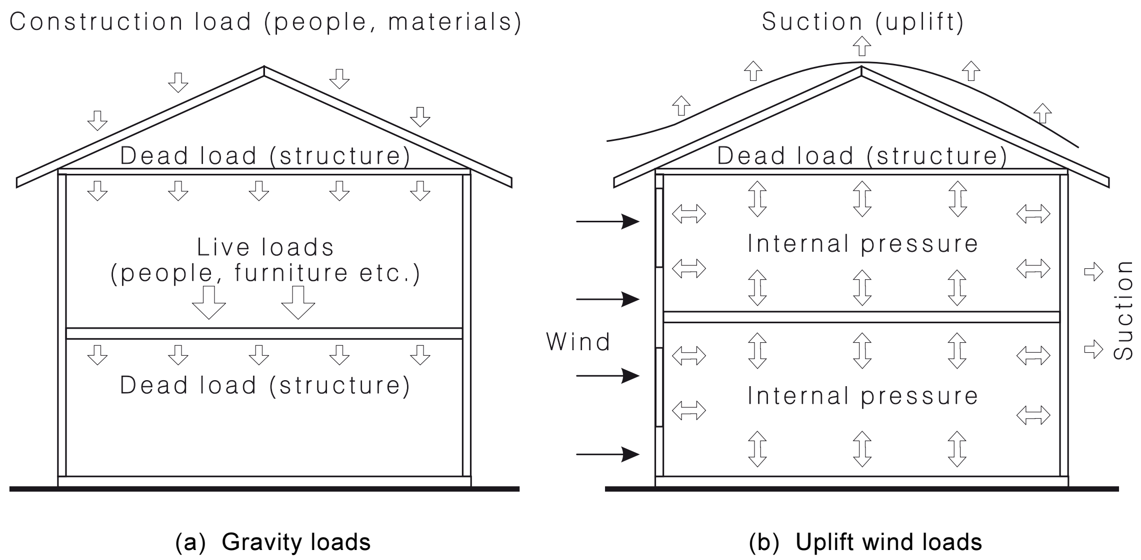
(e) The effects of snow loads up to 0.2 kPa on member sizes, bracing and connection details have been accommodated in the design.

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 Span Tables in the Supplements, the appropriate wind classification (e.g., C2), 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.

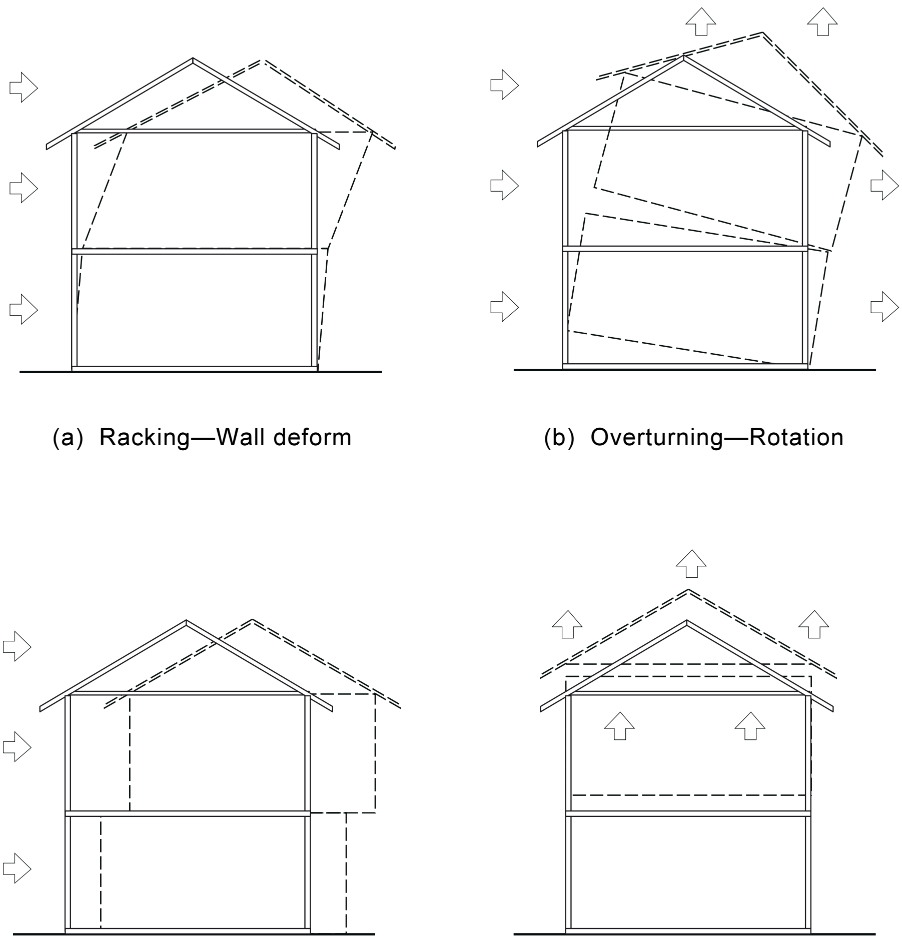
Assumptions used for forces, load combinations and serviceability requirements of framing members are given in AS 1684.1. Forces applied to timber-framed buildings, which shall be considered in the design of framing members, are indicated in Figure 1.2.



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

FIGURE 1.2 LOADS ON BUILDINGS

Forces on buildings produce different effects on a structure. Each effect shall be considered individually and be resisted. Figure 1.3 summarizes some of these actions. This Standard takes account of these.



(a) Racking—Wall deform

(b) Overturning—Rotation

(c) Sliding—Tendency to slide

(d) Uplift—Connection failure

FIGURE 1.3 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.

NOTES:

1 This load path in many cases cannot be maintained in a completely vertical path, relying on structural members that transfer loads horizontally. Offset or cantilevered floor framing supporting loadbearing walls may also be used (see Figures 1.4 and 1.5).

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).

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.

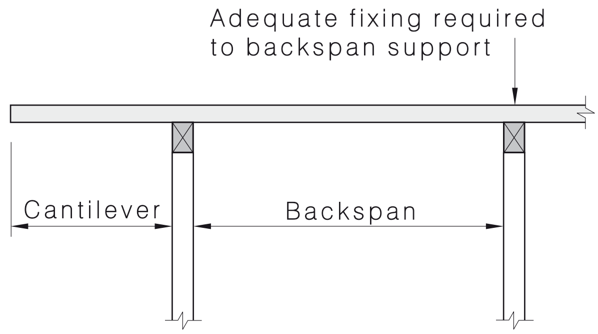


FIGURE 1.4 CANTILEVER

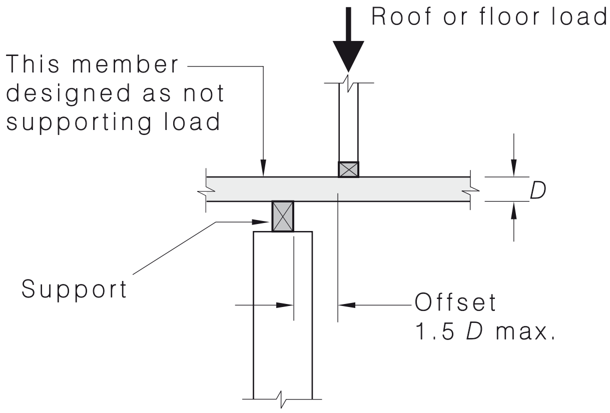


FIGURE 1.5 OFFSET

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 (see 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 1.6); e.g., 90 × 35 mm (studs, joists etc.), 45 × 70 (wall plates, battens, etc.).

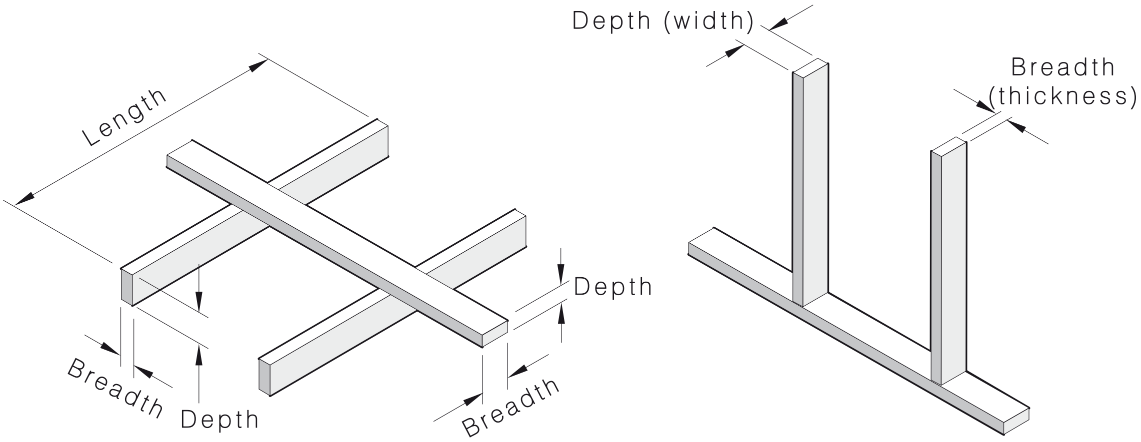


FIGURE 1.6 DIMENSIONS

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.

NOTE: The timber stress grade is usually designated alphanumerically (e.g., F17, MGP12). Stress grades covered by 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*, F11*
Spruce pine fir (SPF) (seasoned)	F5	F8
Hemfir (seasoned)	F5	F8

* Span tables in Supplements for unseasoned hardwood F8 and F11 may be used for unseasoned F8 and F11 softwood as well.

NOTES:

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.

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 complies with the relevant Australian Standards.

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

NOTES:

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

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 the approval of the regulatory authority and the recommendations of the specific manufacturer, who may require provisions additional 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 given in the Supplements, the following maximum undersize tolerances on timber sizes shall be permitted:

(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 dimension, mm	Nominal unseasoned timber dimensions	Min. seasoned W.A. hardwood dimensions
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.

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

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

1.16 CONSIDERATIONS 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 1.7 provides guidance.

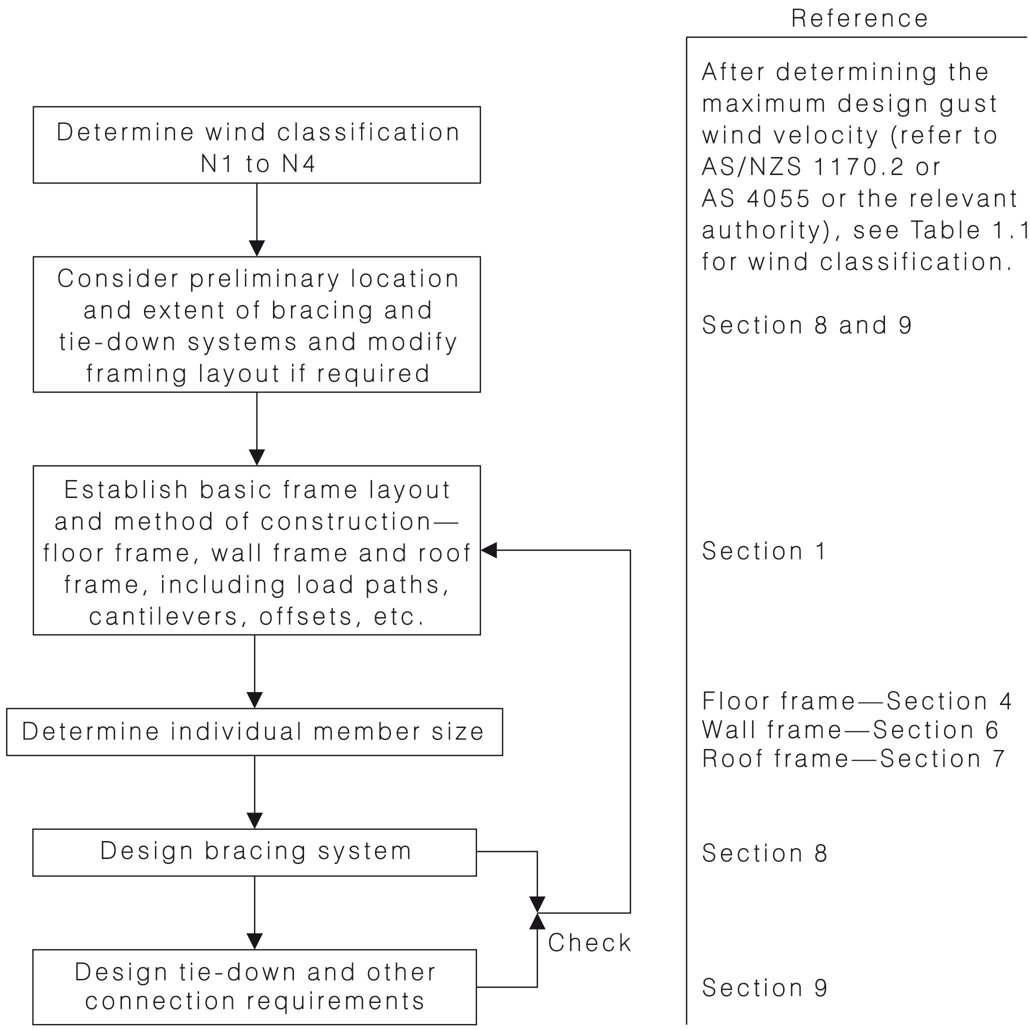


FIGURE 1.7 FLOW CHART FOR DESIGN USING THIS STANDARD

1.17 INTERPOLATION

Interpolation shall be made in accordance with Appendix C.

SECTION 2 TERMINOLOGY AND DEFINITIONS

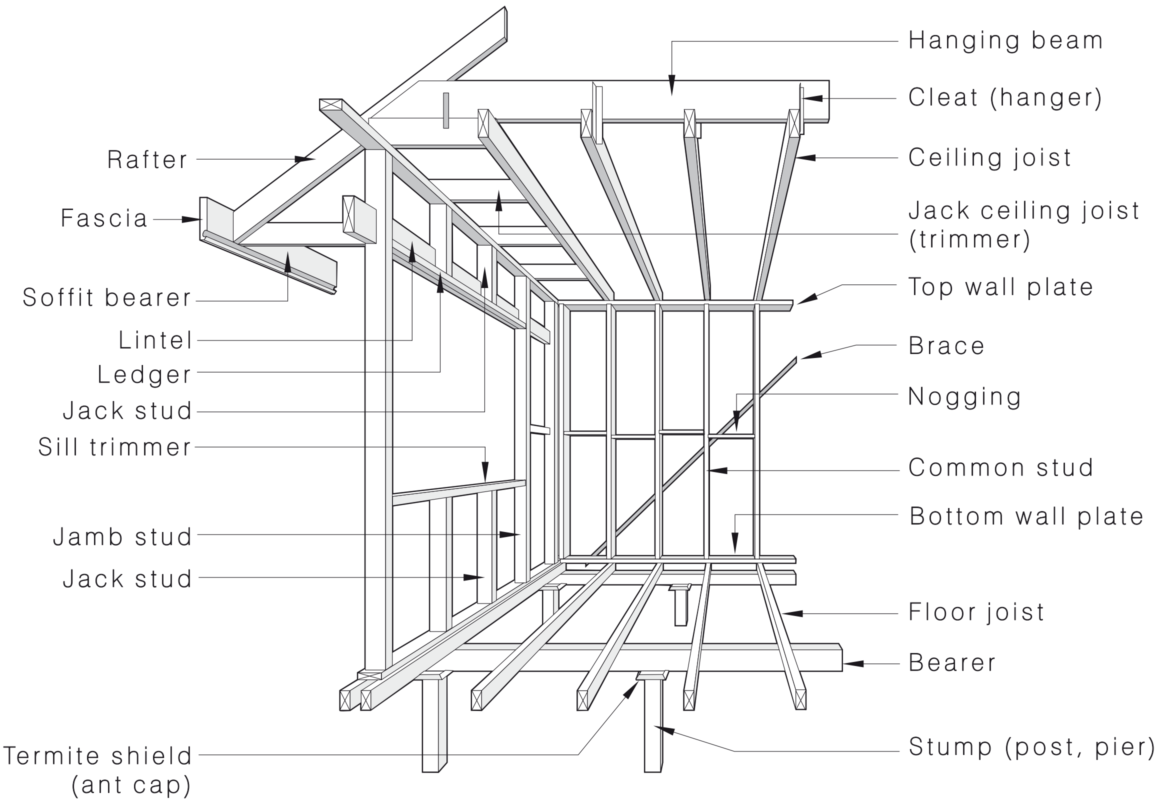
2.1 GENERAL

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

2.2 TERMINOLOGY OF FRAMING MEMBERS

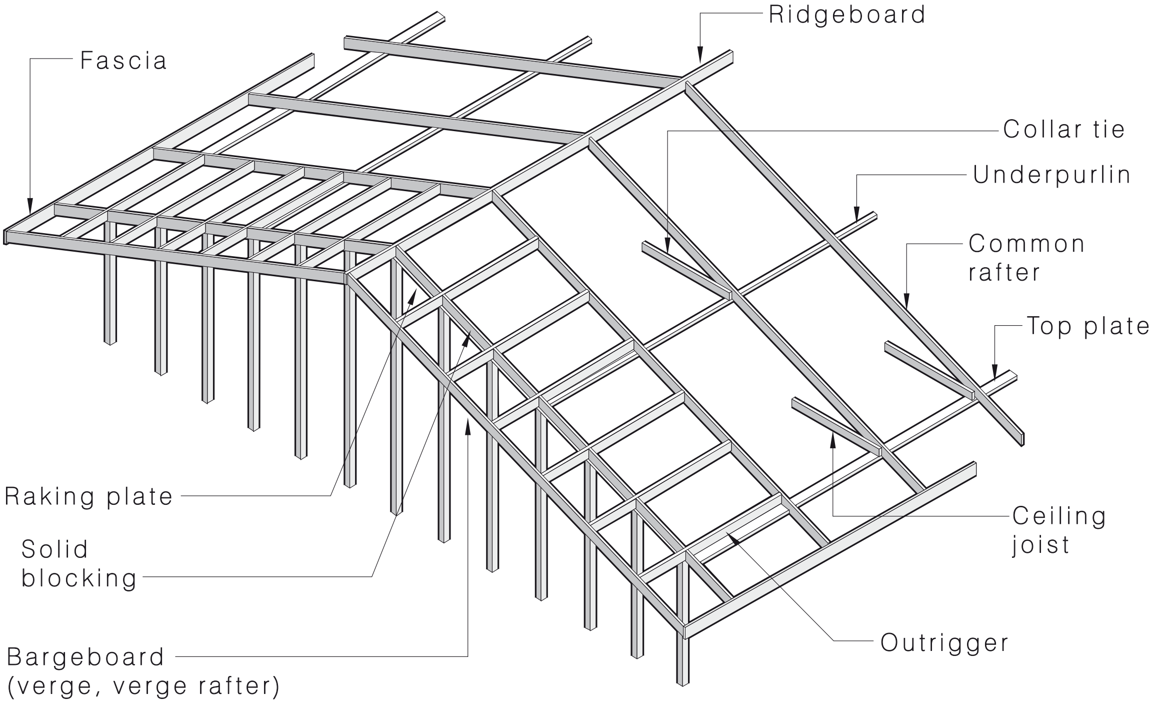
Figure 2.1 details traditional floor, wall and ceiling framing members in general. An alternative wall frame detail is given in Figure 6.1(b).

Figures 2.2 to 2.7 apply to roof framing.



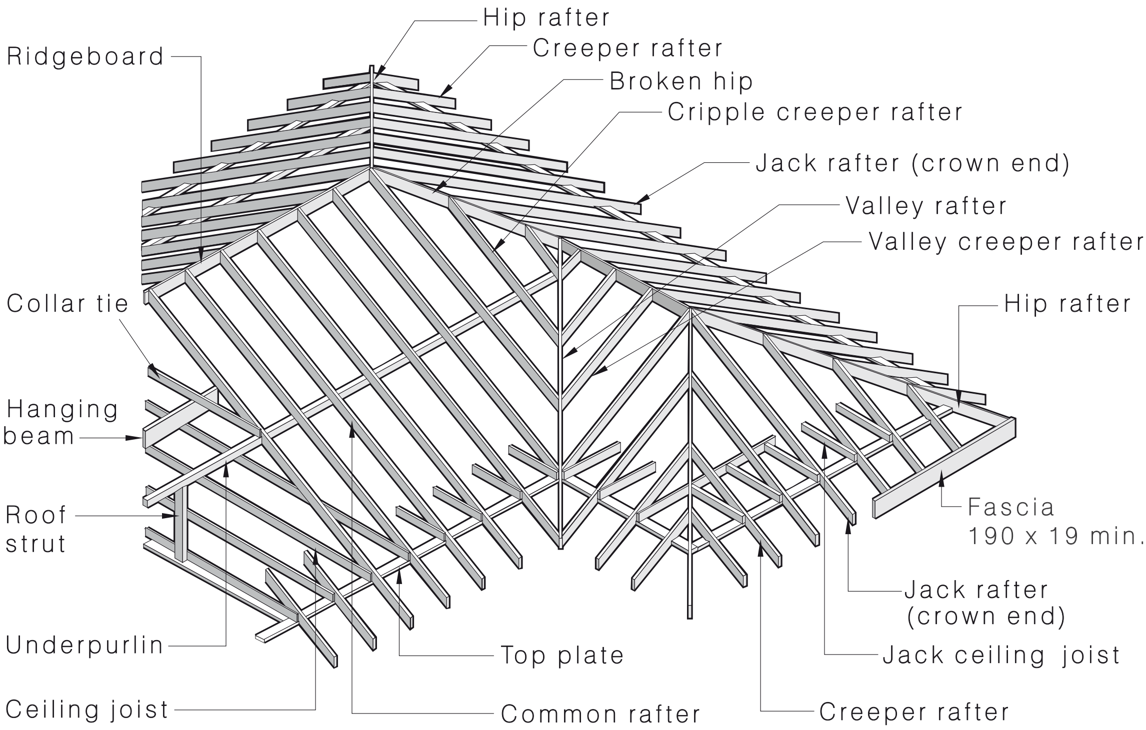
NOTE: The ceiling and floor joists are shown parallel to the external loadbearing wall for clarity. In practice, the more usual case is for the joists to be located perpendicular to the external wall. Lintel location may also vary (see Figure 6.8).

FIGURE 2.1 FRAMING MEMBERS—FLOOR, WALL AND CEILING



NOTE: Some members have been omitted for clarity.

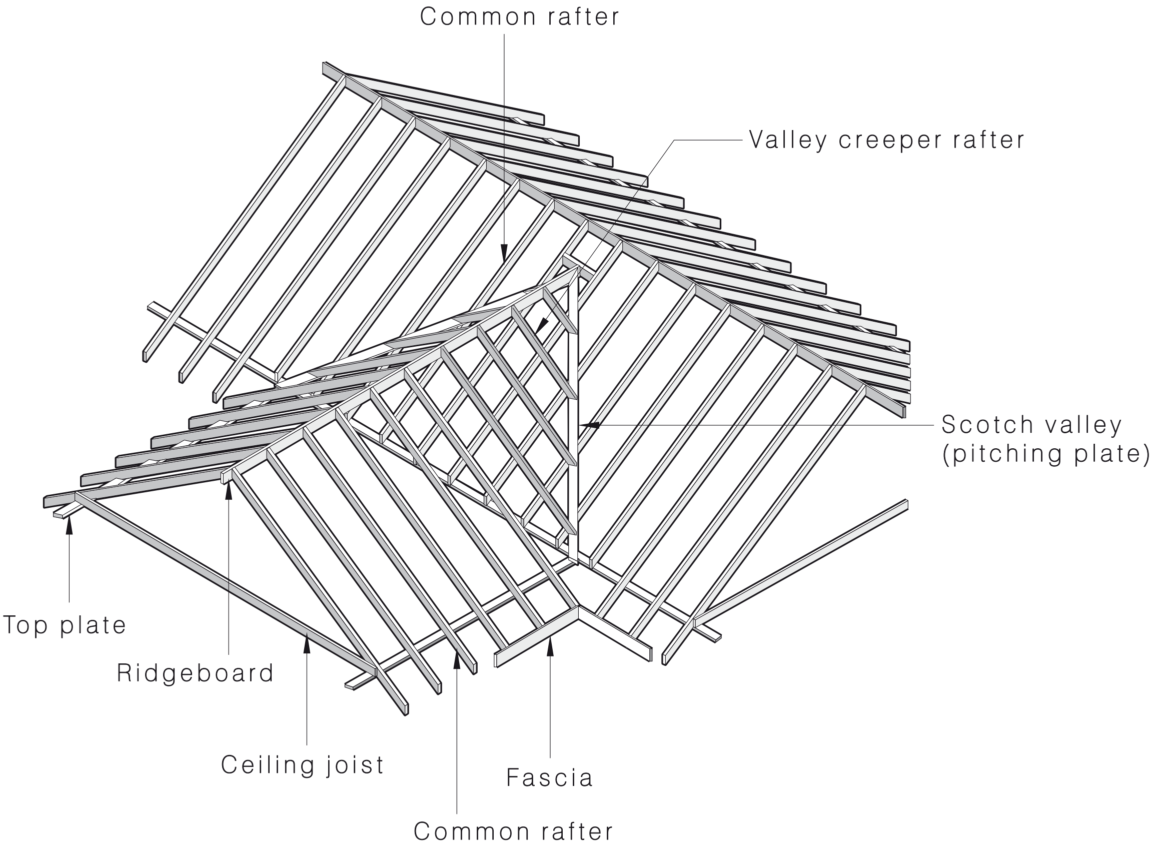
FIGURE 2.2 FRAMING MEMBERS—GABLE ROOF CONSTRUCTION



NOTE: Some members have been omitted for clarity.

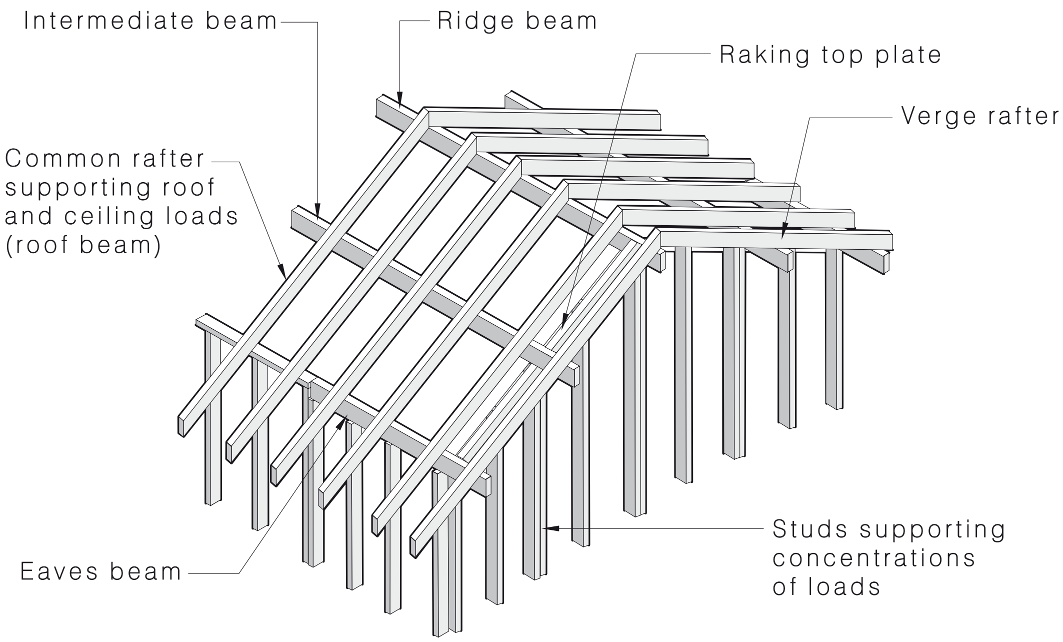
DIMENSIONS IN MILLIMETRES

FIGURE 2.3 FRAMING MEMBERS—HIP AND VALLEY ROOF CONSTRUCTION



NOTE: Some members have been omitted for clarity.

FIGURE 2.4 FRAMING MEMBERS—SCOTCH VALLEY CONSTRUCTION



NOTE: Some members have been omitted for clarity.

FIGURE 2.5 FRAMING MEMBERS—CATHEDRAL ROOF CONSTRUCTION

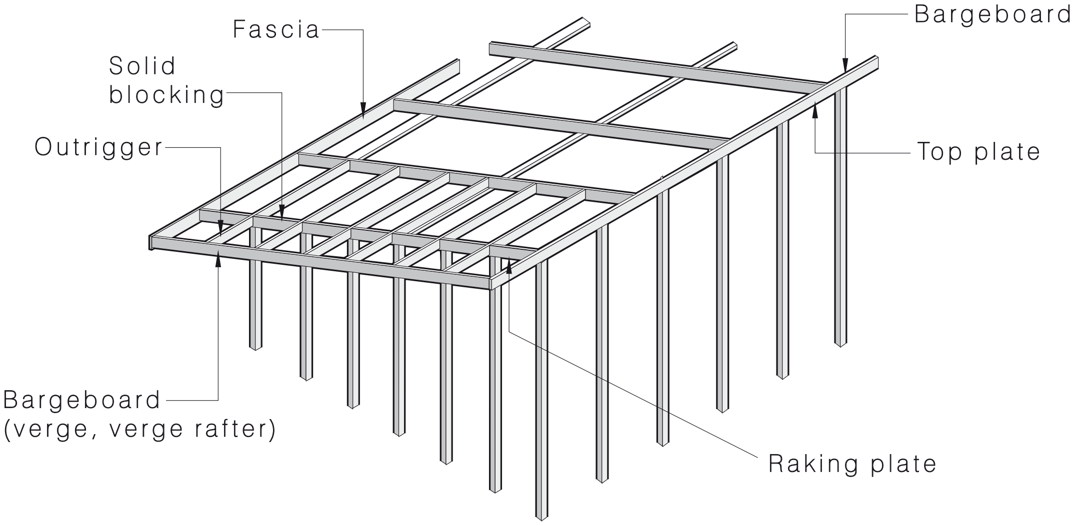
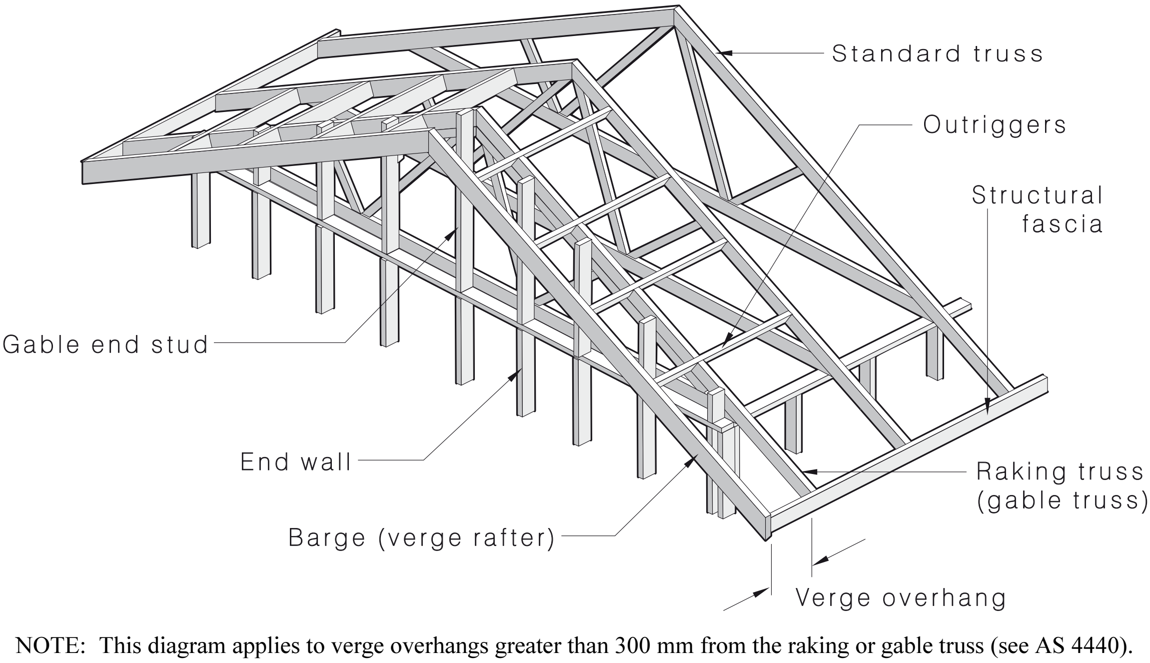


FIGURE 2.6 SKILLION ROOF



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

FIGURE 2.7 GABLE END—TRUSSED ROOF

2.3 VERTICAL LAMINATION

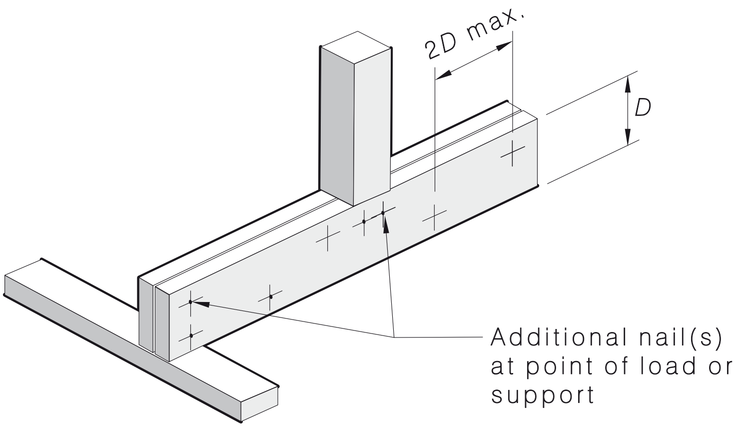
2.3.1 Vertical nail lamination

Vertical nail lamination shall be permitted 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. This is only permissible using seasoned timber laminations of the same timber type and stress grade. Laminations shall be unjoined in their length. Nails shall be a minimum of 2.8 mm in diameter and shall be staggered as shown in Figure 2.8. They shall be through-nailed and clinched, or nailed from both sides.

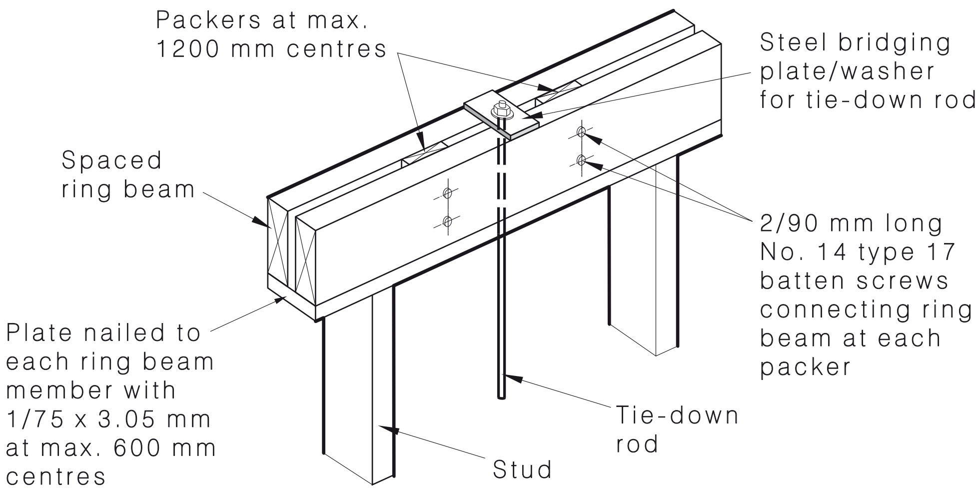
Where screws are used in lieu of nails, they shall be minimum No. 10 screws. They may be at the same spacing and pattern, provided they penetrate a minimum of 75% into the thickness of the final receiving member.

2.3.2 Lamination of spaced ring beams

Ring beams that 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

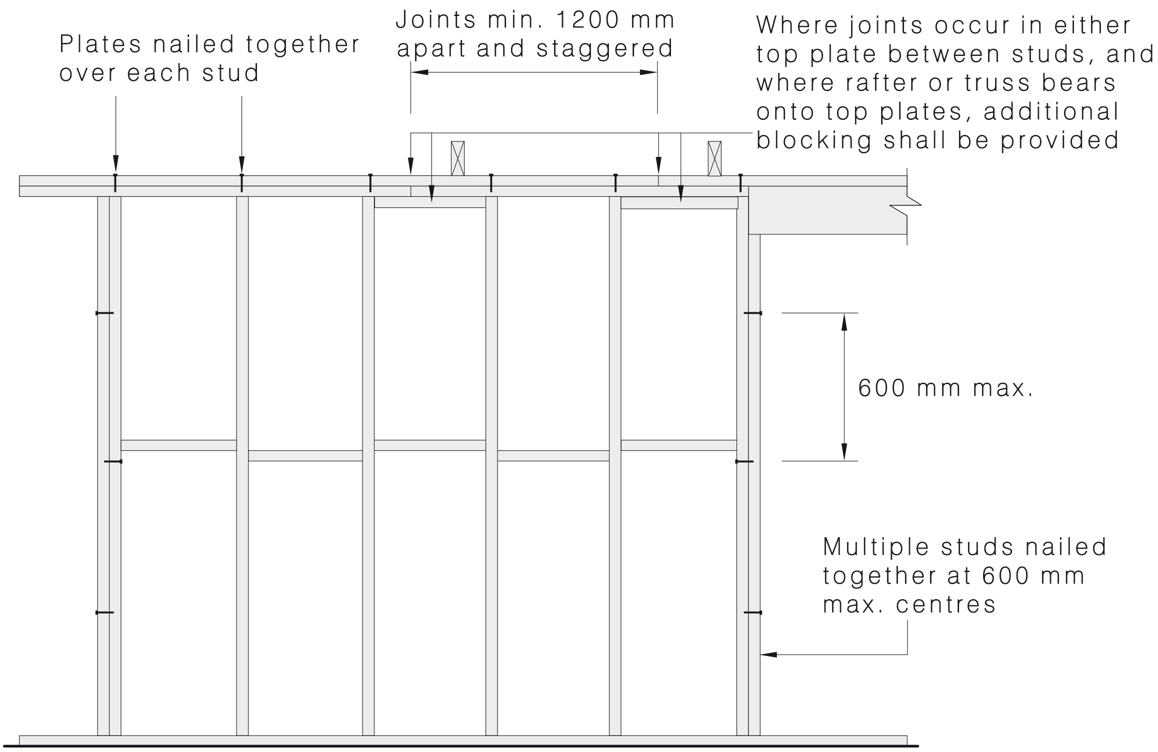
FIGURE 2.8 VERTICAL LAMINATION

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: Refer to 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 × 70) shall be horizontally nail-laminated in accordance with Figure 2.9, using—

(a) two 75 mm long nails for plates up to 38 mm deep; or

(b) two 90 mm long nails for plates up to 50 mm deep (see also Clause 9.2.8).

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

All 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. Refer to Section 9 for 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 Span Tables in the Supplements for all bearers and lower storey wall-framing members. The *FLW* input is illustrated in Figures 2.10 and 2.11.

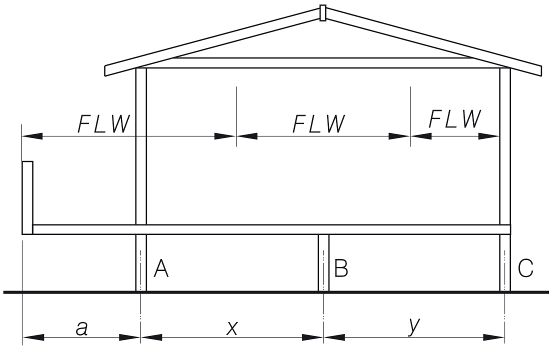
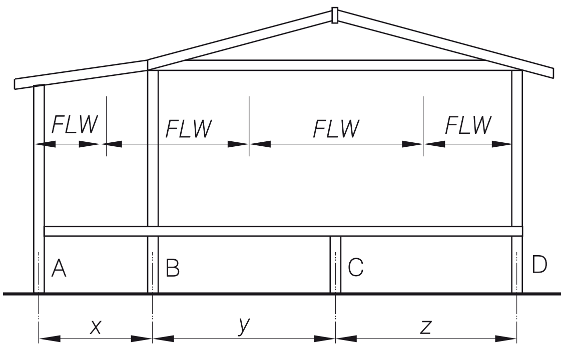
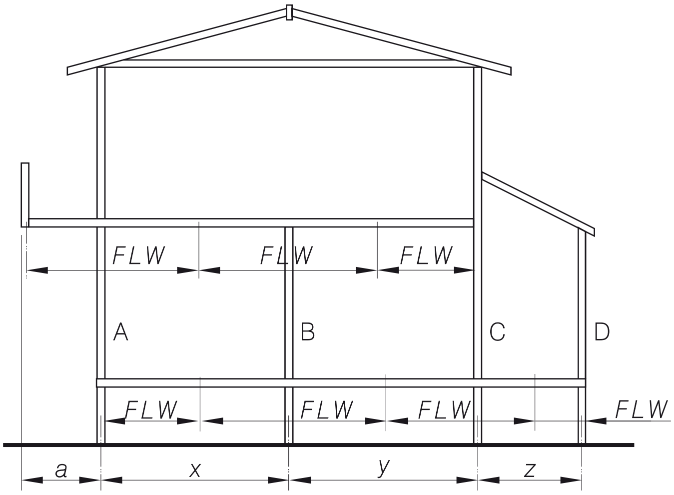
<table>
<tr><th colspan="2">Type of construction</th><th>Location</th><th>Floor load width (FLW)</th></tr>
<tr><td rowspan="3">(a) Cantilevered balcony</td><td rowspan="3">
</td><td>Bearer A</td><td>$FLW = \frac{x}{2} + a$</td></tr>
<tr><td>Bearer B</td><td>$FLW = \frac{x+y}{2}$</td></tr>
<tr><td>Bearer C</td><td>$FLW = \frac{y}{2}$</td></tr>
<tr><td rowspan="4">(b) Supported balcony</td><td rowspan="4">
</td><td>Bearer A</td><td>$FLW = \frac{x}{2}$</td></tr>
<tr><td>Bearer B</td><td>$FLW = \frac{x+y}{2}$</td></tr>
<tr><td>Bearer C</td><td>$FLW = \frac{y+z}{2}$</td></tr>
<tr><td>Bearer D</td><td>$FLW = \frac{z}{2}$</td></tr>
</table>

FIGURE 2.10 FLOOR LOAD WIDTH (*FLW*)—SINGLE- OR UPPER-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*
(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* Lower *FLW* = $\frac{z}{2}$

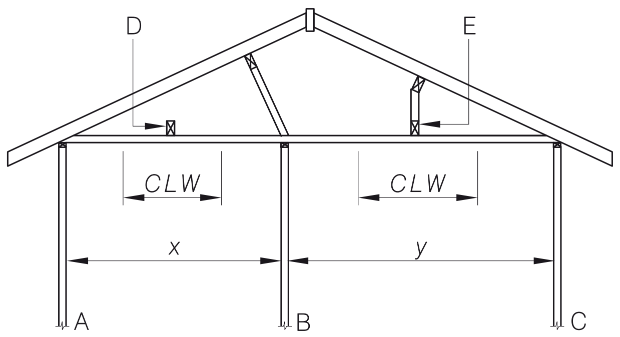
* See single or upper-storey construction.

FIGURE 2.11 FLOOR LOAD WIDTH (*FLW*)—TWO-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 Figure 2.12.



Location	Ceiling load width (*CLW*)
Walls A, B & C	N/A*
Beam D (Hanging beam)	$CLW = \frac{x}{2}$
Beam E (Strutting/hanging beam)	$CLW = \frac{y}{2}$

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

FIGURE 2.12 CEILING LOAD WIDTH (*CLW*)

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. Figures 2.13 to 2.16 define *RLW* in relation to various types of roof construction.

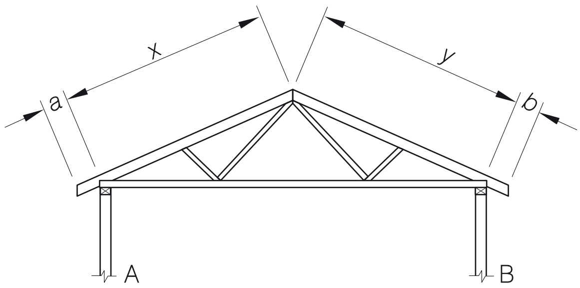
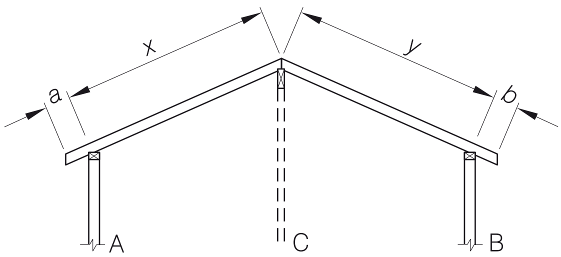
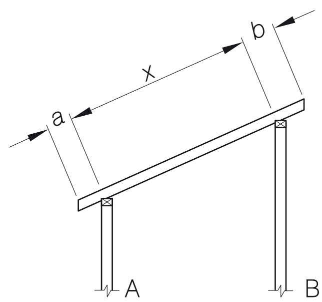
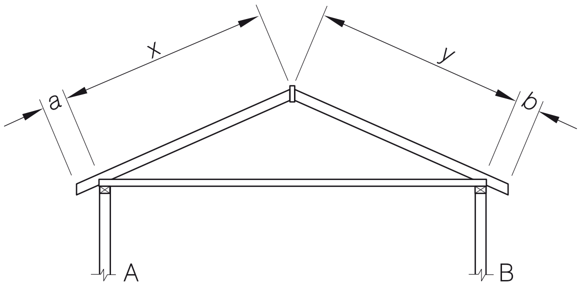
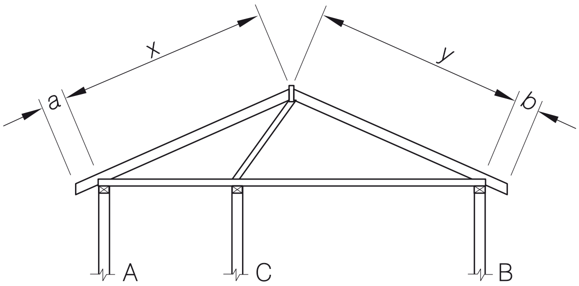
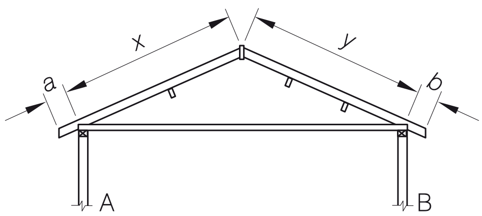
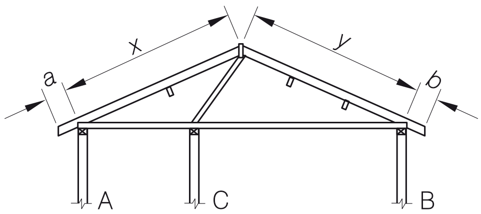
Type of construction		Wall	Roof load width (*RLW*) for member sizing
(a) Truss		A	$RLW = \frac{x+y}{2} + a$
		B	$RLW = \frac{x+y}{2} + b$
(b) Cathedral		A	$RLW = \frac{x}{2} + a$
		B	$RLW = \frac{y}{2} + b$
		C	$RLW = \frac{x+y}{2}$
(c) Skillion		A	$RLW = \frac{x}{2} + a$
		B	$RLW = \frac{x}{2} + b$

FIGURE 2.13 ROOF LOAD WIDTH (*RLW*)—NON-COUPLED ROOFS

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

NOTE: *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 this case, the supported roof area shall be determined for the studs supporting concentrated loads.

FIGURE 2.14 ROOF LOAD WIDTH (*RLW*)—COUPLED ROOFS WITH NO UNDERPURLINS

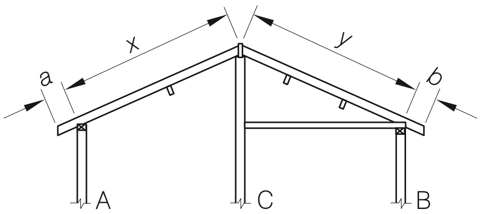
Type of construction	Wall	Roof load width (*RLW*) for member sizing
 (a) No ridge struts	A	$RLW = \frac{x}{2} + a$
	B	$RLW = \frac{y}{3} + b$
 (b) Ridge struts	A	$RLW = \frac{x}{4} + a$
	B	$RLW = \frac{y}{6} + b$
	C	N/A (see Note 1)

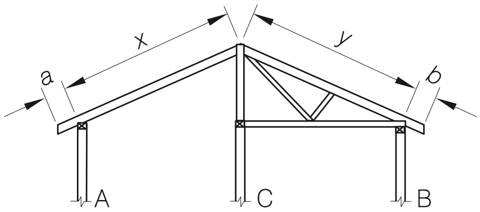
NOTES:

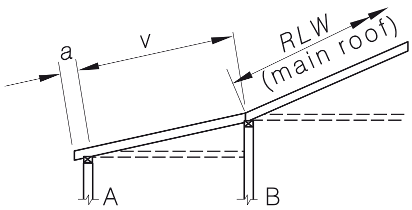
1 *RLW* may not be applicable where strut loads are supported by studs supporting concentrations of load and the remainder of wall C is deemed non-loadbearing. In this case, the supported roof area shall be determined for the studs supporting concentrated loads.

2 Collar ties have been omitted for clarity.

FIGURE 2.15 ROOF LOAD WIDTH (*RLW*)—COUPLED ROOFS WITH UNDERPURLINS

<table>
<tr><th>Type of construction</th><th>Wall</th><th>Roof load width (RLW) for member sizing</th></tr>
<tr><td rowspan="3">

(a) Cathedral—Framed</td><td>A</td><td>$RLW = \frac{x}{4} + a$</td></tr>
<tr><td>B</td><td>$RLW = \frac{y}{6} + b$</td></tr>
<tr><td>C</td><td>$RLW = \frac{x}{4} + \frac{y}{6}$</td></tr>
<tr><td rowspan="3">

(b) Cathedral—Truss</td><td>A</td><td>$RLW = \frac{x}{2} + a$</td></tr>
<tr><td>B</td><td>$RLW = \frac{y}{2} + b$</td></tr>
<tr><td>C</td><td>$RLW = \frac{x + y}{2}$</td></tr>
<tr><td rowspan="2">

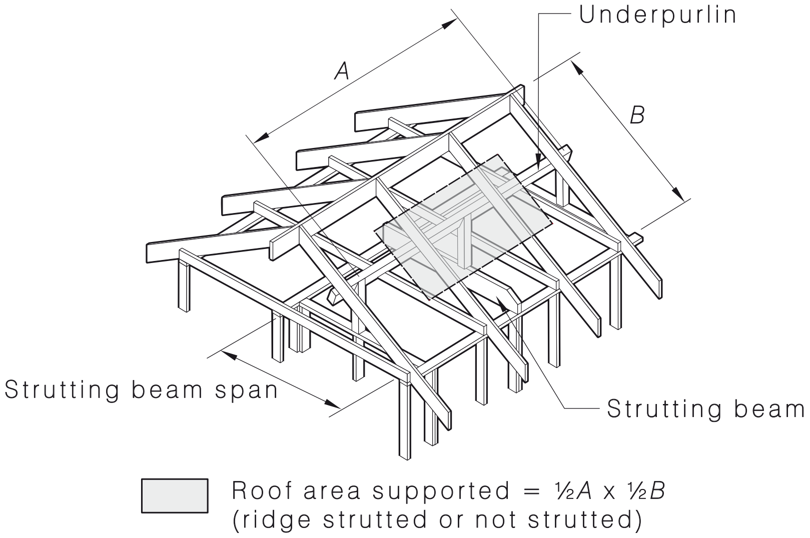
(c) Verandah</td><td>A</td><td>$RLW = \frac{v}{2} + a$</td></tr>
<tr><td>B</td><td>$RLW = RLW$ for main roof $+ \frac{v}{2}$</td></tr>
</table>

NOTE: Collar ties have been omitted for clarity.

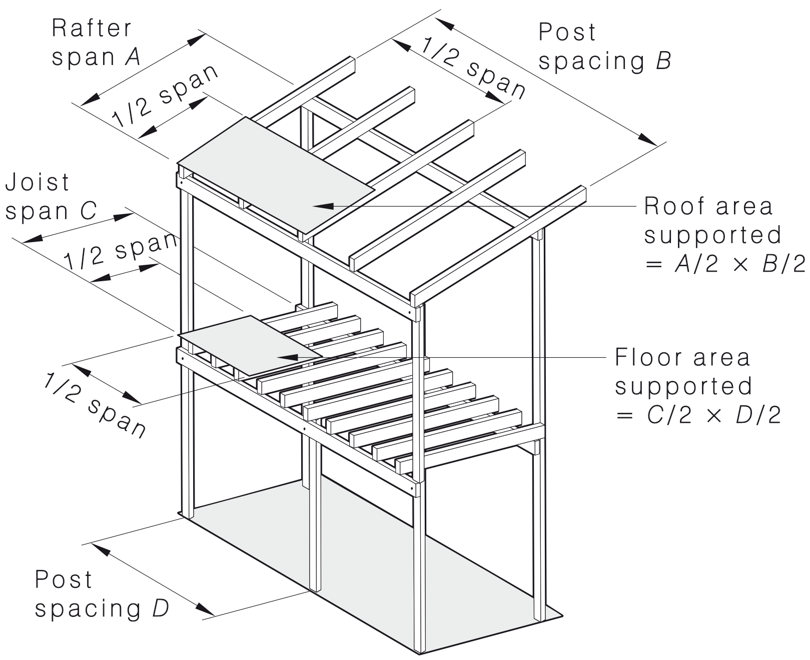
FIGURE 2.16 ROOF LOAD WIDTH (*RLW*) COMBINATIONS AND ADDITIONS

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 Span Tables in the Supplements for studs supporting concentrated loads and posts. Typical 'area supported' inputs for roofs and floors are illustrated in Figure 2.17.



(a) Typical roof area supported by strutting beam



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 = $C/2 \times D$.

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

FIGURE 2.17 AREA SUPPORTED

2.7 DEFINITIONS—GENERAL

2.7.1 Loadbearing wall

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

2.7.2 Non-loadbearing walls

2.7.2.1 *Non-loadbearing wall, external*

A non-loadbearing external wall supports neither roof nor floor loads but may support ceiling loads and act as a bracing wall. A non-loadbearing external wall may support lateral wind loads (e.g., gable or skillion end wall).

2.7.2.2 *Non-loadbearing wall, internal*

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

2.7.3 Regulatory authority

The authority that is authorized by legal statute as having justification to approve the design and construction of a building, or any part of the building design and construction process.

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

2.7.4 Roof

2.7.4.1 *Coupled roof*

Pitched roof construction with a roof slope not less than 10°, with ceiling joists and collar ties fixed to opposing common rafter pairs and a ridgeboard at the apex of the roof (see Figure 7.1). A coupled roof system may include some area where it is not possible to fix ceiling joists or collar ties to all rafters; for example, hip ends or parts of a T- or L-shaped house.

2.7.4.2 *Non-coupled roof*

A pitched roof that is not a coupled roof and includes cathedral roofs and roofs constructed using ridge and intermediate beams.

2.7.4.3 *Pitched roof*

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

2.7.4.4 *Trussed roof*

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

2.7.5 Span and spacing

2.7.5.1 *General*

NOTE: Figure 2.18 illustrates the terms for spacing, span, and single and continuous span.

2.7.5.2 *Spacing*

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

2.7.5.3 *Span*

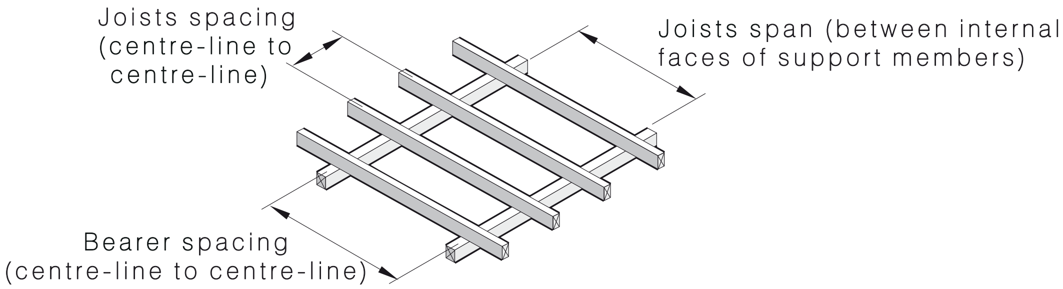
The face-to-face distance between points capable of giving full support to structural members or assemblies. In particular, rafter spans are measured as the distance between points of support along the length of the rafter and not as the horizontal projection of this distance.

2.7.5.4 *Single span*

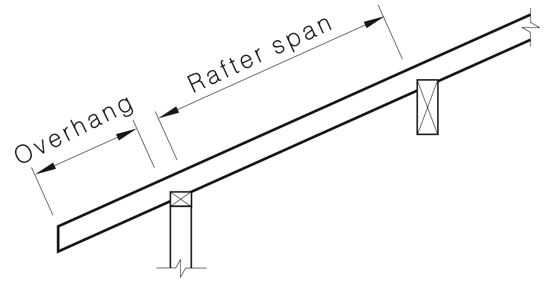
The span of a member supported at or near both ends with no immediate supports. This includes the case where members are partially cut through over intermediate supports to remove spring (see Figures 2.18(c) and 2.18(d)).

2.7.5.5 *Continuous span*

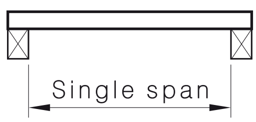
The term applied to members supported at or near both ends and at one or more intermediate points such that no span is greater than twice another (see Figure 2.18(e)).



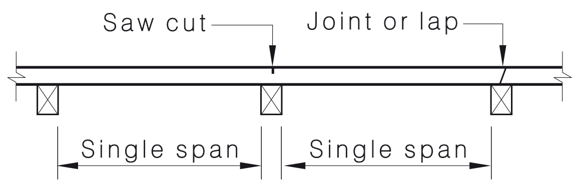
(a) Bearers and joists



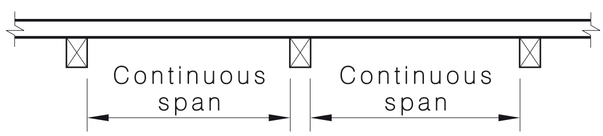
(b) Rafter



(c) Two supports



(d) Joint or sawcut over supports



(e) Continuous span

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 2.18 SPACING AND SPAN

2.7.6 Stress grade

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

2.7.7 Stud height

The 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.

2.7.8 Two-storey

In any section through the house, construction that includes not more than two levels of timber-framed trafficable floor. Trafficable floors in attics and lofts are included in the number of storeys.

In the subfloor of a two-storey construction, the maximum distance from the ground to the underside of the lower floor bearer is 1800 mm.

NOTE: This requirement 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 the regulatory authority.

2.7.9 Rim board

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

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 derived from 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 in accordance with the provisions of the Building Code of Australia.

3.4 DURABILITY

3.4.1 Termite management

Protection against termites shall be provided in accordance with the provisions of the Building Code of Australia.

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.

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 water beds, 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: Table 3.1 provides guidance for the weight of typical floor systems. The weight of quarry or slate tiles and bedding compound are not covered by this Table.

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

(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: 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.

NOTES:

1 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.

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

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:

$$A = P/100$$

NOTES:

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

2 For alternative allowable bearing capacity, a worked example is given in Paragraph D1, Appendix D.

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

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, and 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; that is, not exposed to weather, well ventilated, 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).

NOTES:

1 For information on durability, see Appendix B.

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 E1 in Appendix E).

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.

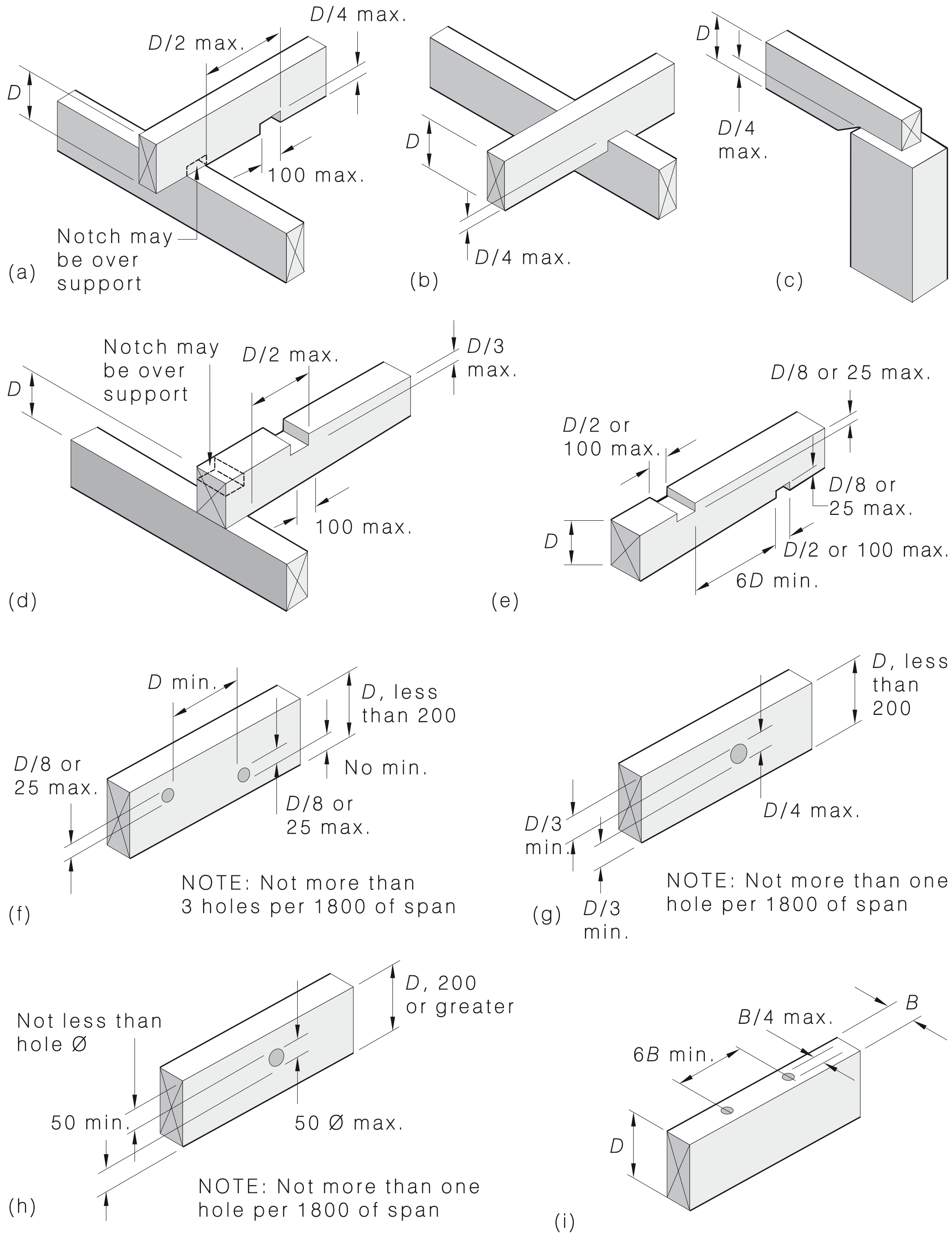
Unless otherwise specified, the member size shall not be reduced by any other method to a net section size less than that required to achieve the span requirements.

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

NOTES:

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

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 Clause 2.7.5).

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.

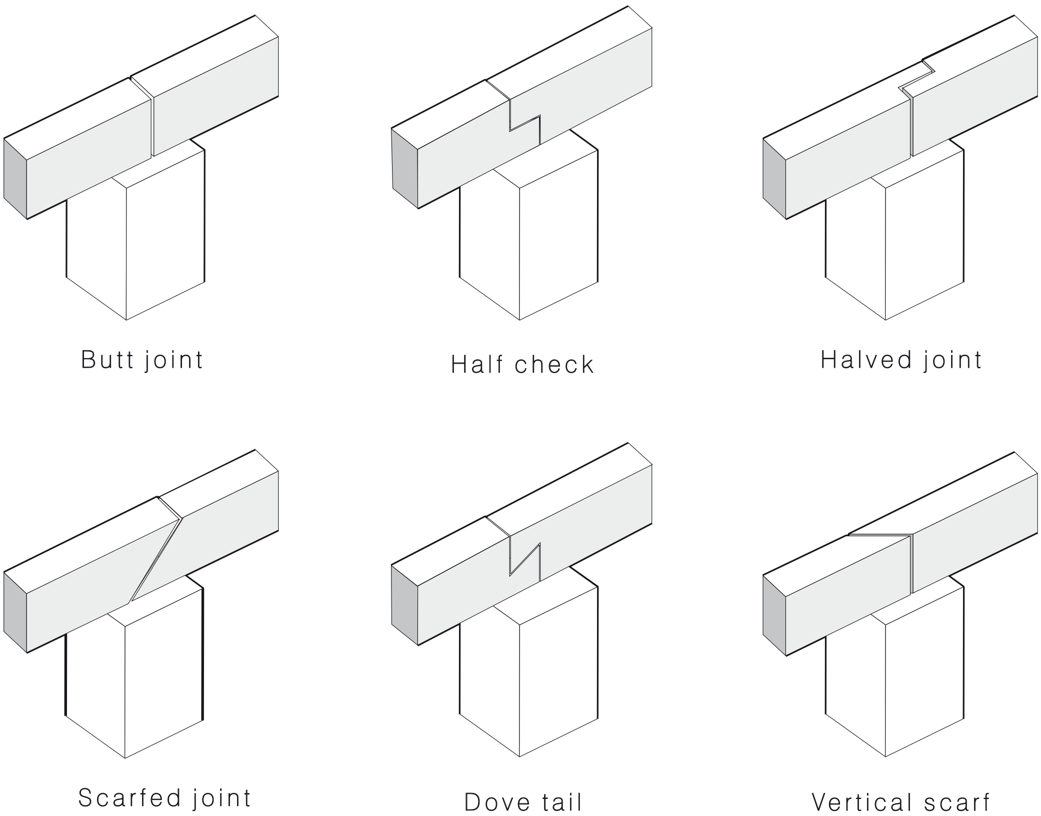
Joints in bearers shall occur only over supports, with adequate bearing for both members. Figure 4.2 shows various connection methods that may be used over supports. All cuts shall be located over a support. The minimum bearing each side of a joint shall be 50 mm.

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.

NOTES:

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

2 Some engineered nailplated 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 BEARER SUPPORTS (ALTERNATIVES)

4.2.1.2 *Fixing of bearers to supports*

Bearers shall be fixed to their supporting stumps, posts or columns in such a manner as will give adequate bearing and provide restraint against lateral movement (see 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

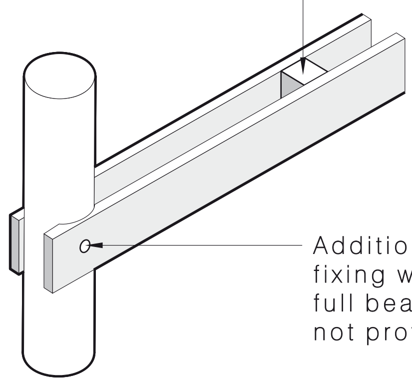


FIGURE 4.3 DOUBLE BEARER

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 minimum 30 mm bearing for each joist. Joints in joists that are required to be in line (for example, supporting wall plates or fitted flooring) shall be butted or scarfed, but shall not be lapped.

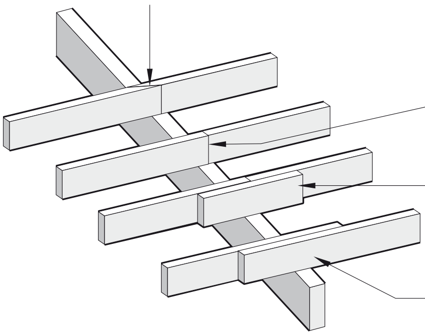


FIGURE 4.4 TYPICAL METHODS OF JOINING JOISTS

4.2.2.2 *Location of joists*

The following shall apply:

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

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

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

4.2.2.3 *Deep joists*

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

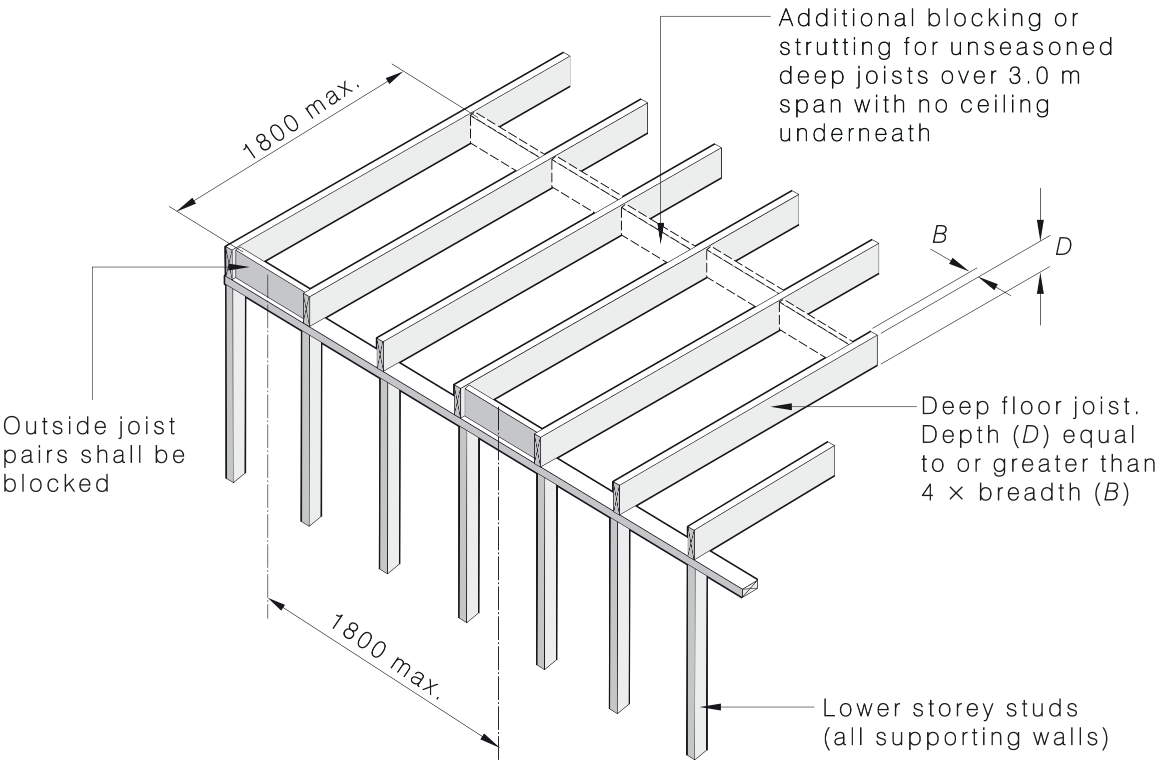
(a) a continuous trimming joist provided to the ends of joists above external bearers or wall plates; or

(b) solid blocking or herringbone strutting between the outer pairs of joists and between intermediate pairs at not more than 1.8 m centres.

Trimmers or solid blocking may be 25 mm less in depth than the joists, 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 1800 mm centres.

Where rim boards (see Clause 2.7.9) 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.



NOTES:

1 For engineered timber products, see Clause 1.12.

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 1200 mm, 2400 mm, 3600 mm and 4800 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 1800 mm and 3600 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.

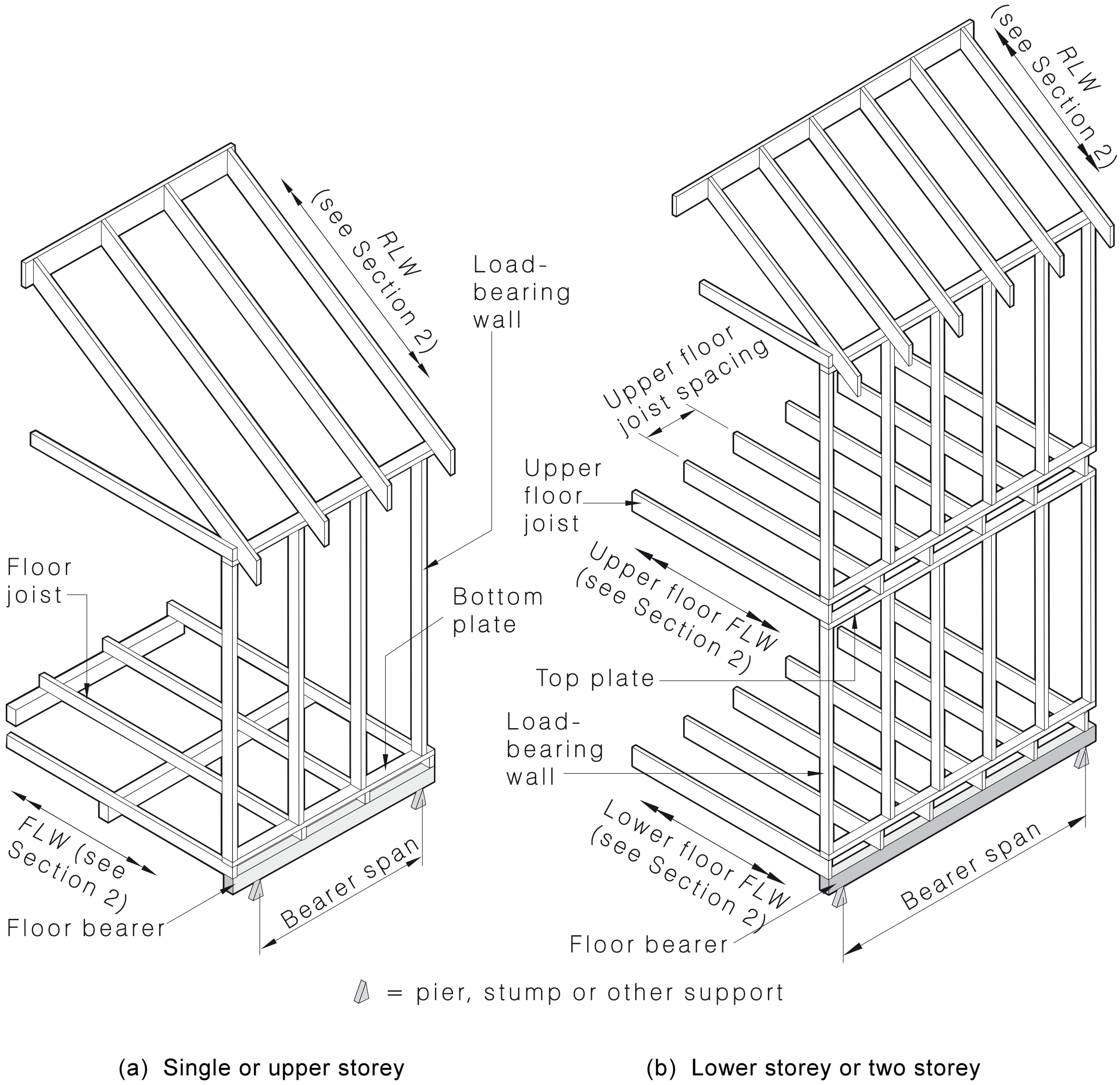


FIGURE 4.6 BEARERS SUPPORTING LOADBEARING WALLS

4.3.1.2 *Bearers supporting floor loads only*

For bearers supporting floor loads only or for decks located equal to or less than 1000 mm above the ground, the size of bearers shall be determined from Span Table 5 of the Supplements. For decks located more than 1000 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.

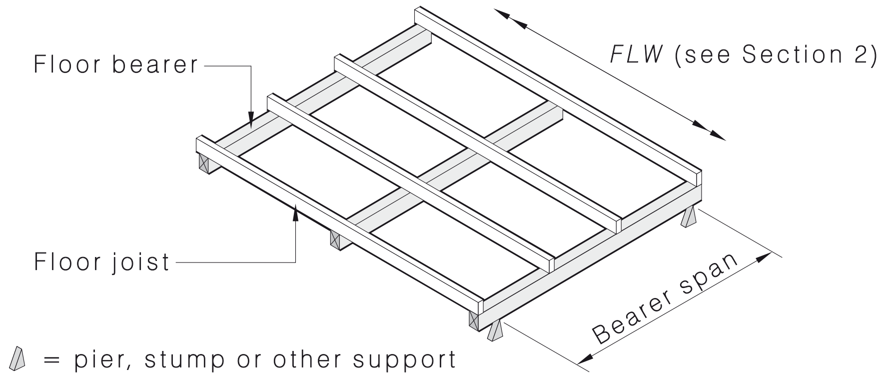


FIGURE 4.7 BEARERS SUPPORTING FLOOR LOADS ONLY

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 1500 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

BEARERS SUPPORTING LOADBEARING WALLS AT RIGHT ANGLES

Depth of member	Permissible cantilevers and offsets for bearers under loadbearing walls (maximum roof load width 3600 mm)			
	Maximum permissible cantilever as proportion of actual backspan, %		Maximum permissible offset as proportion of allowable span, %	
mm	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

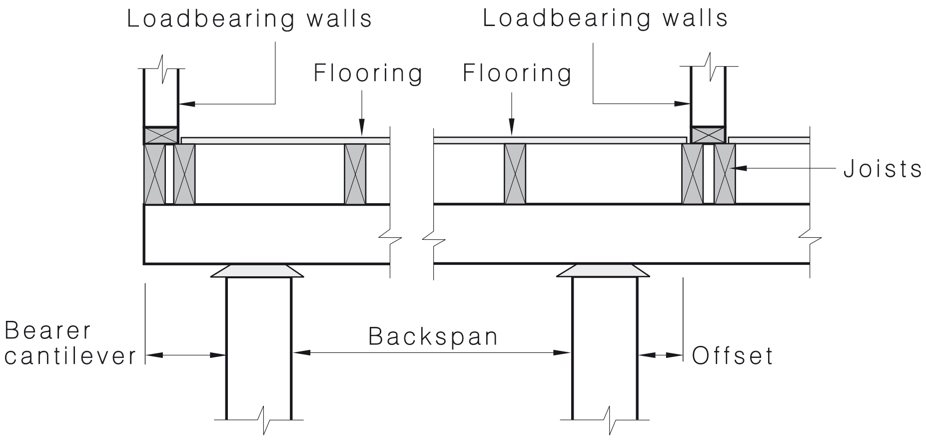


FIGURE 4.8 OFFSETS AND CANTILEVERS

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

BEARERS SUPPORTING PARALLEL LOADBEARING WALLS

Roof type	Uniform load	Point load*
	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

* 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

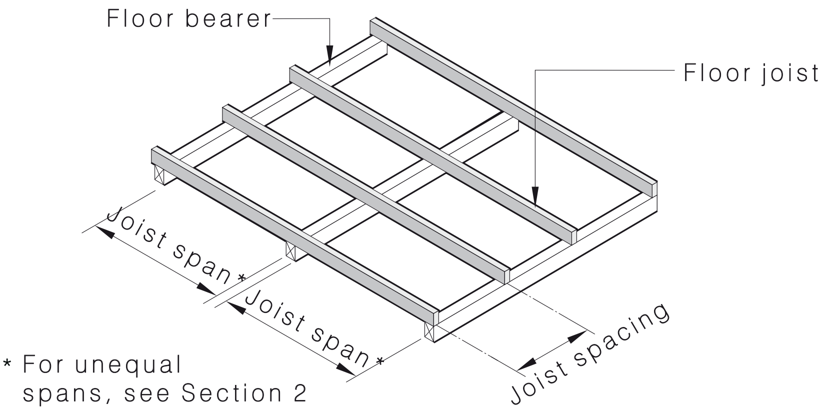
4.3.2.1 *General*

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

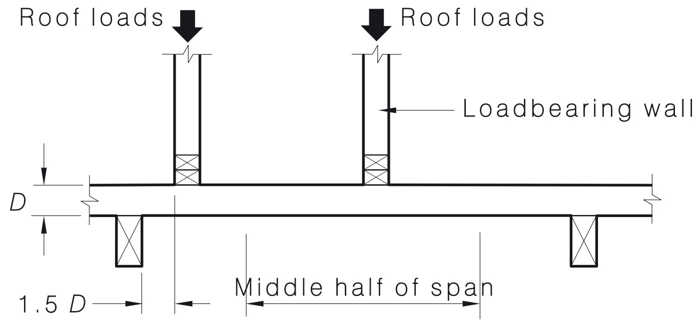
The size of joists for decks located more than 1000 mm above the ground shall be determined from Span Table 50 of the Supplements. For floor joists supporting floor loads only, floor joists may cantilever up to 25% of their allowable span provided the minimum backspan is at least twice the cantilever distance.

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

NOTE: For decks up to 1000 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 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*), and 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	Point load*
	Maximum *RLW* mm	Maximum area of roof supported m^2
Sheet	3 600	5
Tile	2 100	2.5

* 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 shall be not less in size than the associated floor joists.

Trimmers between 1000 mm and 3000 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 1000 mm.

Trimmers exceeding 3000 mm in length shall be designed as bearers.

Trimmers and curtailed joists greater than 1000 mm in length shall not rely solely on the strength of nails into end grain and shall be suitably connected (e.g., metal nailplate connectors), (see Figure 4.10).

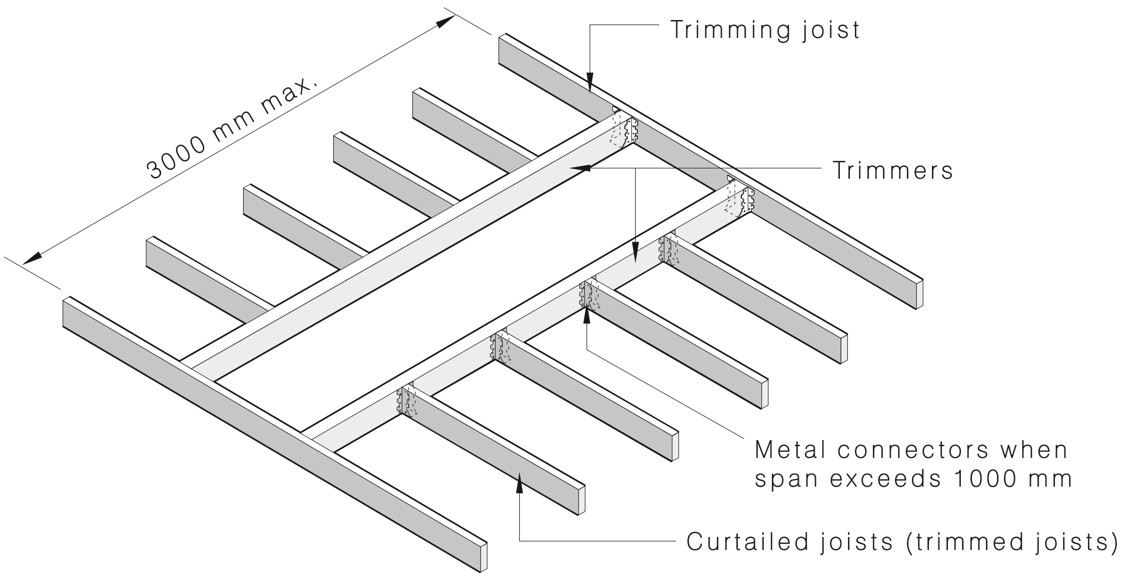


FIGURE 4.10 OPENINGS IN FLOORS

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.

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

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 is not recommended for use where the platform floor is intended to be the final finished surface ('polished floor') of the floor.

5.3 FITTED FLOORS (CUT-IN FLOORS)

Fitted floors (cut-in floors) are installed 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.

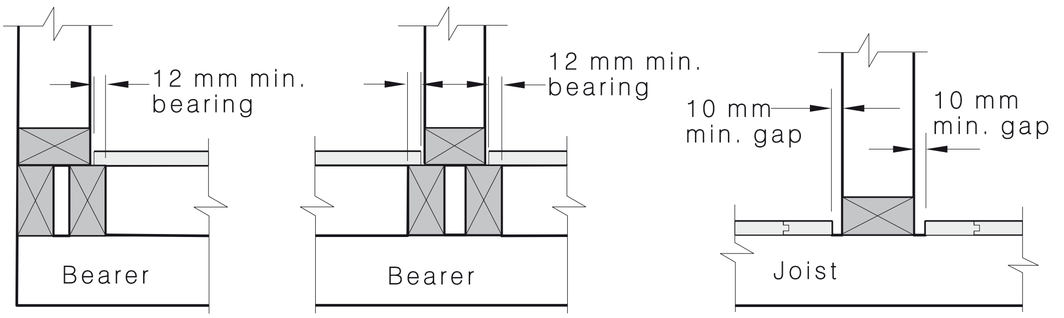


FIGURE 5.1 FITTED FLOORS

5.4 EXPANSION JOINTS

For continuous floor widths over 6 m, measured at right angles to flooring, intermediate expansion joints shall be provided in addition to the perimeter gaps. Each expansion joint shall be either of a single 10 mm wide gap, under a wall or across a hallway and similar situations, or of smaller gaps with closer spacings to give an equivalent space (for example, 1 mm gaps at 1 m spacing or loose cramping).

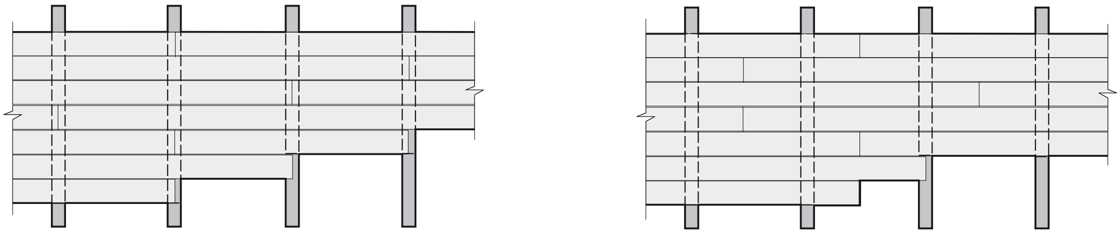
5.5 LAYING AND FIXING

5.5.1 Strip flooring—Laying

Fitted flooring shall be kept 10 mm clear of walls or wall plates that are parallel to the length of the boards.

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 Cramping

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 85 mm cover width shall be fixed by face-nailing with one or two nails or shall be secret-nailed with one nail at each joist (see Figure 5.3). Boards over 85 mm cover width shall be fixed with two face-nails at each joist. Alternate nails in double-nailed boards shall be skewed slightly to the vertical, in opposing directions (see Figure 5.4). The minimum edge distance for nailing at butt joints or board ends shall be 12 mm.

NOTES:

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.

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

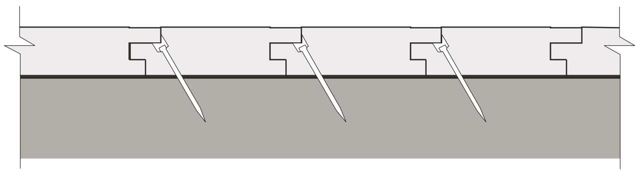


FIGURE 5.3 SECRET NAILING

The nail sizes for 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	Softwood joists	Hardwood and cypress joists
Hand-driven	65 × 2.8 mm bullet-head	50 × 2.8 mm bullet-head
Machine-driven	65 × 2.5 mm	50 × 2.5 mm

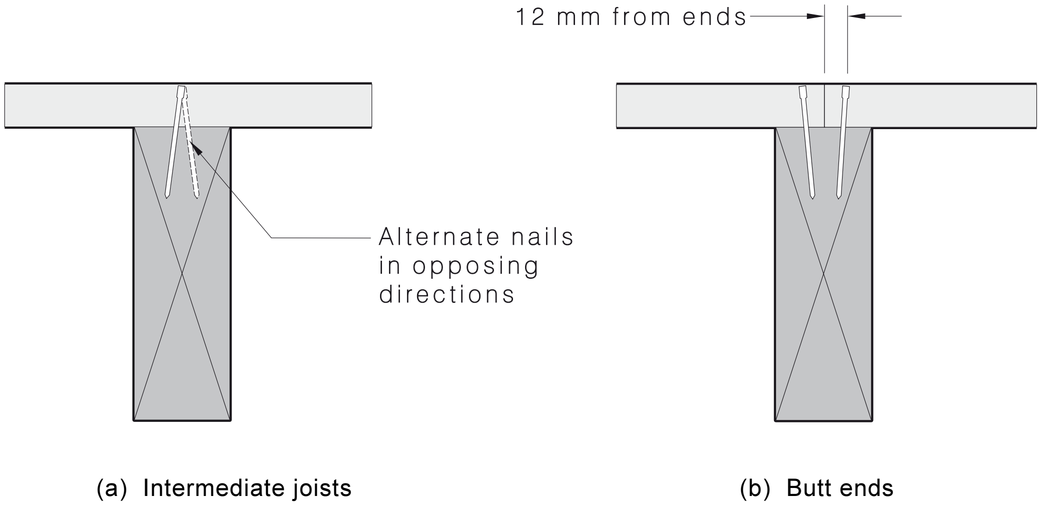


FIGURE 5.4 FACE NAILING

5.5.2.3 *Fixing to structural plywood underlay*

Underlay shall be structural plywood to AS/NZS 2269.0. The thickness shall be determined from Table 5.3 except that it shall be not less than 15 mm thick. Strip flooring shall be face-nailed or secret-nailed to plywood underlay in accordance with Table 5.2. Double face-nailing shall be used for boards exceeding 85 mm cover width.

TABLE 5.2

NAIL SIZES FOR FIXING TONGUED AND GROOVED FLOORING TO STRUCTURAL PLYWOOD UNDERLAY

Strip flooring thickness mm	Required nailing (for 15 mm min. thickness subfloor)
19 or 20	38 × 16 gauge chisel point staples or 38 × 2.2 mm nail, at 300 mm spacing
12 , 19 or 20	32 × 16 gauge chisel point staples or 30 × 2.2 mm nails, at 200 mm spacing

5.5.3 Structural plywood flooring

5.5.3.1 *Laying*

Plywood panels shall be laid with the face grain of the plies at right angles to the line of the supporting joists and shall be continuous over at least two spans. Ends of sheets shall be butted over joists. Edges of sheets, unless tongued and grooved, shall be joined over noggings between joists. Noggings shall be of timber not less than 70 × 35 mm section and shall be set flush with the top of the joists.

5.5.3.2 *Fixing (see Figure 5.5)*

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 and of length of not less than 2.5 times the thickness of the panel. Nails shall be spaced at 150 mm centres at panel ends and at 300 mm centres at intermediate joists and along noggings. Nails shall be not less than 10 mm from edge of sheets.

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

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

Where possible, panel ends shall be staggered.

Structural plywood flooring shall not be cramped during installation.

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

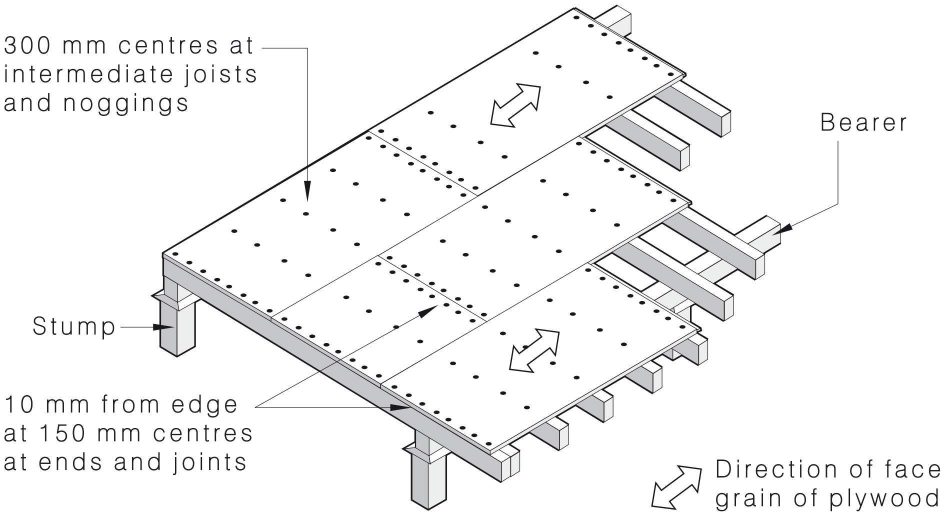


FIGURE 5.5 FIXING OF PLYWOOD SHEET FLOORING

5.5.4 Particleboard

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.

5.6 WET AREA FLOORS

Timber floors in wet areas (e.g., bathrooms, laundries) shall be protected from moisture in accordance with the requirements of BCA.

5.7 JOIST SPACING—FLOORING

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

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

TABLE 5.3

STRUCTURAL FLOORING—MAXIMUM ALLOWABLE SPACING OF JOISTS

Flooring	Standard	Grade	Thickness mm	Maximum spacing of joists, mm	
				Butt joined	End matched
Strip flooring					
Australian hardwoods	AS 2796.1	Select	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 2	20	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:	AS 4785.1				
—Density less than 560 kg/m^3		Standard	19	510	390
—Density greater than 560 kg/m^3		Standard	19	580	450
Sheet flooring					
	Standard	**Thickness mm**	**Grade**		
			F8	**F11**	**F14**
Plywood (see Note 3)	AS/NZS 2269.0	12	400	420	440
		13	430	450	480
		14	460	480	510
		15	480	520	540
		16	510	540	570
		17	540	560	600
		18	560	590	620
		19	590	620	660
		20	610	650	680
		21	640	670	710
		22	660	700	740
Particleboard (see Note 4)	AS/NZS 1860.1	See AS/NZS 1860.1			

NOTES:

1 An allowance has been made for light sanding.

2 Strip flooring boards may be regraded after elimination of imperfections by docking.

3 For plywood flooring thicknesses detailed above, it has been assumed that in any thickness of plywood the veneers are all of equal thickness. For plywood of a given total thickness, the dimensions listed in this Table will be slightly conservative if the outer veneers are thicker than any or all of the inner veneers.

4 For full details on particleboard flooring, see 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 100 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 21	400 450
Treated softwood	Standard grade (AS 4785.1)	19 22	400 450

Decking board 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 (hot-dip galvanized or stainless steel, 2 nails per board crossing)			
		Machine-driven		Hand-driven	
Hardwood and cypress	Hardwood and cypress	50 × 2.5 flat- or dome-head		50 × 2.8 bullet-head	
	Treated softwood	50 × 2.5 flat-head deformed shank	65 × 2.5 flat- or dome-head	50 × 2.8 bullet-head deformed shank	65 × 2.8 bullet-head
Treated softwood	Hardwood and cypress	50 × 2.5 flat- or dome-head		50 × 2.8 flat- 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

SECTION 6 WALL FRAMING

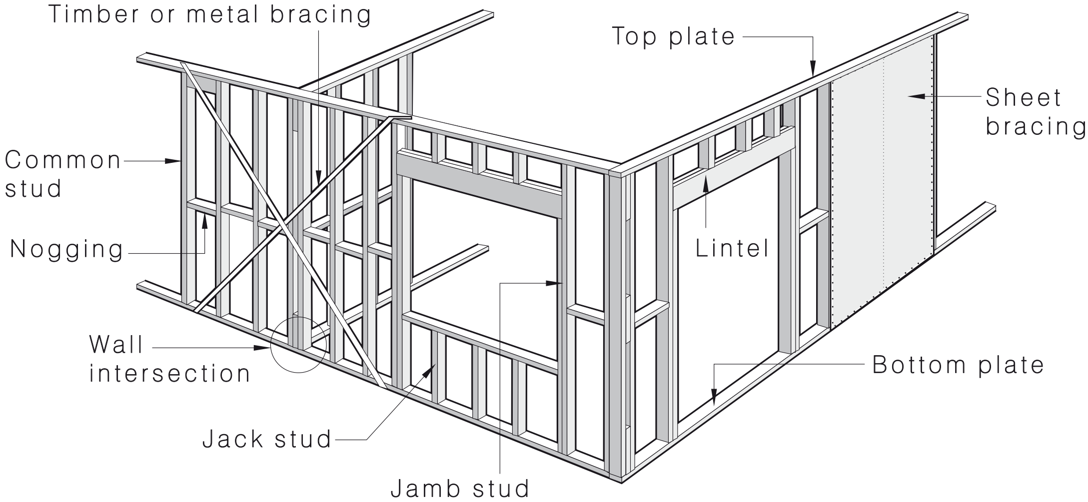
6.1 GENERAL

6.1.1 Application

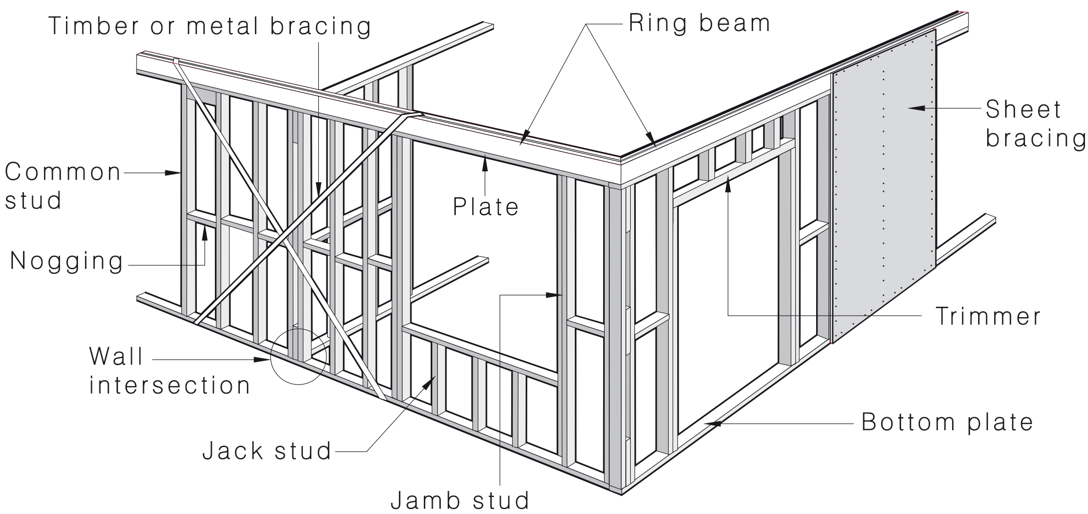
This Section sets out the requirements for the construction of conventional stud-framed walls and shall be used in conjunction with Span Tables 7 to 20 (single- or upper-storey construction), 36 to 48 (lower-storey construction), or 51A and 53 (verandahs and posts) of the Supplements.

6.1.2 Wall frame members

Walls shall be framed with studs, plates, nogging, bracing, lintels, and similar members, as typically 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.

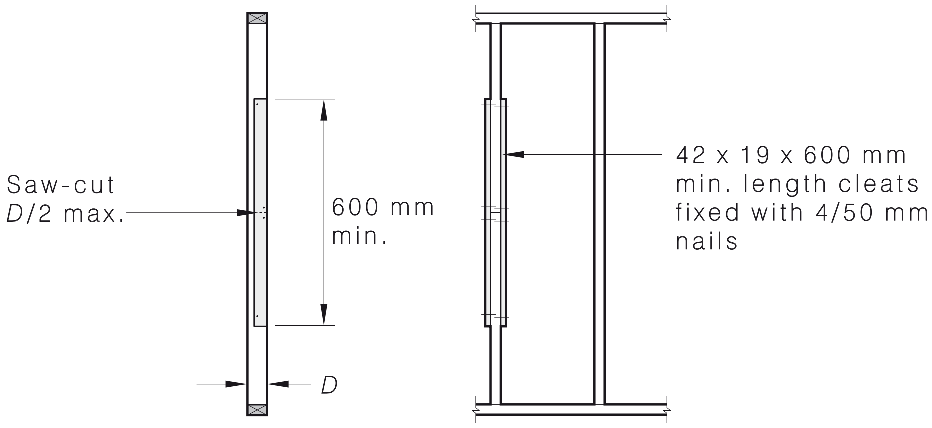


FIGURE 6.2 STUD CRIPPLING

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.

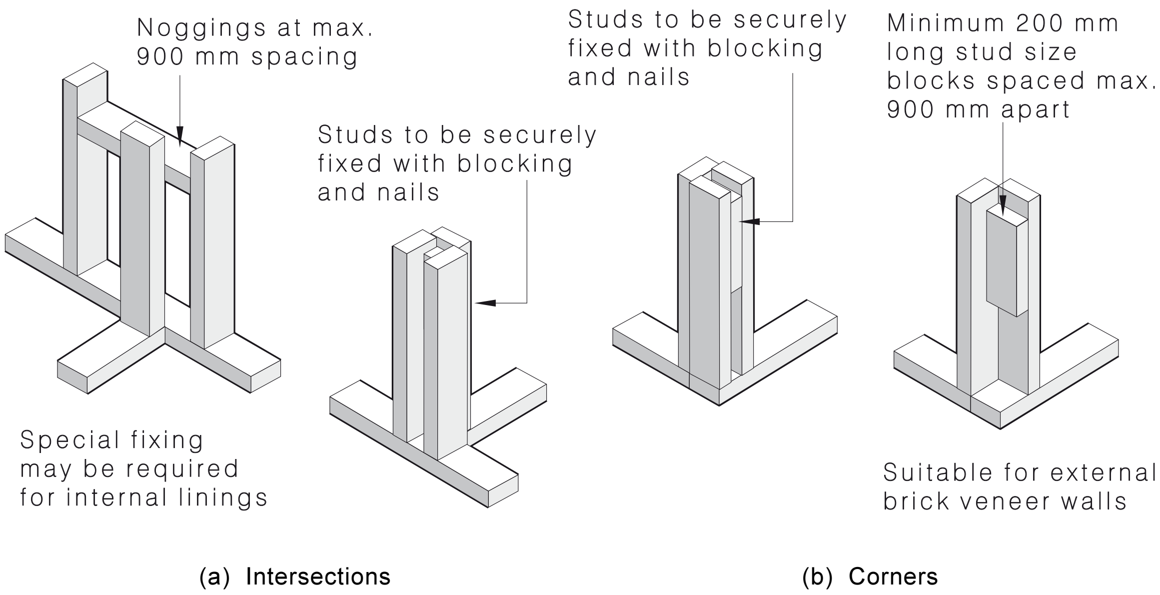


FIGURE 6.3 TYPICAL WALL JUNCTIONS

6.2.1.4 *Notching, trenching and holes in studs and plates*

The 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.

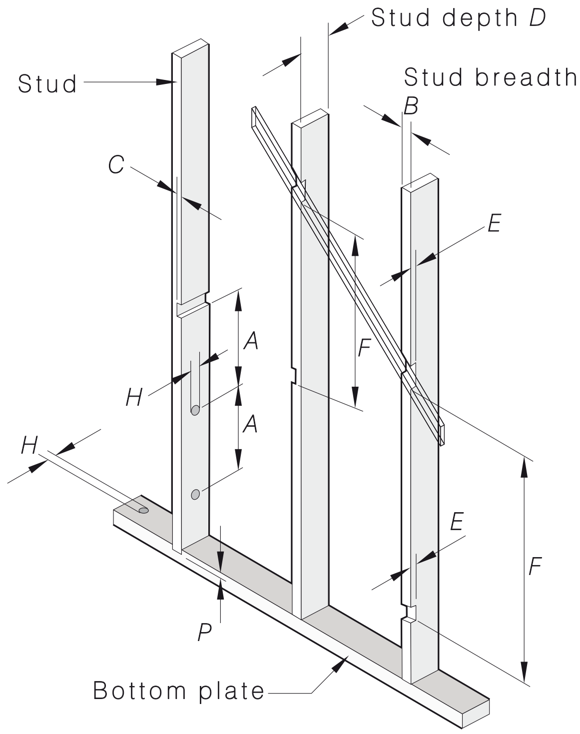


FIGURE 6.4 NOTCHING OF WALL STUDS

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.	

NOTES:

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

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

3 For additional jamb stud requirements, see Figures 6.5 and 6.9.

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 shall 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).

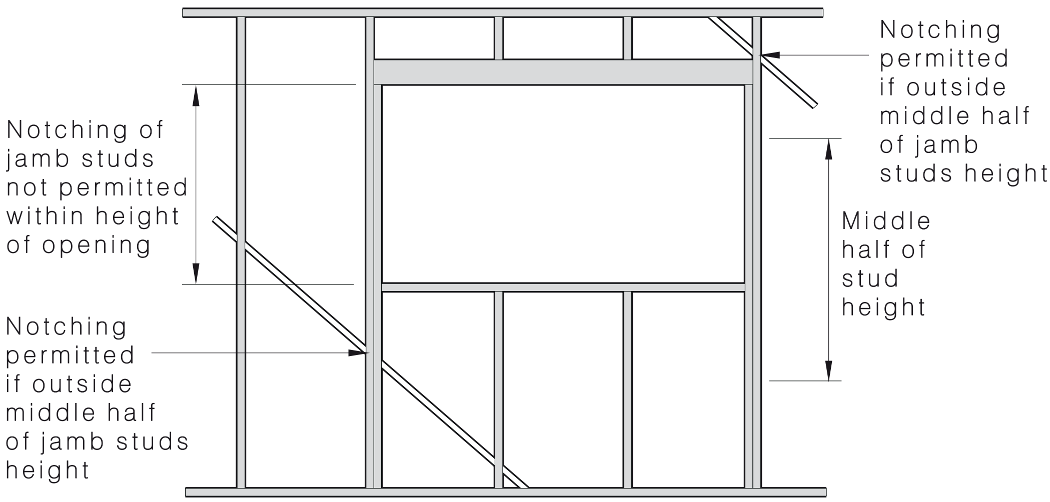


FIGURE 6.5 NOTCHING OF JAMB STUDS

6.2.1.5 *Nogging*

Where required, wall studs shall have continuous rows of noggings, located on flat or on edge, at 1350 mm maximum centres (see Figure 6.6).

Noggings are not required to be stress graded.

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

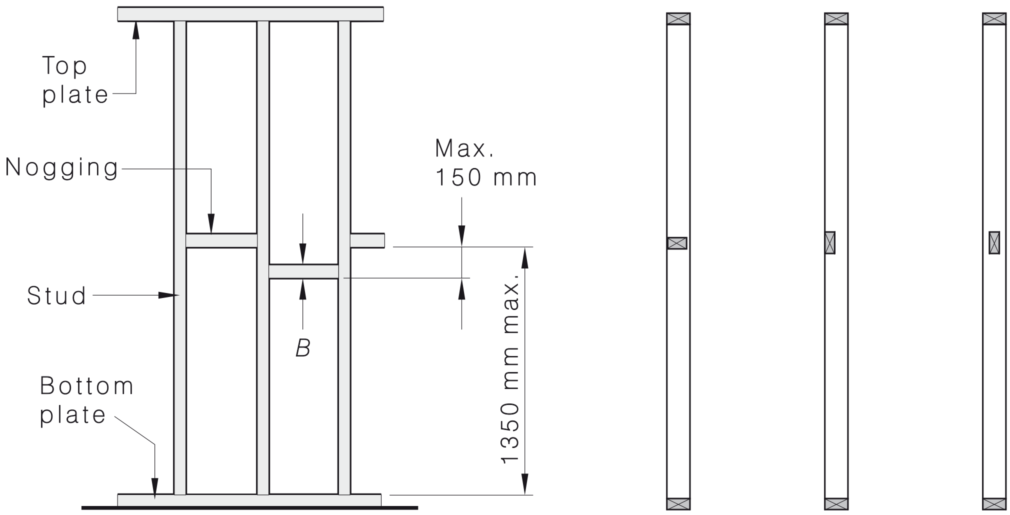


FIGURE 6.6 NOGGING

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 1200 mm, or below studs supporting concentrations of load, shall be stiffened as shown in Figure 6.7.

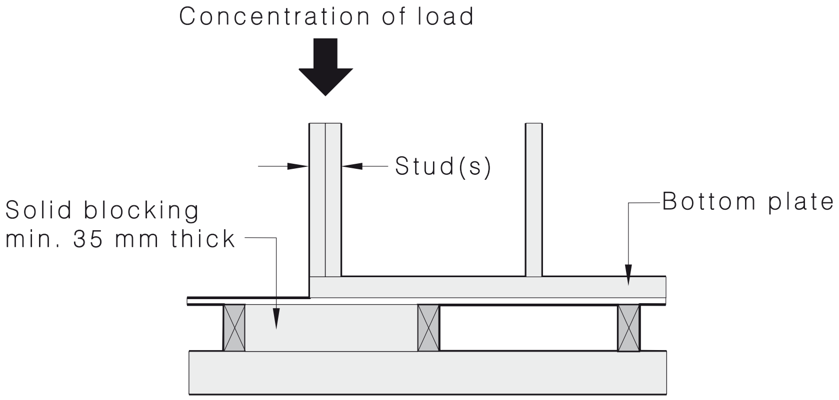


FIGURE 6.7 BOTTOM PLATE STIFFENING

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 3000 mm or more in length, combined strutting/hanging beams, combined strutting/counter beams, or similar members) occurs between studs (that is, 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.

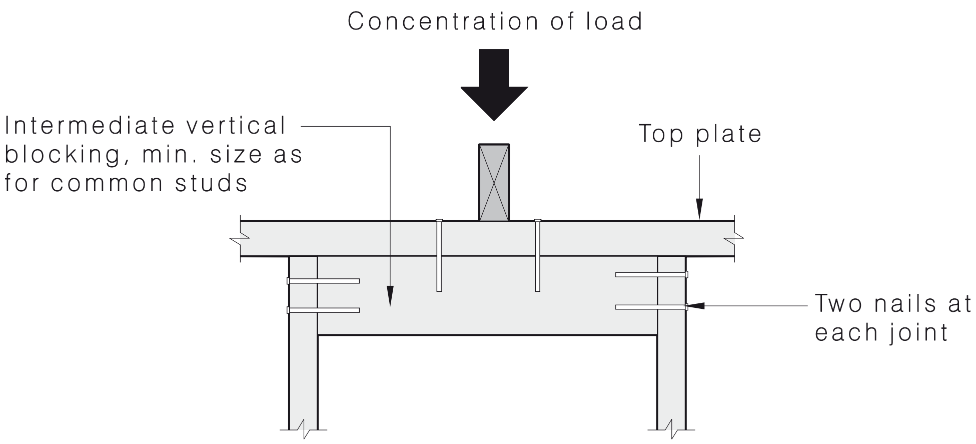


FIGURE 6.8 TOP PLATE STIFFENING

For 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*

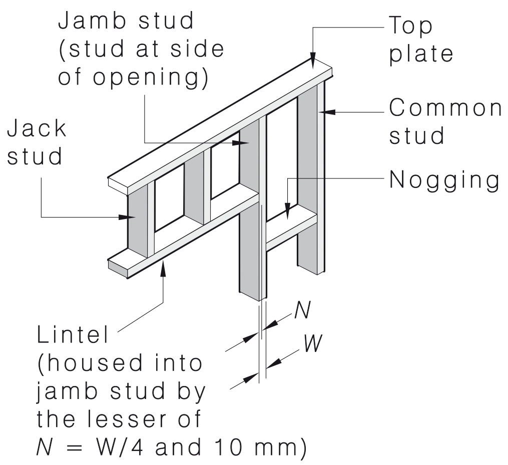
Top plates and ring beams shall be joined using one of the methods, as appropriate, given in Section 9 for the relevant wind classification.

6.2.3 Openings

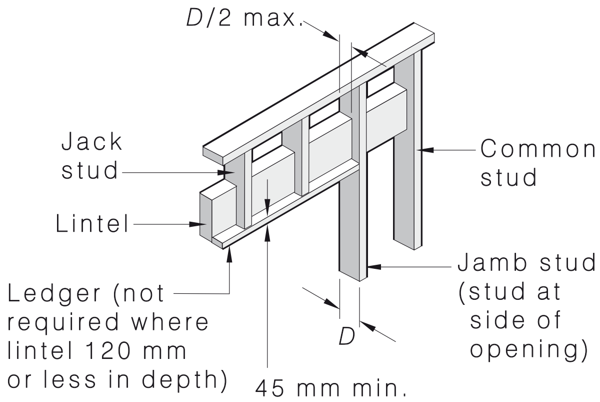
Openings shall be framed with jamb studs and lintels (heads) or ring beams as shown in Figure 6.9. Where required, jack studs shall be the same size, spacing, and orientation as the common studs, as shown in Figure 6.9. Alternatively, jack studs may be made up by horizontal nail lamination. A minimum 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(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 Figure 6.9.

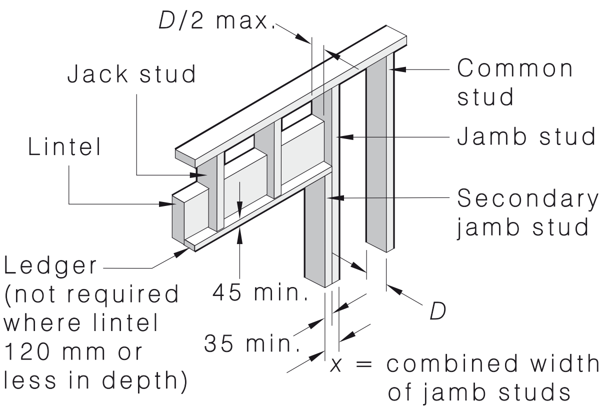
Alternatively, a continuous ring beam may be used without a top plate above, provided it is designed as a stand-alone member without secondary contribution of a top plate as shown in Figures 6.9(f) and 6.9(g).



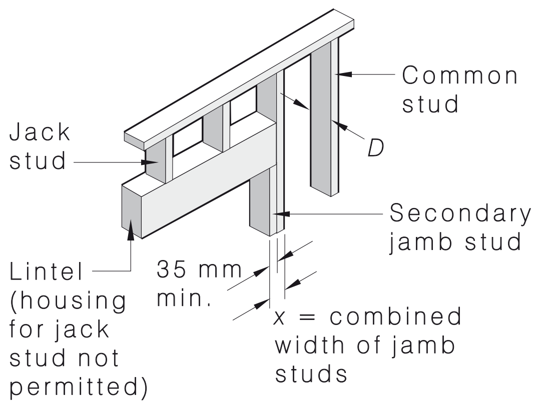
(a) Spans not exceeding 1800 mm (Non-loadbearing walls)



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



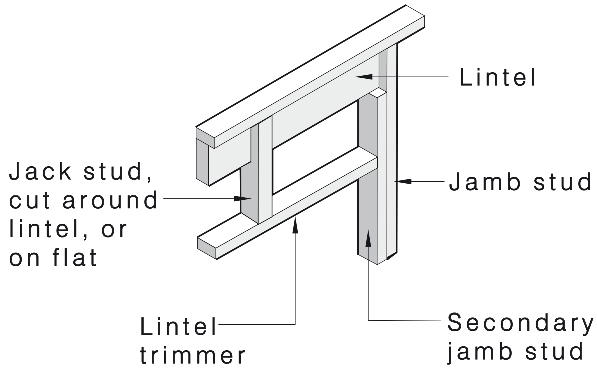
(c) Lintel breadth less than or equal to half stud depth—Alternative



(d) Lintels having breadth greater than half stud depth

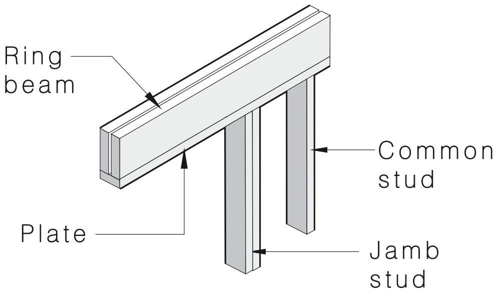
FIGURE 6.9 (in part) OPENINGS

A1

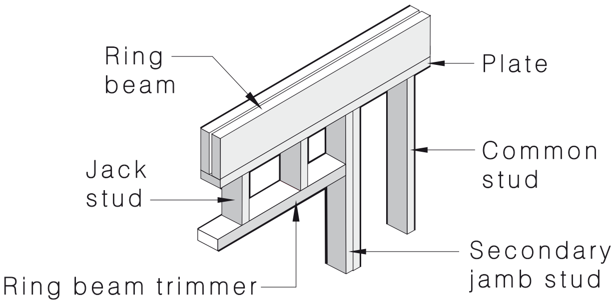


NOTE:Where jack studs are not appropriate, a full-length trimmer shall be fixed to the underside of the lintel.

(e) Lintel directly below top plate



(f) Ring beam



(g) Ring beam with trimmer

FIGURE 6.9 (in part) 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 3000 mm centres by means of—

(a) intersecting walls;

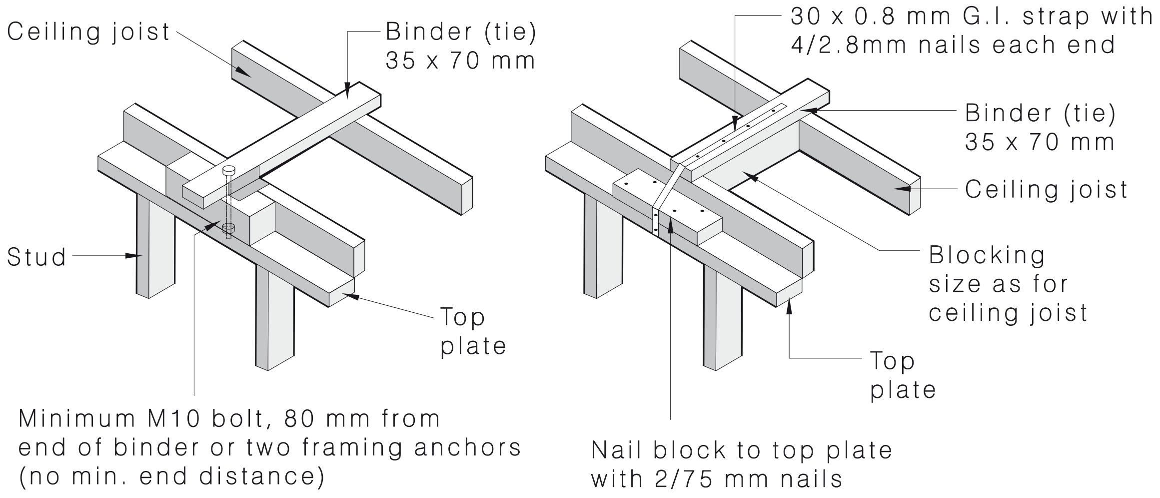
(b) ends of hanging or strutting beams;

(c) continuous timber ceiling battens; or

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

Where binders are required, they shall be 35 × 70 mm min. continuous members fixed to the external top plate as shown in Figure 6.10. Binders may be spliced, provided 4/75 mm nails, or equivalent, are provided for each side of the joint; that is, 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.

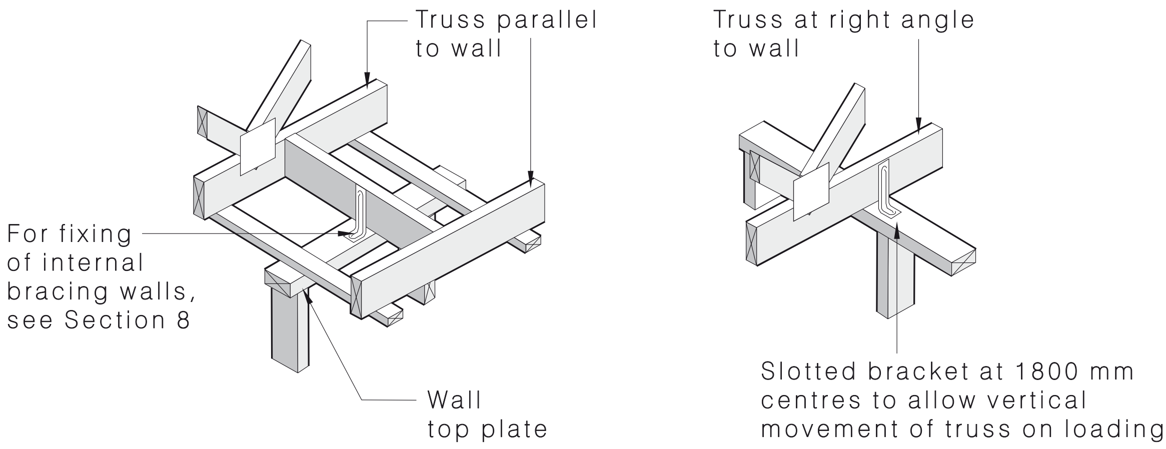


(a) Bolt or framing anchors (b) Metal strap

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.

NOTES:

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

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

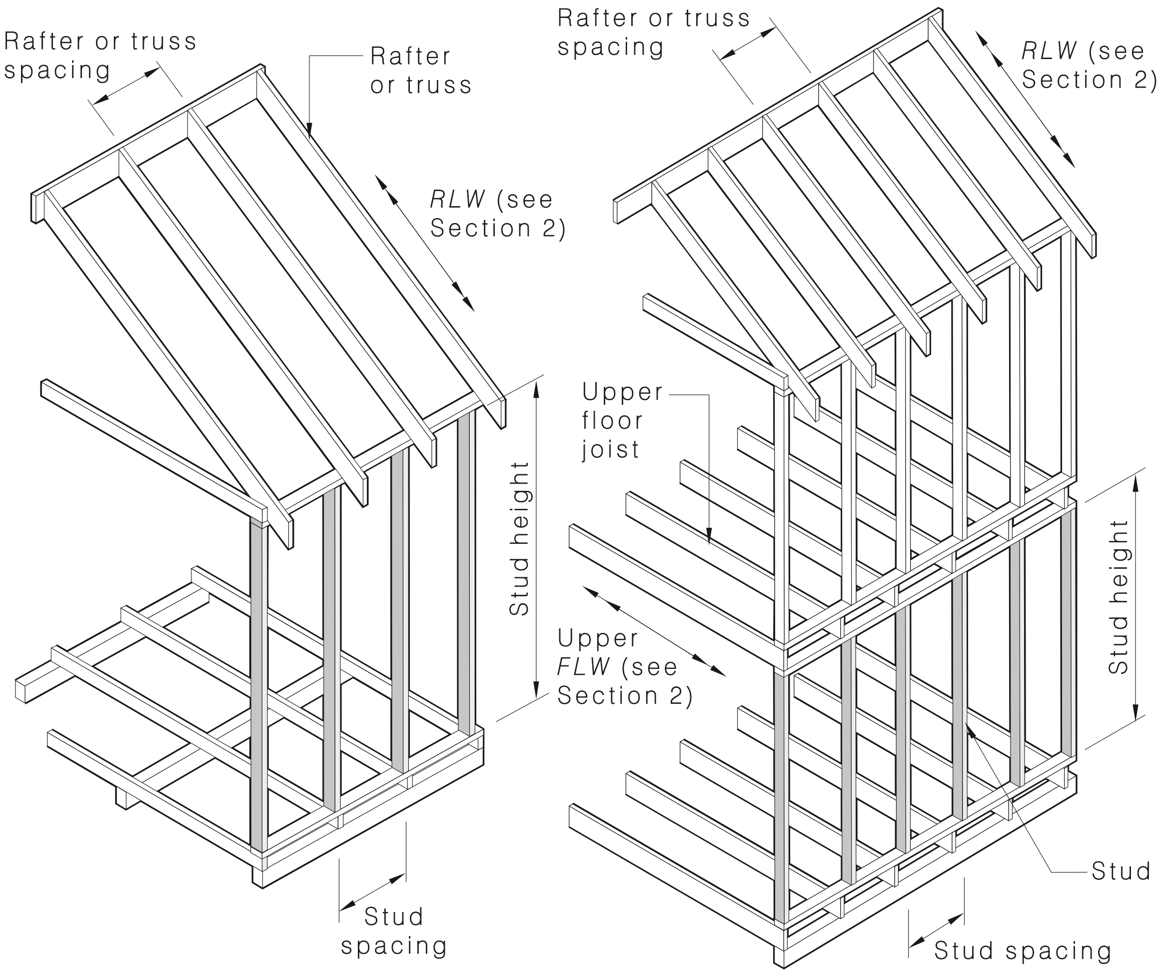
6.3.2 Wall studs

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 notched and not-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*

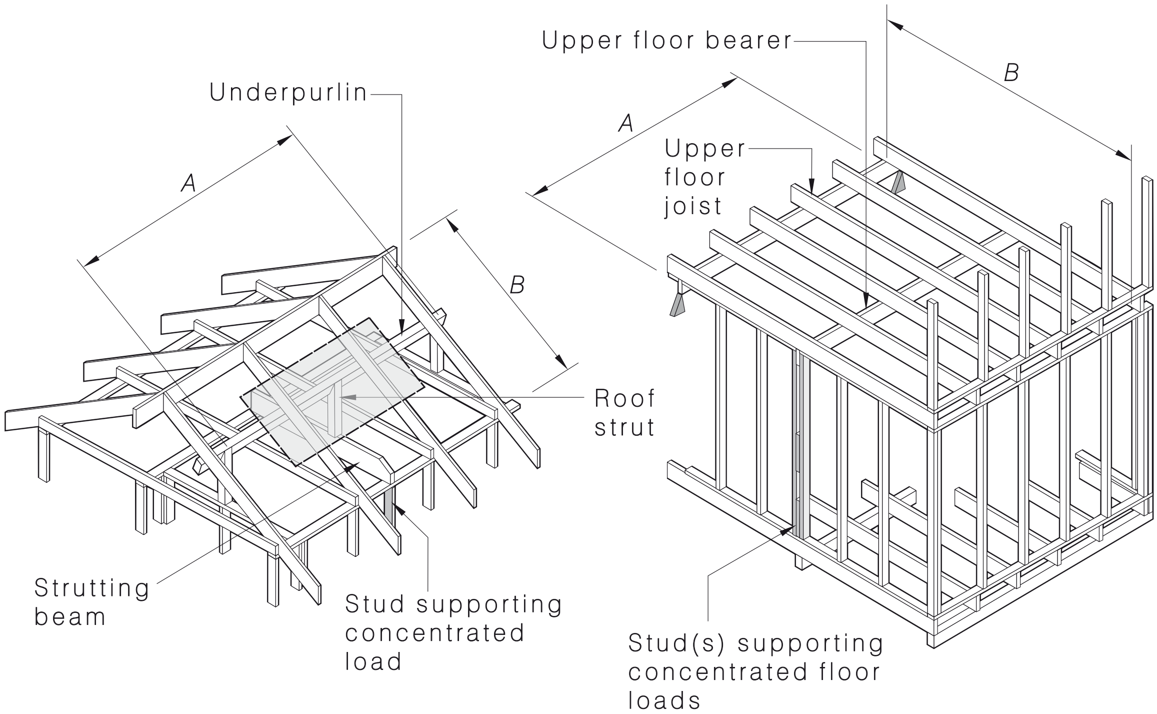
The size of studs supporting concentrated loads in single- or upper-storey construction shall be determined from Span Tables 9 and 10 of the Supplements for not-notched and notched studs respectively.

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) are appropriate for determining the size of studs supporting concentrated loads such as from strutting beams, roof struts, girder trusses or hanging beams 3000 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 should 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 = $(A \times B)/4$
A = total of underpurlin spans
B = total of rafter spans

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

(a) Roof area supported

(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 (*FLWs*) of 1800 mm, 3600 mm and 4800 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 × 35)*—provide 1 full-length stud plus 1 secondary jamb stud.

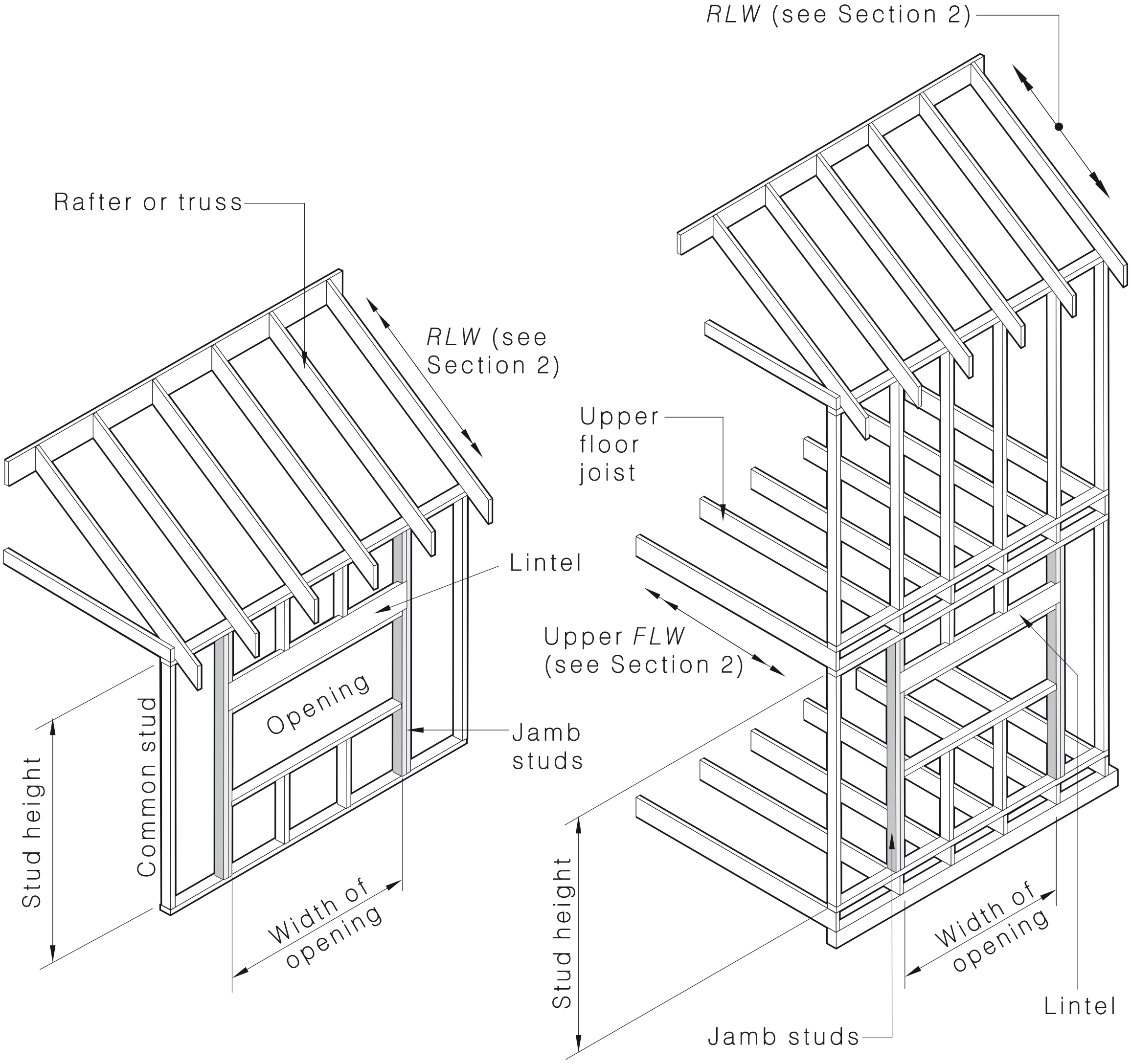
(b) *3 members (e.g., 3/70 × 35)*—provide 2 full-length studs plus 1 secondary jamb stud.

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

For the terminology of secondary jamb stud, see Figure 6.9.

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.



(a) Single or upper storey

(b) Lower storey

NOTE: Noggings have been omitted for clarity.

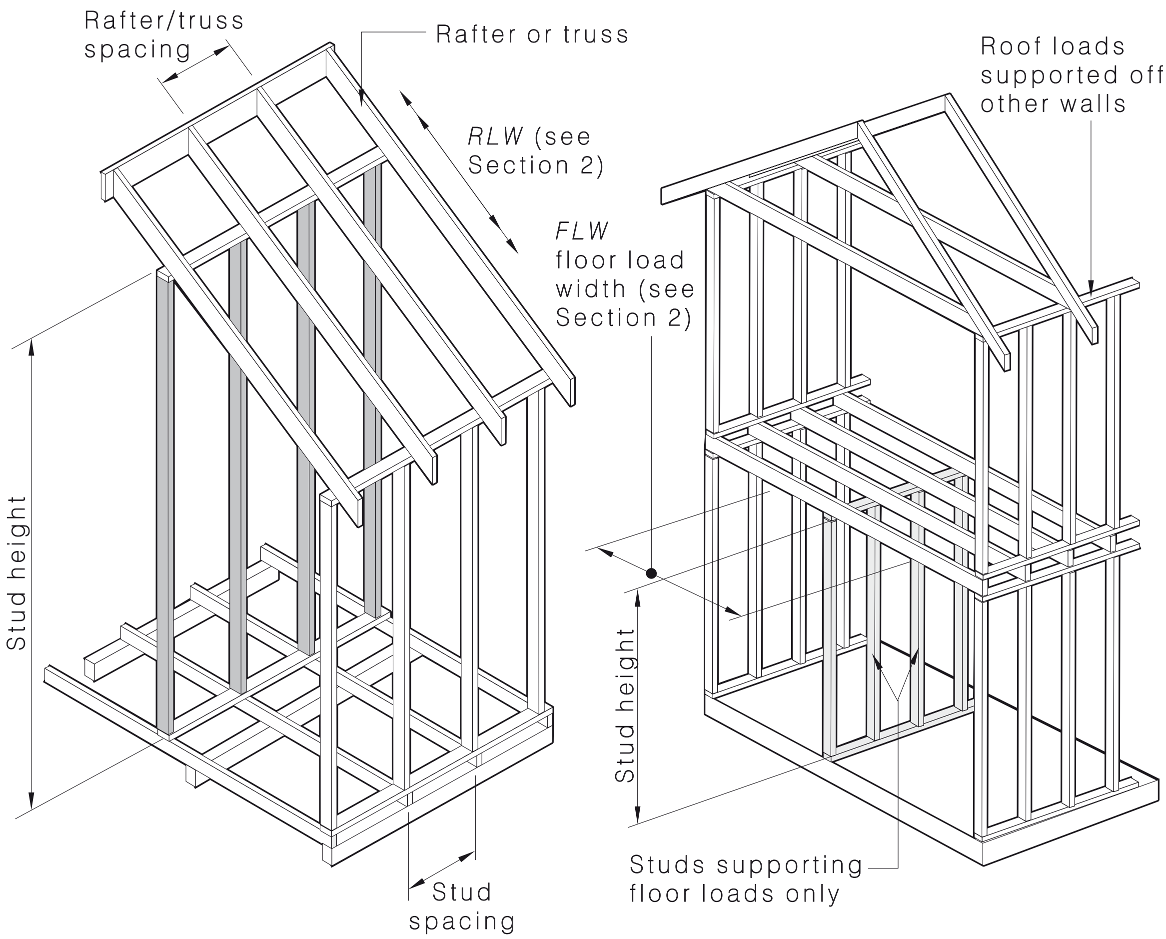
FIGURE 6.14 JAMB STUDS

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.



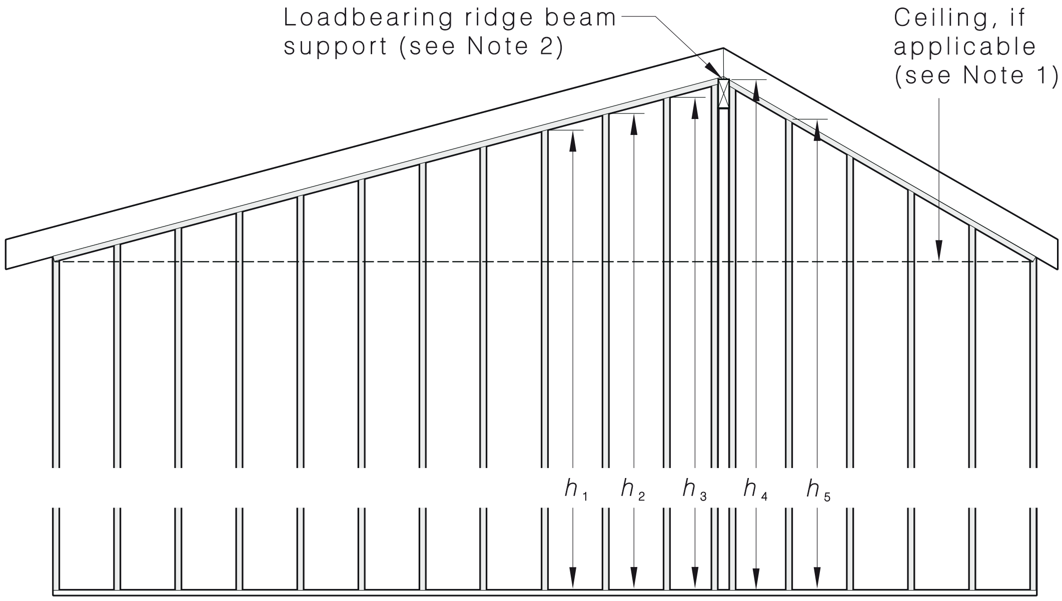
(a) Single or upper storey (b) Lower storey

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 (that is, wall studs—single or upper storey, or lower storey) and 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*.



NOTES:

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.

2 Where studs support a loadbearing ridge or intermediate beam, separate consideration is required; for example, studs supporting concentration of load.

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 except that 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.

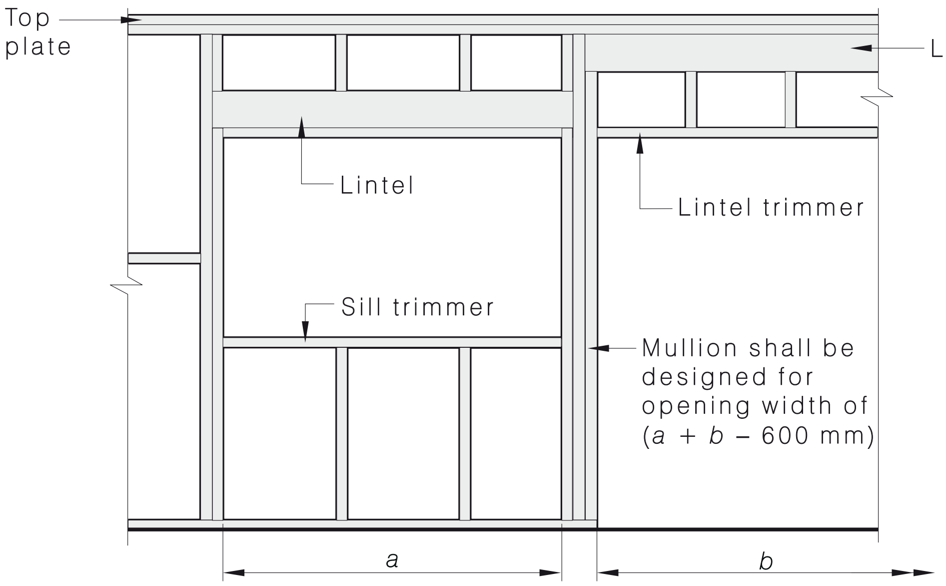


FIGURE 6.17 MULLIONS

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 × 70; 3/38 × 75).

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

35 × 70 mm on top of a 45 × 70 mm.

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

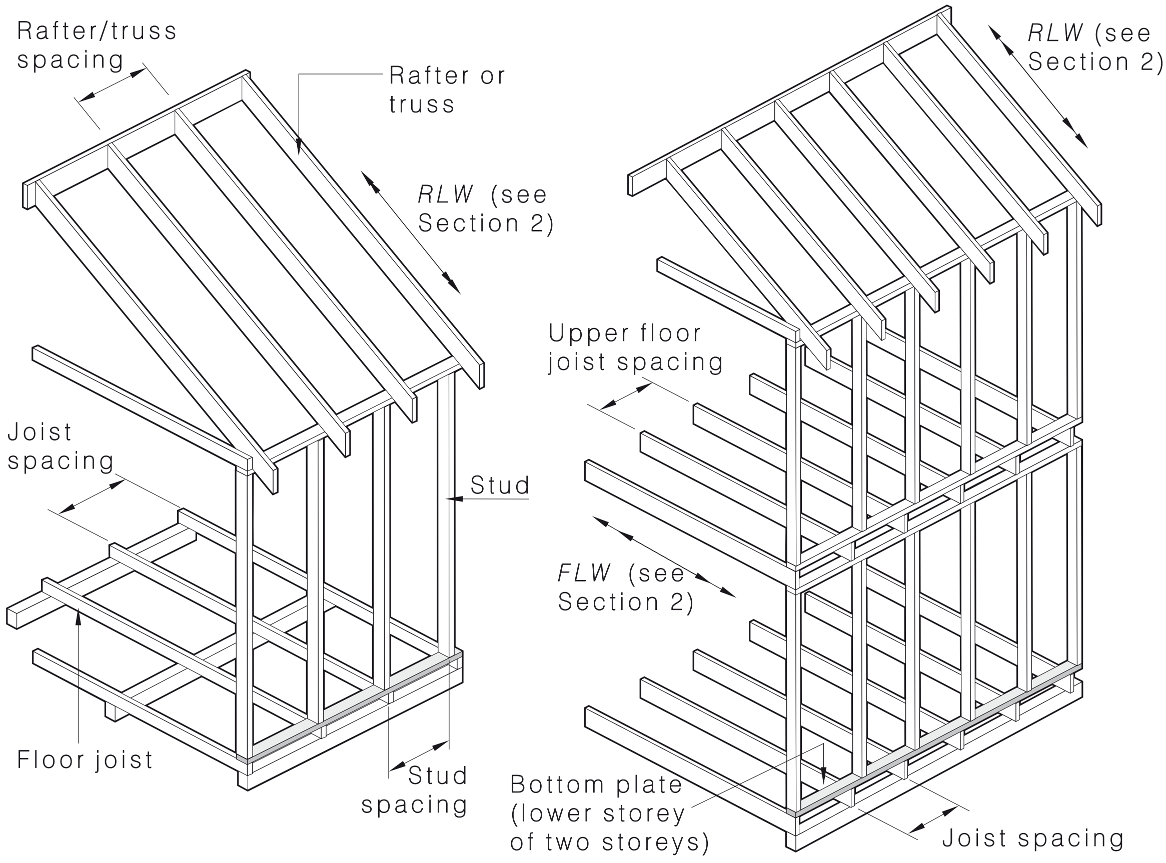
(b) Calculate the *RLW* assuming 2/45 × 70 = RLW_2.

(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 are appropriate 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 (see 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.

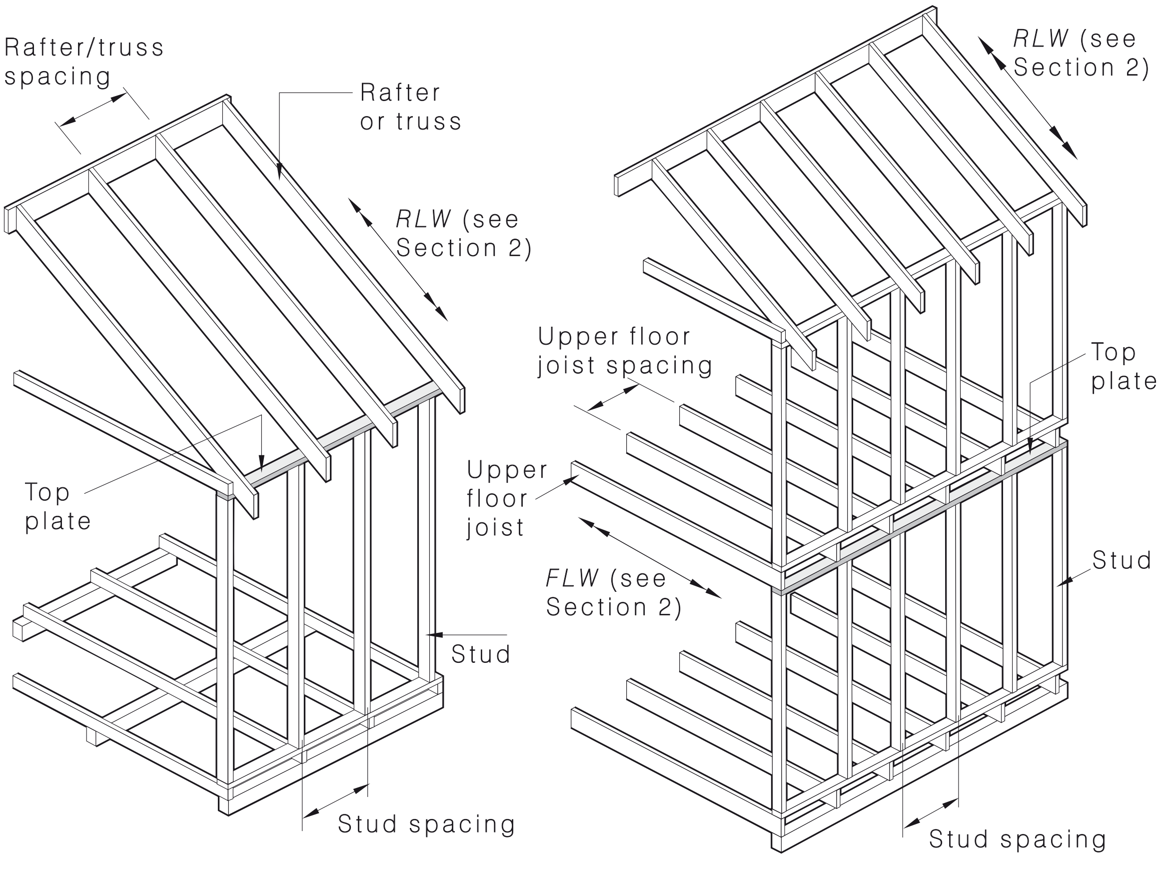
Double or multiple top plates (ribbon plates) may be used provided the allowable roof load width (*RLW*) is determined in accordance with the Span Tables for members indicated as being made up of multiples (e.g., 2/35 × 70; 3/38 × 75).

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

Case 1: 35 × 70 mm on top of a 45 × 70 mm	**Case 2: 35 × 70 mm F7 on top of a 45 × 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 3000 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		
2700 mm	70 × 35	600
3300 mm	90 × 35 or 2/70 × 35	600
3600 mm	90 × 35 or 2/70 × 35	600
4200 mm	90 × 45 or 2/90×35	600
Studs supporting lintels	As for common studs	—

NOTES:

1 Plates may be trenched up to 5 mm.

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 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.

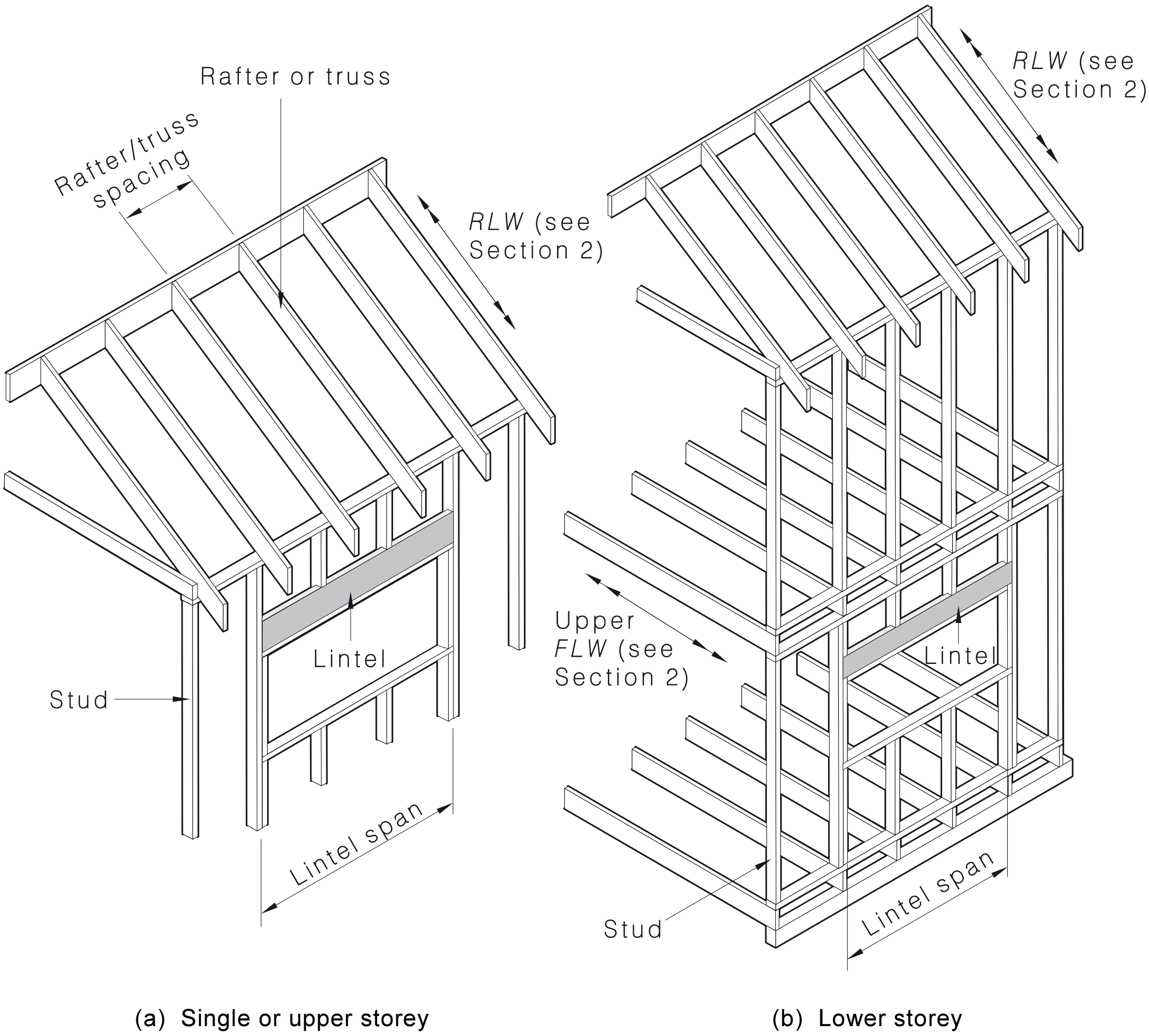
6.3.6.2 *Lintels and ring beams in loadbearing walls*

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 that for all 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: For instance, if a ring beam (lintel) is required to span a 2400 mm opening but is tied down at 2700 mm centres, then the opening width required to determine the size is 2700 mm. If the size determined for this is 2/190 × 35, the minimum ring beam size required is 2/240 × 35.

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



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 1500 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 also 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 1800 mm, the size of the lintel shall be determined from Span Table 23 using a ceiling load width of 1800 mm.

Where wall openings wider than 1800 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 1800 mm.

6.3.6.6 *Windowsill trimmers*

For opening widths up to 1500 mm, windowsill trimmers may be the same size and grade as the common studs in that wall.

For opening widths greater than 1500 mm, the windowsill trimmer size shall be determined from Table 6.3.

Lintel trimmers, see Figure 6.9, 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 Figure 6.9) 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.

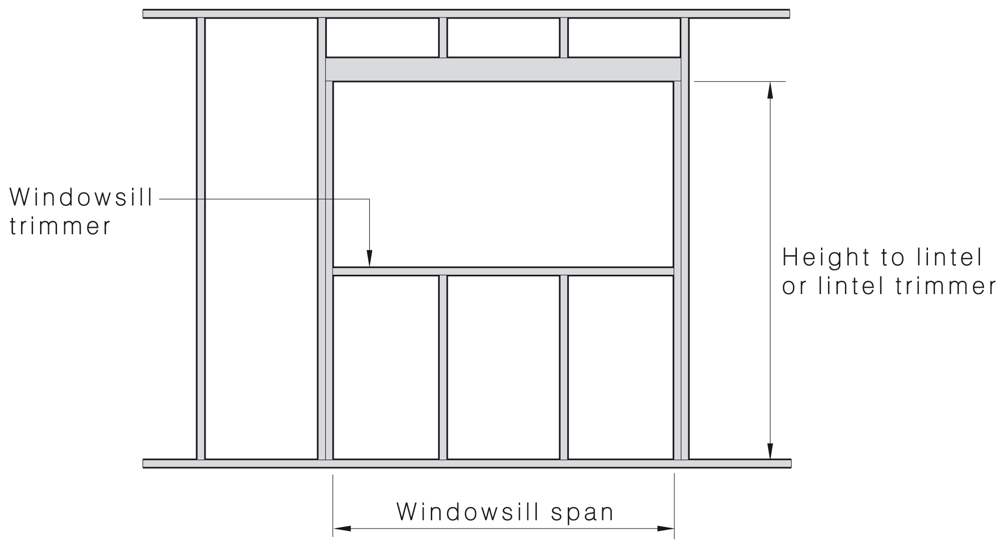


FIGURE 6.21 WINDOWSILL TRIMMERS

TABLE 6.3

SIZE OF WINDOWSILL TRIMMERS (2100 mm HIGH TO LINTEL/RING BEAM OR LINTEL/RING BEAM TRIMMER)

Opening width, mm	Stress grade	Wind classification		
		C1	C2	C3
1800	F5/MGP10	70 × 45 or 90 × 35	2/70 × 35 or 90 × 45	2/70 × 45 or 2/90 × 35
	F8/MGP12	70 × 35 or 90 × 35	70 × 45 or 90 × 35	2/70 × 35 or 90 × 35
	F14	70 × 35 or 90 × 35	70 × 35 or 90 × 35	70 × 45 or 90 × 35
2100	F5/MGP10	2/70 × 35 or 90 × 35	2/70 × 45 or 90 × 35	3/70 × 45 or 2/90 × 45
	F8/MGP12	70 × 45 or 90 × 35	2/70 × 35 or 90 × 35	2/70 × 45 or 2/90 × 35
	F14	70 × 35 or 90 × 35	70 × 35 or 90 × 35	2/70 × 35 or 90 × 35
2400	F5/MGP10	2/70 × 35 or 90 × 45	3/70 × 35 or 2/90 × 35	3/90 × 35
	F8/MGP12	2/70 × 35 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
2700	F5/MGP10	2/70 × 35 or 2/90 × 35	2/90 × 45	3/90 × 45
	F8/MGP12	2/70 × 35 or 90 × 45	3/70 × 35 or 2/90 × 35	2/90 × 45
	F14	70 × 45 or 90 × 35	2/70 × 35 or 90 × 45	2/70 × 45 or 2/90 × 35
3000	F5/MGP10	3/70 × 45 or 2/90 × 45	3/90 × 45	—
	F8/MGP12	2/70 × 45 or 2/90 × 35	3/70 × 45 or 2/90 × 45	3/90 × 45
	F14	2/70 × 35 or 90 × 35	2/70 × 45 or 2/90 × 35	3/70 × 45 or 2/90 × 45
3300	F5/MGP10	3/90 × 45	—	—
	F8/MGP12	3/70 × 45 or 2/90 × 35	3/90 × 35	—
	F14	2/70 × 45 or 90 × 45	3/70 × 45 or 2/90 × 35	3/90 × 35
3600	F5/MGP10	—	—	—
	F8/MGP12	3/90 × 35	3/90 × 45	—
	F14	3/70 × 35 or 2/90 × 35	2/90 × 45	3/90 × 45
4200	F5/MGP10	—	—	—
	F8/MGP12	—	—	—
	F14	3/90 × 45	—	—

NOTES:

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

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.

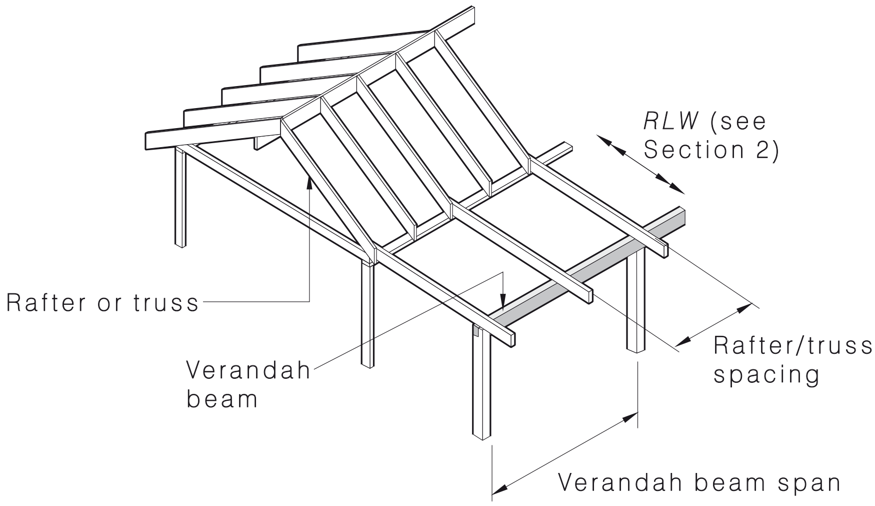
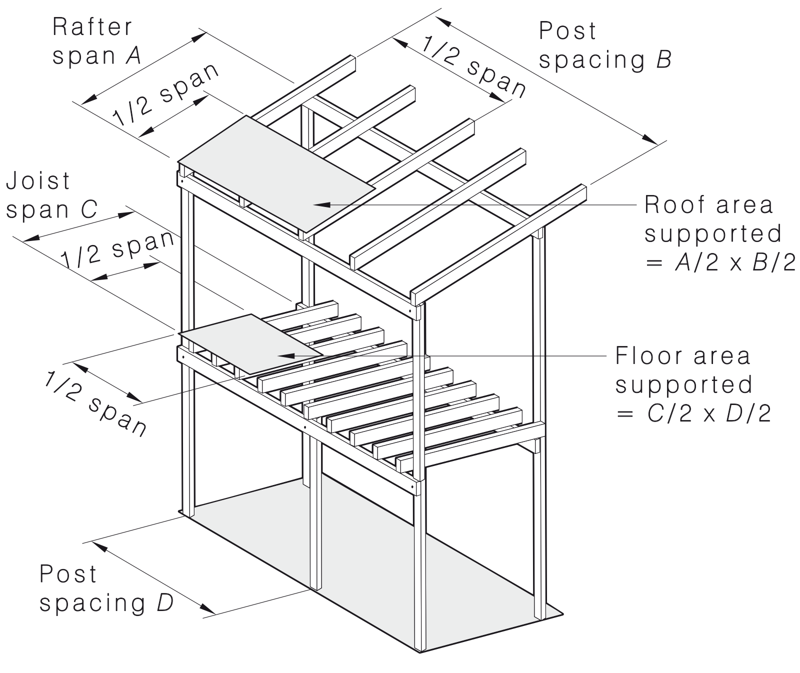


FIGURE 6.22 VERANDAH BEAMS

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

The 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 2.7.4).

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 shall be spliced and supported in accordance with the manufacturer's recommendations.

7.1.2.2 *Coupled roof*

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

Rafters shall be continuous in length from ridge to wall plate, or shall be 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 6000 mm for sheet roofs or 4000 mm for tile roofs, except where the roof connections and members are designed in accordance with AS 1720.1.

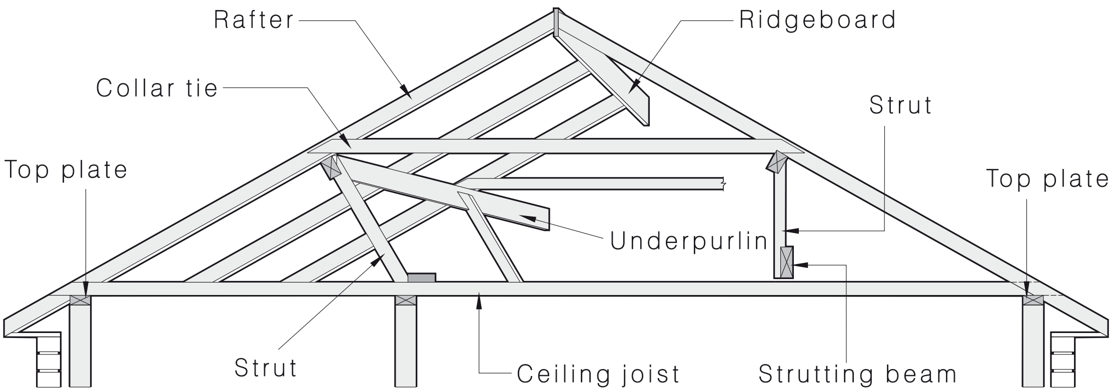


FIGURE 7.1 COUPLED ROOF

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 × 32 mm min. timber cleats, 25 × 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 1000 mm—same size as ceiling joist.

(b) Openings greater than 1000 mm and up to a maximum of 3000 mm—breadth of trimmer to be increased by 20% for each 300 mm in length greater than 1000 mm. Members shall be connected by framing brackets.

(c) Openings greater than 3000 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.

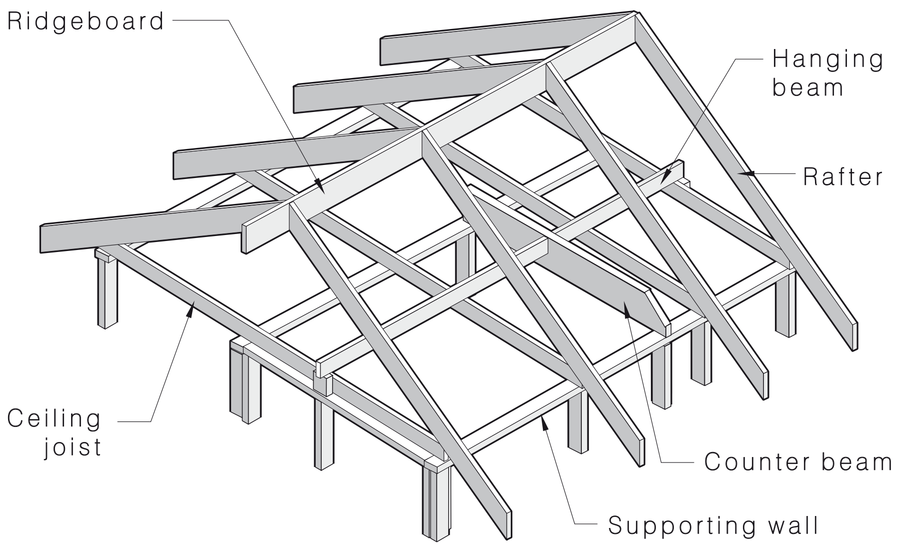


FIGURE 7.2 COUNTER BEAM SUPPORTING HANGING BEAMS

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.

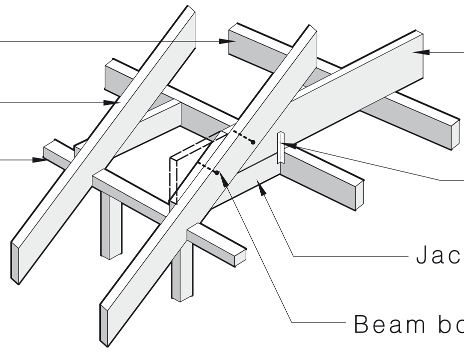


FIGURE 7.3 SUPPORT OF HANGING BEAM WITH JACK CEILING JOIST (TRIMMER)

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 × 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).

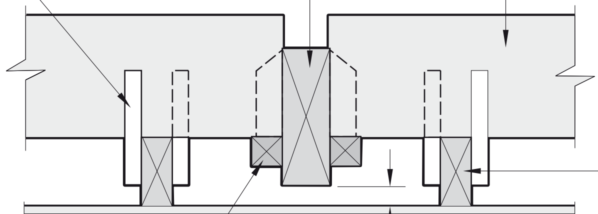


FIGURE 7.4 FIXING HANGING BEAM TO COUNTER BEAM

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.

NOTES:

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

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 45×42 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).

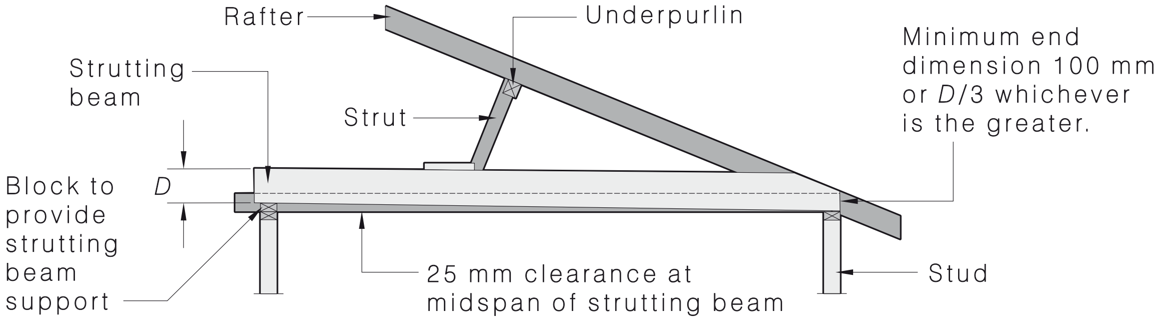


FIGURE 7.5 INSTALLATION OF STRUTTING BEAMS

7.2.10 Underpurlins

7.2.10.1 *General*

Underpurlins shall be in single lengths where possible and shall be in 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.

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.

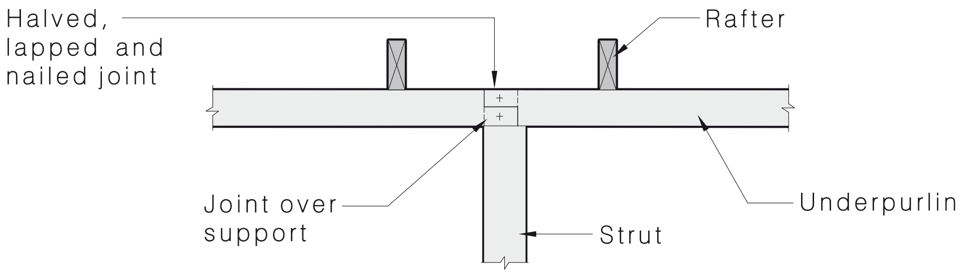


FIGURE 7.6 JOINING UNDERPURLINS

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:*

  (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 3 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* 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.

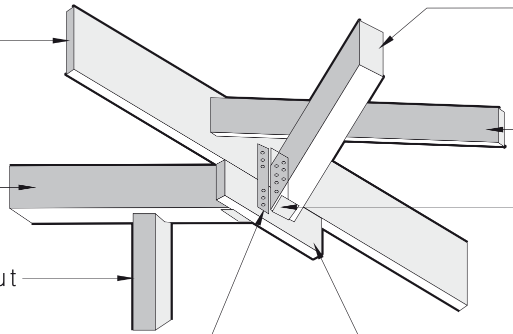


FIGURE 7.7 TYPICAL UNDERPURLIN CONNECTIONS TO HIP OR VALLEY

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 alternative provisions shall be made for the full support of the roof loads.

NOTE: An example of an alternative would be the provision of a tie-bolt truss.

7.2.12.2 *Joints in ridgeboards*

Ridgeboards may be joined using a scarf joint at the abutment of a rafter pair or, preferably, 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 should be used wherever possible.

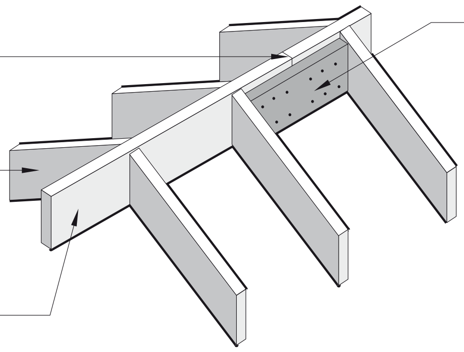


FIGURE 7.8 FISHPLATED RIDGEBOARD SPLICE

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 perpendicular to the rafter. They shall be birdsmouthed or halved to underpurlins as shown in Figures 7.9 and 7.10.

Alternatively, for struts in a position between vertical and perpendicular to rafter that are not birdsmouthed or halved to the underpurlin, a 30 × 0.8 G.I. strap shall be passed over the underpurlin and nailed to each side of the strut with 4/30 × 2.8 dia. nails and to the underpurlin with 2/30 × 2.8 dia. nails each side in addition to at least 2 skew nails. One framing anchor with four nails to each leg may be used as an alternative to the strap.

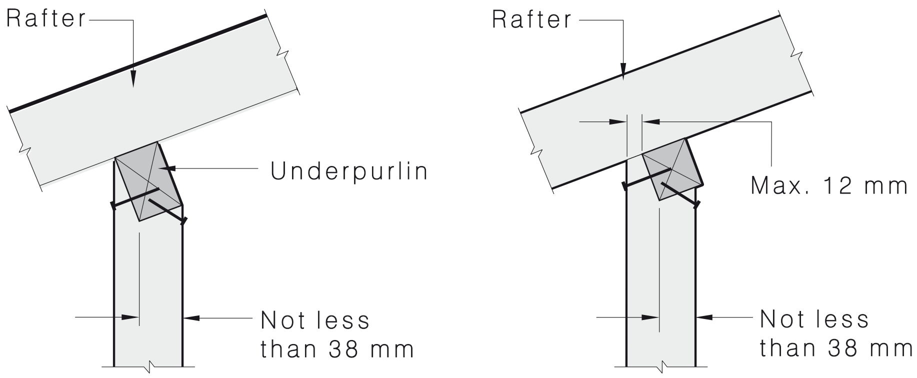


FIGURE 7.9 VERTICAL STRUTS

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.

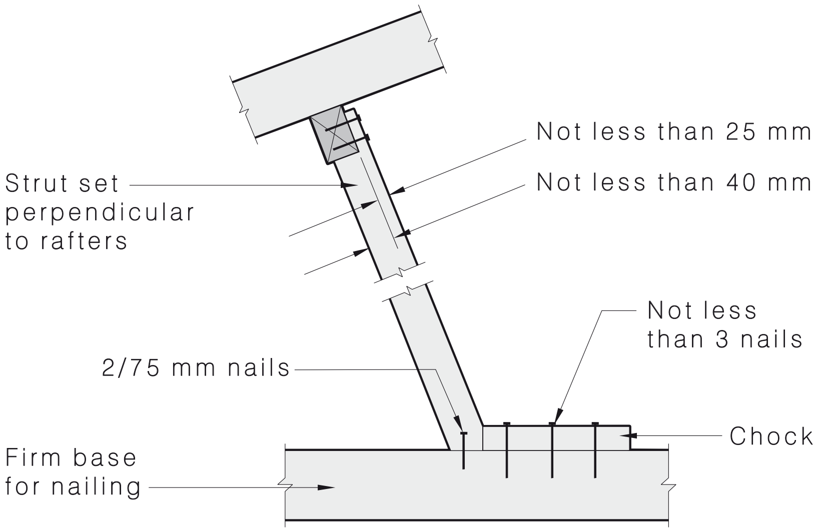
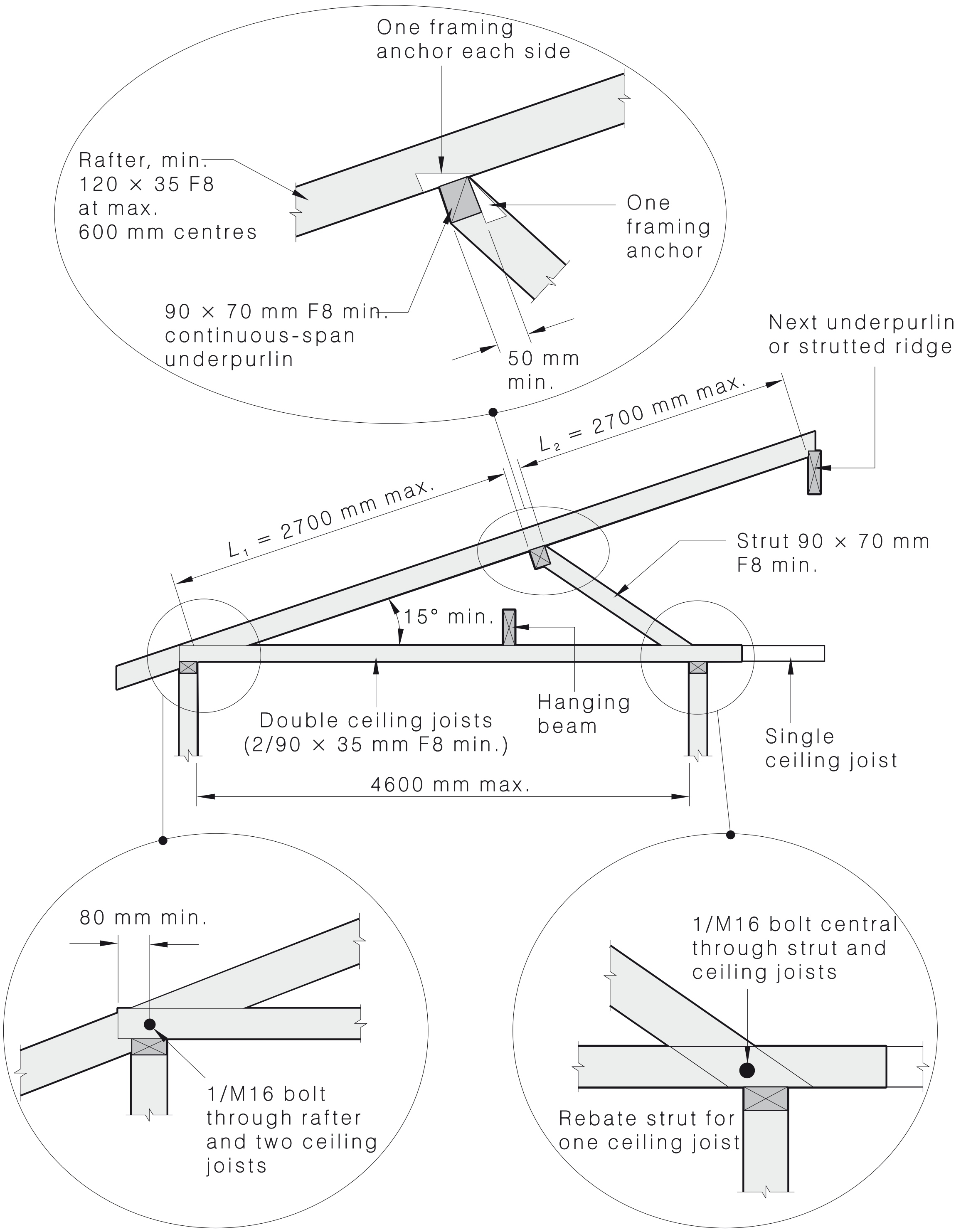


FIGURE 7.10 STRUTS PERPENDICULAR TO RAFTERS

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.



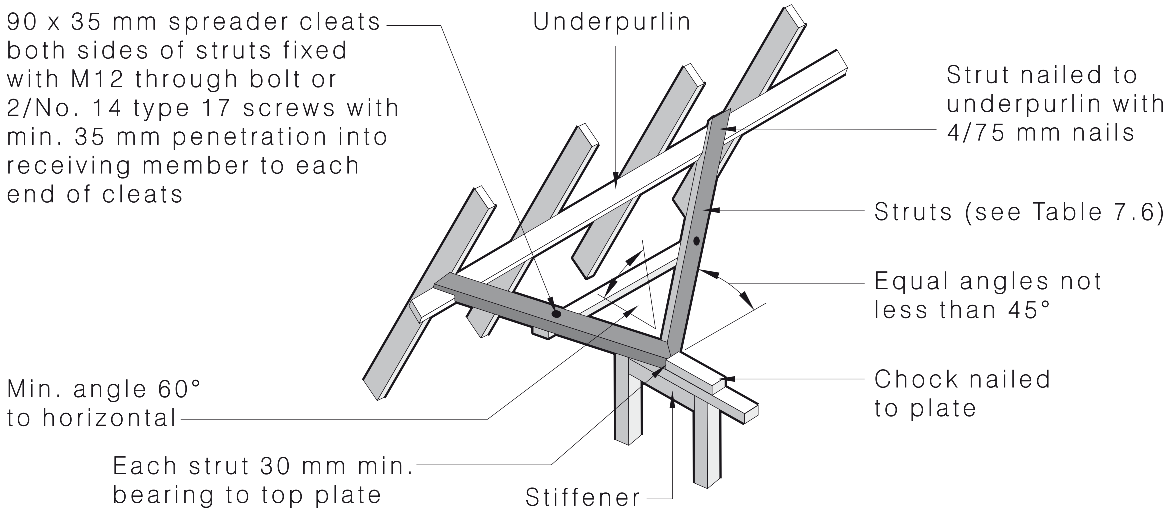
Length of L_1 shall be between L_2 and 1.25 times L_2

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.

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



NOTE: Maximum rafter span = 3000 mm.

FIGURE 7.12 FAN OR FLYING STRUTS

7.2.15.4 *Opposing struts*

Where roofs are strutted using opposing struts, they shall comply with Figure 7.13.

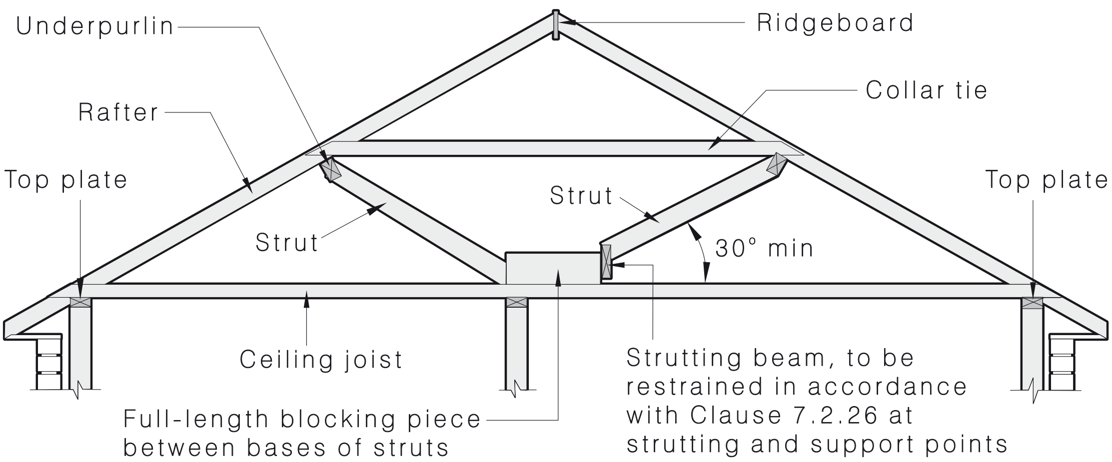


FIGURE 7.13 OPPOSING STRUTS

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 common 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 common rafters, or at 1200 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 hand-driven nails or 3/75 × 3.05 mm ∅ 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 I1, Appendix I.

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.

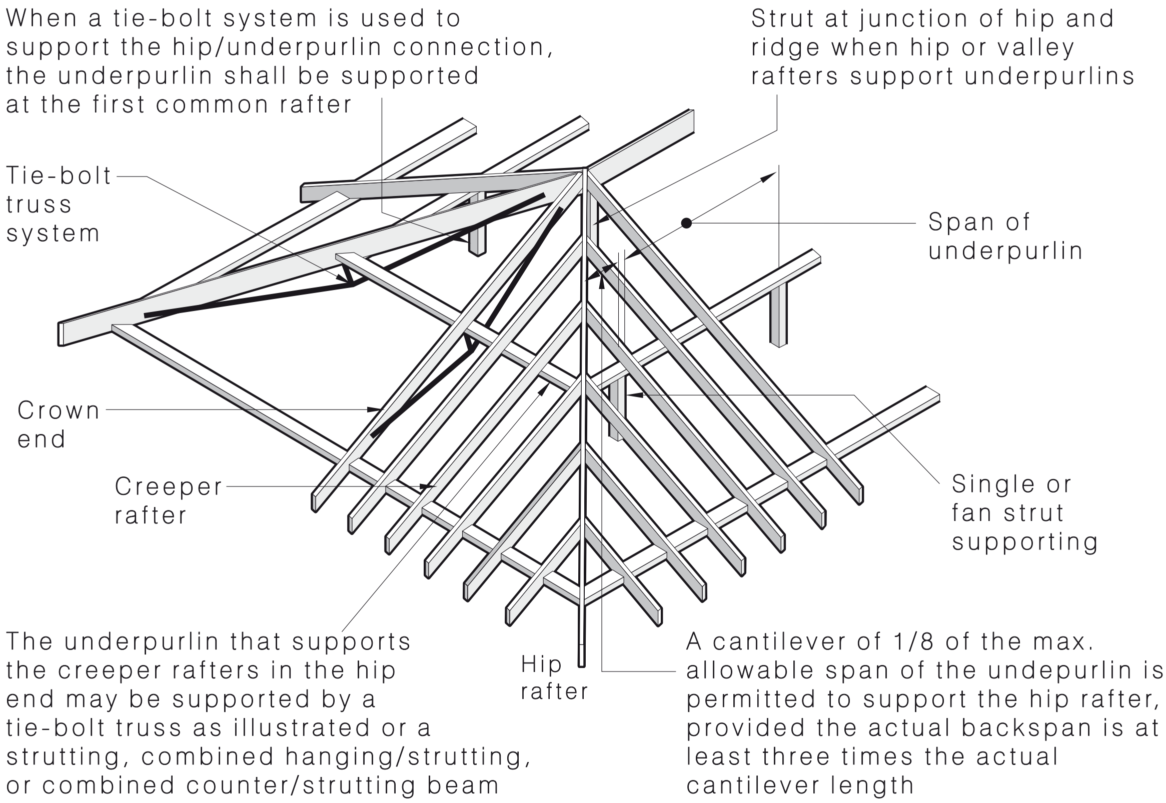


FIGURE 7.14 HIP END

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*

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.

7.2.19.2 *Ridge and intermediate beams*

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

Ridge beams shall be at right angles to the rafters and shall be 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 shall 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 × 19 mm shall be used.

NOTES:

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

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 verandah beam.

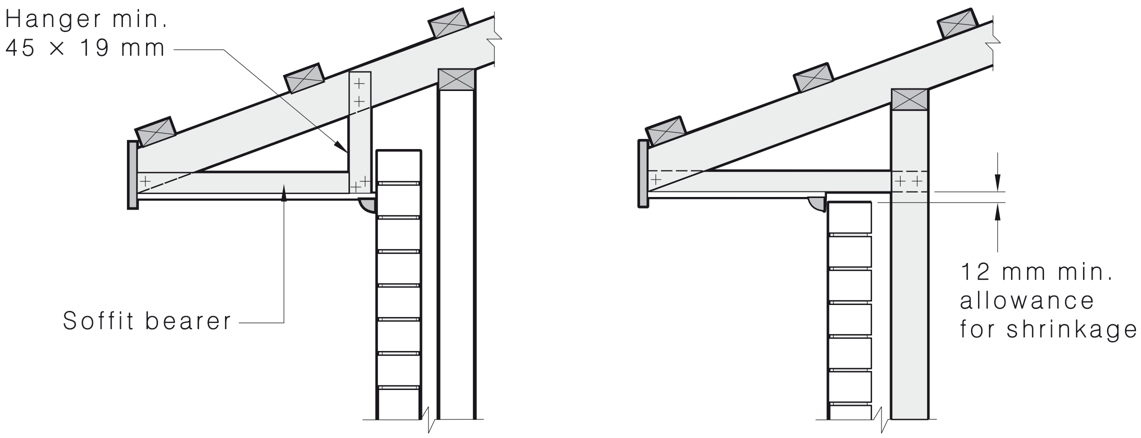
7.2.24.2 *Boxed eaves*

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

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

(b) 70 × 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 × 19 mm hangers from rafters (see Figure 7.15(a)), or shall 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 and 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, and 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.

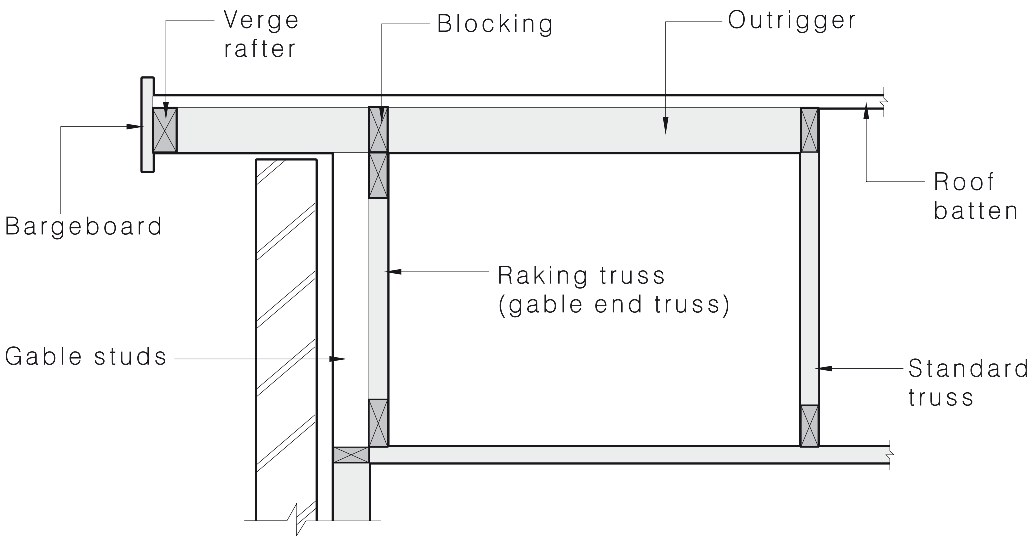


FIGURE 7.16 OPEN GABLE OR VERGE—TRUSSED ROOF

7.2.25.3 *Boxed gables*

Boxed gables shall have 70 × 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.

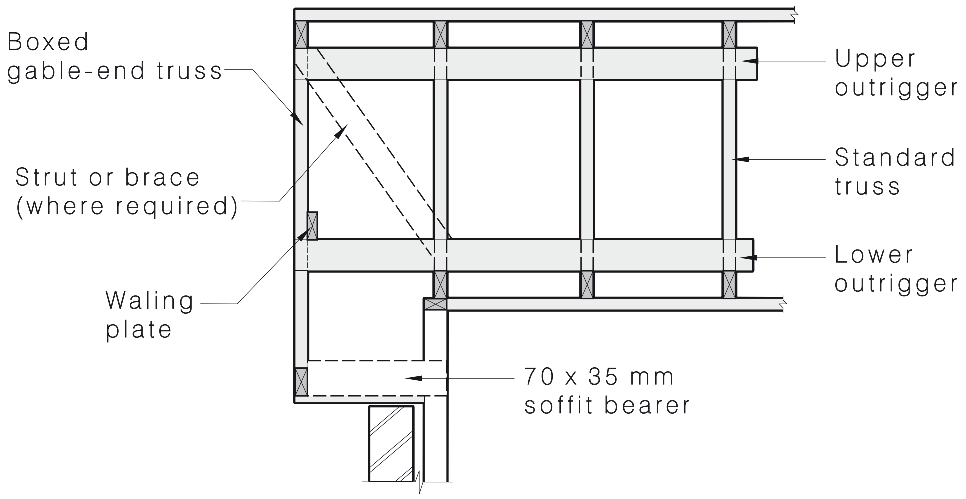
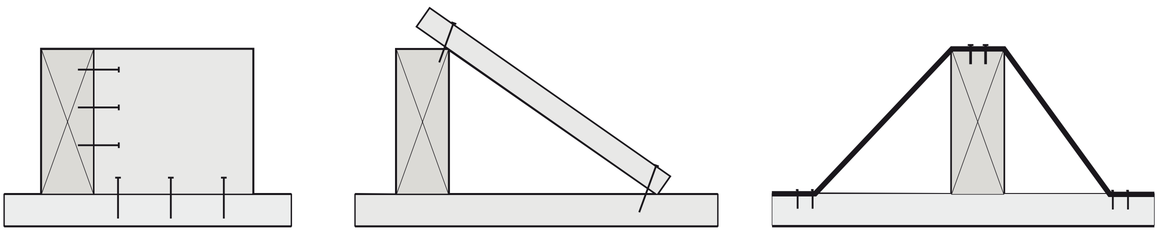


FIGURE 7.17 BOXED GABLE—TRUSSED ROOF

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.



(a) Block skew nailed to beam and to support with 3/75 mm skew nails to each member

(b) Min. 35 × 32 mm tie nailed to top of beam and to support with 2/75 mm nails each end (see Note 2)

(c) Galvanized strap nailed to support and top of beam with 2/30 × 2.8 mm nails each end and to beam (see Note 2)

NOTES:

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

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 Clause 2.7.4).

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			1200		
	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	1200
AS 2796.1	Western Australian hardwoods	Standard	11	13	19	24
		Select	10	12	17	22
AS 2796.1	South-eastern Australian hardwoods	Standard	10	13	19	24
		Select	11	12	17	22
AS 2796.1	North-eastern Australian hardwoods	Standard	10	13	18	23
		Select	10	12	17	22
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)					

NOTES:

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

2 Finger jointing is permitted.

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
1200	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, and 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		
		C1	C2	C3
800 or 900	Flat-head nails	3.15 mm ∅ × 65 mm	3.15 mm ∅ × 75 mm	N/A (see Note 2)
	Countersunk self-drilling timber screws	No. 8 × 50 mm	No. 10 × 50 mm	No. 10 × 75 mm
1200	Flat-head nails	3.75 mm ∅ × 75 mm	N/A (see Note 2)	N/A (see Note 2)
	Countersunk self-drilling timber screws	No. 10 × 50 mm	No. 10 × 60 mm	No. 10 × 75 mm
Fastener	**Roof area**			**Spacing, mm**
Nail	General roof areas			200
	Within 1200 mm of roof perimeter			100
Screw	All roof areas			200

NOTES:

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

2 Screw fixing is considered more appropriate in these high wind uplift areas. If nail fixing is required, a suitably qualified engineer should be consulted for a nail specification.

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 × 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 × 70 mm F5.

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

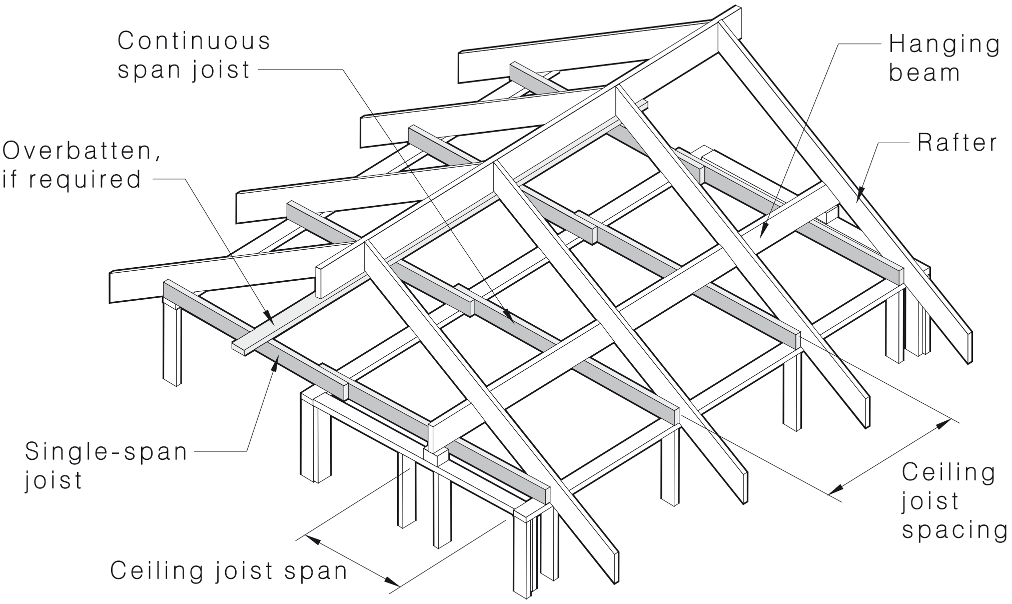


FIGURE 7.19 CEILING JOISTS

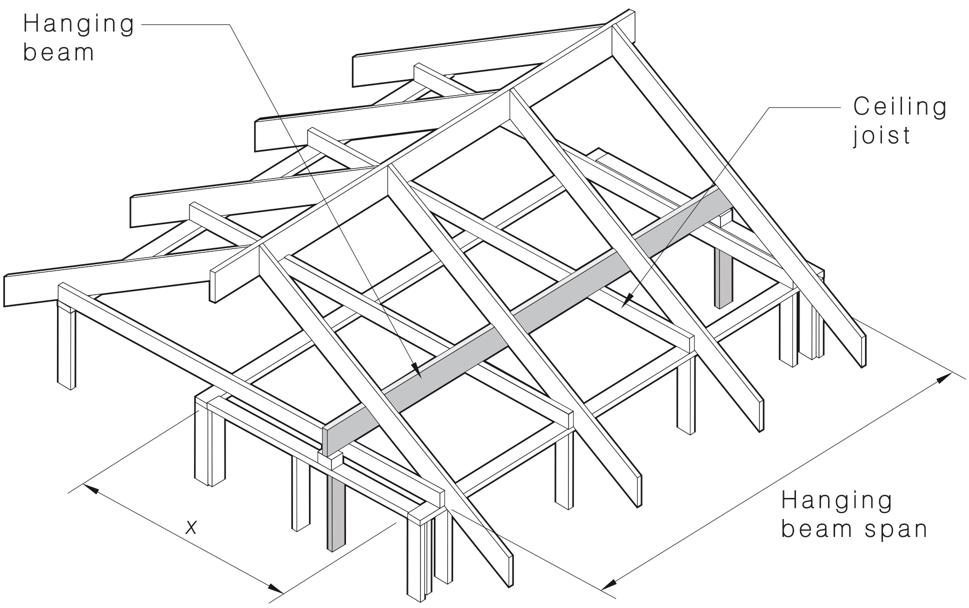
7.3.7 Hanging beams

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.



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

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

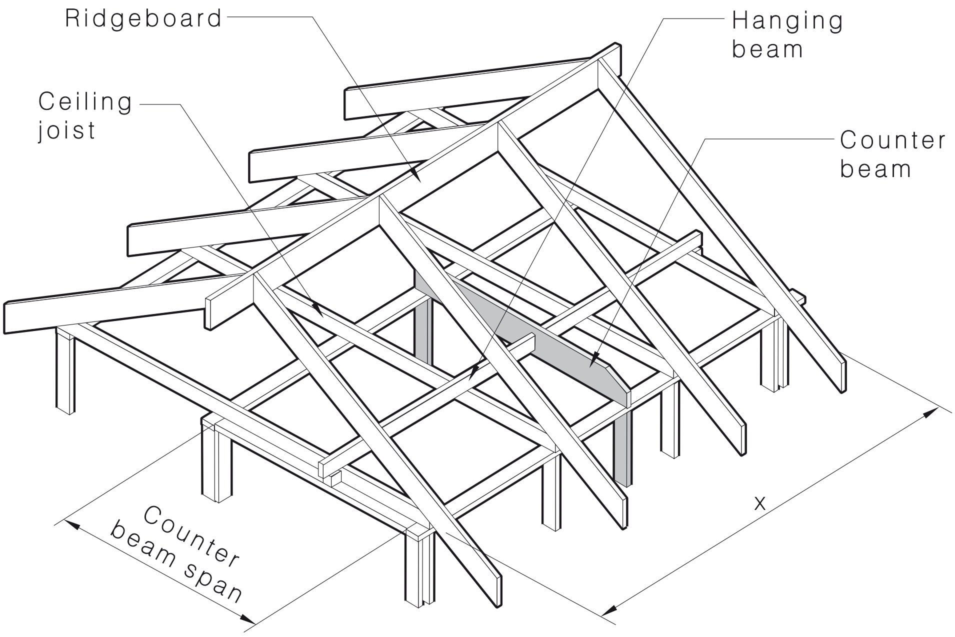
FIGURE 7.20 HANGING BEAMS

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.



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

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

FIGURE 7.21 COUNTER BEAMS

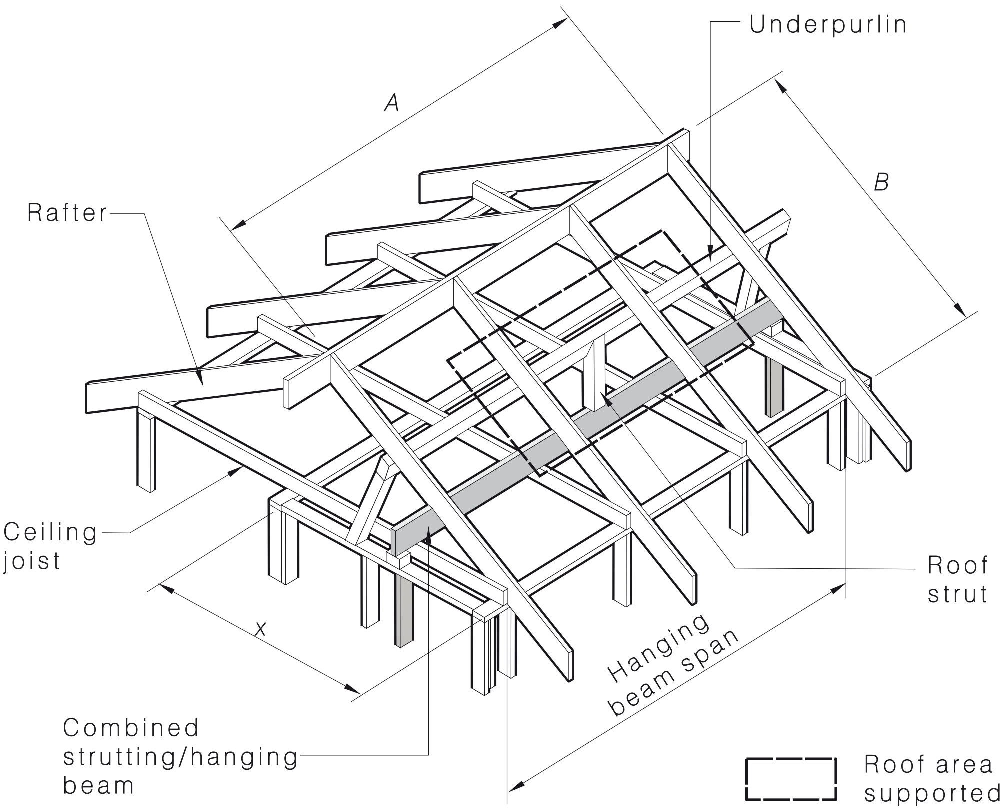
7.3.9 Combined strutting/hanging beams

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.



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

NOTES:

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

2 Ridge struts have been omitted for clarity.

FIGURE 7.22 COMBINED STRUTTING/HANGING BEAMS

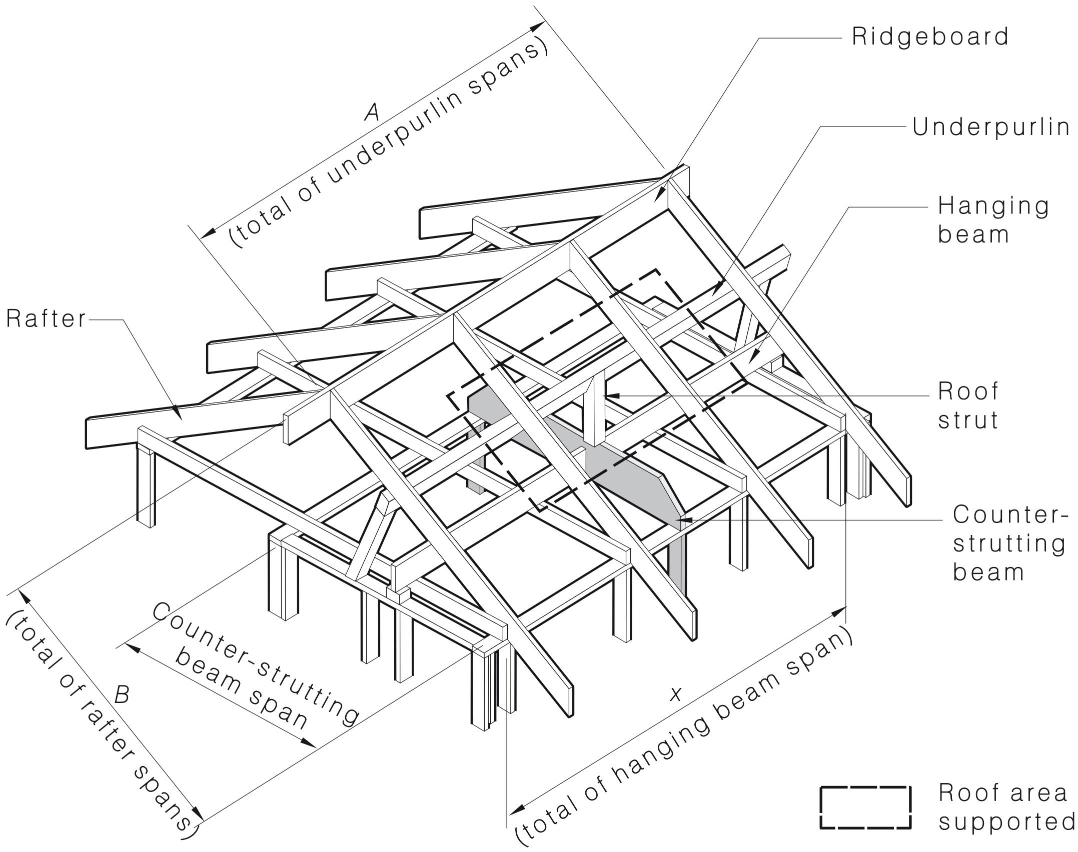
7.3.10 Combined counter/strutting beams

The size of combined counter/strutting beams shall be determined from Span Tables 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.



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

A = total of underpurlin spans either side of strut

B = total of rafter spans

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

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

x = total of hanging beam spans

NOTE: Ridge struts have been omitted for clarity.

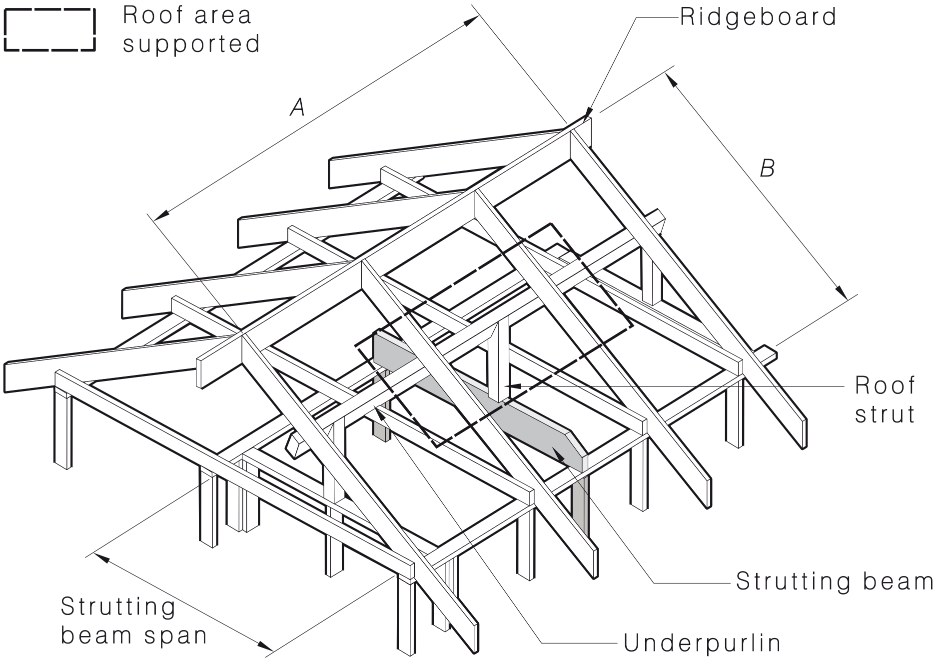
FIGURE 7.23 COMBINED COUNTER/STRUTTING BEAMS

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.



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

A = total of underpurlin spans

B = total of rafter spans

NOTES:

1 Strutting beams to support roof loads only

2 Ridge struts have been omitted for clarity.

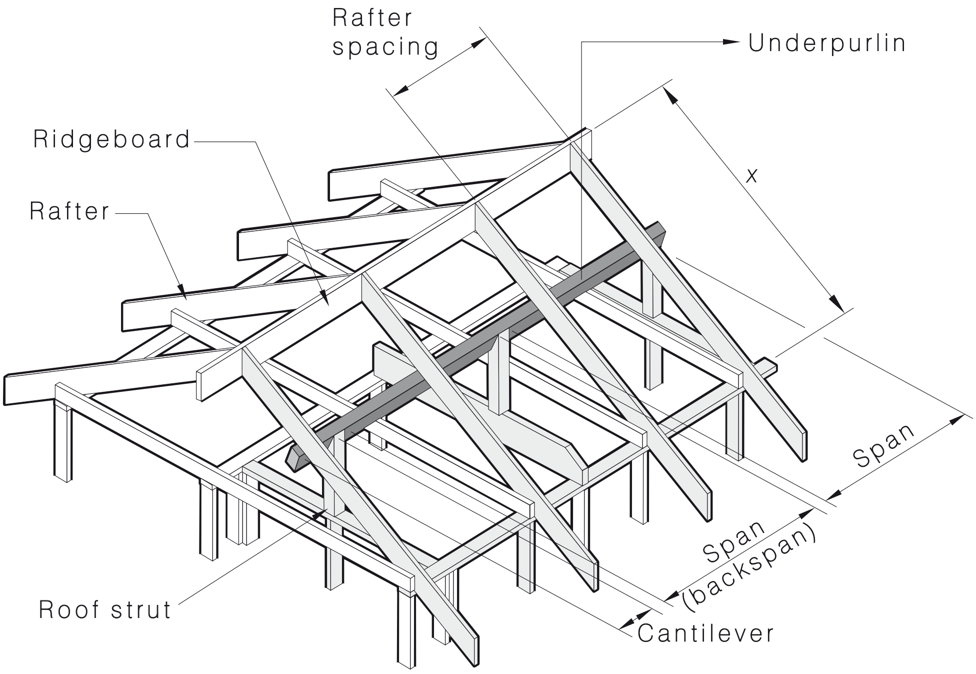
FIGURE 7.24 STRUTTING BEAMS

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.



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)

NOTES:

1 For single spans, continuous spans, and unequal spans, see Clause 2.7.5.

2 Ridge struts have been omitted for clarity.

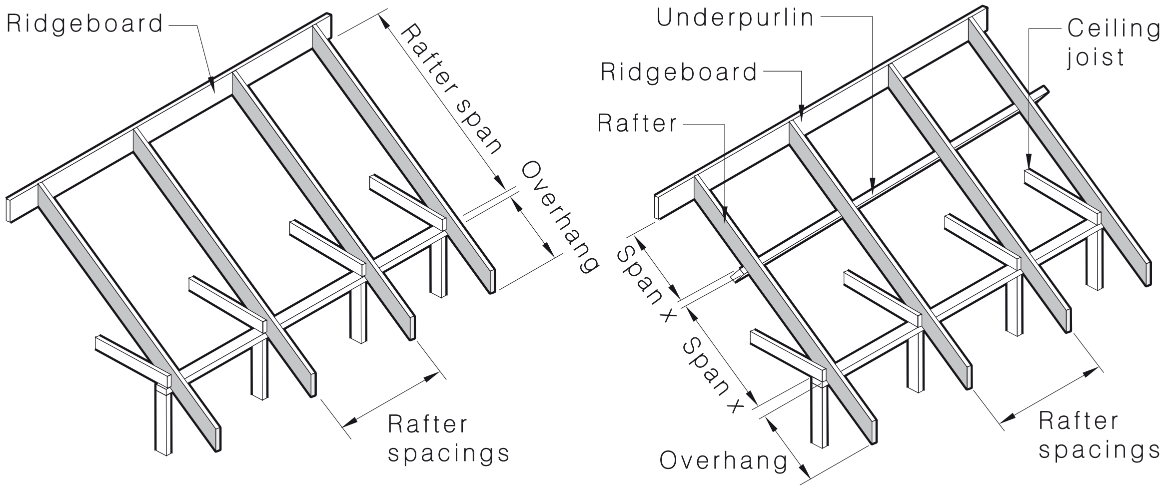
FIGURE 7.25 UNDERPURLINS

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. Design parameters for rafters supporting both roof and ceiling loads shall be as shown in Figure 7.27.



(a) Single span

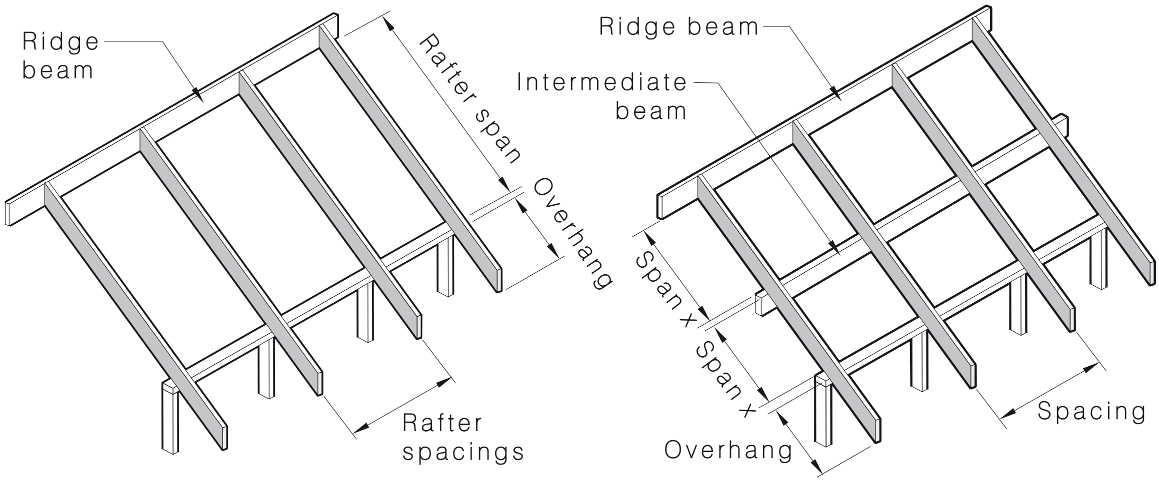
(b) Continuous span (for unequal spans, see Figure 2.18)

NOTES:

1 Maximum birdsmouth = 1/3 of rafter depth.

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

FIGURE 7.26 RAFTERS/PURLINS (COUPLED ROOFS)



(a) Single span

(b) Continuous span (for unequal spans, see Figure 2.18)

NOTES:

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

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

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 × 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.

NOTES:

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.

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 × 35 × 900 mm long fishplates extending 450 mm either side of the birdsmouth.

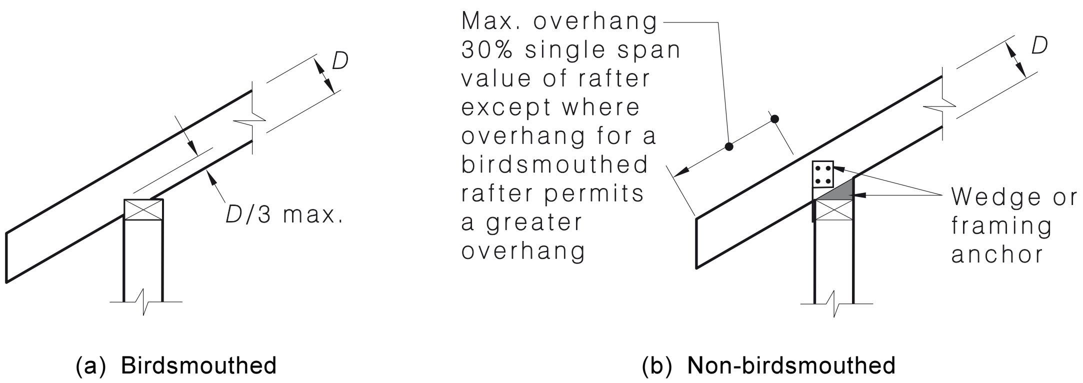


FIGURE 7.28 RAFTER OVERHANG AND BIRDSMOUTHING

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

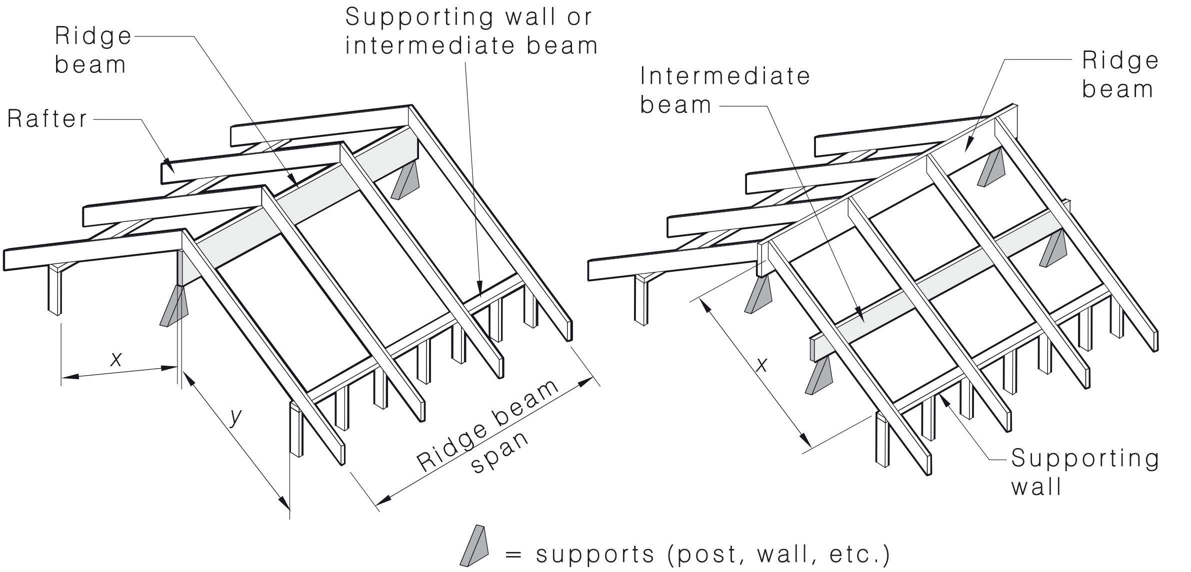
REDUCED SPANS AND OVERHANGS FOR DRESSED RAFTERS

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.



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

Beams shall not be checked or birdsmouthed at their supports.

(a) Ridge beams

(b) Intermediate beams

NOTES:

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

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 1200 mm. For spans greater than 1200 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.

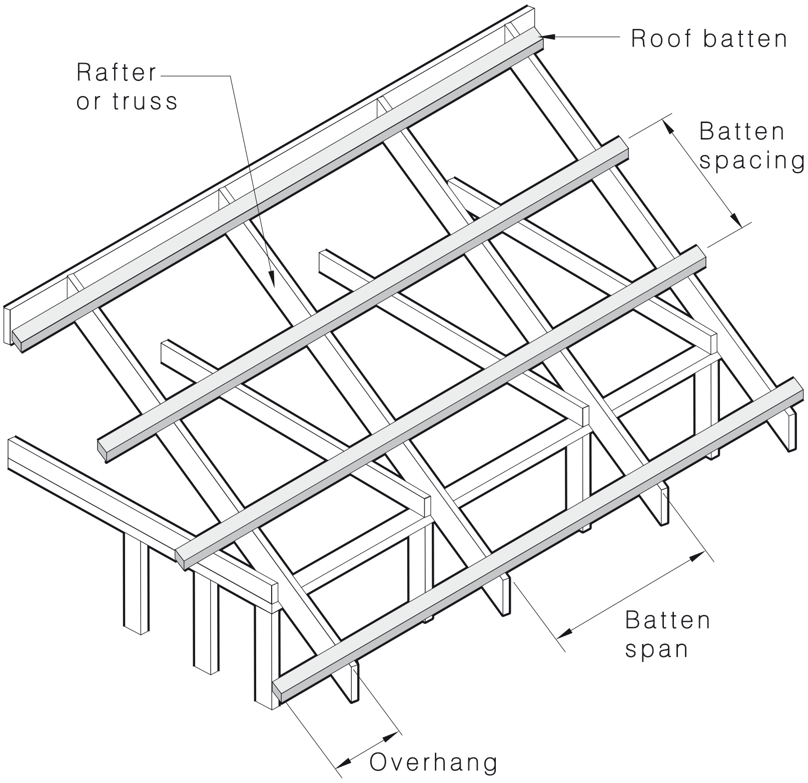
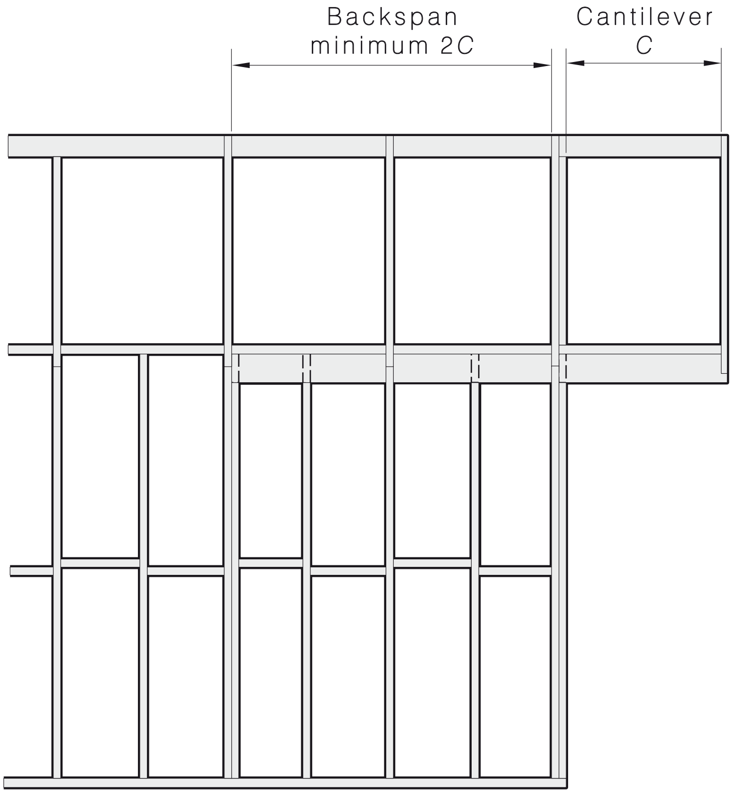


FIGURE 7.30 ROOF BATTENS

7.3.16 Cantilevered gable ends

Where cantilevered at gable ends as shown in Figure 7.31, the size of lintels, ring beams, verandah beams, underpurlins, and similar members, 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 Span Tables.



NOTE: To determine the size of a cantilevered member, refer to the appropriate Span Tables 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.

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.

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 1800 mm	Depth not less than length of the rafter plumb-cut × 19 thick
	Strutted ridge in coupled roof with strut spacing greater than 1800 mm and up to 2300 mm	Depth not less than length of the rafter plumb-cut × 35 thick
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	See Note	19 min. thick × width to support valley gutter
Roof struts (sheet roof)	Struts to 1500 mm long for all stress grades	90 × 45 or 70 × 70
	Struts 1500 mm to 2400 mm long for all stress grades	70 × 70
Collar ties	Ties to 4200 mm long for F8/MGP12 or higher stress grade	70 × 35
	Ties to 4200 mm long for less than F8/MGP 12 stress grade	70 × 45 or 90 × 35
	Ties over 4200 mm long for F8/MGP 12 or higher stress grade	90 × 35
	Ties over 4200 mm long for less than F8/MGP 12 stress grade	90 × 45 or 120 × 35
Soffit bearers (boxed eaves)	Max. span 600 mm	42 × 35
	Span 600 mm to 1500 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 1500 mm long for F8/MGP12 and higher stress grades	90 × 45 or 70 × 70
	Struts to 1500 mm long for less than F8/MGP12 stress grade	70 × 70
	Struts 1500 to 2400 mm long for F8/MGP12 and higher stress grades	70 × 70
	Struts 1500 to 2400 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 1500	F5 or better	Solid, glued or nail-laminated	90 × 45 or 2/70 × 35
	1501 to 2400			2/90 × 45
	2401 to 3000	F8 or better		2/90 × 45
	3001 to 3600	MGP 12 or better		2/90 × 45
Tile	Up to 1500	F5 or better	Solid, glued or nail-laminated	2/70 × 45 or 2/90 × 35
	1501 to 2400	F8 or better	Nail-laminated	2/120 × 45
			Solid or glue-laminated	2/90 × 35
	2401 to 3000	MGP 12 or better	Nail-laminated	2/120 × 45
			Solid or glue-laminated	2/90 × 35
	3001 to 3600	MGP 12 or better	Solid or glue-laminated	2/90 × 45

NOTE: 175 × 25 × 6 mm hardwood weatherboards may also be used for valley boards.

SECTION 8 RACKING AND SHEAR FORCES (BRACING)

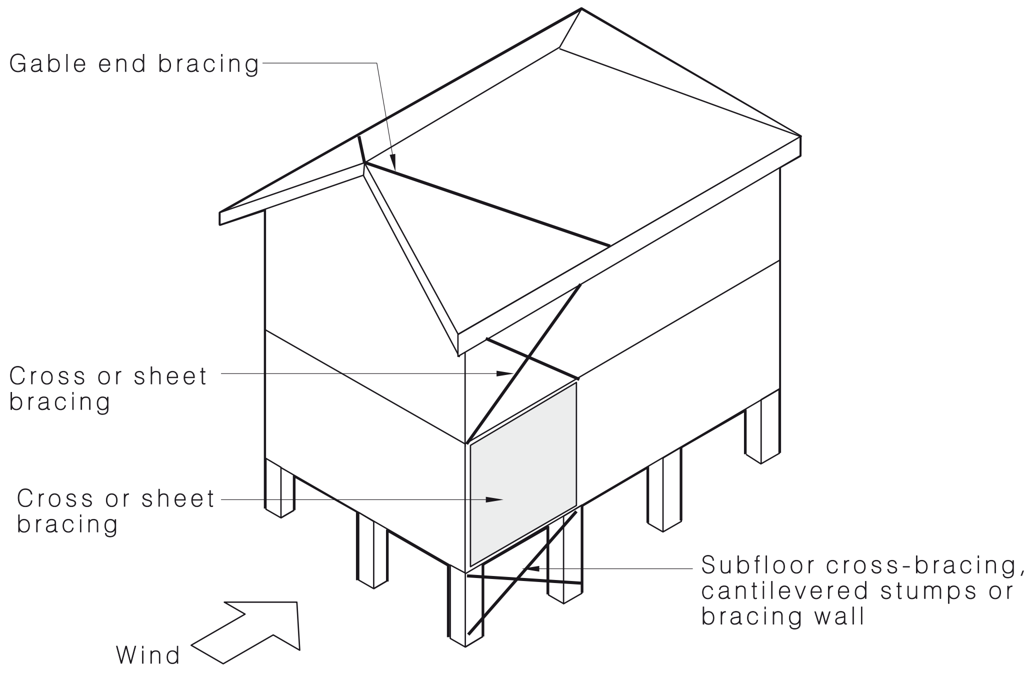
8.1 GENERAL

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.



NOTES:

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

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.

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 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 Figure 8.2).

(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.

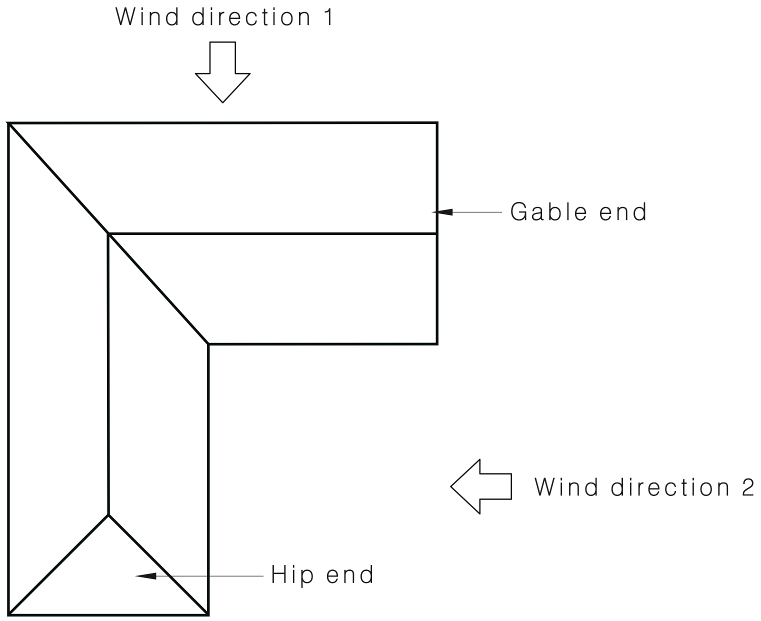
For complex building shapes, buildings that are composed of a combination of storeys or rectangles (i.e., L, H or U shapes), the shapes may be considered individually and added together later or the total area as a whole can be calculated. Irrespective of which method is used, bracing shall be calculated to address the most adverse situation and 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.

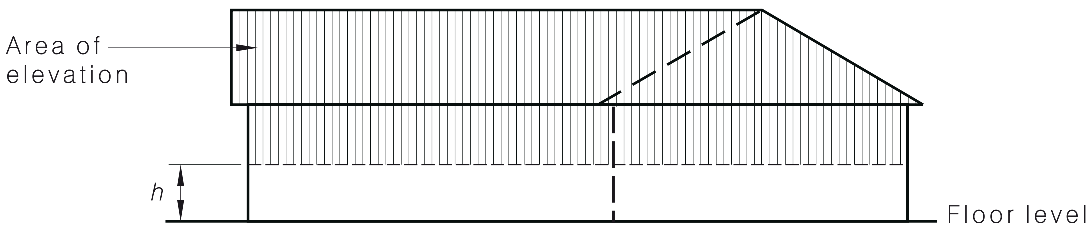
Where there is more than one floor level in a building, each level shall be considered separately for the purpose of calculating the minimum bracing required.

Determination of the area of elevation shall be as shown in Figure 8.2.

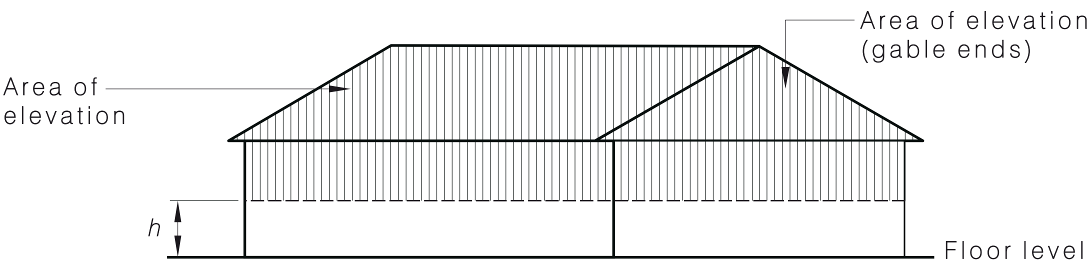
Bracing shall be evenly distributed, as specified in Clauses 8.3.6.6 and 8.3.6.7.



(a) Plan



(b) Wind direction 1



(c) Wind direction 2

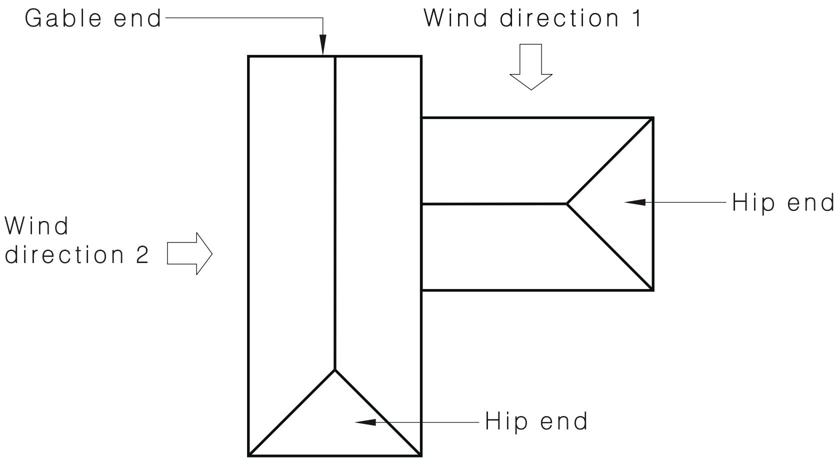
NOTES:

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

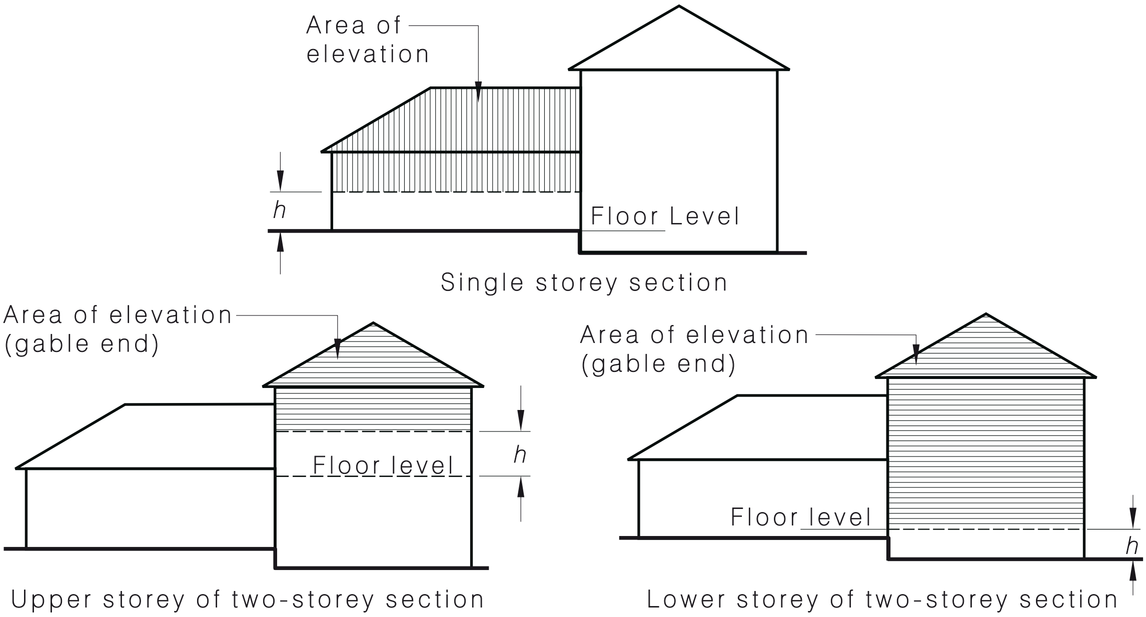
2 For wind direction 2, the pressure on the gable end is determined from Table 8.1 and the pressure on the hip section of the elevation is determined from Table 8.2. The total of racking forces is the sum of the forces calculated for each section.

3 The area of elevation of the triangular portion of eaves overhang up to 1000 mm wide may be ignored in the determination of area of elevation.

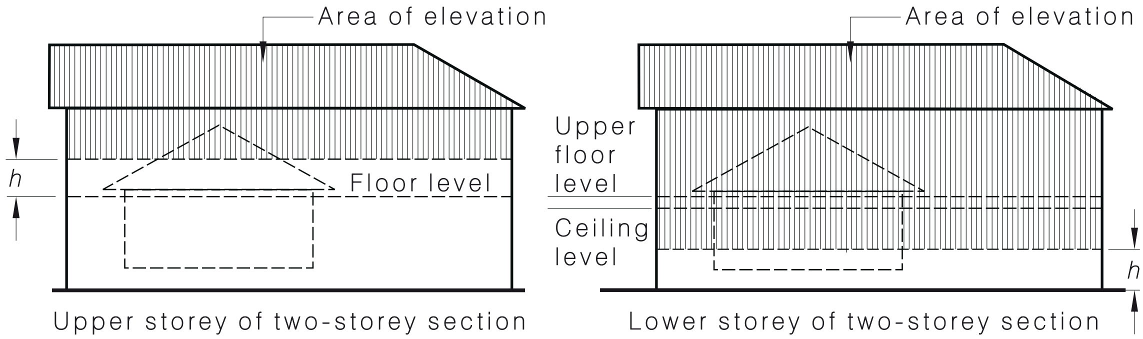
FIGURE 8.2(A) DETERMINING AREA OF ELEVATION—A SINGLE-STOREY BUILDING



(a) Plan



(b) Wind direction 1



(c) Wind direction 2

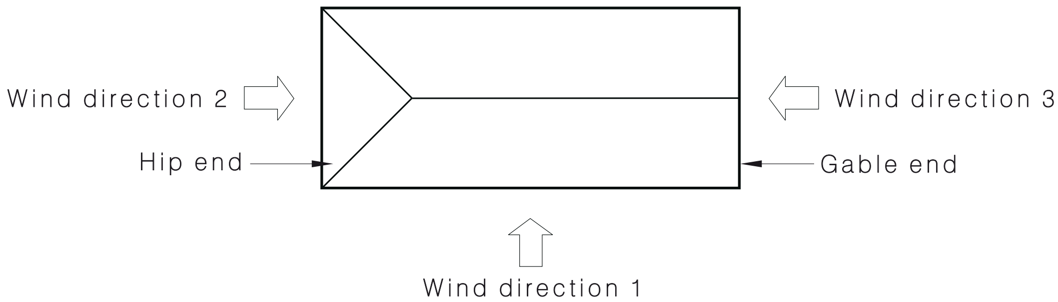
NOTES:

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

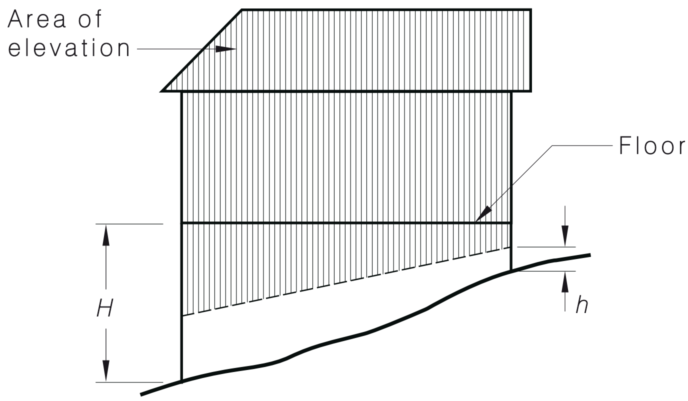
2 For lower storey of two storey section *h* = half the height of the lower storey (i.e., lower storey floor to lower storey ceiling).

3 The area of elevation of the triangular portion of eaves overhang up to 1000 mm wide may be ignored in the determination of area of elevation.

FIGURE 8.2(B) DETERMINING AREA OF ELEVATION—A TWO-STOREY OR SPLIT LEVEL BUILDING

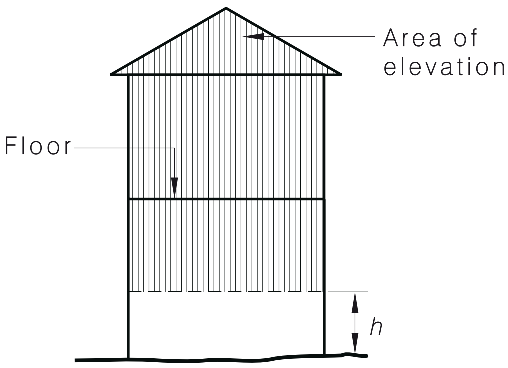


(a) Plan

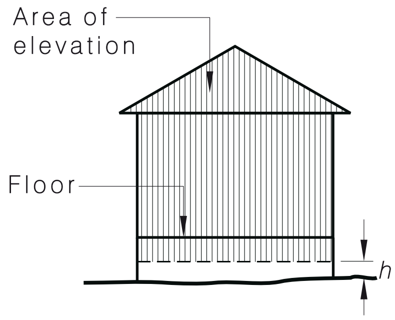


In the subfloor of a two-storey construction, the maximum distance (*H*) from the ground to the underside of the bearer in the lower floor shall be 1800 mm.

(b) Wind direction 1



(c) Wind direction 2—Hip end



(d) Wind direction 3—Gable end

NOTES:

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

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.

3 The area of elevation of the triangular portion of eaves overhang up to 1000 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.

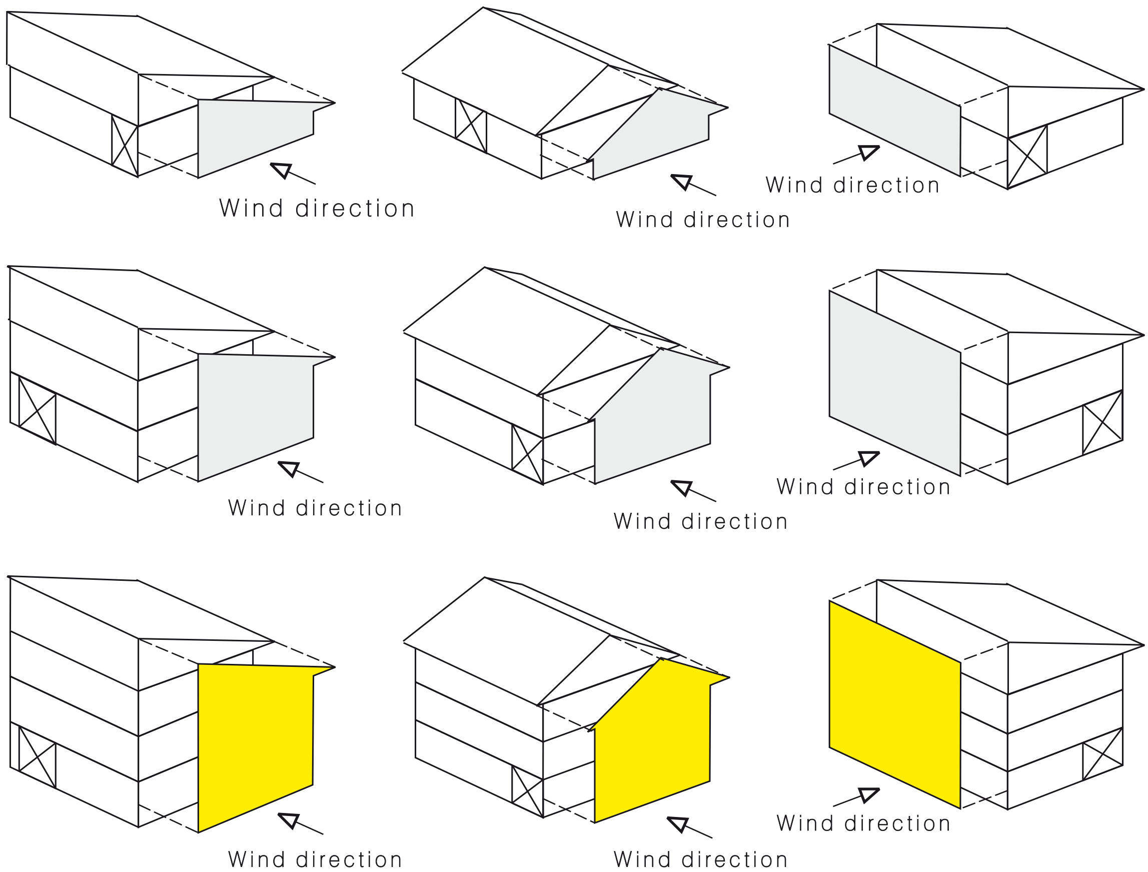
The total racking force for each storey or level of the building shall be the product of the projected area of elevation of the building multiplied by the lateral wind pressure determined from Tables 8.1 to 8.5. The racking force shall be calculated for both directions (long and short sides) of the building.

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

$$\text{Total racking force} = \text{Area of elevation (m}^2\text{)} \times \text{Lateral wind pressure (kPa)}$$

TABLE 8.1

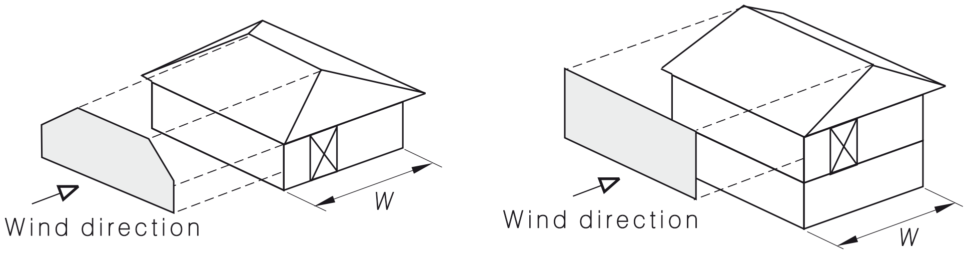
PRESSURE (kPa) ON AREA OF ELEVATION (m^2)—SINGLE STOREY, UPPER OF TWO STOREYS, LOWER STOREY OR SUBFLOOR OF SINGLE STOREY OR TWO STOREYS—ALL VERTICAL SURFACE ELEVATIONS (GABLE ENDS, SKILLION ENDS AND FLAT WALL SURFACES)



Wind classification	Pressure, kPa
C1	1.4
C2	2.1
C3	3.2

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



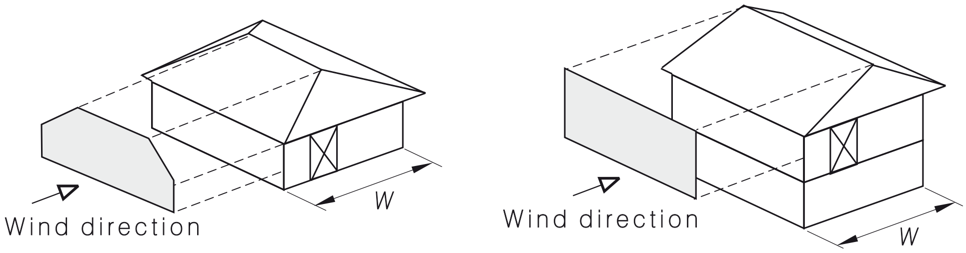
NOTE: See Figure 1.1 for guidance on determining *W*.

W	Roof pitch, degrees							
m	0	5	10	15	20	25	30	35
C1								
4.0	1.3	1.2	1.0	0.95	0.96	1.1	1.2	1.2
5.0	1.3	1.1	1.0	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
C2								
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: 0° pitch is provided for interpolation purposes only.

(*continued*)

TABLE 8.2 (*continued*)



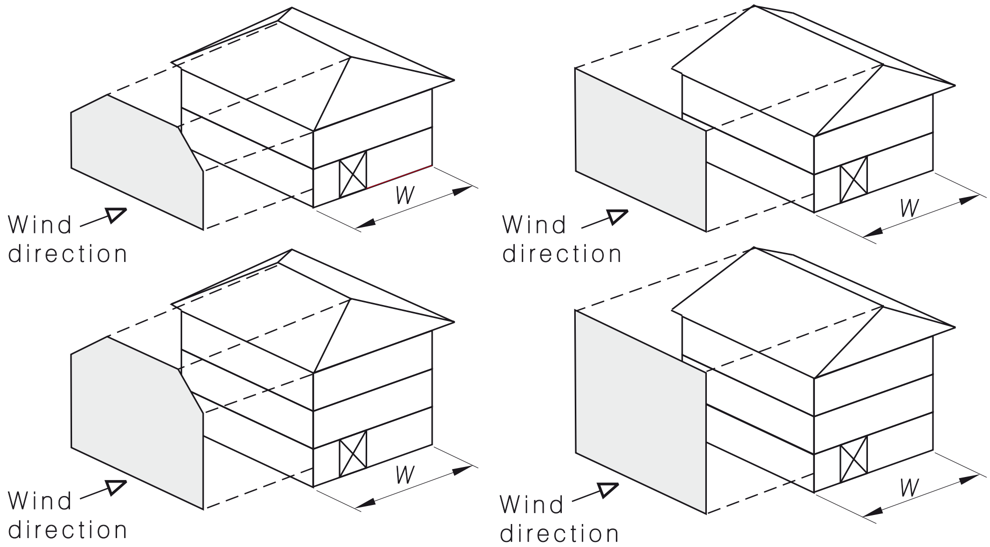
NOTE: See Figure 1.1 for guidance on determining *W*.

W	**Roof pitch, degrees**							
m	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**
C3								
4.0	2.9	2.5	2.3	2.1	2.1	2.5	2.6	2.6
5.0	2.9	2.4	2.2	1.9	2.0	2.4	2.6	2.6
6.0	2.9	2.4	2.1	1.9	2.0	2.4	2.5	2.6
7.0	2.9	2.3	2.0	1.8	2.0	2.4	2.5	2.6
8.0	2.9	2.2	1.9	1.7	2.1	2.4	2.5	2.6
9.0	2.9	2.2	1.8	1.7	2.1	2.4	2.4	2.6
10.0	2.9	2.1	1.8	1.6	2.1	2.5	2.4	2.6
11.0	2.9	2.1	1.7	1.7	2.1	2.5	2.4	2.6
12.0	2.9	2.0	1.6	1.7	2.1	2.5	2.4	2.6
13.0	2.9	2.0	1.6	1.7	2.2	2.5	2.4	2.6
14.0	2.9	1.9	1.5	1.7	2.2	2.5	2.5	2.6
15.0	2.9	1.9	1.4	1.7	2.2	2.5	2.5	2.6
16.0	2.9	1.8	1.4	1.7	2.2	2.5	2.5	2.7

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

TABLE 8.3

PRESSURE (kPa) ON AREA OF ELEVATION (m^2)—LOWER STOREY OR SUBFLOOR OF SINGLE STOREY OR TWO STOREYS—LONG LENGTH OF BUILDING—HIP OR GABLE ENDS



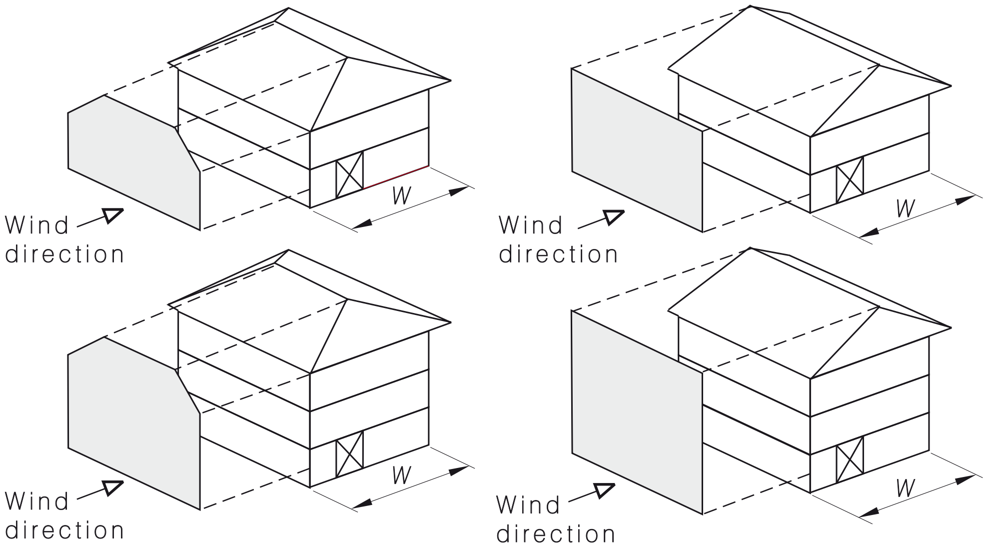
NOTE: See Figure 1.1 for guidance on determining *W*.

W	**Roof pitch, degrees**							
m	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**
C1								
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
C2								
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

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

(*continued*)

TABLE 8.3 (*continued*)



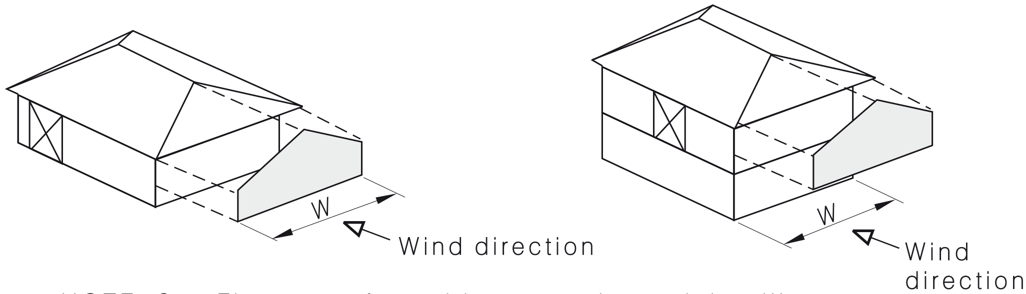
NOTE: See Figure 1.1 for guidance on determining *W*.

W m	Roof pitch, degrees 0	5	10	15	20	25	30	35
C3								
4.0	2.9	2.8	2.7	2.6	2.6	2.8	2.9	2.9
5.0	2.9	2.7	2.6	2.5	2.5	2.8	2.9	2.8
6.0	2.9	2.7	2.6	2.5	2.5	2.8	2.8	2.8
7.0	2.9	2.7	2.5	2.4	2.5	2.8	2.8	2.8
8.0	2.9	2.7	2.5	2.4	2.5	2.8	2.8	2.8
9.0	2.9	2.6	2.4	2.3	2.5	2.8	2.7	2.8
10.0	2.9	2.6	2.4	2.3	2.5	2.8	2.7	2.8
11.0	2.9	2.6	2.4	2.3	2.5	2.8	2.7	2.8
12.0	2.9	2.5	2.3	2.3	2.5	2.7	2.7	2.8
13.0	2.9	2.5	2.3	2.3	2.5	2.7	2.7	2.8
14.0	2.9	2.5	2.2	2.3	2.5	2.7	2.7	2.8
15.0	2.9	2.5	2.2	2.3	2.5	2.7	2.7	2.8
16.0	2.9	2.5	2.1	2.3	2.5	2.7	2.7	2.8

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

TABLE 8.4

PRESSURE (kPa) ON AREA OF ELEVATION (m^2)—SINGLE STOREY OR UPPER OF TWO STOREYS—SHORT END OF BUILDING—HIP ENDS



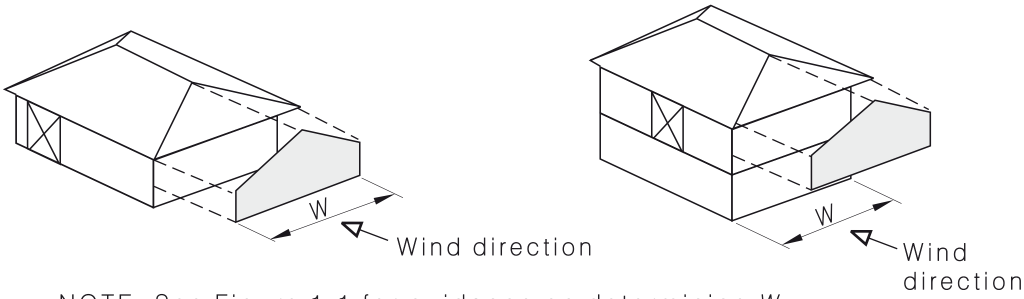
NOTE: See Figure 1.1 for guidance on determining *W*.

W	**Roof pitch, degrees**							
m	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**
C1								
4.0	1.4	1.3	1.3	1.2	1.2	1.2	1.3	1.3
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
C2								
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: 0° pitch is provided for interpolation purposes only.

(*continued*)

TABLE 8.4 (*continued*)



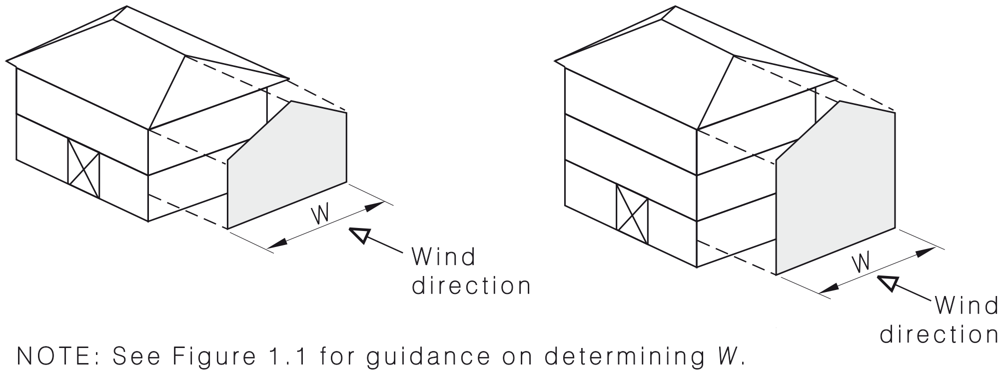
NOTE: See Figure 1.1 for guidance on determining *W*.

W m	Roof pitch, degrees 0	5	10	15	20	25	30	35
C3								
4.0	3.2	2.9	2.8	2.6	2.6	2.7	2.8	2.8
5.0	3.2	2.9	2.7	2.5	2.5	2.6	2.8	2.7
6.0	3.2	2.8	2.6	2.4	2.5	2.6	2.7	2.7
7.0	3.2	2.8	2.6	2.4	2.5	2.6	2.7	2.7
8.0	3.2	2.8	2.5	2.3	2.5	2.6	2.6	2.7
9.0	3.2	2.7	2.4	2.3	2.5	2.6	2.6	2.7
10.0	3.2	2.7	2.4	2.2	2.5	2.6	2.6	2.7
11.0	3.2	2.6	2.3	2.2	2.5	2.6	2.6	2.7
12.0	3.2	2.6	2.2	2.2	2.5	2.6	2.6	2.7
13.0	3.2	2.5	2.2	2.2	2.5	2.6	2.6	2.7
14.0	3.2	2.5	2.1	2.2	2.5	2.6	2.6	2.7
15.0	3.2	2.5	2.1	2.2	2.5	2.6	2.6	2.7
16.0	3.2	2.4	2.0	2.2	2.5	2.6	2.6	2.7

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

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



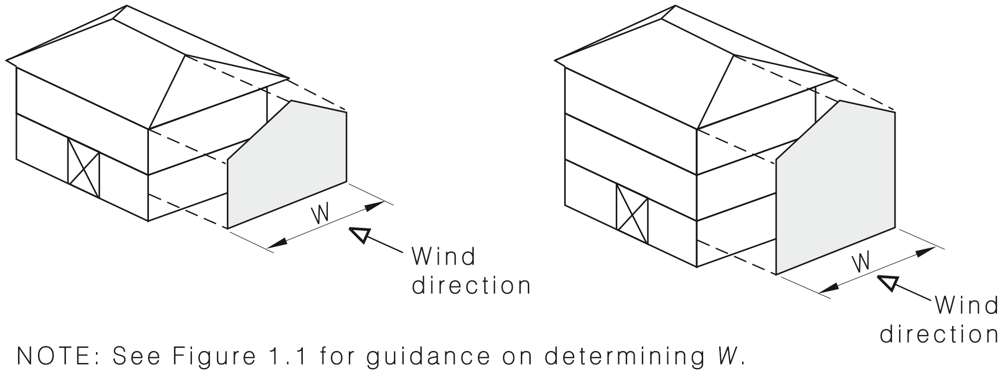
NOTE: See Figure 1.1 for guidance on determining *W*.

W	**Roof pitch, degrees**							
m	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**
C1								
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
C2								
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
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: 0° pitch is provided for interpolation purposes only.

(*continued*)

TABLE 8.5 (*continued*)



NOTE: See Figure 1.1 for guidance on determining *W*.

W	Roof pitch, degrees							
m	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**
C3								
4.0	3.2	3.1	3.0	3.0	3.0	3.0	3.0	3.0
5.0	3.2	3.1	3.0	2.9	2.9	2.9	3.0	3.0
6.0	3.2	3.1	3.0	2.9	2.9	2.9	3.0	2.9
7.0	3.2	3.0	2.9	2.9	2.9	2.9	2.9	2.9
8.0	3.2	3.0	2.9	2.8	2.9	2.9	2.9	2.9
9.0	3.2	3.0	2.9	2.8	2.9	2.9	2.9	2.9
10.0	3.2	3.0	2.9	2.8	2.9	2.9	2.9	2.9
11.0	3.2	3.0	2.8	2.8	2.8	2.9	2.9	2.9
12.0	3.2	3.0	2.8	2.7	2.8	2.9	2.9	2.9
13.0	3.2	2.9	2.8	2.7	2.8	2.9	2.8	2.9
14.0	3.2	2.9	2.7	2.7	2.8	2.9	2.8	2.9
15.0	3.2	2.9	2.7	2.7	2.8	2.9	2.8	2.9
16.0	3.2	2.9	2.7	2.7	2.8	2.9	2.8	2.9

NOTE: 0° itch is provided for interpolation purposes only.

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, that is, 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 C1. For wind classifications C2 and C3, 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 C1

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

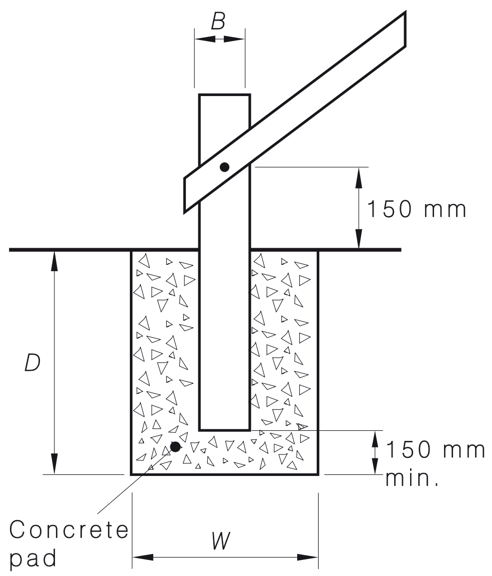
8.3.5.4 *Braced timber stumps*

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 TO C1



Concrete pier diameter (*W*)	Concrete depth (*D*), mm			
	400	600	800	1000
mm	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

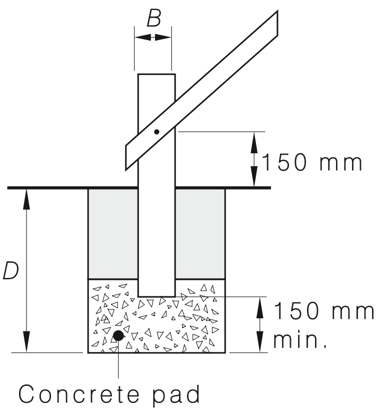
NOTES:

1 This Table is suitable for wind classification up to C1.

2 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 TO C1



Stump diameter (*B*)	Concrete depth (*D*), mm			
	400	600	800	1000
mm	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

NOTES:

1 This Table is suitable for wind classification up to C1.

2 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 × 90 mm	90 × 45 mm F11 or better over 3 columns or 140 × 45 mm F11 or better over 2 columns	4/No. 14 Type 17 screws	13
Concrete/masonry or timber column min. 90 × 90 mm	90 × 45 mm F11 or better over 3 columns or 140 × 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 × 120 mm or 150 mm diameter	170 × 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.

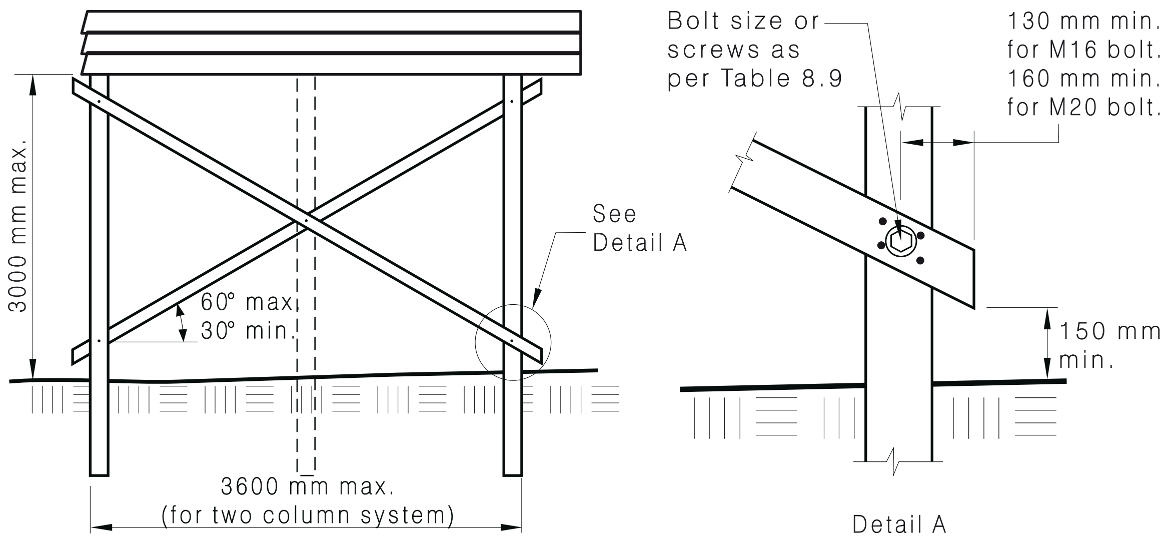


FIGURE 8.3 TIMBER BRACES ON MASONRY OR TIMBER COLUMNS

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 C1 where no uplift occurs. For wind classifications C2 and C3, see 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.

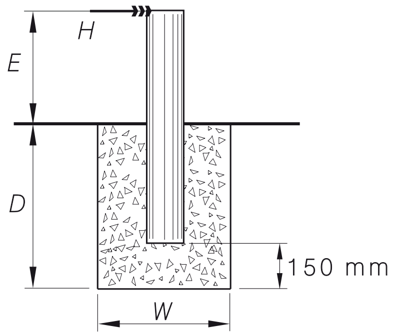
The footing size shall also be assessed for bearing (see Clause 3.6).

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

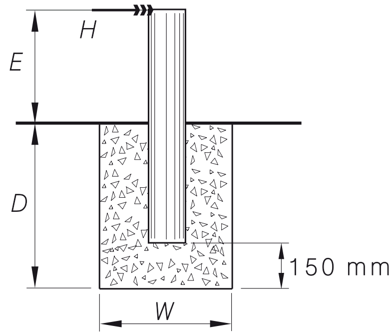
BRACING CAPACITY—CANTILEVERED STUMPS IN CONCRETE BACKFILL—SOIL CLASSIFICATIONS A, S AND M—WIND CLASSIFICATIONS TO C1



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
	1000	9.5	11	13	15	17	23
	1200	13	15	18	21	23	31
	1400	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
	1000	7.7	9.2	11	12	14	18
	1200	11	13	15	17	19	26
	1400	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
	1000	6.5	7.8	9.1	10	11	16
	1200	9.2	11	13	15	17	22
	1400	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
	1000	5.6	6.7	7.8	9.0	10	13
	1200	8.1	9.7	11	13	15	19
	1400	11	13	15	17	19	25

NOTE: This Table is suitable for wind classifications up to C1. (*continued*)

TABLE 8.10 (*continued*)

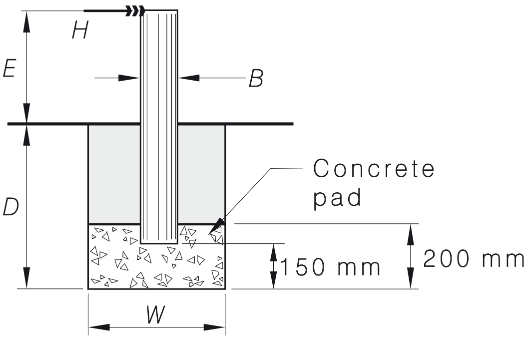


Height above footing (*E*) mm	Pier depth (*D*) mm	Bracing capacity (*H*), kN					
		Pier diameter (*W*), mm					
		250	**300**	**350**	**400**	**450**	**600**
1000	400	0.7	0.8	1.0	1.1	1.2	1.7
	600	1.7	2.1	2.4	2.7	3.1	4.1
	800	3.1	3.7	4.3	5.0	5.6	7.4
	1000	4.9	5.9	6.9	7.9	8.9	12
	1200	7.2	8.6	10	11	13	17
	1400	9.5	11	13	15	17	23
1200	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
	1000	4.4	5.3	6.2	7.0	7.9	11
	1200	6.5	7.8	9.1	10	12	15
	1400	8.6	10	12	14	15	21
1400	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
	1000	4.0	4.8	5.6	6.4	7.1	9.5
	1200	5.9	7.1	8.2	9.4	11	14
	1400	7.9	9.5	11	13	14	19
1600	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
	1000	3.6	4.3	5.1	5.8	6.5	8.7
	1200	5.4	6.5	7.6	8.6	9.7	13
	1400	7.3	8.7	10	12	13	17
1800	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
	1000	3.3	4.0	4.7	5.3	6.0	8.0
	1200	5.0	6.0	7.0	8.0	9.0	12
	1400	6.7	8.1	9.4	11	12	16

NOTE: This Table is suitable for wind classifications up to C1

TABLE 8.11

BRACING CAPACITY—CANTILEVERED STUMPS IN SOIL BACKFILL—SOIL CLASSIFICATIONS A, S AND M— WIND CLASSIFICATIONS TO C1



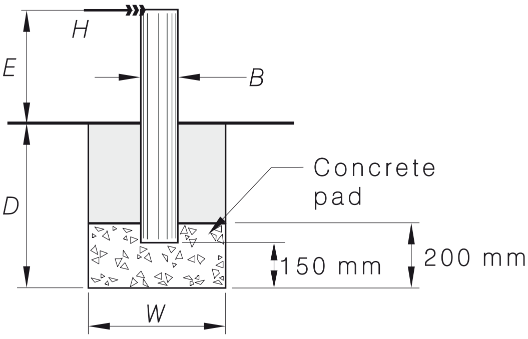
Concrete base support W = 300 mm

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
	1000	3.8	3.9	4.6	6.2	7.7
	1200	4.4	5.5	6.6	8.8	11
	1400	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
	1000	2.8	2.9	3.5	4.7	5.8
	1200	3.4	4.3	5.2	6.9	8.6
	1400	4.8	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	1.4	1.4
	800	1.8	1.8	1.8	2.3	2.9
	1000	2.3	2.4	2.9	3.9	4.8
	1200	2.9	3.6	4.4	5.8	7.3
	1400	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
	1000	1.9	2.0	2.5	3.3	4.1
	1200	2.5	3.2	3.8	5.1	6.3
	1400	3.6	4.5	5.4	7.2	9.0

NOTE: This Table is suitable for wind classifications up to C1.

(*continued*)

TABLE 8.11 (*continued*)

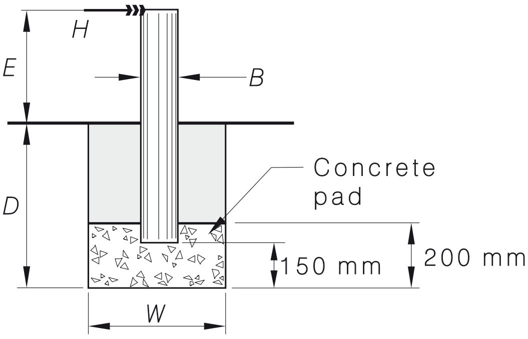


Concrete base support *W* = 300 mm

Height above footing (*E*) mm	Stump depth (*D*) mm	Bracing capacity (*H*), kN				
		Stump thickness/diameter (*B*), mm				
		100	125	150	200	250
1000	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
	1000	1.7	1.8	2.2	2.9	3.6
	1200	2.2	2.8	3.3	4.5	5.6
	1400	3.2	4.0	4.8	6.4	8.0
1200	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
	1000	1.5	1.6	1.9	2.6	3.2
	1200	2.0	2.5	3.0	4.0	5.0
	1400	2.9	3.6	4.3	5.8	7.2
1400	400	—	—	—	—	—
	600	0.5	0.7	0.7	0.7	0.7
	800	1.0	1.0	1.0	1.3	1.6
	1000	1.3	1.4	1.7	2.3	2.9
	1200	1.8	2.3	2.7	3.6	4.5
	1400	2.6	3.3	3.9	5.3	6.6
1600	400	—	—	—	—	—
	600	0.5	0.6	0.6	0.6	0.6
	800	0.9	0.9	0.9	1.2	1.5
	1000	1.2	1.3	1.6	2.1	2.6
	1200	1.6	2.1	2.5	3.3	4.1
	1400	2.4	3.0	3.6	4.8	6.0

NOTE: This Table is suitable for wind classifications up to C1. (*continued*)

TABLE 8.11 (*continued*)



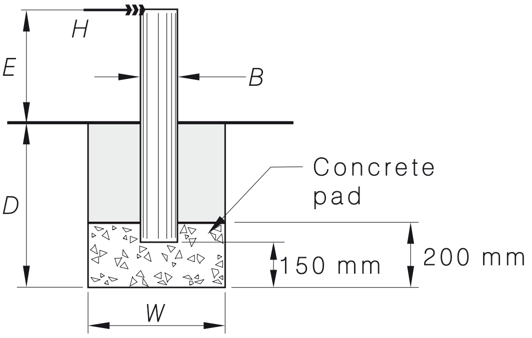
Concrete base support W = 300 mm

Height above footing (E) mm	Stump depth (D) mm	Bracing capacity (H), kN				
		Stump thickness/diameter (B), mm				
		100	125	150	200	250
1800	400	—	—	—	—	—
	600	0.4	0.5	0.5	0.5	0.6
	800	0.8	0.8	0.8	1.1	1.3
	1000	1.0	1.1	1.4	1.9	2.4
	1200	1.5	1.9	2.3	3.0	3.8
	1400	2.2	2.8	3.3	4.4	5.6

NOTE: This Table is suitable for wind classifications up to C1.

TABLE 8.12

BRACING CAPACITY—CANTILEVERED STUMPS IN SOIL BACKFILL—SOIL CLASSIFICATIONS A, S AND M—WIND CLASSIFICATIONS TO C1



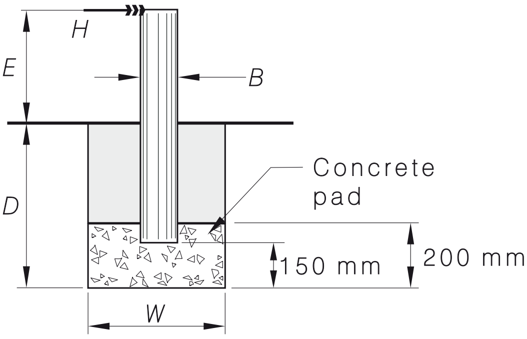
Concrete base support W = 400 mm

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
	1000	3.8	4.7	5.0	6.2	7.7
	1200	5.2	5.7	6.6	8.8	11
	1400	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
	1000	3.2	3.8	3.8	4.7	5.8
	1200	4.5	4.5	5.2	6.9	8.6
	1400	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
	1000	2.8	3.1	3.1	3.9	4.8
	1200	3.7	3.7	4.4	5.8	7.3
	1400	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
	1000	2.6	2.6	2.6	3.3	4.1
	1200	3.1	3.2	3.8	5.1	6.3
	1400	3.6	4.5	5.4	7.2	9.0
1000	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
	1000	2.2	2.2	2.2	2.9	3.6
	1200	2.7	2.8	3.3	4.5	5.6
	1400	3.2	4.0	4.8	6.4	8.0

NOTE: This Table is suitable for wind classifications up to C1.

(*continued*)

TABLE 8.12 (*continued*)



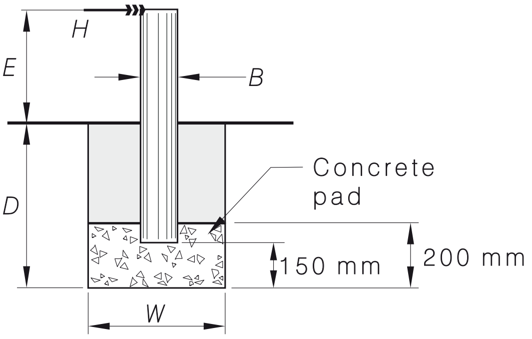
Concrete base support W = 400 mm

Height above footing (E) mm	Stump depth (D) mm	Bracing capacity (H), kN Stump thickness/diameter (B), mm				
		100	125	150	200	250
1200	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
	1000	1.9	1.9	1.9	2.6	3.2
	1200	2.4	2.5	3.0	4.0	5.0
	1400	2.9	3.6	4.3	5.8	7.2
1400	400	—	—	—	—	—
	600	0.5	0.7	0.8	0.9	0.9
	800	1.1	1.3	1.3	1.3	1.6
	1000	1.7	1.7	1.7	2.3	2.9
	1200	2.1	2.3	2.7	3.6	4.5
	1400	2.6	3.3	3.9	5.3	6.6
1600	400	—	—	—	—	—
	600	0.5	0.6	0.7	0.8	0.8
	800	1.0	1.2	1.2	1.2	1.5
	1000	1.5	1.5	1.6	2.1	2.6
	1200	1.9	2.1	2.5	3.3	4.1
	1400	2.4	3.0	3.6	4.8	6.0
1800	400	—	—	—	—	—
	600	0.4	0.5	0.6	0.7	0.7
	800	0.9	1.1	1.1	1.1	1.3
	1000	1.4	1.4	1.4	1.9	2.4
	1200	1.8	1.9	2.3	3.0	3.8
	1400	2.2	2.8	3.3	4.4	5.6

NOTE: This Table is suitable for wind classifications up to C1.

TABLE 8.13

BRACING CAPACITY—CANTILEVERED STUMPS IN SOIL BACKFILL—SOIL CLASSIFICATIONS A, S AND M—WIND CLASSIFICATIONS TO C1



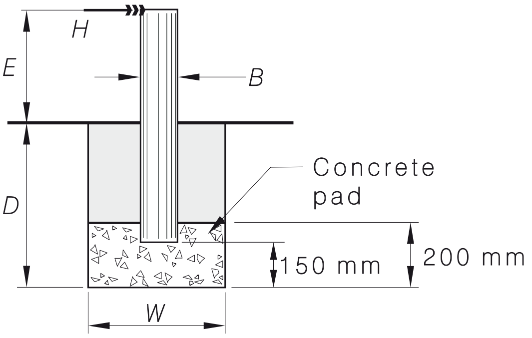
Concrete base support W = 600 mm

Height above footing (*E*) mm	Stump depth (*D*) mm	Bracing capacity (*H*), kN Stump thickness/diameter (*B*), mm				
		100	**125**	**150**	**200**	**250**
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
	1000	3.8	4.7	5.7	7.5	7.7
	1200	5.2	6.5	7.8	8.8	11
	1400	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
	1000	3.2	4.0	4.8	5.7	5.8
	1200	4.5	5.7	6.7	6.9	8.6
	1400	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
	1000	2.8	3.5	4.2	4.6	4.8
	1200	4.0	5.0	5.5	5.8	7.3
	1400	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
	1000	2.6	3.1	3.7	3.9	4.1
	1200	3.6	4.5	4.7	5.1	6.3
	1400	4.9	5.3	5.4	7.2	9.0
1000	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
	1000	2.2	2.8	3.3	3.3	3.6
	1200	3.3	4.1	4.1	4.5	5.6
	1400	4.5	4.5	4.8	6.4	8.0

NOTE: This Table is suitable for wind classifications up to C1.

(*continued*)

TABLE 8.13 (*continued*)



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**
1200	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
	1000	2.0	2.5	2.9	2.9	3.2
	1200	3.0	3.6	3.6	4.0	5.0
	1400	4.2	4.2	4.3	5.8	7.2
1400	400	—	—	—	—	—
	600	0.5	0.7	0.8	1.0	1.3
	800	1.1	1.4	1.6	2.0	2.0
	1000	1.8	2.3	2.6	2.6	2.9
	1200	2.7	3.2	3.2	3.6	4.5
	1400	3.7	3.7	3.9	5.3	6.6
1600	400	—	—	—	—	—
	600	0.5	0.6	0.7	1.0	1.2
	800	1.0	1.3	1.5	1.8	1.8
	1000	1.7	2.1	2.3	2.3	2.6
	1200	2.5	2.9	2.9	3.3	4.1
	1400	3.4	3.4	3.6	4.8	6.0
1800	400	—	—	—	—	—
	600	0.4	0.5	0.7	0.9	1.1
	800	0.9	1.2	1.4	1.6	1.6
	1000	1.4	1.8	2.1	2.1	2.4
	1200	2.4	2.7	2.7	3.0	3.8
	1400	3.1	3.1	3.3	4.4	5.6

NOTE: This Table is suitable for wind classifications up to C1.

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
1000	1.4	3.5	7.3	13	23	50
1200	0.8	2.0	4.2	7.8	13	33
1400	0.5	1.3	2.7	4.9	8.4	20
1600	0.4	0.9	1.8	3.3	5.6	14
1800	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 above:

(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.

(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.

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.

TABLE 8.15

COLUMN BRACING CAPACITY

Height of column above ground	Column details				Footing plan size or diameter	Footing depth (D)	Bracing capacity
	Concrete and masonry		Timber diameter	Steel			
	Plan size	Reinforcement					
mm	mm		mm	mm	mm	mm	kN
600 or less	M200 × 200	1-Y12	125	76 × 76 × 3.2	350 × 350	900	6
601 to 900	M200 × 200	1-Y12	150	76 × 76 × 4.0	350 × 350	900	4.5
901 to 1800	C200 × 200 M200 × 400 M300 × 300	4-R10	200	—	350 × 350	900	3
1801 to 2400	C200 × 200 M200 × 400 M300 × 300	4-Y12	225	—	400 × 400	900	3
2401 to 3000	C250 × 250 M200 × 400 M300 × 300	4-Y12	250	—	600 × 600	900	2.3

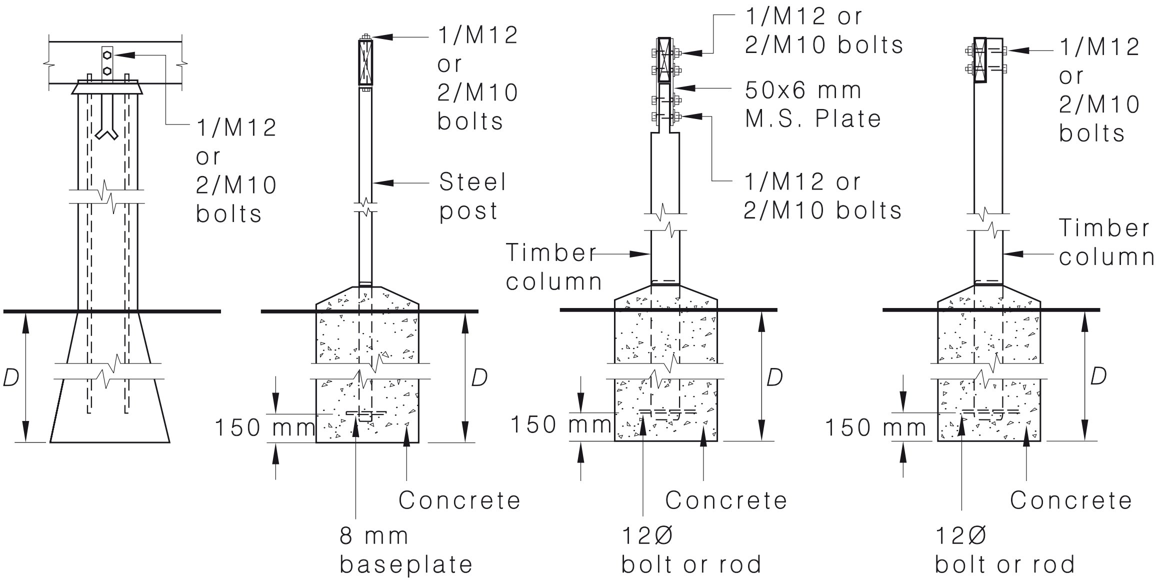
NOTES:

1 C = reinforced concrete column; M = reinforced concrete masonry.

2 Footing depth 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.

3 For concrete and masonry columns and walls, see AS 3600 and AS 3700, respectively.

4 For bearer tie-down, see Section 9.



No-fines concrete shall be used for external hardwood columns

NOTE: For guidance on durability, see Appendix B.

FIGURE 8.4 CONCRETE, MASONRY AND STEEL BRACING COLUMNS

8.3.5.8 *Unreinforced masonry bracing*

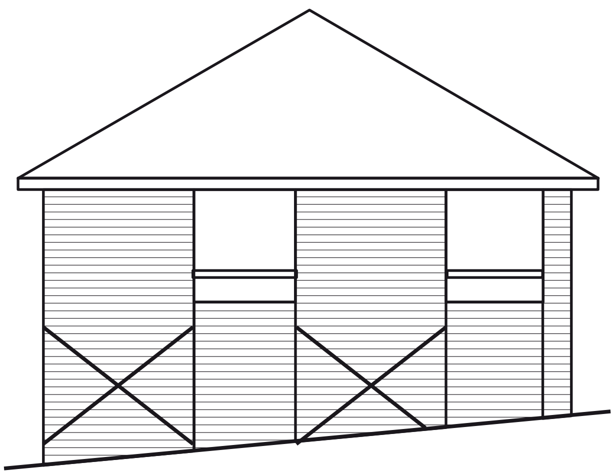
Unreinforced masonry walls may be used to transfer racking forces in the subfloor region. The walls shall be a minimum of 90 mm thick, and engaged-piers shall be regularly spaced. All brickwork shall comply with AS 3700 or the Building Code of Australia.

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 (for example, under verandah roofs, decks or similar structures).

The total minimum length of unreinforced masonry bracing walls in any full length of wall shall be 3000 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 stand-alone panels of masonry less than 3000 mm.

TABLE 8.16

UNREINFORCED MASONRY BRACING CAPACITY



Tie-down shall be provided from bearers to footings

Description	Bracing capacity kN/m
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 the 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 classification C1, 14 000 mm if the minimum width of floor is 4800 mm.

(b) For wind classification C2, 14 000 mm if the minimum width of floor is 6000 mm.

(c) For wind classification C3, 11 500 mm if the minimum width of floor is 6000 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 see 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.

NOTES:

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.

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 wide 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 J4 or JD4. If JD5 is used, the bracing capacity given bracing types (g) to (k) in Table 8.18 shall be reduced by 12.5%, and in bracing types (l) to (n), by 16%.

NOTES:

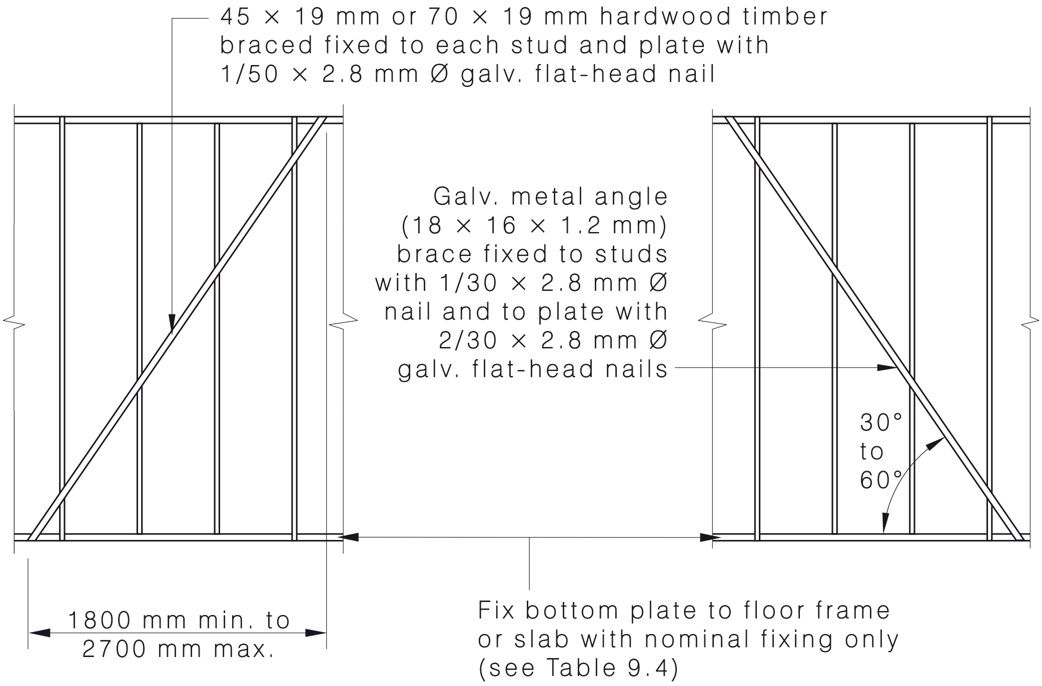
1 Joint groups for commonly available timbers are given in Clause 9.6.5 and Appendix G.

2 For wall heights greater than 2700 mm, the values in Table 8.18 may be proportioned downward relative to the wall heights. For example, for a wall height of 3600 mm multiply the values in the table by 2700/3600 = 0.75 (see Clause 8.3.6.4).

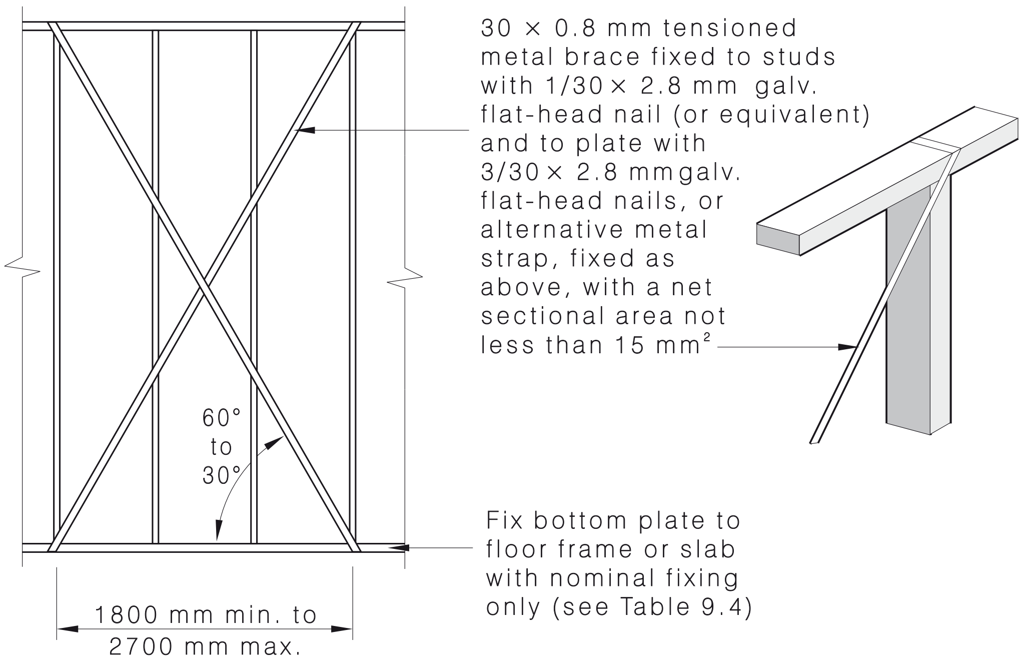
TABLE 8.18

STRUCTURAL WALL BRACING (MAXIMUM WALL HEIGHT 2.7 m)

<table>
<tr><th>Type of bracing</th><th>Bracing capacity kN/m</th></tr>
<tr><td>(a) Two diagonally opposed timber or metal angle braces



NOTE: All flat-head nails shall be galvanized or equivalent.</td><td>0.8</td></tr>
<tr><td>(b) Metal straps—Tensioned

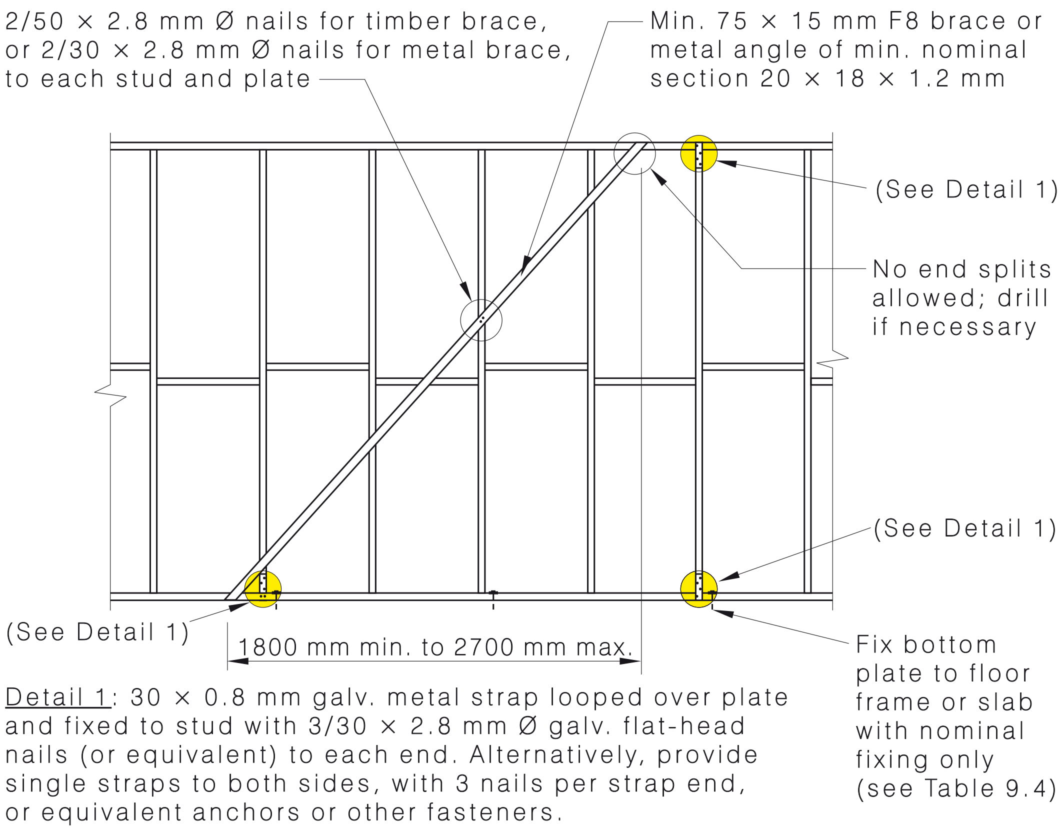

</td><td>1.5</td></tr>
</table>

(*continued*)

TABLE 8.18 *(continued)*

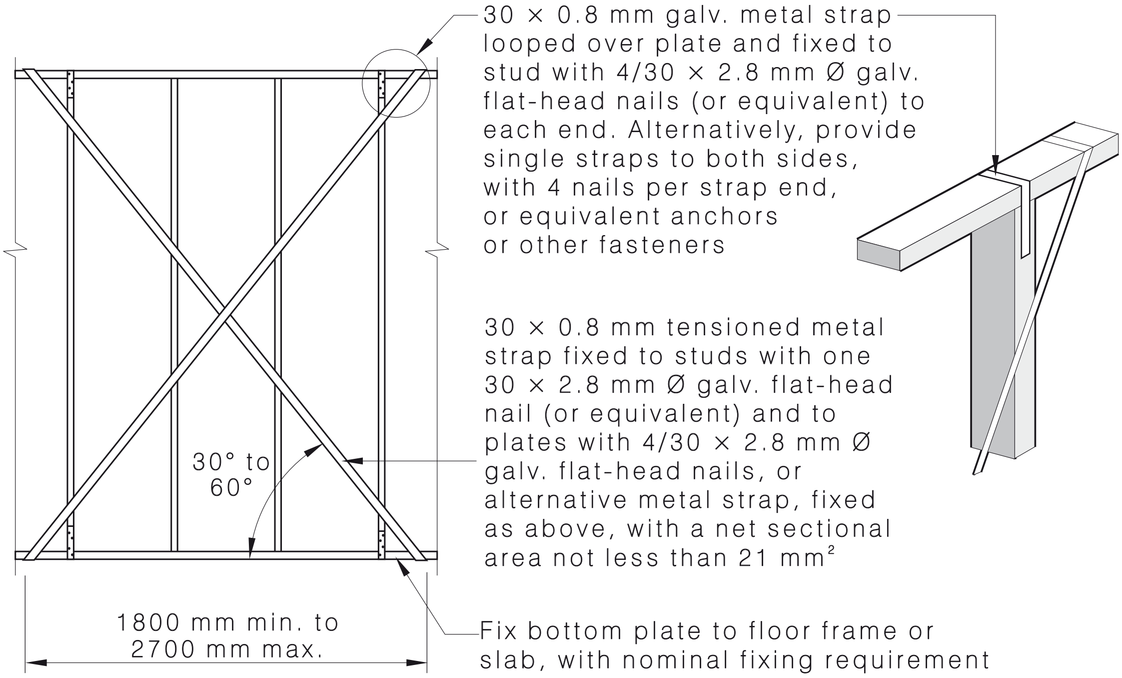
<table>
<tr><th>Type of bracing</th><th>Bracing capacity kN/m</th></tr>
<tr><td>

(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.



</td><td>1.5</td></tr>
<tr><td>

(d) *Metal straps—Tensioned—With stud straps*



</td><td>3.0</td></tr>
</table>

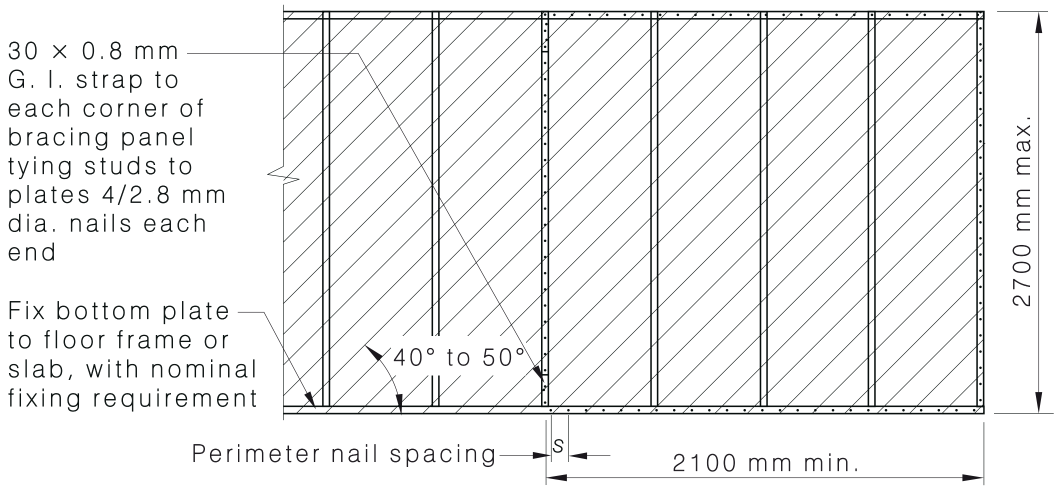
(continued)

TABLE 8.18 (*continued*)

Type of bracing	Bracing capacity kN/m

(e) *Diagonal timber wall lining or cladding* Minimum thickness of board—12 mm fixed with 2/20 × 50 mm long T-head nails.

Intermediate crossings of boards and studs shall be fixed with one nail.

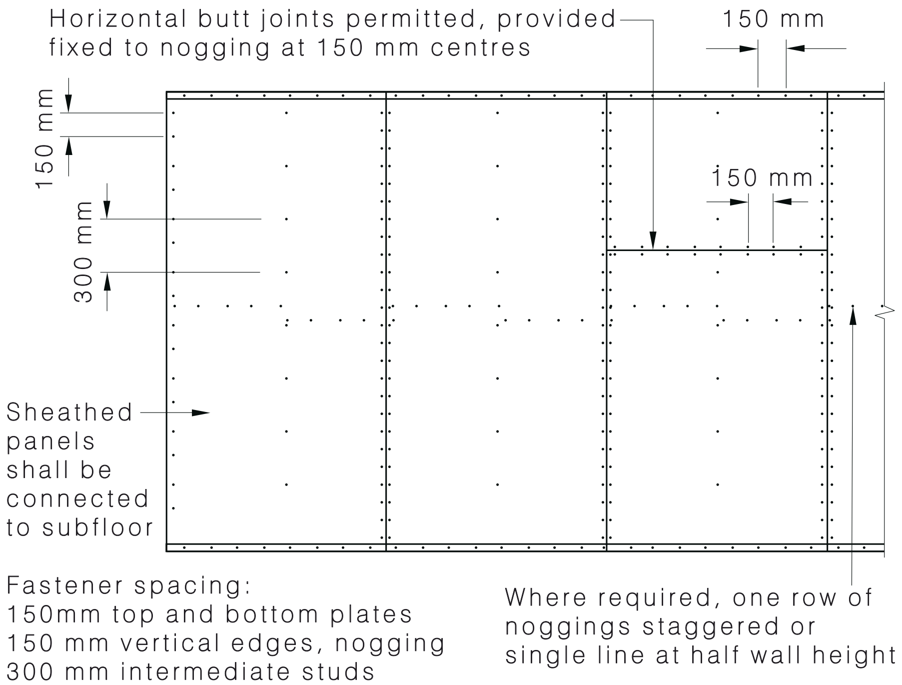


NOTE: Noggings have been omitted for clarity.

s, mm	Bracing capacity kN/m
60	2.1
40	3.0

(f) Other timber, metal angle and strap bracing shall be designed and installed in accordance with engineering principles.

(g) *Plywood* Plywood shall be nailed to frame using 30 mm × 2.8 mm ∅ galvanized flat-head nails or equivalent.



Minimum plywood thickness, mm			Bracing capacity kN/m
Stress grade	Stud spacing mm		
	450	600	
No nogging (except horizontal butt joints)			
F8	7	9	
F11	4.5	7	
F14	4	6	
F27	3	4.5	
One row of nogging			
F8	7	7	
F11	4.5	4.5	
F14	4	4	
F27	3	3	
			3.4

NOTES:

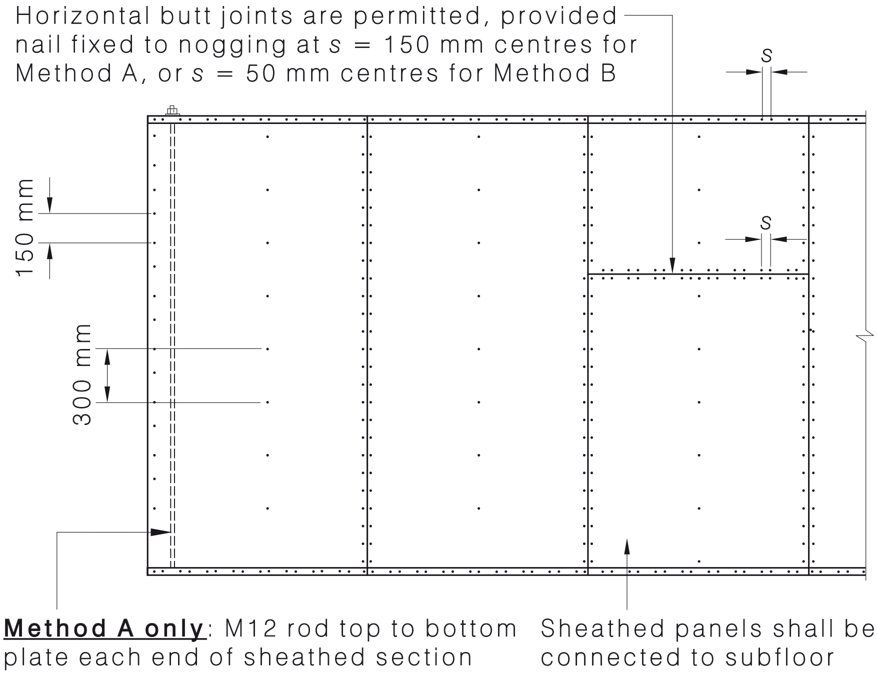
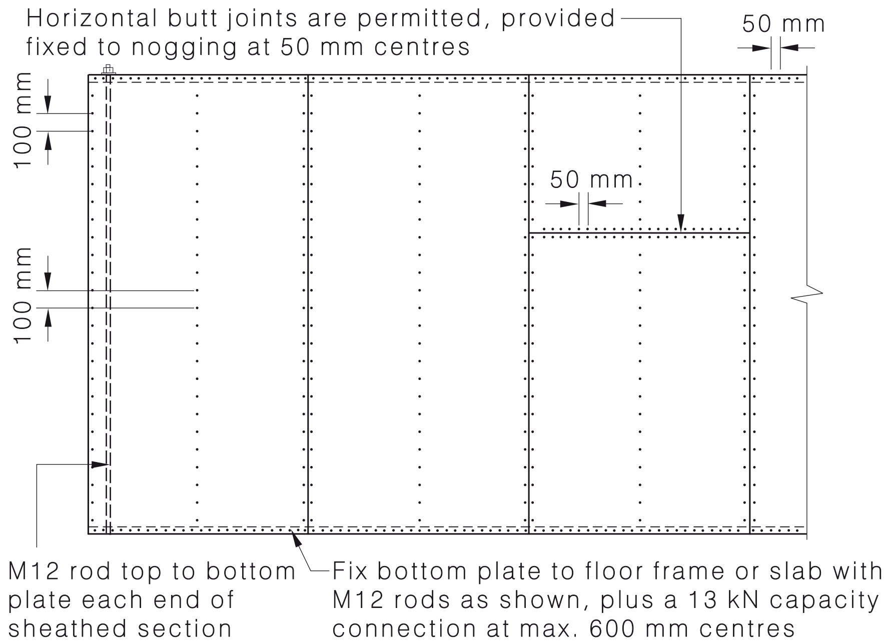
1 For plywood fixed to both sides of the wall, see Clauses 8.3.6.5 and 8.3.6.10.

2 No other rods or straps are required between top or bottom plate.

3 Fix bottom plate to floor frame or slab with nominal fixing only (see Table 9.4).

(*continued*)

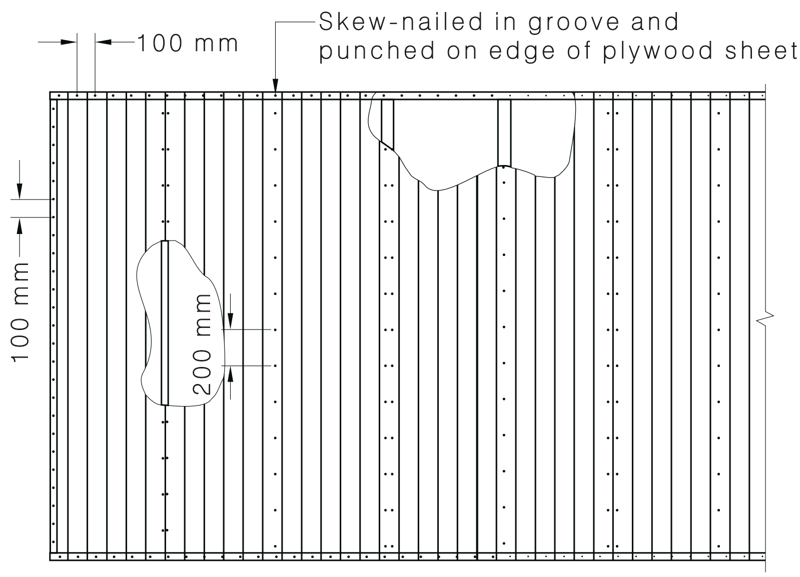
TABLE 8.18 (*continued*)

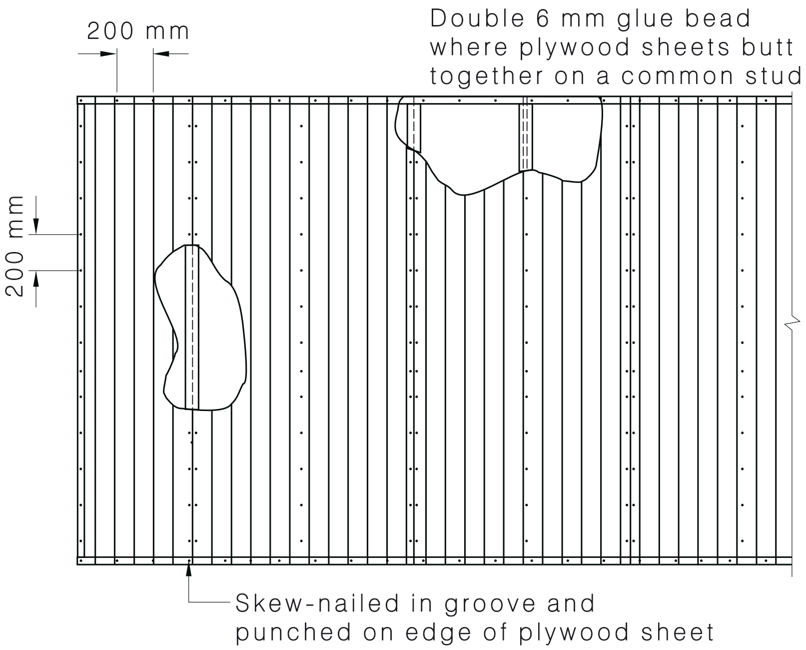
Type of bracing		Bracing capacity kN/m
(h) *Plywood* Plywood shall be nailed to frame using 30 × 2.8 ∅ galvanized flat-head nails or equivalent. For Method A, M12 rods shall be used at each end of sheathed section top plate to bottom plate/floor frame. Method B has no rods but sheathing shall be nailed to top and bottom plates and any horizontal joints at 50 mm centres.  NOTE: For plywood fixed to both sides of the wall, see Clauses 8.3.6.5 and 8.3.6.10.	Minimum plywood thickness, mm Stress grade / Stud spacing mm: 450, 600 F8: 7, 9 F11: 6, 7 F14: 4, 6 F27: 4, 4.5 Fastener spacing, (*s*) mm Top and bottom plate: — Method A: 150 — Method B: 50 Vertical edges: 150 Intermediate studs: 300 Fixing of bottom plate to floor frame or slab Method A: M12 rods as shown plus a 13 kN capacity connection at max. 1200 mm centres Method B: A 13 kN capacity connection at each end and intermediately at max. 1200 mm centres	Method A 6.4 Method B 6.0
(i) *Plywood* Plywood shall be nailed to frame using 30 × 2.8 mm ∅ galvanized flat-head nails or equivalent.  NOTE: For plywood fixed to both sides of the wall, see Clauses 8.3.6.5 and 8.3.6.10.	Minimum plywood thickness, mm Stress grade / Stud spacing mm: 450, 600 No nogging (except horizontal butt joints) F11: 4.5, 4.5 F11: 7.0, 7.0 Fastener spacing mm Top and bottom plate: 50 Vertical edges: 100 Intermediate studs: 100	 7.5 8.7

(*continued*)

TABLE 8.18 (*continued*)

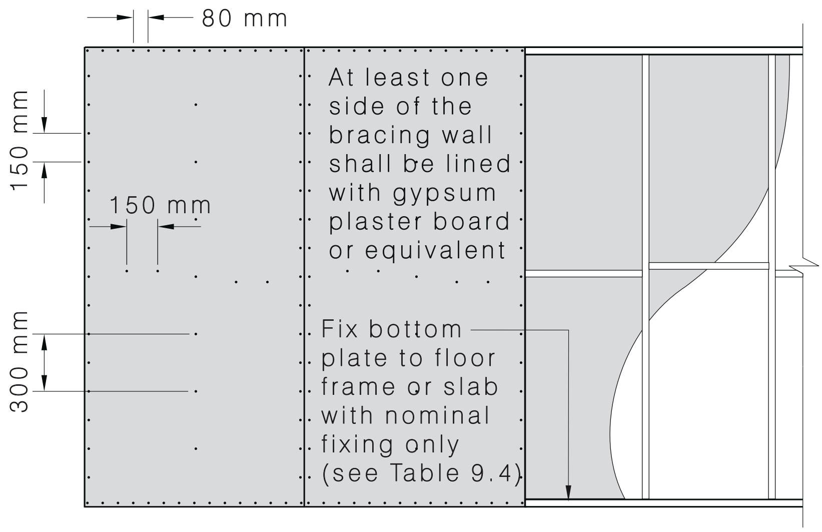
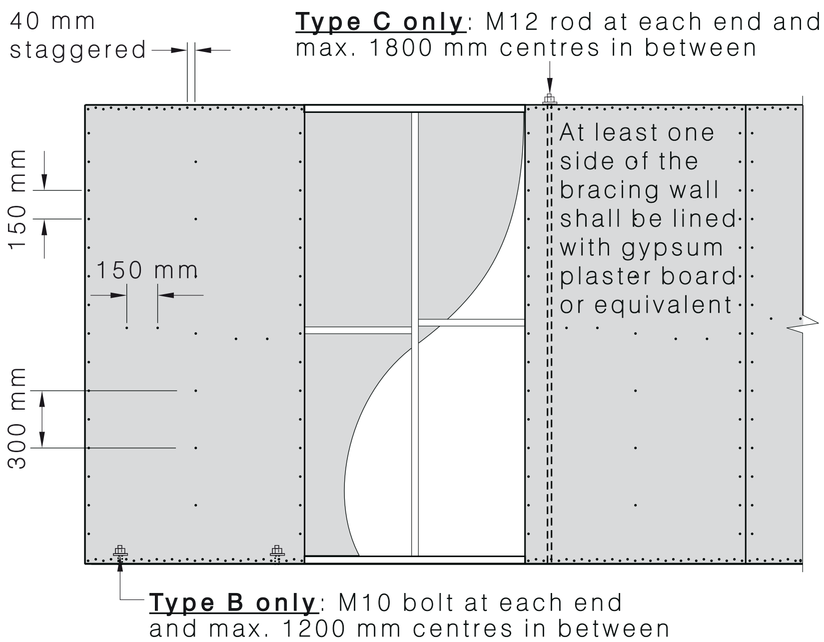
Type of bracing			Bracing capacity kN/m
(j) *Decorative plywood—Nailed* Decorative plywood shall be nailed to frame using min. 40 mm × 2.5 mm ∅ bullet-head nails. The depth of groove shall not exceed one-third the nominal thickness.	Minimum nominal thickness of decorative structural plywood, mm		2.1
	Stress grade	Stud spacing mm (600 max.)	
	F11	6	
	Fastener spacing mm		
	Top and bottom plate:	100	
	Vertical edges	100	
NOTE: Fix bottom plate to floor frame or slab with nominal fixing only (see Table 9.4).	Intermediate studs	200	
(k) *Decorative plywood—Glued and nailed* Decorative plywood shall be nailed to frame using min. 40 × 2.5 mm ∅ bullet-head nails. Continuous 6 mm bead of elastomeric adhesive to studs and plates. Double 6 mm glue bead 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		5.3
	Stress grade	Stud spacing mm (600 max.)	
	F11	6	
	Fastener spacing mm		
	Top and bottom plates	200	
	Vertical edges	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. 1200 mm centres.	Intermediate studs	200	





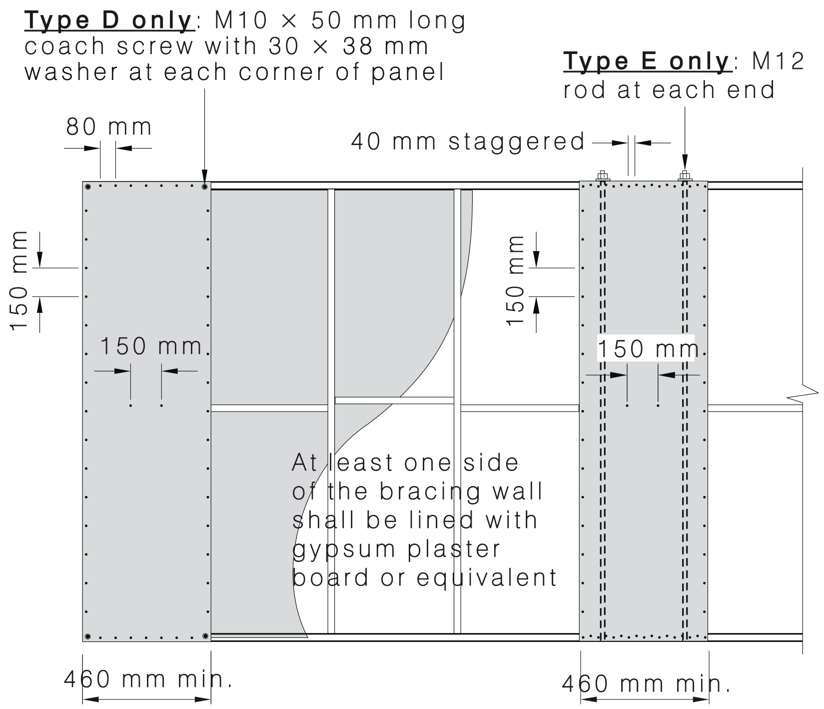
(*continued*)

TABLE 8.18 (*continued*)

<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 comply with AS/NZS 1859.4.
Hardboard shall be nailed to frame using minimum 30 × 2.8 mm ∅ galvanized flat-head nails or equivalent.
Nails shall be located a minimum of 10 mm from the vertical edges and 15 mm from the top and bottom edges. Maximum stud spacing = 600 mm.
Bracing panel minimum width = 900 mm.

</td><td colspan="2">Minimum hardboard thickness 4.8 mm</td><td rowspan="7">Type A
3.4</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>
<tr><td rowspan="7">(m) Hardboard Types B and C Hardboard shall comply with AS/NZS 1859.4.
Hardboard shall be nailed to frame using minimum 30 × 2.8 mm ∅ galvanized flat-head nails or equivalent.
Nails shall be located a minimum of 10 mm from the vertical edges and 15 mm from the top and bottom edges. Maximum stud spacing = 600 mm.
Bracing panel minimum width = 900 mm.

</td><td colspan="2">Minimum hardboard thickness 4.8 mm</td><td rowspan="7">Type B
6.0
Type C
9.0</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>300</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. 1200 mm centres
Type C:
M12 rods at each end and intermediately at max. 1800 mm centres.
NOTE: Bolt/rod washer sizes as per Table 9.1.</td></tr>
</table>

(*continued*)

TABLE 8.18 (*continued*)

<table>
<tr><th colspan="4">Type of bracing</th><th>Bracing capacity kN/m</th></tr>
<tr>
<td rowspan="8">(n) Hardboard Type D and E—Short wall bracing systems
Hardboard shall comply with AS/NZS 1859.4.
Hardboard shall be nailed to frame using minimum 30 × 2.8 mm ∅ galvanized flat-head nails or equivalent.
Nails shall be located a minimum of 10 mm from the vertical edges and 15 mm from the top and bottom edges. Maximum stud spacing = 600 mm.
Bracing panel minimum width = 460 mm.


NOTE: Bolt/rod washer sizes as per Table 9.1.</td>
<td colspan="3">Minimum hardboard thickness 4.8 mm</td>
<td rowspan="8">Type D
3.4
Type E
6.0</td>
</tr>
<tr><td colspan="3">Fastener spacing, mm</td></tr>
<tr><td rowspan="2">Top and bottom plates</td><td>Type D</td><td>80</td></tr>
<tr><td>Type E</td><td>40</td></tr>
<tr><td colspan="2">Vertical edges and nogging</td><td>150</td></tr>
<tr><td colspan="3">Fixing of bottom plate to floor frame or slab.</td></tr>
<tr><td colspan="3">Type D:
Fix bottom plate to floor frame or slab with no6minal fixing only (see Table 9.4)
Type E:
M12 rods at each end.</td></tr>
</table>

8.3.6.4 *Wall capacity and height modification*

The capacity of bracing walls given in Table 8.18 is appropriate to wall heights up to and including 2700 mm. For wall heights greater than 2700 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
4 200	0.64

8.3.6.5 *Length and capacity for plywood bracing walls*

For the bracing capacities given in Table 8.18 for plywood, the minimum length of the panels shall be 900 mm, except—

(a) in bracing type given in Item (h) for Method A only, the minimum length of the panels may be 600 mm; or

(b) in bracing type given in Item (g)—

  (i) for panel length of 600 mm, the bracing capacity shall be half of that for 900 mm; and

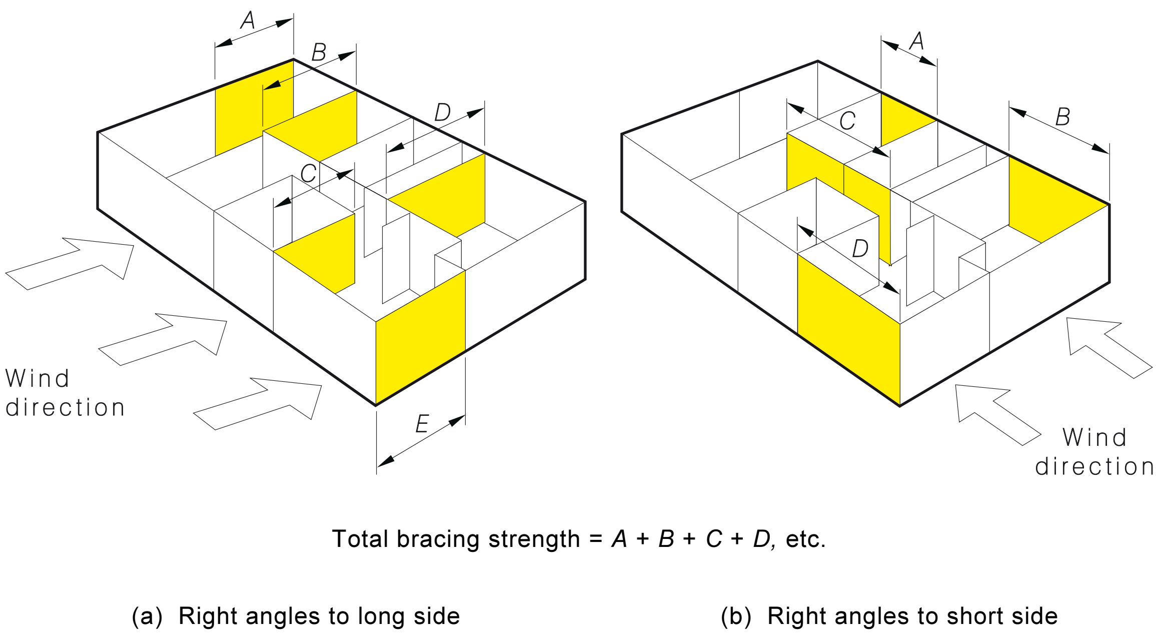
  (ii) for panel length between 600 mm and 900 mm, the bracing capacity may be determined by multiplying the respective capacities by 0.5 for 600 mm long varying linearly to 1.0 for 900 mm.

8.3.6.6 *Location and distribution of bracing*

Bracing shall be approximately evenly distributed and shall be 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.



NOTE: *A*, *B*, *C* and *D* are the design strengths of individual bracing walls.

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 the values given in Tables 8.20, 8.21 and 8.22 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.

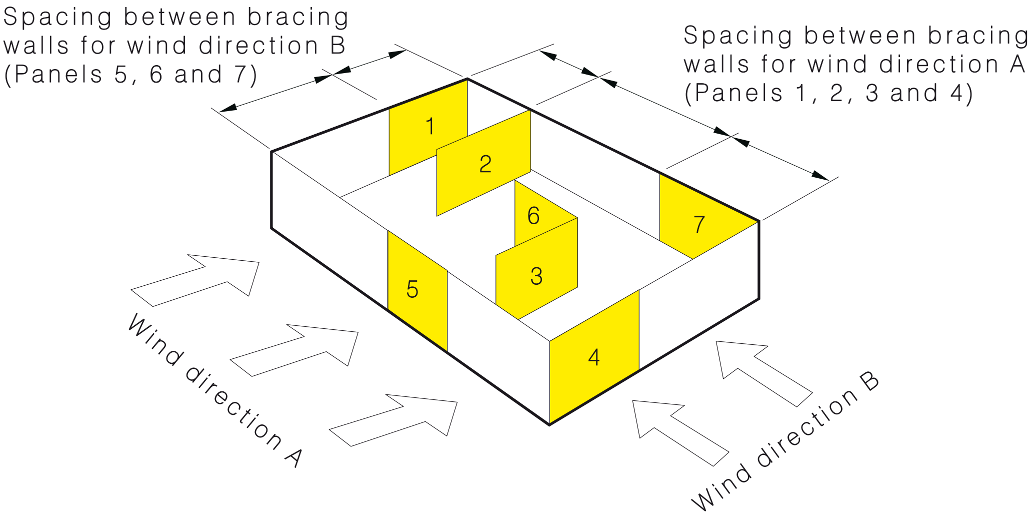


FIGURE 8.6 SPACING OF BRACING

TABLE 8.20

MAXIMUM SPACING OF BRACING WALLS—WIND CLASSIFICATION C1

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
16	9	9	9	9	9	9	9	8.6	6.9

TABLE 8.21

MAXIMUM SPACING OF BRACING WALLS—WIND CLASSIFICATION C2

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

TABLE 8.22

MAXIMUM SPACING OF BRACING WALLS—WIND CLASSIFICATION C3

Ceiling depth m	Maximum bracing wall spacing, m								
	Roof pitch, degrees								
	0	5	10	15	17.5	20	25	30	35
≤4	2.7	3	3.4	3.5	3.2	3	2.3	2	1.9
5	3.4	3.8	4.3	4.4	4	3.6	2.8	2.3	2.2
6	4.1	4.6	5.1	5.1	4.6	4.1	3.1	2.6	2.4
7	4.8	5.5	6	5.8	5	4.4	3.3	2.8	2.6
8	5.5	6.3	6.7	6.5	5.4	4.7	3.5	3.1	2.6
9	6.2	7.1	7.6	7.2	5.9	5	3.7	3.3	2.7
10	6.8	7.9	8.3	7.8	6.2	5.1	3.9	3.6	2.9
11	7.5	8.7	9	8.4	6.5	5.3	4	3.6	2.9
12	8.2	9	9	8.6	6.7	5.5	4.1	3.7	3
13	8.9	9	9	8.9	6.9	5.7	4.3	3.7	3
14	9	9	9	9	7.1	5.7	4.3	3.8	3.1
15	9	9	9	9	7.2	5.9	4.4	3.9	3.1
16	9	9	9	9	7.4	6	4.6	4	3.2

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.

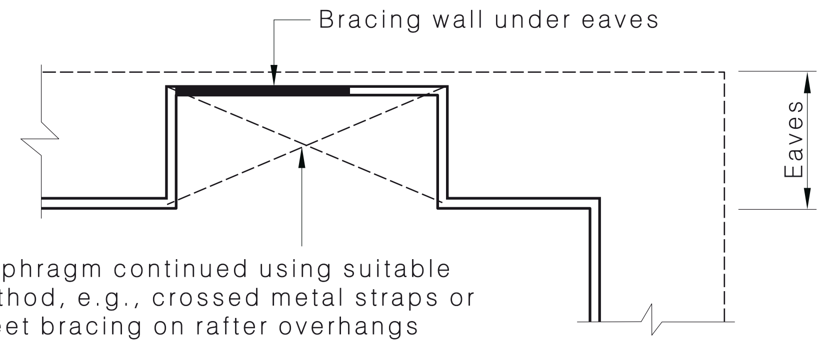


FIGURE 8.7 BRACING UNITS UNDER EAVES

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 Table 8.23.

NOTES:

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.

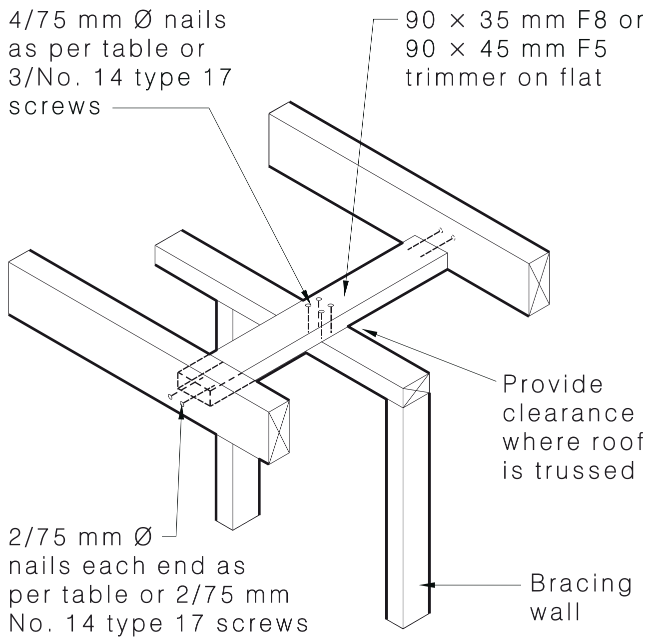
2 For an explanation and further information on joint groups (J and JD), as referenced in Table 8.23, see Table 9.15, Clause 9.6.5 and Appendix G.

3 For trussed roofs, where nominal fixings are permitted as above, the nominal fixings should permit vertical movement of the trusses. See Table 8.23, Items (a) and (i).

TABLE 8.23

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

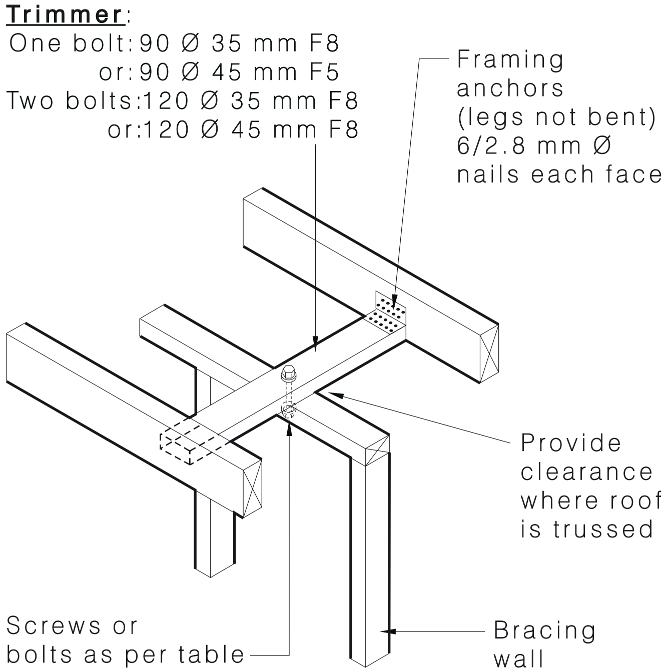


NOTE: For trussed roofs, nails or screws through the top plate shall be placed in holes that permit free vertical movement of the trusses. Alternatively, timber blocks shall be provided either side of the trimmer, fixed as prescribed for each block.

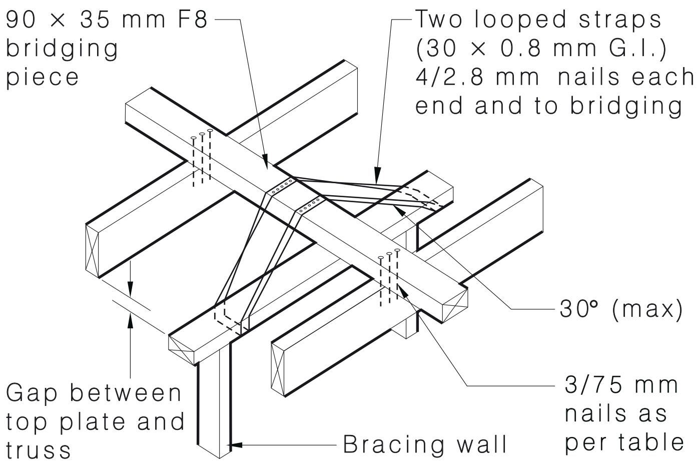
(*continued*)

TABLE 8.23 (*continued*)

<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="9">(b)

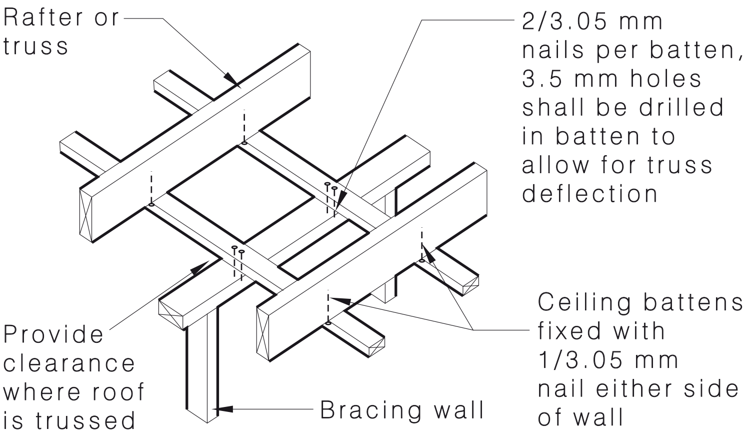
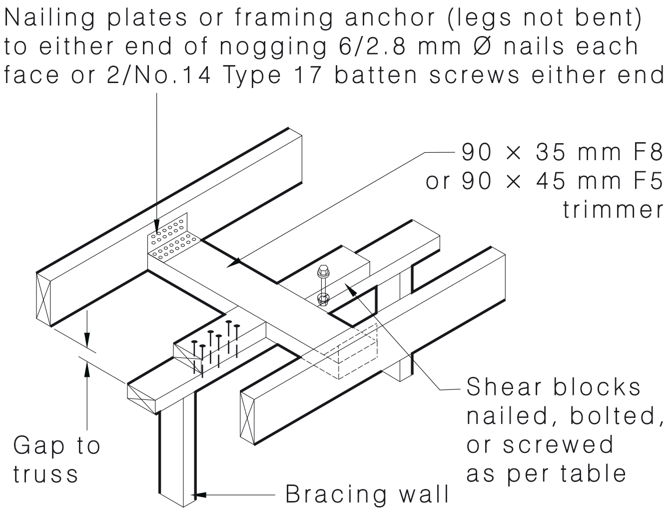
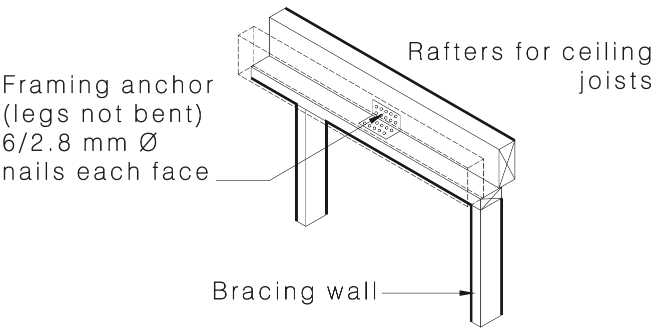


NOTE: For trussed roofs, screws or bolts through the top plate shall be placed in holes that permit free vertical movement of the trusses.</td><td colspan="7">Screws</td></tr>
<tr><td>1/No.14 Type 17</td><td>4.8</td><td>3.5</td><td>2.5</td><td>3.5</td><td>2.5</td><td>1.8</td></tr>
<tr><td>2/No.14 Type 17</td><td>9.7</td><td>6.9</td><td>4.9</td><td>6.9</td><td>4.9</td><td>3.6</td></tr>
<tr><td>3/No.14 Type 17</td><td>13</td><td>9.3</td><td>6.6</td><td>9.8</td><td>7.4</td><td>5.4</td></tr>
<tr><td colspan="7">Bolts</td></tr>
<tr><td>M10</td><td>6.4</td><td>4.1</td><td>2.6</td><td>4.3</td><td>3.0</td><td>2.0</td></tr>
<tr><td>M12</td><td>7.6</td><td>4.9</td><td>3.1</td><td>5.1</td><td>3.6</td><td>2.5</td></tr>
<tr><td>2/M10</td><td>12</td><td>8.0</td><td>5.1</td><td>8.4</td><td>5.9</td><td>4.0</td></tr>
<tr><td>2/M12</td><td>13</td><td>9.3</td><td>6.1</td><td>9.8</td><td>7.0</td><td>4.9</td></tr>
<tr><td rowspan="3">(c)


</td><td colspan="7">Nails</td></tr>
<tr><td>Ø3.05</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>Ø3.33</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>

(*continued*)

TABLE 8.23 (*continued*)

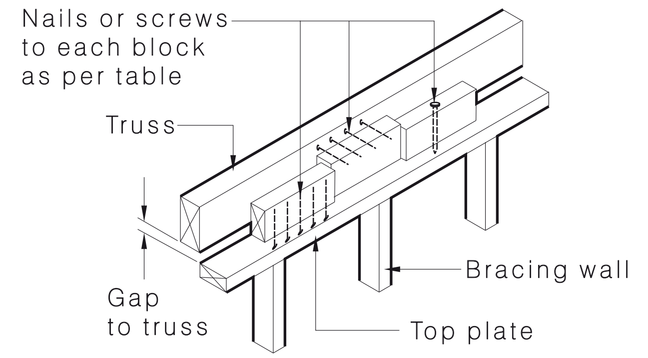
Rafters, joists or trusses to bracing wall		Shear capacity, kN — Unseasoned timber J2	J3	J4	Seasoned timber JD4	JD5	JD6
(d)  		2.5	1.8	1.3	1.8	1.5	1.1
(e)  	Nails						
	4/3.05	5.0	3.6	2.5	3.6	3.0	2.2
	6/3.05	6.6	4.7	3.4	5.0	4.2	3.1
	4/3.33	5.6	4.0	2.8	4.0	3.3	2.5
	6/3.33	7.4	5.3	3.7	5.5	4.6	3.5
	Bolts						
	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
(f)  		6.5	4.6	3.3	4.9	4	3.1

(*continued*)

TABLE 8.23 (*continued*)

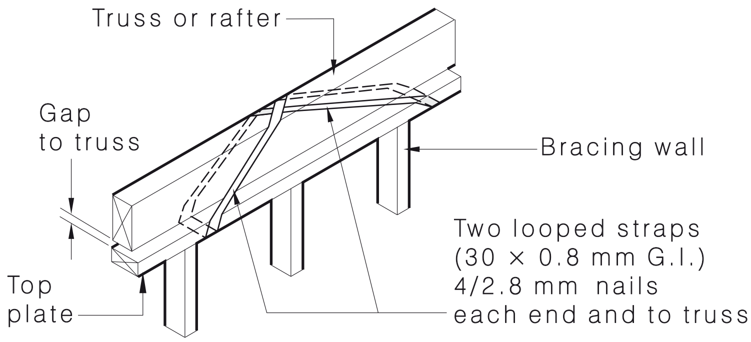
Rafters, joists or trusses to bracing wall — **Shear capacity, kN** (Unseasoned timber: J2, J3, J4; Seasoned timber: JD4, JD5, JD6)

(g)



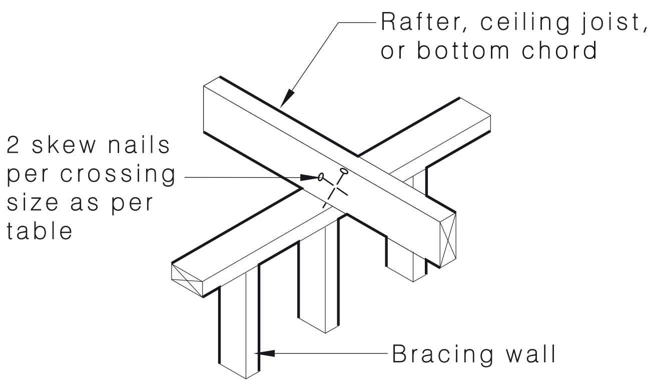
	J2	J3	J4	JD4	JD5	JD6
Nails						
4/3.05	5.0	3.6	2.5	3.6	3.0	2.2
6/3.05	6.6	4.7	3.4	5.0	4.2	3.1
4/3.33	5.6	4.0	2.8	4.0	3.3	2.5
6/3.33	7.4	5.3	3.7	5.5	4.6	3.5
Screws						
2/No.14 Type 17	9.7	6.9	4.9	6.9	4.9	3.6
3/No.14 Type 17	15	10	7.4	10	7.4	5.4

(h)



J2	J3	J4	JD4	JD5	JD6
8.7	6.2	4.4	6.6	5.4	4.1

(i)



NOTE: For trussed roof, nails through the top plate shall be placed in holes that permit free vertical movement of the trusses.

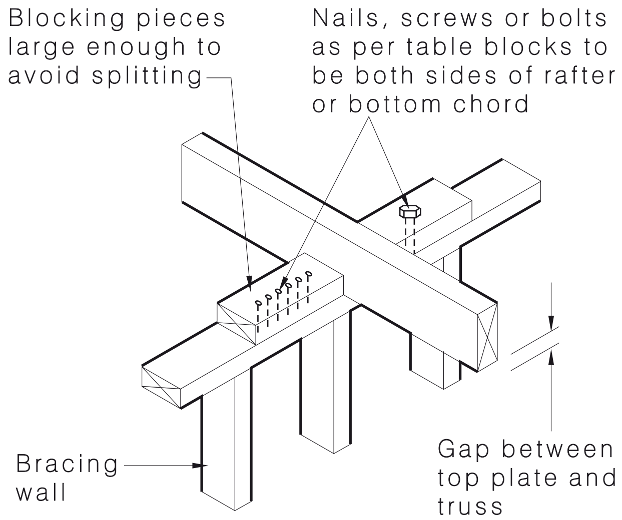
Nails	J2	J3	J4	JD4	JD5	JD6
2/3.05	1.4	1.1	0.77	1.1	0.90	0.66
2/3.33	1.7	1.2	0.85	1.2	1.0	0.75

(*continued*)

TABLE 8.23 (*continued*)

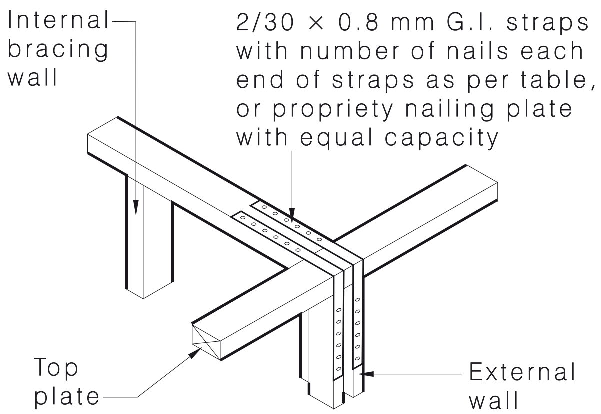
Rafters, joists or trusses to bracing wall	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
	J2	J3	J4	JD4	JD5	JD6

(j)



(j)	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

(k)



Straps	Nails	J2	J3	J4	JD4	JD5	JD6
1	4/2.8	4.3	3.1	2.2	3.3	3.0	2.1
	6/2.8	6.5	4.6	3.3	4.9	4.0	3.1
2	4/2.8	8.7	6.2	4.4	6.6	5.4	4.1
	6/2.8	13	9.3	6.6	9.8	8.1	6.1

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 8.24 and Table 8.25.

For bracing wall systems of capacity 6 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.1200 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 8.25.

Where bracing systems require more fixings or stronger fixings than determined from Tables 8.24 and 8.25, such systems shall be used.

Nominal bracing walls require nominal fixing only (i.e., no additional fixing requirements).

TABLE 8.24

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
2400	2.4	3.6	4.8	6.0	7.2	8.4	10	11	12	13	14	19	24
2700	2.7	4.1	5.4	6.8	8.1	9.5	11	12	14	15	16	22	27
3000	3.0	4.5	6.0	7.5	9.0	11	12	14	15	17	18	24	30

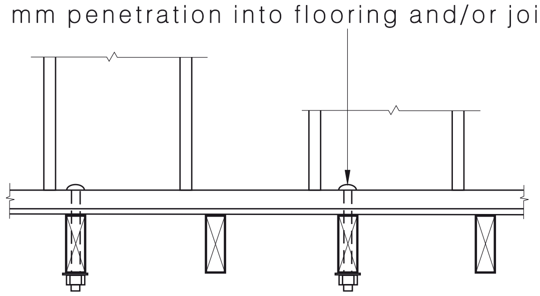
NOTES:

1 Some bracing wall systems require fixings to be full-length anchor rods, that is from the top plate to the floor frame or concrete slab.

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.

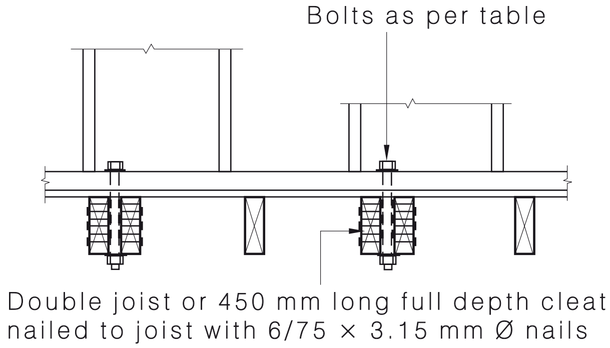
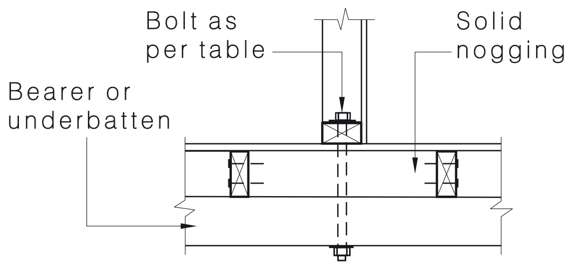
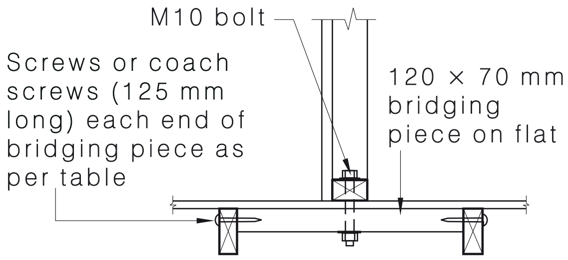
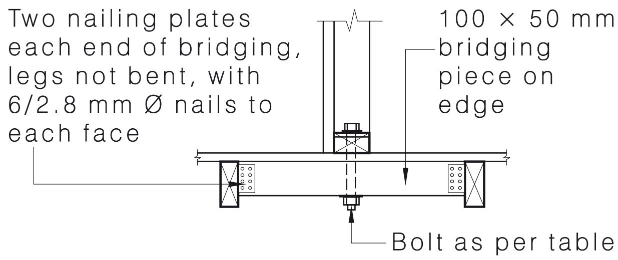
TABLE 8.25

FIXING OF BOTTOM OF BRACING WALLS

Fixing details		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
		J2	J3	J4	JD4	JD5	JD6
(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 	M10 cup-head	16	14	10	10	7	5
	2/No.14 Type17 screws	11	8.4	4.8	9.0	7.2	5.4

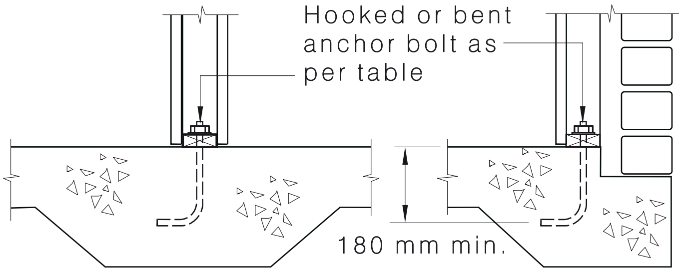
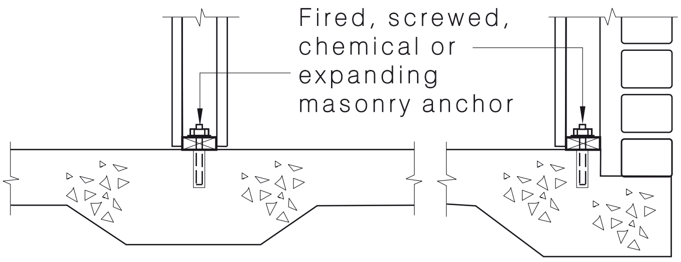
(*continued*)

TABLE 8.25 (*continued*)

<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="3">(b)
</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 rowspan="2">(c)
</td><td>M10 bolt</td><td>18</td><td>18</td><td>18</td><td>15</td><td>12</td><td>9.0</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>
<tr><td rowspan="3">(d)
</td><td>2/No. 14 Type 17 screws</td><td>12</td><td>8.3</td><td>5.9</td><td>8.3</td><td>5.9</td><td>4.3</td></tr>
<tr><td>3/No. 14 Type 17 screws</td><td>17</td><td>13</td><td>9.0</td><td>13</td><td>9.0</td><td>7.0</td></tr>
<tr><td>2/M12 coach screws</td><td>18</td><td>18</td><td>13</td><td>15</td><td>12</td><td>9.0</td></tr>
<tr><td rowspan="2">(e)
</td><td>M10 bolt</td><td>18</td><td>16</td><td>11</td><td>15</td><td>12</td><td>9</td></tr>
<tr><td>M12 bolt</td><td>22</td><td>16</td><td>11</td><td>18</td><td>15</td><td>11</td></tr>
</table>

(*continued*)

TABLE 8.25 (*continued*)

Fixing details		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
		J2	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(f) 	M10 bolt	18	18	18	15	12	9
	M12 bolt	27	27	26	20	16	12
(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)* Gable roof buildings shall be provided with roof bracing using one of the following alternatives:

(i) *Ridge to external wall (roof pitch greater than 10°but less than 25°, wind classification C1 only)*—minimum 90 × 19 mm F8 hardwood single diagonal timber brace on both sides of the ridge at approximately 45° (see Figure 8.8 and Figure 8.9).

(ii) *Ridge to internal wall*—minimum of two timber braces in opposing directions at approximately 45° (see Tables 8.26 and 8.27).

(iii) *Diagonal metal bracing, single or double diagonal*—designed and installed in accordance with engineering principles.

(iv) *Structural sheet bracing*—designed and installed in accordance with engineering principles.

TABLE 8.26

GABLE ROOF BRACING—GABLE STRUT SIZE AND GRADE

Wind classification	Stress grade	Width of gable roof, mm											
		6000			9000			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
C1	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
C2	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
C3	F5 or MGP10	70×35	2/90×45	3/90×45	2/70×45	3/90×45	NS	3/70×45	NS	NS	3/140×45	NS	NS
	F14 or MGP15	70×35	2/70×35	3/70×35	2/70×35	3/90×35	3/140×45	3/70×35	3/140×45	NS	3/90×45	NS	NS

NS = not suitable, seek engineering advice.

TABLE 8.27

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

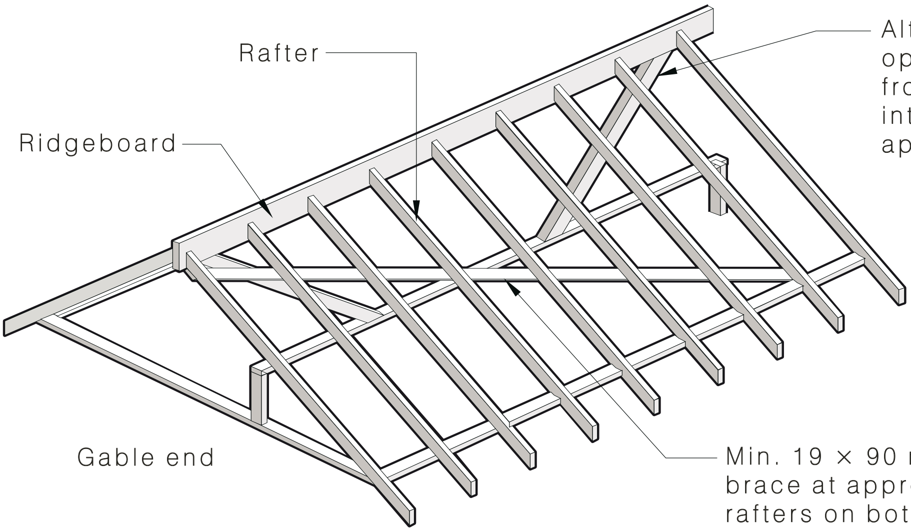


FIGURE 8.8 GABLE ROOF BRACING

(c) *Intersection of timber braces* Where timber braces intersect, they shall be spliced in accordance with Figure 8.9.

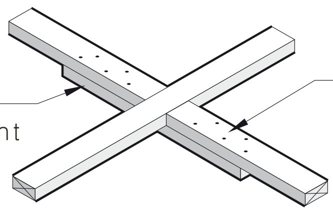


FIGURE 8.9 TIMBER BRACING SPLICE

8.3.7.2 *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.

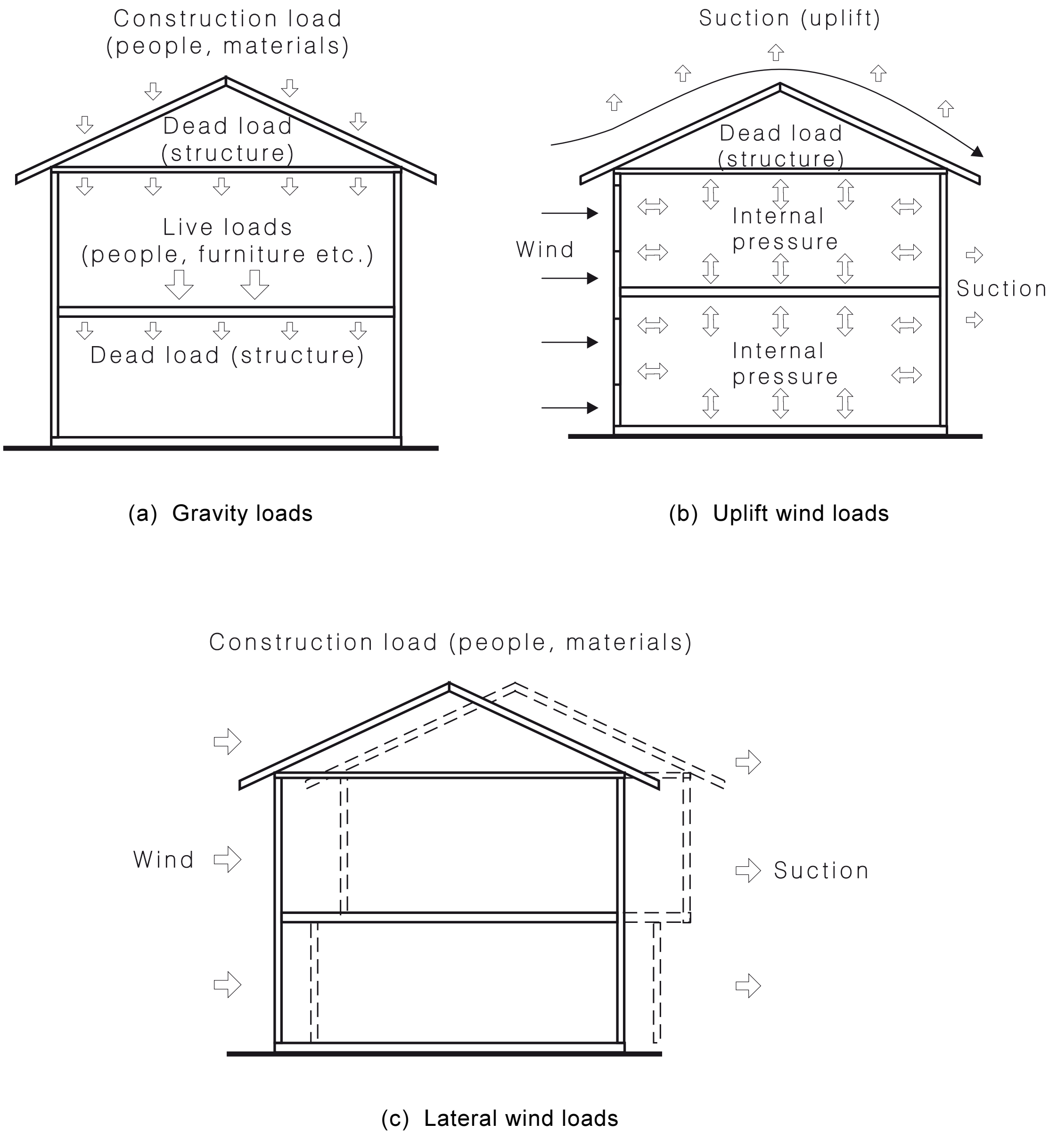


FIGURE 9.1 LOAD ACTIONS

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 be manufactured in accordance with, or shall comply with, 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 are also permitted 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, that is, 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; that is 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

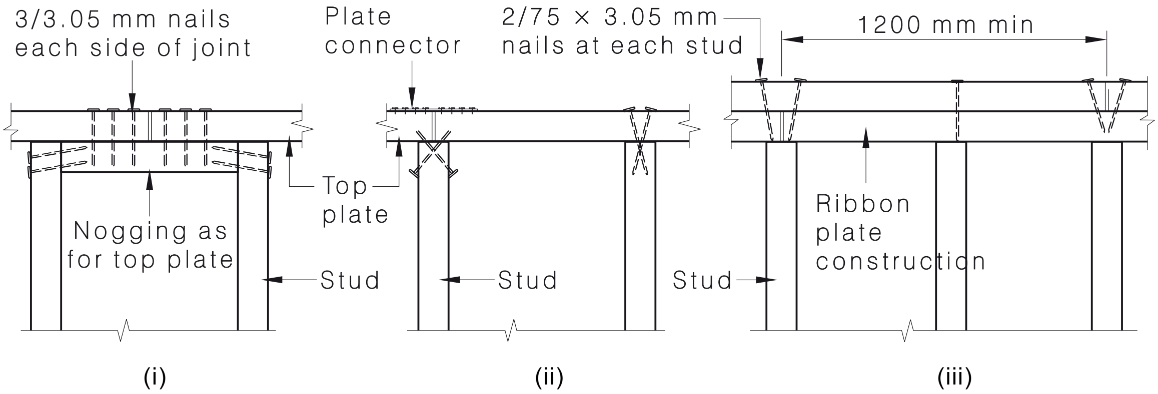
The minimum penetration of the threaded portion of screws and coach screws into the receiving member shall not be less than 35 mm for screws and 5 times the diameter of coach screws, unless otherwise noted.

9.2.7 Framing anchor and strap nails

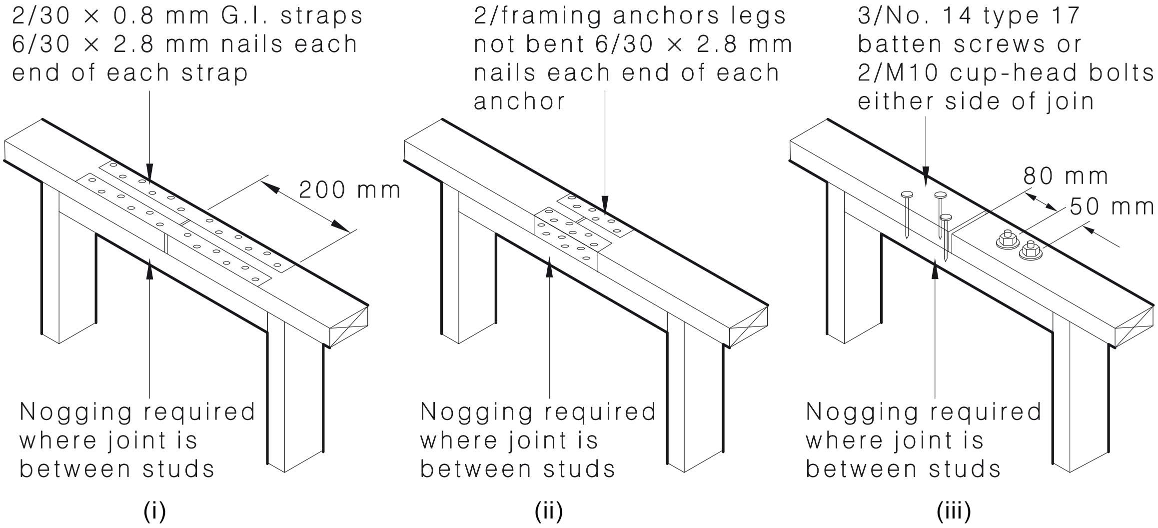
All nails used for framing anchor and straps shall be corrosion protected flat-head connector nails. Clout shall not be used for this purpose.

9.2.8 Joining of top plates and ring beam

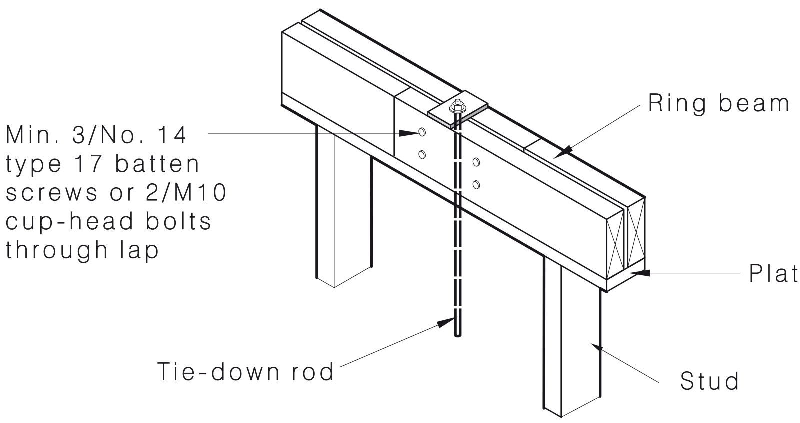
Top plates and ring beam in walls shall be joined by one of the methods shown in Figure 9.2 for the relevant wind classification.



(a) Suitable for wind classification C1



(b) Suitable for wind classifications C1 to C3



(g) Suitable for wind classifications C1 to C3

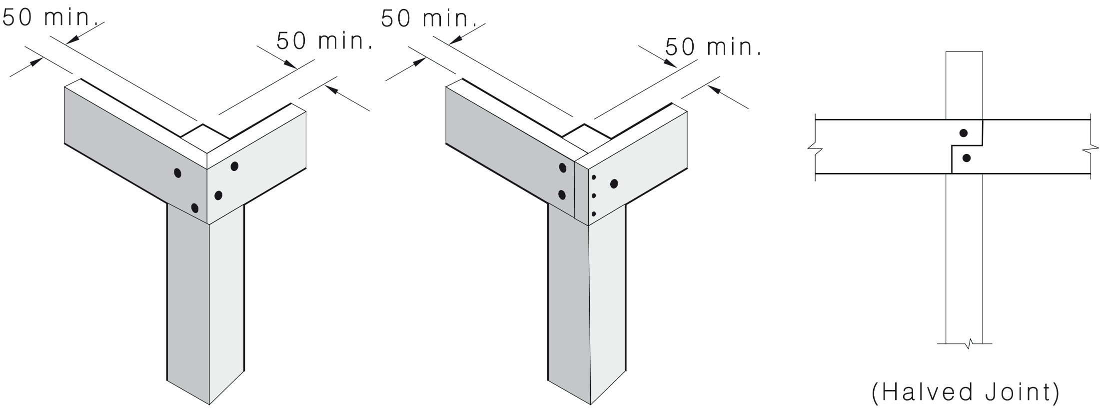
FIGURE 9.2 JOINING OF TOP PLATES AND RING BEAMS

9.2.9 Tie-down of members joined over supports

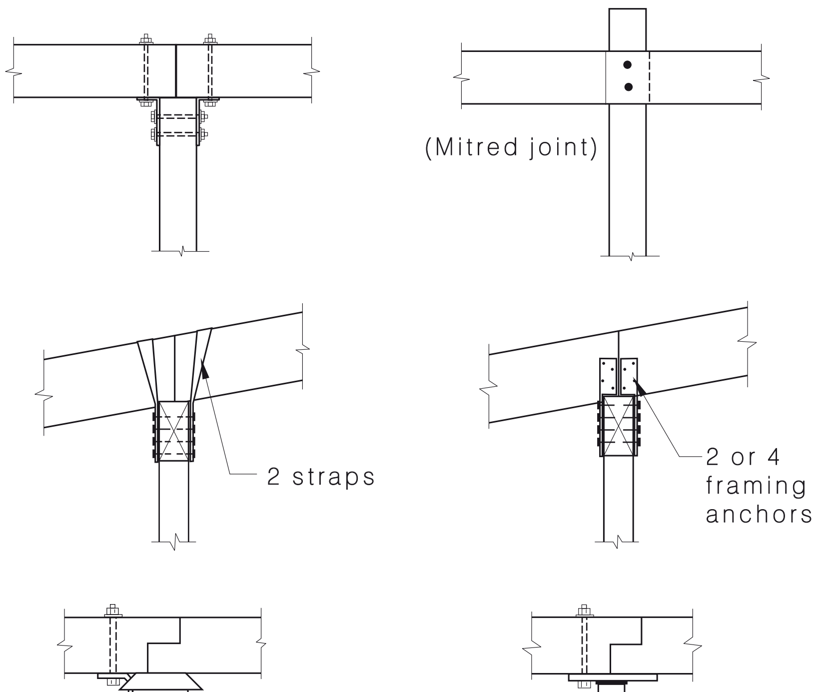
Unless shown or illustrated, the uplift capacities given in the relevant details of Tables 9.16 to 9.25 apply to members that are continuous over supports. Where members are joined over supports, consideration shall be given to the effect of reduced end distances for connectors (bolts, screws, etc.).

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.

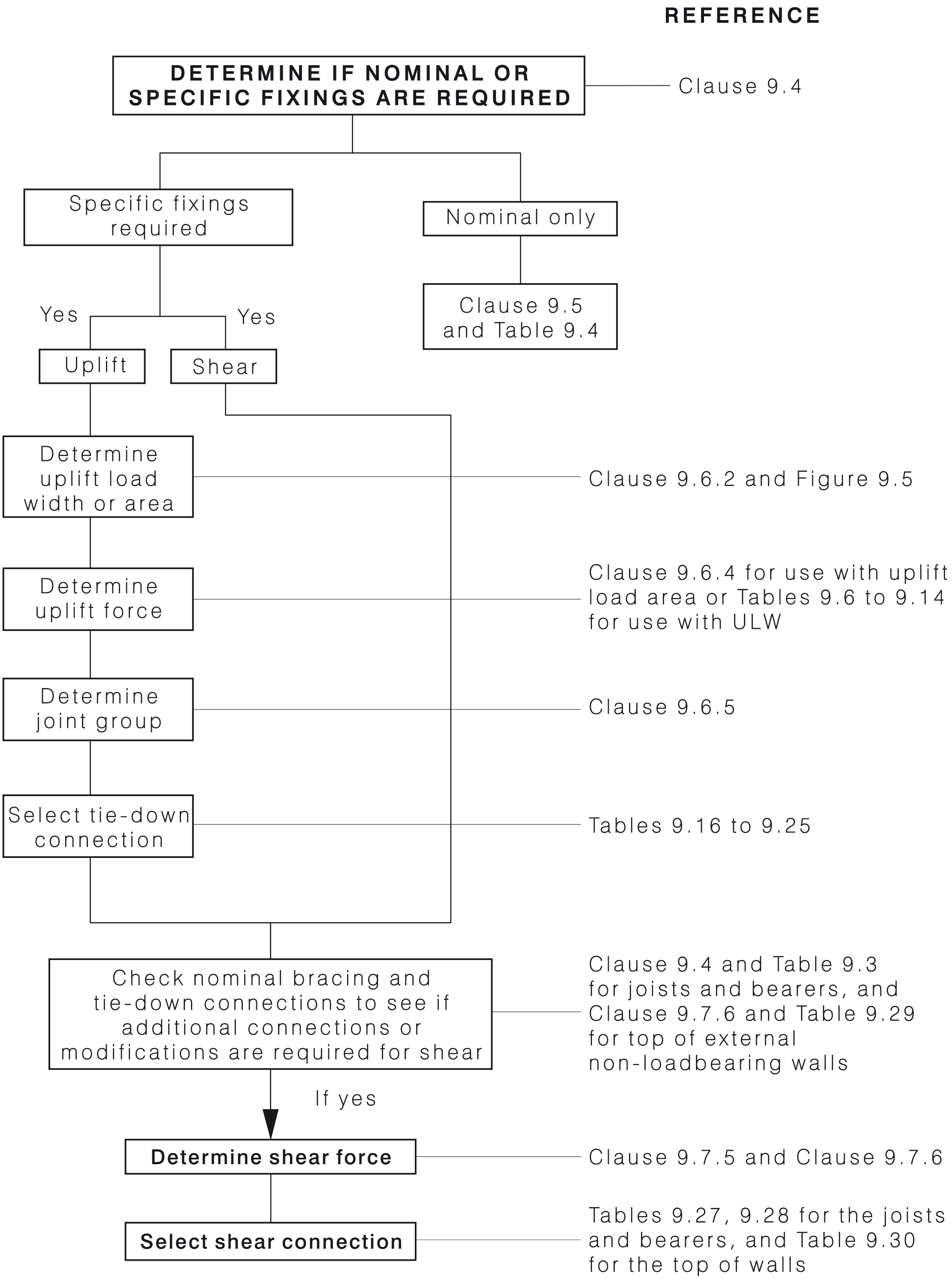


FIGURE 9.4 FLOW CHART SHOWING PROCEDURE FOR TIE-DOWN REQUIREMENTS

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					
	C1		C2		C3	
	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof
Roof battens to rafters/trusses — within 1200 mm of edges — general area	 S S	 S S	 S S	 S S	 S S	 S S
Single or upper storey rafters/trusses or wall frame to floor frame or slab	S	S	S	S	S	S
Single or upper storey floor frame to supports	S	S	S	S	S	S
Lower storey wall frame to floor frame or slab	S	S	S	S	S	S
Lower storey floor frame to supports	S	S	S	S	S	S

S = specific connection may be required for uplift forces (refer to Clause 9.7)

TABLE 9.3

SHEAR

Connection	Wind classification		
	C1	C2	C3
Bottom plate to slab	N	N at 600 mm max. centres	N at 600 mm max. centres
Joists to bearers	N	S	S
Bearers to stumps	S	S	S

N = nominal (minimum) connection only (see Clause 9.5)

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 Table 5.2 or elsewhere, 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 × 3.33 mm or 5/75 × 3.05 mm machine-driven nails plus 1/30 × 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 × 3.33 mm or 5/75 × 3.05 mm machine-driven nails
Bearer to masonry column/wall/pier (excluding masonry veneer construction)		1/M10 bolt or 1/50 × 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 × 3.05 mm dia. nails
Wall framing		
Plates to studs and plates to ring beams at 600mm max. centres		Plates up to 38 mm thick—2/75 × 3.05 mm nails through plate; Plates 38 to 50 mm thick—2/90 × 3.05 mm nails through plate; *OR* 2/75 × 3.05 mm nails skewed through stud into plate
Noggings to studs		2/75 × 3.05 mm nail skewed or through nailed
Timber braces to studs or plates/ring beams		2/50 × 2.8 mm dia. nails at each joint
Lintel to jamb stud		2/75 × 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 × 3.05 mm nails at max.600 mm centres Plates 38 to 50 mm thick—2/90 × 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 1200 mm centres
Ribbon plate to top plate		Refer to Clause 2.5 and Clause 9.2.8
Multiple studs		1/75 × 3.05 mm nail at 600 centres max.
Posts to bearers or joists		1/M12 or 2/M10 bolts (unless otherwise specified)

(*continued*)

TABLE 9.4 (*continued*)

Joint		Minimum fixing for each joint
Roof framing		
Roof trusses to top plates/ring beams	Standard trusses	See Clause 1.12; *OR* One framing anchor with three nails to each leg; *OR* 1/30 × 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
Ceiling joists to top plates		2/75 mm skew nails
Ceiling joists to rafters		In coupled roof construction, 1/75 hand-driven nail; *OR* 2/75 × 3.05 mm 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)

NOTES:

1 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.

2 The nominal connections for roof trusses to top plates given in this Table are based on the minimum connection details recommended by truss plate manufacturers.

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, etc.), 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.

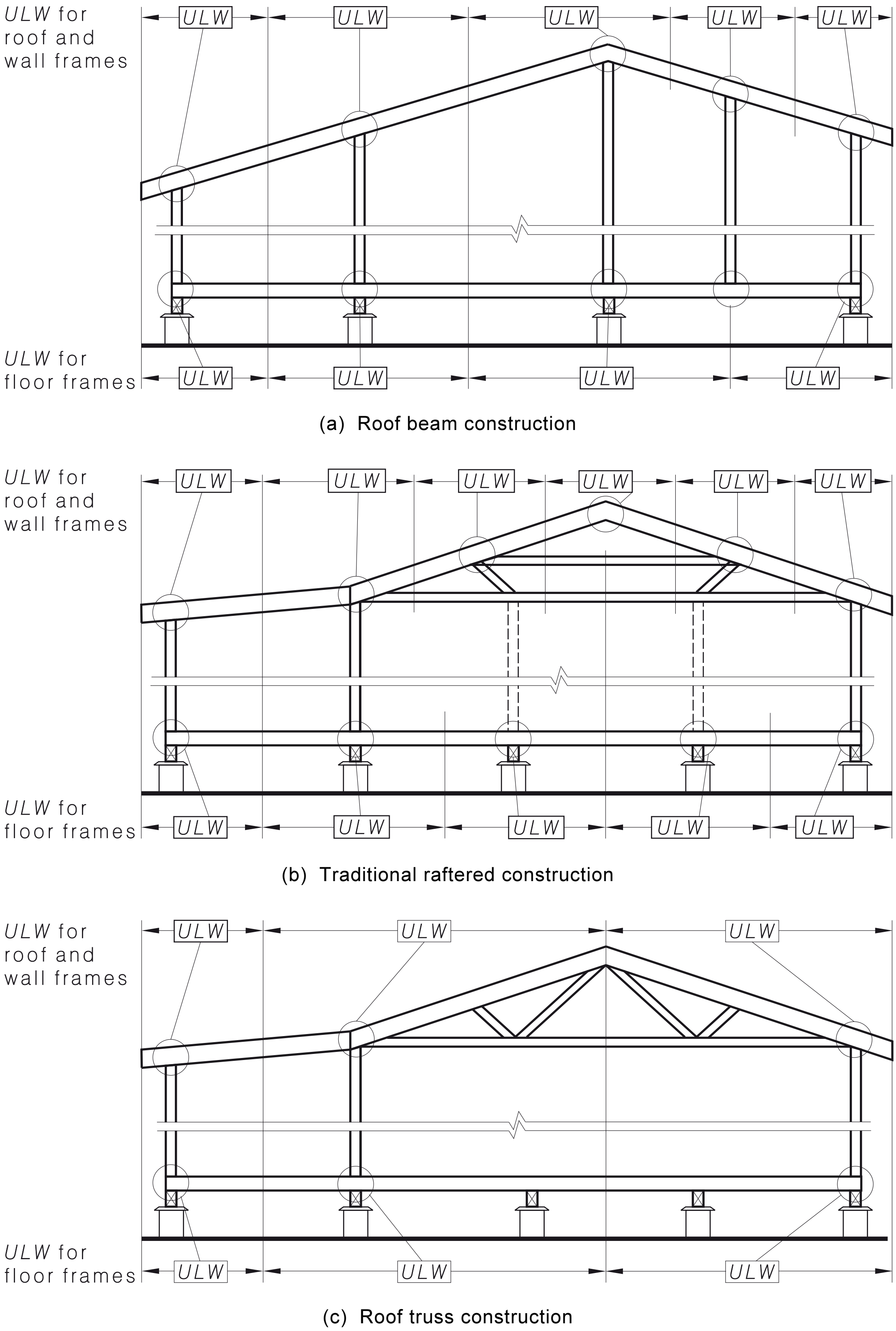
9.6.3 Application

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.



NOTES:

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.

2 Circles indicate tie-down points.

3 Trusses may be specially designed for tie-down from their ridge or panel points through internal walls.

4 For single storey slab on ground construction, the only *ULWs* applicable are those shown for roof and wall frames.

FIGURE 9.5 ROOF UPLIFT LOAD WIDTH ULW FOR WIND

(d) Enter the appropriate design strength Tables 9.16 to 9.25 and establish a suitable tie-down detail.

NOTES:

1 *ULW* for uplift may differ significantly from the *RLW*, *CLW* or *FLW* used for determination of timber member sizes.

2 The tie-down details given in Tables 9.16 to 9.25 are interchangeable for other tie-down positions, that is a detail shown for a floor joist to bearer would be equally applicable to use for a rafter to beam connection and vice versa.

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.

TABLE 9.5

NET UPLIFT PRESSURE, kPa

Connection/tie-down position	Wind classification					
	C1		C2		C3	
	Tile	Sheet	Tile	Sheet	Tile	Sheet
Roof battens to rafters/trusses — within 1200 mm of edges — general area	 3.27 1.92	 3.67 2.32	 5.10 3.09	 5.50 3.49	 7.73 4.78	 8.13 5.18
Single- or upper storey-rafters/trusses to wall frames and wall plates to studs, floor frame or slab	1.68	2.08	2.85	3.25	4.54	4.94
Single- or upper- storey bottom plates to floor frame or slab	1.36	1.76	2.53	2.93	4.22	4.62
Single- or upper- storey floor frame to supports	*1.0*	*1.2*	*2.0*	*2.1*	*3.8*	*3.8*
Lower storey wall frame to floor frame or slab	*1.0*	*1.2*	*2.0*	*2.1*	*3.8*	*3.8*
Lower storey floor frame to supports	*0.5*	*0.6*	*1.7*	*1.8*	*3.8*	*3.8*

NOTE: The values in italics 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*)	Fixing spacing	Uplift force, kN					
		Wind classification					
		C1		C2		C3	
mm	mm	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1500	1800	1.4	1.6	4.6	4.9	10	10
	2400	1.8	2.2	6.1	6.5	14	14
	3000	2.3	2.7	7.7	8.1	17	17
	3600	2.7	3.2	9.2	9.7	20	20
	4200	3.2	3.8	11	11	24	24
3000	1800	2.7	3.2	9.2	9.7	20	20
	2400	3.6	4.3	12	13	27	27
	3000	4.5	5.4	15	16	34	34
	3600	5.4	6.5	18	19	41	41
	4200	6.3	7.6	21	23	48	48
4500	1800	4.1	4.9	14	15	31	31
	2400	5.4	6.5	18	19	41	41
	3000	6.8	8.1	23	24	51	51
	3600	8.1	9.7	27	29	62	62
	4200	9.5	11	32	34	72	72
6000	1800	5.4	6.5	18	19	41	41
	2400	7.2	8.6	24	26	55	55
	3000	9.0	11	31	32	68	68
	3600	11	13	37	39	82	82
	4200	13	15	43	45	96	96
7500	1800	6.8	8.1	23	24	51	51
	2400	9.0	11	31	32	68	68
	3000	11	13	38	40	85	85
	3600	13	16	46	49	103	103
	4200	16	19	54	57	120	120

NOTE: Interpolation within the Table is permitted.

TABLE 9.7

NET UPLIFT FORCE—FLOOR JOISTS—LOWER STOREY OF TWO STOREYS—TO BEARERS OR SUPPORTS

Wind uplift load width (*ULW*)	Fixing spacing	Uplift force, kN					
		Wind classification					
		C1		C2		C3	
mm	mm	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1500	450	0.34	0.41	1.1	1.2	2.6	2.6
	600	0.45	0.54	1.5	1.6	3.4	3.4
	900	0.68	0.81	2.3	2.4	5.1	5.1
	1200	0.90	1.1	3.1	3.2	6.8	6.9
	1350	1.0	1.2	3.4	3.6	7.7	7.7
3000	450	0.68	0.81	2.3	2.4	5.1	5.1
	600	0.90	1.1	3.1	3.2	6.8	6.9
	900	1.3	1.6	4.6	4.9	10	10
	1200	1.8	2.2	6.1	6.5	14	13
	1350	2.0	2.4	6.9	7.3	15	15
4500	450	1.0	1.2	3.4	3.6	7.7	7.7
	600	1.3	1.6	4.6	4.9	10	10
	900	2.0	2.4	6.9	7.3	15	15
	1200	2.7	3.2	9.2	9.7	21	21
	1350	3.0	3.6	10	11	23	23
6000	450	1.3	1.6	4.6	4.9	10	10
	600	1.8	2.2	6.1	6.5	14	14
	900	2.7	3.2	9.2	9.7	21	21
	1200	3.6	4.3	12	13	27	27
	1350	4.0	4.9	14	15	31	31
7500	450	1.7	2.0	5.7	6.1	13	13
	600	2.2	2.7	7.6	8.1	17	17
	900	3.4	4.0	11	12	26	26
	1200	4.5	5.4	15	16	34	34
	1350	5.1	6.1	17	18	38	38

NOTE: Interpolation within the Table is permitted.

TABLE 9.8

NET UPLIFT FORCE—WALL FRAME—LOWER STOREY OF TWO STOREYS—TO FLOOR FRAME OR SLAB

Wind uplift load width (*ULW*)	Fixing spacing	Uplift force, kN					
		Wind classification					
		C1		C2		C3	
mm	mm	Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1500	450	0.7	0.81	1.3	1.4	2.6	2.6
	600	0.9	1.1	1.8	1.9	3.4	3.4
	900	1.3	1.6	2.7	2.8	5.1	5.1
	1200	1.8	2.2	3.6	3.8	6.8	6.8
	1350	2.0	2.4	4.1	4.2	7.7	7.7
	1800	2.7	3.2	5.4	5.7	10	10
	3000	4.5	5.4	9.0	9.4	17	17
3000	450	1.3	1.6	2.7	2.8	5.1	5.1
	600	1.8	2.2	3.6	3.8	6.8	6.8
	900	2.7	3.2	5.4	5.7	10	10
	1200	3.6	4.3	7.2	7.6	14	14
	1350	4.0	4.9	8.1	8.5	15	15
	1800	5.4	6.5	11	11	21	21
	3000	9.0	11	18	19	34	34
4500	450	2.0	2.4	4.1	4.2	7.7	7.7
	600	2.7	3.2	5.4	5.7	10	10
	900	4.0	4.9	8.1	8.5	15	15
	1200	5.4	6.5	11	11	21	21
	1350	6.1	7.3	12	13	23	23
	1800	8.1	9.7	16	17	31	31
	3000	13	16	27	28	51	51
6000	450	2.7	3.2	5.4	5.7	10	10
	600	3.6	4.3	7.2	7.6	14	13
	900	5.4	6.5	11	11	21	21
	1200	7.2	8.6	14	15	27	27
	1350	8.1	9.7	16	17	31	31
	1800	11	13	22	23	41	41
	3000	18	21	36	38	68	68
7500	450	3.4	4.0	6.7	7.1	13	13
	600	4.5	5.4	9.0	9.4	17	17
	900	6.7	8.1	13	14.2	26	26
	1200	9.0	11	18	19	34	34
	1350	10	12	20	21	38	38
	1800	13	16	27	28	51	51
	3000	22	27	45	47	85	85

NOTE: Interpolation within the Table is permitted.

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 C1 Tile roof	C1 Sheet roof	C2 Tile roof	C2 Sheet roof	C3 Tile roof	C3 Sheet roof
1500	1800	2.7	3.2	5.4	5.7	10	10
	2400	3.6	4.3	7.2	7.6	14	14
	3000	4.5	5.4	9.0	9.5	17	17
	3600	5.4	6.5	11	11	20	20
	4200	6.3	7.6	13	13	24	24
3000	1800	5.4	6.5	11	11	20	20
	2400	7.2	8.6	14	15	27	27
	3000	9.0	11	18	19	34	34
	3600	11	13	22	23	41	41
	4200	13	15	25	26	48	48
4500	1800	8.1	9.7	16	17	31	31
	2400	11	13	22	23	41	41
	3000	13	16	27	28	51	51
	3600	16	19	32	34	62	62
	4200	19	23	38	40	72	72
6000	1800	11	13	22	23	41	41
	2400	14	17	29	30	55	55
	3000	18	22	36	38	68	68
	3600	22	26	43	45	82	82
	4200	25	30	50	53	96	96
7500	1800	13	16	27	28	51	51
	2400	18	22	36	38	68	68
	3000	22	27	45	47	85	85
	3600	27	32	54	57	103	103
	4200	31	38	63	66	120	120

NOTE: Interpolation within the Table is permitted.

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					
		C1		C2		C3	
		Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1500	450	0.68	0.81	1.4	1.4	2.6	2.6
	600	0.90	1.1	1.8	1.9	3.4	3.4
	900	1.4	1.6	2.7	2.8	5.1	5.1
	1200	1.8	2.2	3.6	3.8	6.8	6.8
	1350	2.0	2.4	4.1	4.3	7.7	7.7
3000	450	1.4	1.6	2.7	2.8	5.1	5.1
	600	1.8	2.2	3.6	3.8	6.8	6.8
	900	2.7	3.2	5.4	5.7	10	10
	1200	3.6	4.3	7.2	7.6	14	14
	1350	4.1	4.9	8.1	8.5	15	15
4500	450	2.0	2.4	4.1	4.3	7.7	7.7
	600	2.7	3.2	5.4	5.7	10	10
	900	4.1	4.9	8.1	8.5	15	15
	1200	5.4	6.5	11	11	21	21
	1350	6.1	7.3	12	13	23	23
6000	450	2.7	3.2	5.4	5.7	10	10
	600	3.6	4.3	7.2	7.6	14	14
	900	5.4	6.5	11	11	21	21
	1200	7.2	8.6	14	15	27	27
	1350	8.1	9.7	16	17	31	31
7500	450	3.4	4.1	6.8	7.1	13	13
	600	4.5	5.4	9.0	9.5	17	17
	900	6.8	8.1	14	14	26	26
	1200	9.0	11	18	19	34	34
	1350	10	12	20	21	38	38

NOTE: Interpolation within the Table is permitted.

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 (see Note 2) mm	Uplift force, kN					
		Wind classification					
		C1		C2		C3	
		Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1500	450	0.92	1.2	1.7	2.0	2.8	3.1
	600	1.2	1.6	2.3	2.6	3.8	4.2
	900	1.8	2.4	3.4	4.0	5.7	6.2
	1200	2.4	3.2	4.6	5.3	7.6	8.3
3000	450	1.8	2.4	3.4	4.0	5.7	6.2
	600	2.4	3.2	4.6	5.3	7.6	8.3
	900	3.7	4.8	6.8	7.9	11	12
	1200	4.9	6.3	9.1	10.5	15	17
4500	450	2.8	3.6	5.1	5.9	8.5	9.4
	600	3.7	4.8	6.8	7.9	11	12
	900	5.5	7.1	10	12	17	19
	1200	7.3	9.5	14	16	23	25
6000	450	3.7	4.8	6.8	7.9	11	12
	600	4.9	6.3	9.1	11	15	17
	900	7.3	9.5	14	16	23	25
	1200	9.8	12.7	18	21	30	33
7500	450	4.6	5.9	8.5	9.9	14	16
	600	6.1	7.9	11	13	19	21
	900	9.2	12	17	20	28	31
	1200	12	16	23	26	38	42

NOTES:

1 Interpolation within the Table is permitted.

2 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 (see Note 2) mm	Uplift force, kN — Wind classification — C1 Tile roof	C1 Sheet roof	C2 Tile roof	C2 Sheet roof	C3 Tile roof	C3 Sheet roof
1500	1800	4.5	5.6	7.7	8.8	12	13
	2400	6.0	7.5	10	12	16	18
	3000	7.6	9.4	13	15	20	22
	3600	9.1	11	15	18	25	27
3000	1800	9.1	11	15	18	25	27
	2400	12	15	21	23	33	36
	3000	15	19	26	29	41	44
	3600	18	22	31	35	49	53
4500	1800	14	17	23	26	37	40
	2400	18	22	31	35	49	53
	3000	23	28	38	44	61	67
	3600	27	34	46	53	74	80
6000	1800	18	22	31	35	49	53
	2400	24	30	41	47	65	71
	3000	30	37	51	59	82	89
	3600	36	45	62	70	98	107

NOTES:

1 Interpolation within the Table is permitted.

2 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 (see Note 2) mm	Uplift force, kN					
		Wind classification					
		C1		C2		C3	
		Tile roof	Sheet roof	Tile roof	Sheet roof	Tile roof	Sheet roof
1500	450	1.1	1.4	1.9	2.2	3.1	3.3
	600	1.5	1.9	2.6	2.9	4.1	4.4
	900	2.3	2.8	3.8	4.4	6.1	6.7
	1200	3.0	3.7	5.1	5.9	8.2	8.9
	1350	3.4	4.2	5.8	6.6	9.2	10
	1800	4.5	5.6	7.7	8.8	12	13
	3000	7.6	9.4	13	15	20	22
3000	450	2.3	2.8	3.8	4.4	6.1	6.7
	600	3.0	3.7	5.1	5.9	8.2	8.9
	900	4.5	5.6	7.7	8.8	12	13
	1200	6.0	7.5	10	12	16	18
	1350	6.8	8.4	12	13	18	20
	1800	9.1	11	15	18	25	27
	3000	15	19	26	29	41	44
4500	450	3.4	4.2	5.8	6.6	9.2	10
	600	4.5	5.6	7.7	8.8	12	13
	900	6.8	8.4	12	13	18	20
	1200	9.1	11	15	18	25	27
	1350	10	13	17	20	28	30
	1800	14	17	23	26	37	40
	3000	23	28	38	44	61	67
6000	450	4.5	5.6	7.7	8.8	12	13
	600	6.0	7.5	10	12	16	18
	900	9.1	11	15	18	25	27
	1200	12	15	21	23	33	36
	1350	14	17	23	26	37	40
	1800	18	22	31	35	49	53
	3000	30	37	51	59	82	89
7500	450	5.7	7.0	9.6	11	15	17
	600	7.6	9.4	13	15	20	22
	900	11	14	19	22	31	33
	1200	15	19	26	29	41	44
	1350	17	21	29	33	46	50
	1800	23	28	38	44	61	67
	3000	38	47	64	73	102	111

NOTES:

1 Interpolation within the Table is permitted.

2 Fixing spacing equals to rafter/truss, beams, lintels, stud or bottom plate fixing-spacing. 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 1800 mm.

TABLE 9.14

NET UPLIFT FORCE ON ROOF BATTENS

Rafter or truss spacing	Batten spacing	Uplift force, kN											
		Maximum internal pressure						Partial internal pressure					
		C1		C2		C3		C1		C2		C3	
mm	mm	General area	Edges	General area	Edges	General area	Edges	General area	Edges	General area	Edges	General area	Edges
Tile roof													
450	330	0.29	0.49	0.46	0.76	0.71	1.1	0.17	0.37	0.29	0.59	0.47	0.90
600	330	0.38	0.65	0.61	1.0	0.95	1.5	0.23	0.50	0.39	0.79	0.62	1.2
900	330	0.57	0.97	0.92	1.5	1.4	2.3	0.35	0.75	0.59	1.2	0.93	1.8
Sheet roof													
600	370	0.52	0.81	0.77	1.2	1.1	1.8	0.35	0.65	0.53	0.97	0.79	1.4
	450	0.63	0.99	0.94	1.5	1.4	2.2	0.42	0.79	0.64	1.2	0.96	1.8
	600	0.84	1.3	1.3	2.0	1.9	2.9	0.57	1.1	0.85	1.6	1.3	2.3
	750	1.0	1.7	1.6	2.5	2.3	3.7	0.71	1.3	1.1	2.0	1.6	2.9
	900	1.3	2.0	1.9	3.0	2.8	4.4	0.85	1.6	1.3	2.4	1.9	3.5
	1200	1.7	2.6	2.5	4.0	3.7	5.9	1.1	2.1	1.7	3.2	2.5	4.7
900	370	0.77	1.2	1.2	1.8	1.7	2.7	0.52	0.97	0.79	1.5	1.2	2.2
	450	0.94	1.5	1.4	2.2	2.1	3.3	0.64	1.2	0.96	1.8	1.4	2.6
	600	1.3	2.0	1.9	3.0	2.8	4.4	0.85	1.6	1.3	2.4	1.9	3.5
	750	1.6	2.5	2.4	3.7	3.5	5.5	1.1	2.0	1.6	3.0	2.4	4.4
	900	1.9	3.0	2.8	4.5	4.2	6.6	1.3	2.4	1.9	3.5	2.9	5.3
	1200	2.5	4.0	3.8	5.9	5.6	8.8	1.7	3.2	2.6	4.7	3.8	7.0
1200	370	1.0	1.6	1.5	2.4	2.3	3.6	0.70	1.3	1.1	1.9	1.6	2.9
	450	1.3	2.0	1.9	3.0	2.8	4.4	0.85	1.6	1.3	2.4	1.9	3.5
	600	1.7	2.6	2.5	4.0	3.7	5.9	1.1	2.1	1.7	3.2	2.5	4.7
	750	2.1	3.3	3.1	5.0	4.7	7.3	1.4	2.6	2.1	3.9	3.2	5.8
	900	2.5	4.0	3.8	5.9	5.6	8.8	1.7	3.2	2.6	4.7	3.8	7.0
	1200	3.3	5.3	5.0	7.9	7.5	12	2.3	4.2	3.4	6.3	5.1	9.3

NOTES:

1 Tile roof also includes concrete or terracotta tiles. Sheet roof also includes metal or other 'lightweight' tiles or other sheet material.

2 General area also includes any roof area that is greater than 1200 mm away from the edges of a roof. Edges include edges, hips, ridges, fascias and barges.

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.

4 Interpolation within the table is permitted.

5 Where ceiling or eaves lining is placed on top of rafters or trusses, or where the ceiling or eaves lining does not have sufficient strength to resist internal pressures, or where roof cavities are vented to internal room, e.g., manhole covers not rigidly fixed, then 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, then the batten to rafter/truss connection may be designed for partial internal pressure.

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 (see 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).

Where a timber joint is comprised of 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 shown in Figure 9.6.

TABLE 9.15

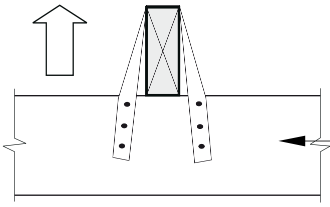
JOINT GROUPS

Species or species group		Joint group
Seasoned softwood (radiata, slash and other plantation pines)	Seasoned—Free of heart-in material	JD4
	Seasoned—Heart-in material included	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

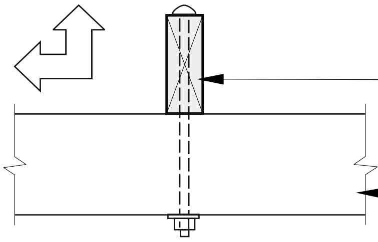
NOTES:

1 The appropriate joint group for a single timber species can be determined by reference to Table G1, Appendix G, or AS 1720.2.

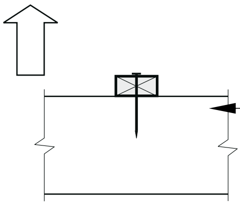
2 For timber with a joint group of JD2 or JD3, the values given in this Standard for J2 may be used.



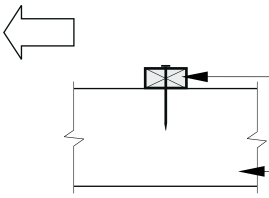
(a) Joint type 1



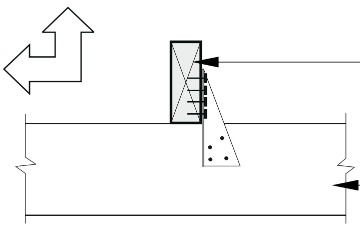
(b) Joint type 2



(c) Joint type 3



(d) Joint type 4



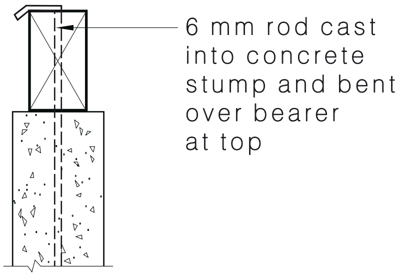
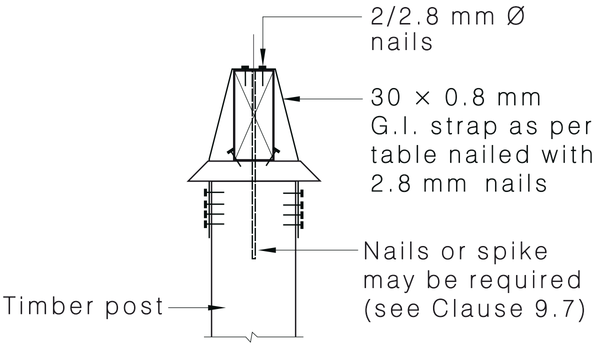
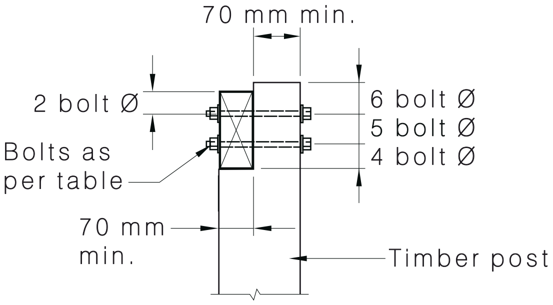
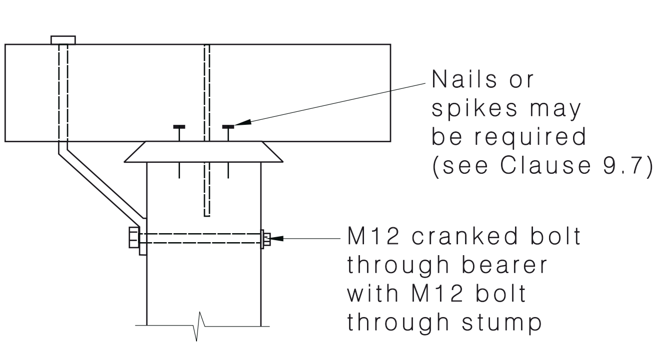
(e) Joint type 5

NOTE: Large arrows indicate direction of load.

FIGURE 9.6 JOINT GROUP SELECTION

TABLE 9.16

UPLIFT CAPACITY OF BEARER 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">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 colspan="2">(a)
</td><td>1.0</td><td>1.0</td><td>1.0</td><td>1.0</td><td>1.0</td><td>1.0</td></tr>
<tr><td colspan="2" rowspan="8">(b)
</td><td colspan="6">1 strap with 4 nails each end</td></tr>
<tr><td>9.9</td><td>7.1</td><td>5.0</td><td>7.1</td><td>5.8</td><td>4.4</td></tr>
<tr><td colspan="6">2 strap with 4 nails each end</td></tr>
<tr><td>17</td><td>12</td><td>8.4</td><td>12</td><td>9.7</td><td>7.4</td></tr>
<tr><td colspan="6">1 strap with 6 nails each end</td></tr>
<tr><td>13</td><td>9.3</td><td>6.6</td><td>9.3</td><td>7.6</td><td>5.8</td></tr>
<tr><td colspan="6">2 strap with 6 nails each end</td></tr>
<tr><td>23</td><td>17</td><td>12</td><td>17</td><td>14</td><td>10</td></tr>
<tr><td rowspan="6">(c)
</td><td colspan="7">No. of bolts</td></tr>
<tr><td>1/M10</td><td>5.7</td><td>5.2</td><td>3.6</td><td>5.2</td><td>4.5</td><td>3.9</td></tr>
<tr><td>1/M12</td><td>8.1</td><td>6.8</td><td>4.7</td><td>7.4</td><td>6.4</td><td>5</td></tr>
<tr><td>2/M10</td><td>13</td><td>10</td><td>7.3</td><td>12</td><td>11</td><td>8.3</td></tr>
<tr><td>2/M12</td><td>17</td><td>14</td><td>9.4</td><td>17</td><td>14</td><td>10</td></tr>
<tr><td>2/M16</td><td>26</td><td>20</td><td>14</td><td>27</td><td>20</td><td>13</td></tr>
<tr><td colspan="2">(d)
</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
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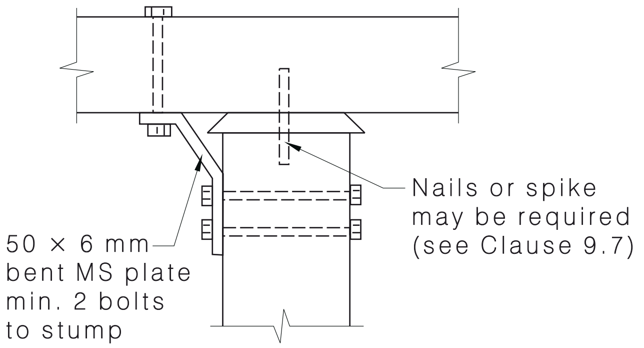
(*continued*)

TABLE 9.16 (*continued*)

<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>
<tr><td colspan="2">(e)

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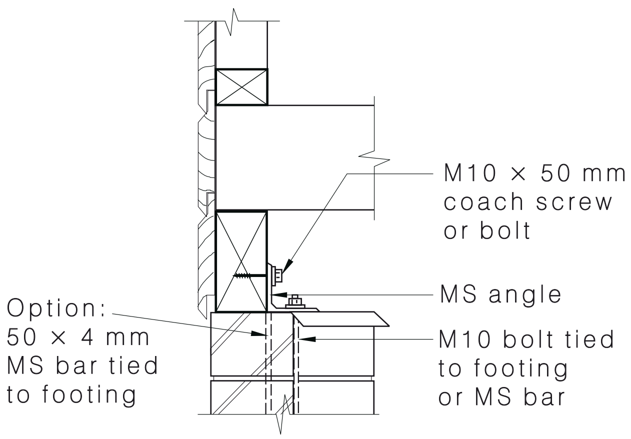
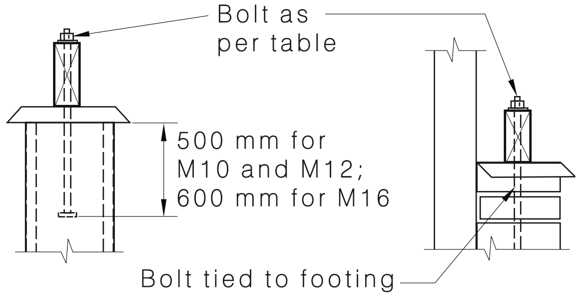
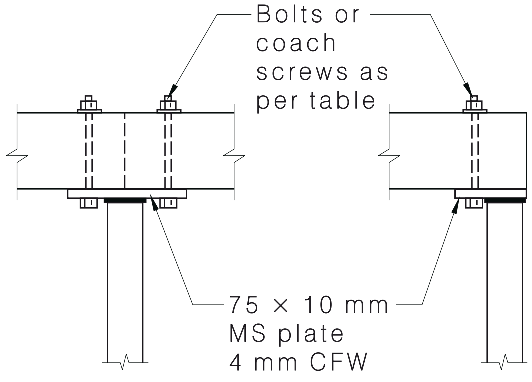
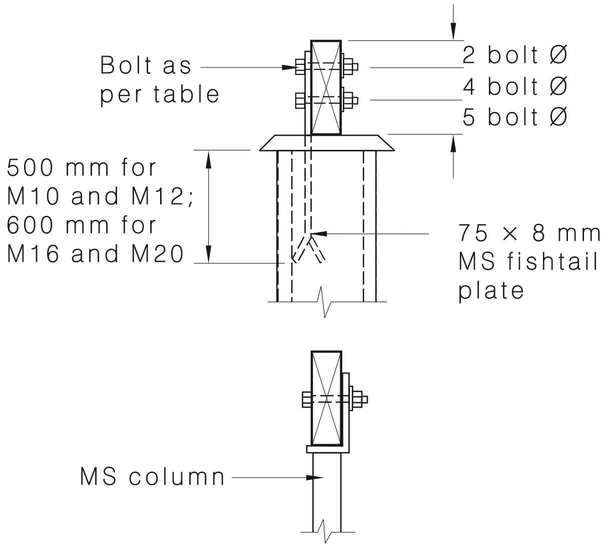
<tr><td colspan="2">(f)

</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>
<tr><td rowspan="4">(g)

</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>
<tr><td rowspan="10">(h)

</td><td colspan="7">No. of bolts</td></tr>
<tr><td>1/M10</td><td>18</td><td>18</td><td>18</td><td>15</td><td>12</td><td>9</td></tr>
<tr><td>1/M12</td><td>27</td><td>27</td><td>26</td><td>20</td><td>16</td><td>12</td></tr>
<tr><td>2/M10</td><td>36</td><td>36</td><td>36</td><td>30</td><td>24</td><td>18</td></tr>
<tr><td>2/M12</td><td>54</td><td>54</td><td>52</td><td>40</td><td>32</td><td>24</td></tr>
<tr><td colspan="7">No. of coach screw (75 mm min.)</td></tr>
<tr><td>1/M10</td><td>7.5</td><td>5.5</td><td>3.7</td><td>4.7</td><td>3.6</td><td>2.6</td></tr>
<tr><td>1/M12</td><td>8.2</td><td>6.0</td><td>4.0</td><td>5.0</td><td>4.2</td><td>3.0</td></tr>
<tr><td>2/M10</td><td>15</td><td>11</td><td>7.4</td><td>9.4</td><td>7.2</td><td>5.2</td></tr>
<tr><td>2/M12</td><td>16</td><td>12</td><td>8.0</td><td>10</td><td>8.4</td><td>6.0</td></tr>
</table>

(*continued*)

TABLE 9.16 (*continued*)

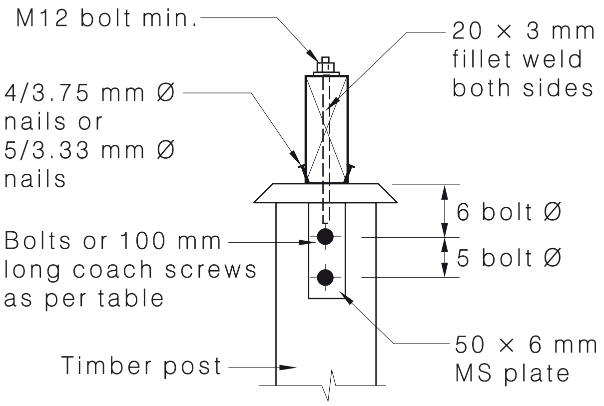
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		J2	J3	J4	JD4	JD5	JD6

(i)



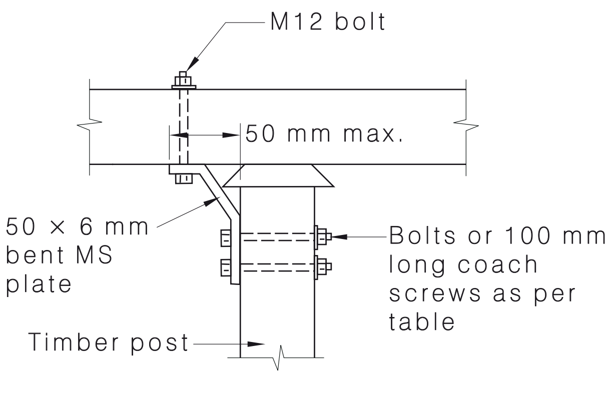
Bolts	J2	J3	J4	JD4	JD5	JD6
1/M10	7.7	6.2	4.4	7.9	6.3	5.0
1/M12	10	8.2	5.7	10	8.3	6.0
1/M16	16	12	8.6	16	12	8.0
2/M10	15	12	8.8	16	13	9.9
2/M12	21	16	11	21	17	12
2/M16	32	24	17	32	24	16

(j)



No. of bolts	J2	J3	J4	JD4	JD5	JD6
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

(k)



No. of bolts	J2	J3	J4	JD4	JD5	JD6
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

(*continued*)

TABLE 9.16 (*continued*)

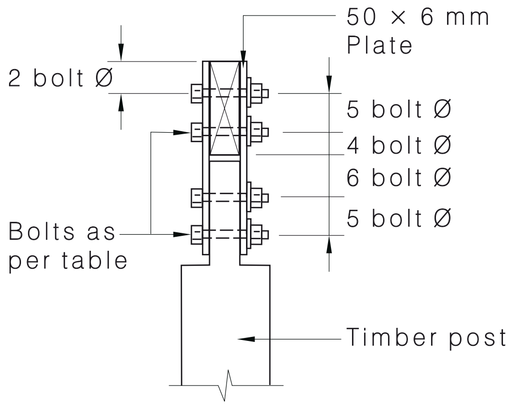
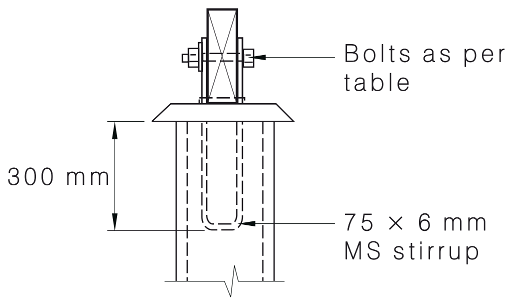
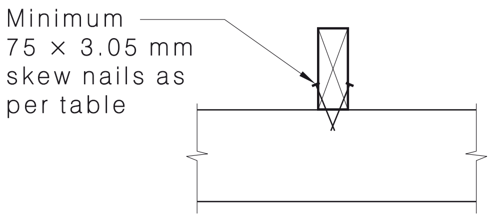
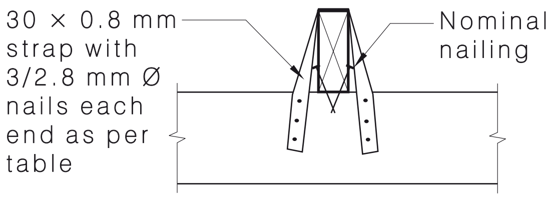
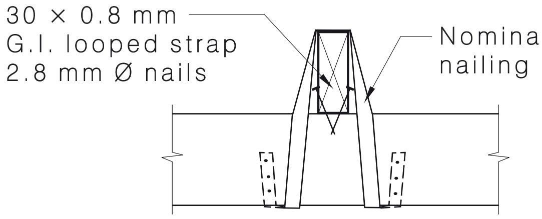
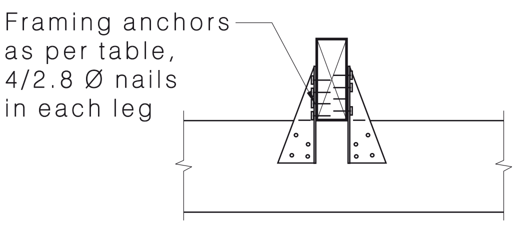
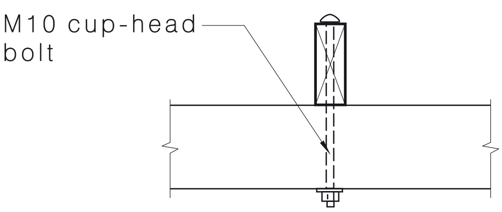
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(l) 	No. of bolts						
	2/M10	31	20	13	20	14	9.8
	2/M12	36	23	15	24	17	12
	2/M16	49	31	20	33	23	16
(m) 	No. of bolts						
	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

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	Glue-coated or deformed shank machine-driven nails shall be used.					
	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
(b) 	No. of straps						
	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
(c)  Nails required for each end of looped strap: 3/2.8 mm Ø for J2 4/2.8 mm Ø for J3 and JD4 5/2.8 mm Ø for J4, JD5 and JD6		13	13	13	13	13	13
(d) 	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
	3	12	8.4	5.9	8.4	6.9	5.2
	4	15	11	7.7	11	8.9	6.8
(e) 		16	14	10	10	7.0	5.0

(*continued*)

TABLE 9.17 (*continued*)

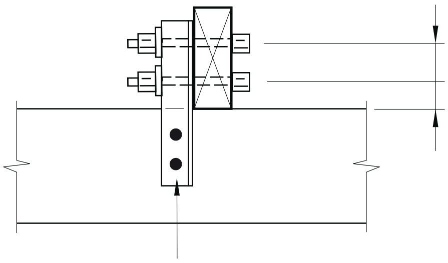
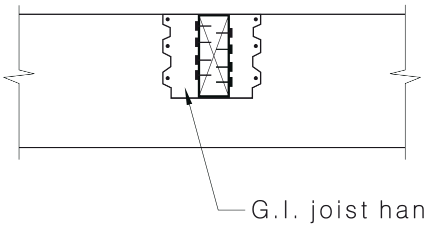
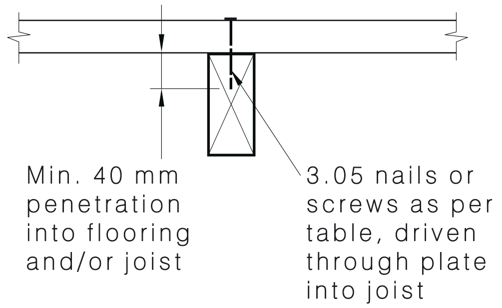
Position of tie-down connection		**Uplift capacity, kN**					
		Unseasoned timber			**Seasoned timber**		
Floor joists to bearers or top plates		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(f) 	No. of bolts						
	2/M10	14	9.2	5.9	10	7.3	4.9
	2/M12	18	11	7.0	12	8.7	6.1
	Coach screws						
	2/M10	7	4.6	3.0	5	3.6	2.5
(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

UPLIFT CAPACITY OF BOTTOM PLATE TIE-DOWN CONNECTIONS

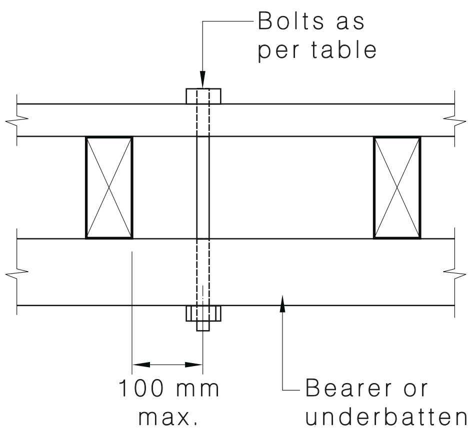
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Bottom plates to floor joists or slab	J2	J3	J4	JD4	JD5	JD6

(a)



No. of Nails	J2	J3	J4	JD4	JD5	JD6
2	1.3	1.1	0.95	0.68	0.45	0.32
3	1.9	1.6	1.4	1.0	0.67	0.48
2/No. 14 Type 17 screws	11	8.4	4.8	9.0	7.2	5.4

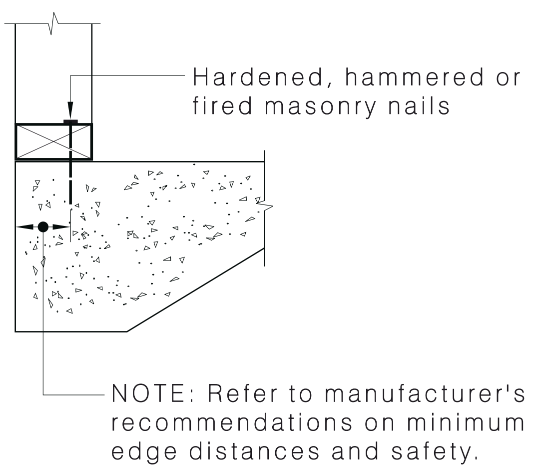
(b)



Bolts	J2	J3	J4	JD4	JD5	JD6
M10 cup-head	16	14	10	10	7.0	5.0
M10	18	18	18	15	12	9.0
M12	27	27	26	20	16	12

Axial load in bolt, kN	Underbatten size (depth × breadth), mm			
	F5	F8	F14	F17
6	70 × 70	45 × 70	45 × 70	35 × 70
10	90 × 70	70 × 70	70 × 70	45 × 70
15	90 × 70	90 × 70	70 × 70	70 × 70
20	120 × 70	90 × 70	70 × 70	70 × 70
30	140 × 70	120 × 70	90 × 70	90 × 70
50	190 × 70	170 × 70	140 × 70	120 × 70

(c)



	J2	J3	J4	JD4	JD5	JD6
(c)	1.0	1.0	1.0	1.0	1.0	1.0

(*continued*)

TABLE 9.18 (*continued*)

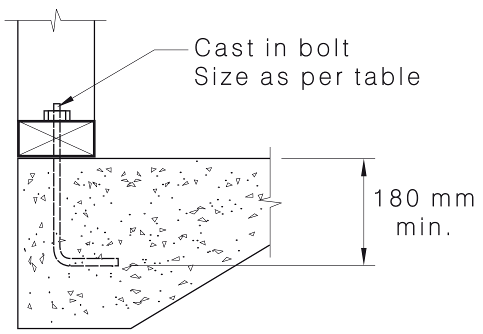
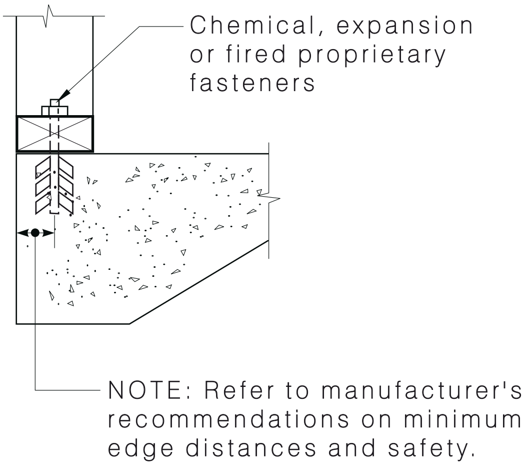
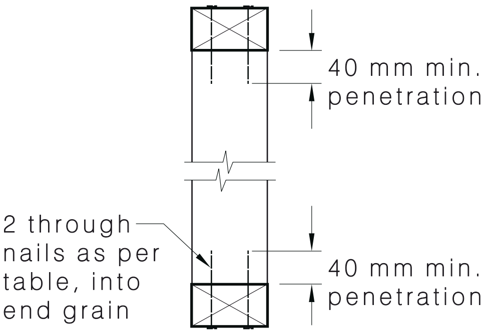
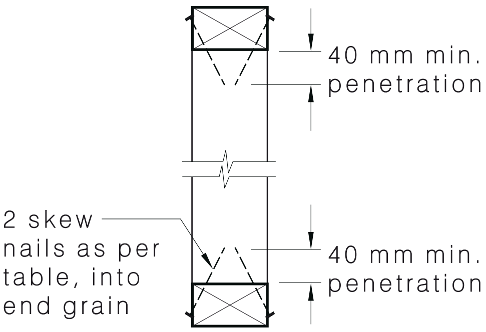
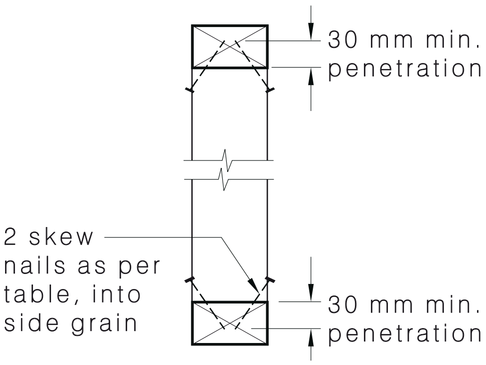
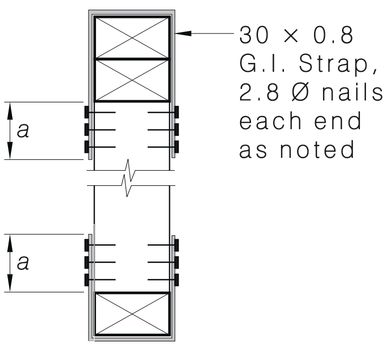
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Bottom plates to floor joists or slab		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(d) 	Bolts						
	M10	18	18	18	15	12	9.0
	M12	27	27	26	20	16	12
(e) 	NOTE: Refer to manufacturer's specifications. The strength of their proprietary fasteners with respect to the strength of the fastener in the timber bottom plate shall be considered.						

TABLE 9.19

UPLIFT CAPACITY OF WALL FRAME TIE-DOWN CONNECTIONS

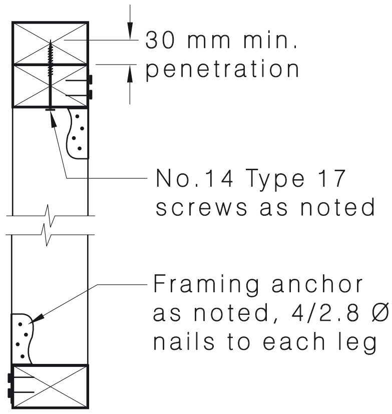
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Studs to plates		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(a) 	Hand-driven nail dia.						
	2/3.15	0.32	0.27	0.24	0.17	0.11	0.08
	2/3.75	0.37	0.32	0.29	0.22	0.13	0.10
	Glue-coated or deformed shank machine-driven 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
(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
(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
(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.						

(*continued*)

TABLE 9.19 (*continued*)

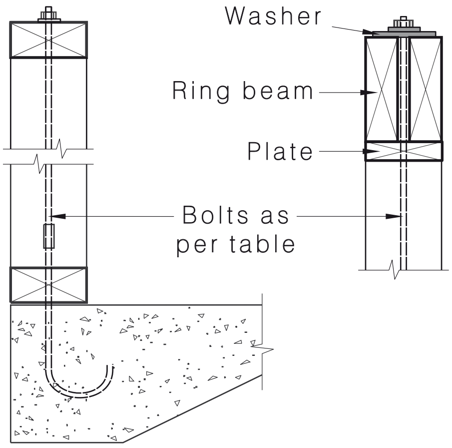
Position of tie-down connection			Uplift capacity, kN					
			Unseasoned timber			Seasoned timber		
Studs to plates			**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**

(e)



No. of screws	No. of anchors	J2	J3	J4	JD4	JD5	JD6
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

(f)

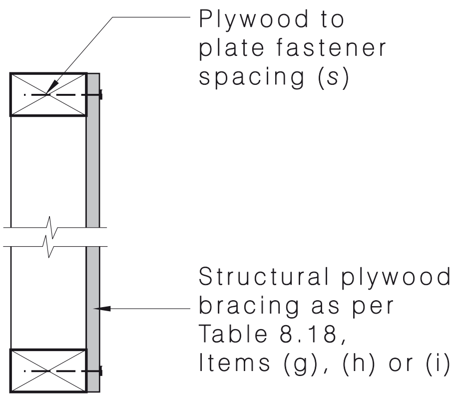


		J2	J3	J4	JD4	JD5	JD6
Bolt	M10	18	18	18	15	15	9.0
	M12	27	27	26	20	16	12
	M16	50	50	46	35	28	21

NOTE: This detail is also suitable for tie-down of ring beam.

Tie-down rods or bolts	M10 or M12	M16
Plate size, mm	75 × 75	90 × 75
Washer thickness, mm	6	8

(g)



NOTES:

1 Suitable for rafter spacings of 600 mm, 900 mm or 1200 mm.

2 Rafters shall be fixed a minimum of 300 mm away from stud at either end of sheathed section.

3 Bottom plate to subfloor fixing capacity shall be at least 13 kN, tie-down every 1200 mm.

4 Minimum plywood panel width is 900 mm.

5 This detail is not applicable for tie-down outside of the openings. The details for tie-down outside of the openings are given in Table 9.20.

6 See Table 9.21(i) for full details.

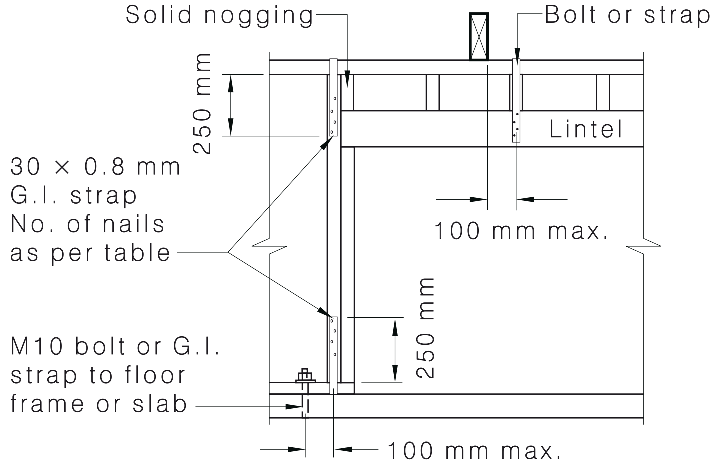
Fastener spacing (*s*), mm	Uplift capacity, kN/rafter
50	16.7
150	10.4

TABLE 9.20

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**

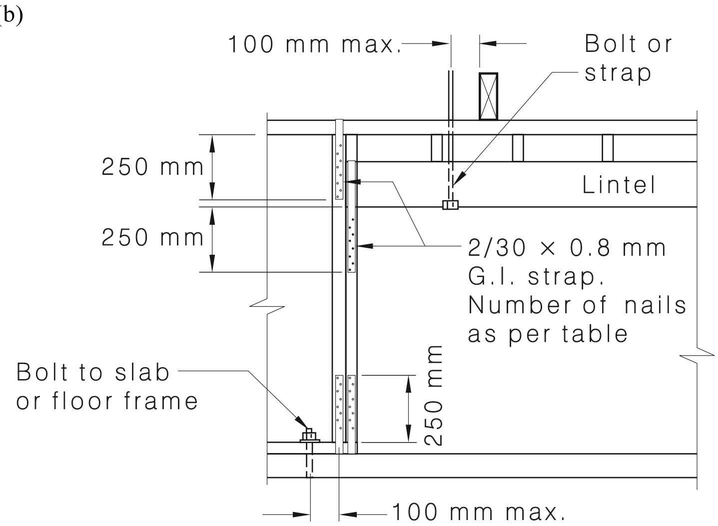
(a)



Position of tie-down connection	J2	J3	J4	JD4	JD5	JD6
4/2.8 mm ∅ nails each end of strap	8.3	5.9	4.2	5.9	4.9	3.7
6/2.8 mm ∅ nails each end of strap	12	8.4	5.9	8.4	6.9	5.2

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.

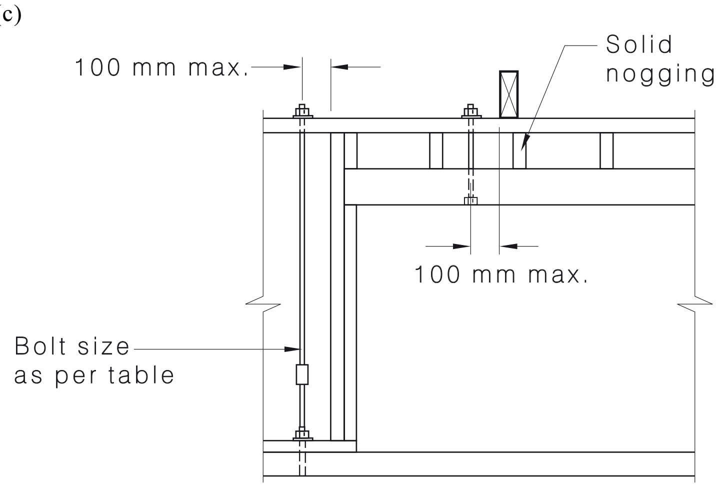
(b)



Position of tie-down connection	J2	J3	J4	JD4	JD5	JD6
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

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.

(c)



Bolt	J2	J3	J4	JD4	JD5	JD6
M10	18	18	18	15	12	9.0
M12	27	27	26	20	16	12

NOTES:

1 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.

2 For M16 bolt, detail in Item (d) or (e) shall be used.

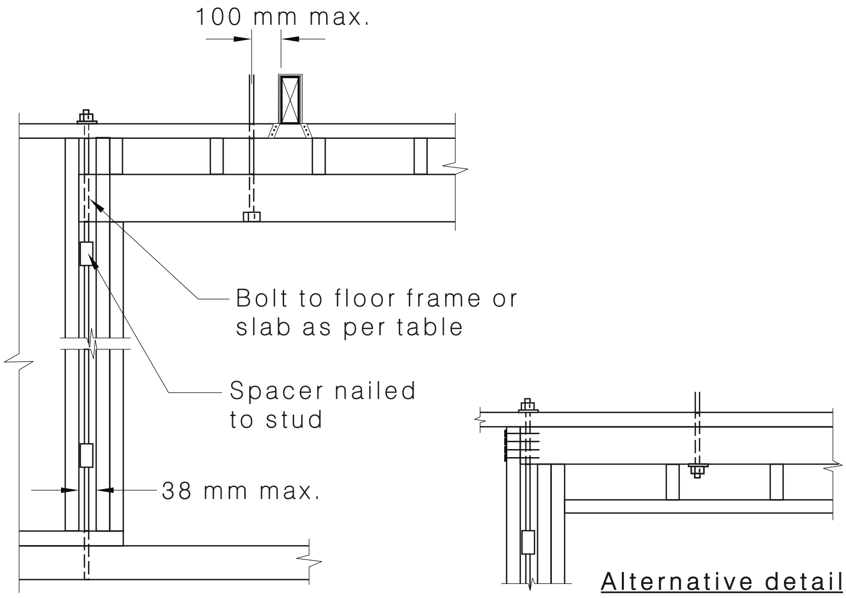
(*continued*)

TABLE 9.20 (*continued*)

(d)

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.

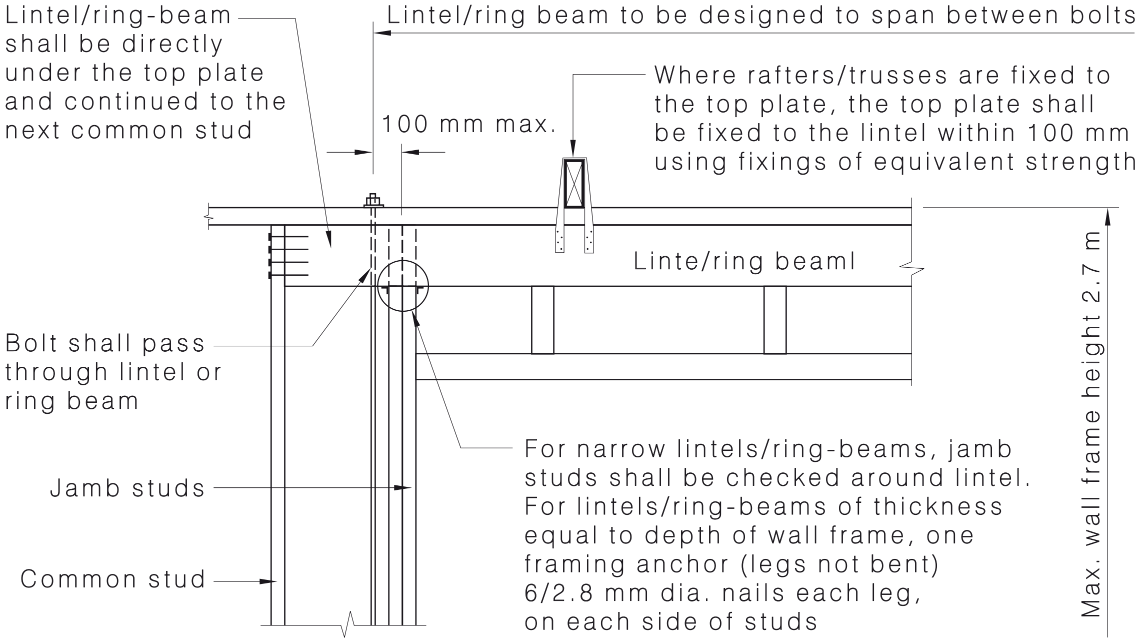
Bolt size						
M12	27	27	26	20	16	12
M16	50	50	46	35	28	21



(e)

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.

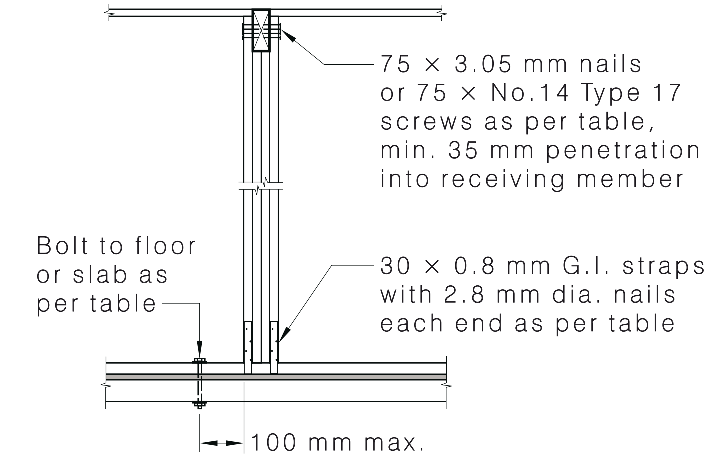
Bolt size						
M10	18	18	18	15	12	9.0
M12	27	27	26	20	16	12
M16	50	50	46	35	28	21



(*continued*)

TABLE 9.20 (*continued*)

(f)

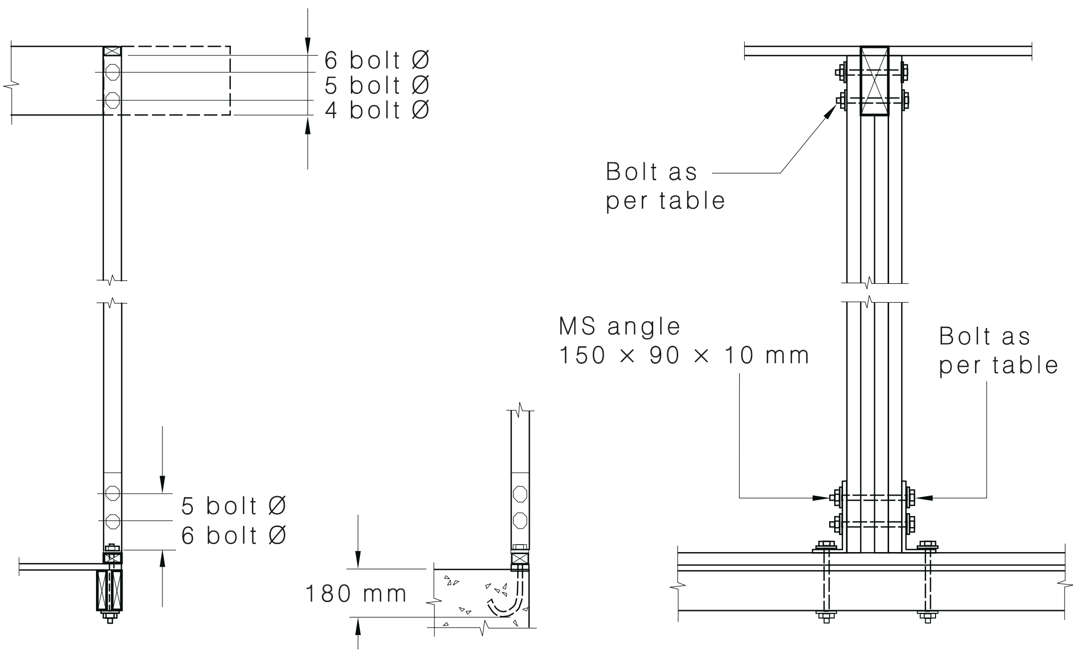


NOTE: The uplift capacity of the detail will be governed by the lowest of the capacities at either the top or bottom of post or the bottom plate to floor frame or slab.

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

(g)

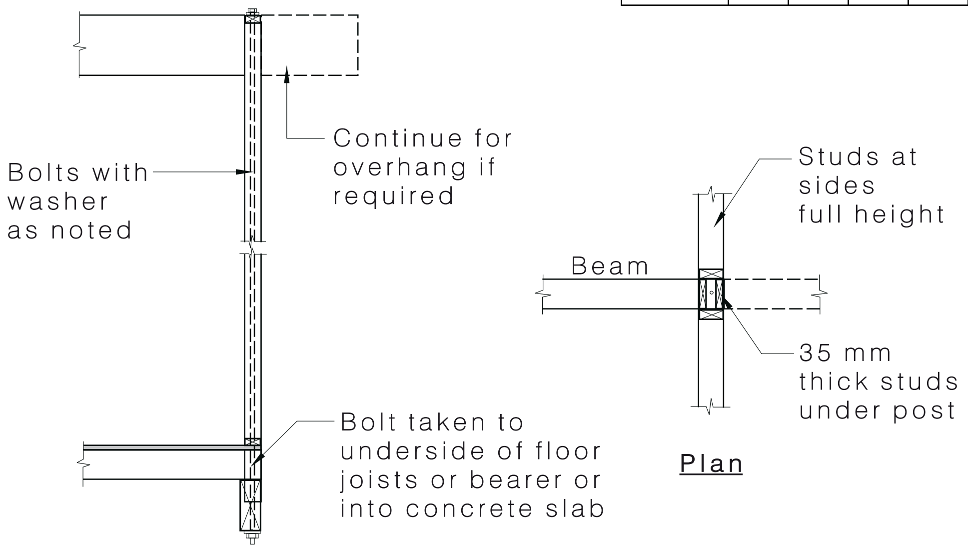
Bolts						
2/M10	17	15	9.8	17	12	8.2
2/M12	17	17	12	17	14	10



(*continued*)

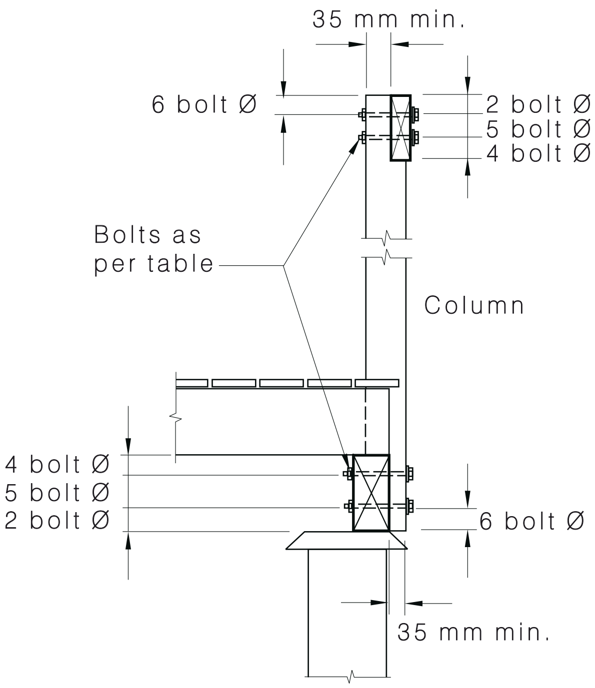
TABLE 9.20 (*continued*)

(h)



Bolts						
M10	18	18	18	15	12	9.0
M12	27	27	26	20	16	12
M16	50	50	46	35	28	21

(i)

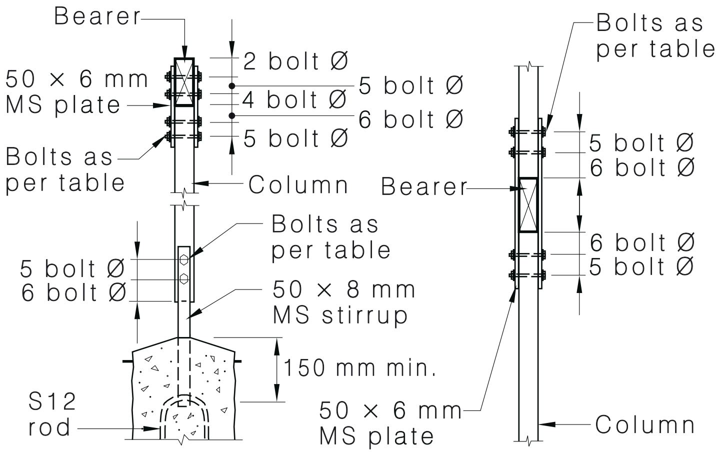


No. 14 Type 17 screws (min. 35 mm penetration into receiving member)						
2	7.7	5.5	3.9	5.5	3.9	2.8
4	15	11	7.8	11	7.8	5.7
Bolts						
1/M10 cup-head	3.9	2.3	1.5	2.6	1.8	1.2
1/M12 cup-head	4.4	2.7	1.8	3.0	2.2	1.5
1/M16 cup-head	5.7	3.7	2.3	4.2	2.9	2.0
2/M10 cup-head	7.7	4.6	2.9	5.2	3.6	2.5
2/M12 cup-head	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

(*continued*)

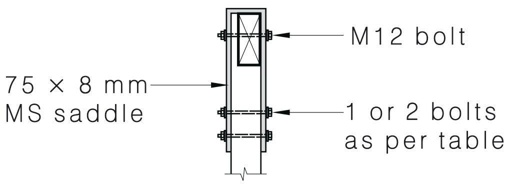
TABLE 9.20 (*continued*)

(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

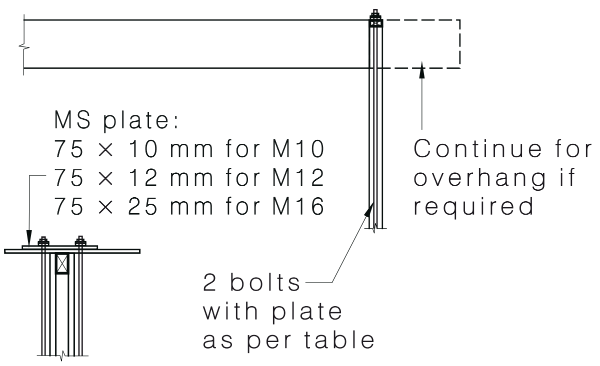
(k)



NOTE: The same or an equivalent detail is required at the bottom of the post.

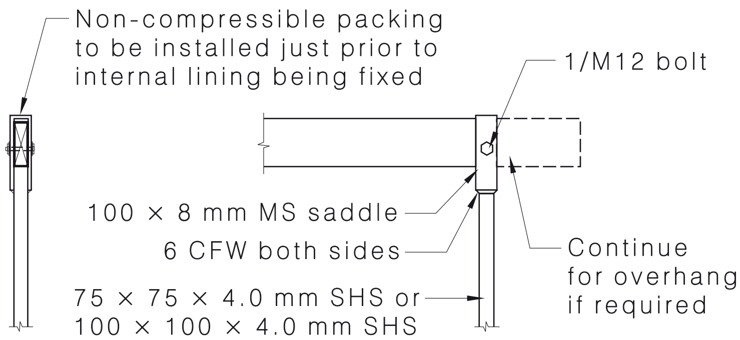
Bolts						
1/M12	22	20	16	20	17	15
2/M12	43	39	32	39	34	30
1/M16	38	35	27	35	30	24
2/M16	76	71	53	71	60	49

(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

(m)

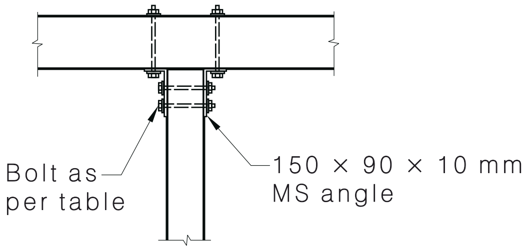


106	85	55	85	69	55

(*continued*)

TABLE 9.20 (*continued*)

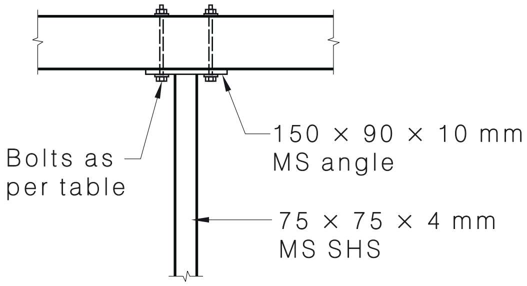
(n)



NOTE: The same or an equivalent detail is required at the bottom of the post.

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

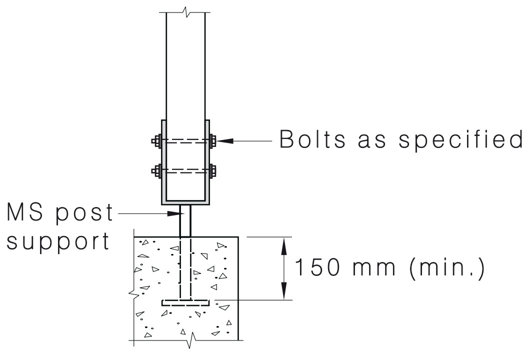
(o)



NOTE: The same or an equivalent detail is required at the bottom of the post.

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

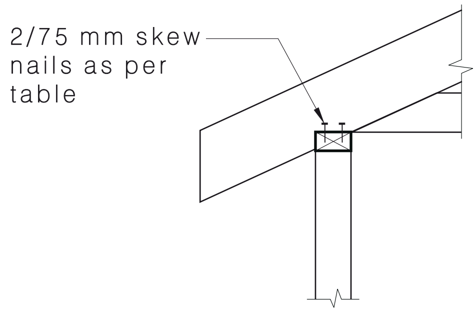
(p)

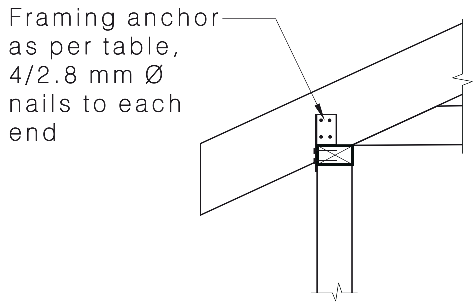
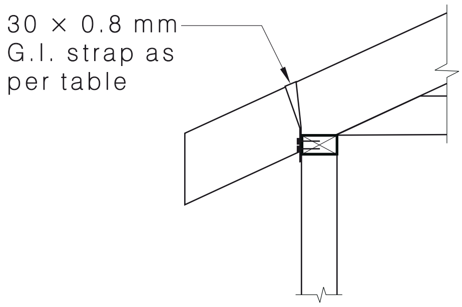
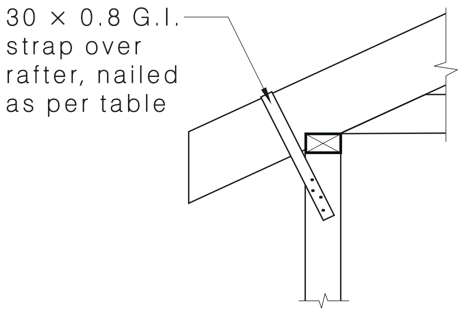


(Refer to manufacturer's specifications)

TABLE 9.21

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="6">(a)


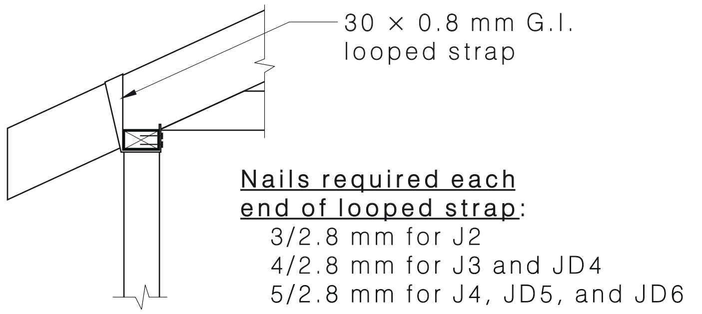
The uplift capacities given in this Item are applicable to the joint, not individual nails.</td><td colspan="7">Hand-driven nail dia.</td></tr>
<tr><td>3.15</td><td>0.97</td><td>0.82</td><td>0.71</td><td>0.51</td><td>0.34</td><td>0.24</td></tr>
<tr><td>3.75</td><td>1.1</td><td>0.97</td><td>0.87</td><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 rowspan="3">(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 rowspan="6">(c)

</td><td colspan="7">No. of straps with 2/2.8 dia nails each end</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">No. of straps with 3/2.8 dia nails each end</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>
<tr><td rowspan="5">(d)

</td><td colspan="7">No. of 2.8 dia nails each end</td></tr>
<tr><td>2</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>3</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>4</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>6</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>

(*continued*)

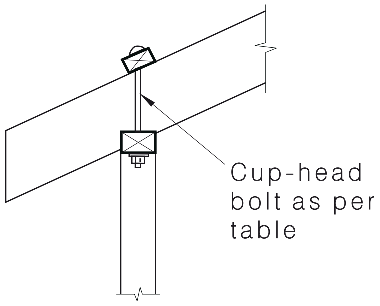
TABLE 9.21 (*continued*)

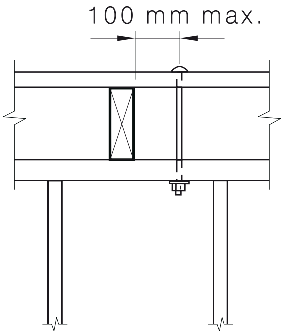
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters/trusses to wall frame or floor frame		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(e)	No. of looped straps						
	1	13	13	13	13	13	13
	2	25	25	25	25	25	25
(f)	M10	16	14	10	10	7	5
NOTE: Min. roof batten size—up to F7: 35 × 70, F8 and better: 38 × 50.							
(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
NOTE: Where bolts are connected to top plates, the top plate shall be designed for uplift.	2/M12	54	54	52	40	32	24
(h)	No. of bolts						
	2/M10	36	36	36	30	24	18
	2/M12	54	54	52	40	32	24

(e)



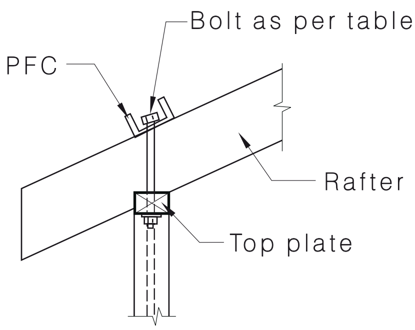
(f)

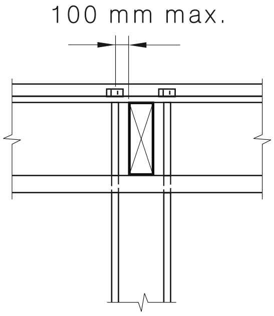




NOTE: Min. roof batten size—up to F7: 35 × 70, F8 and better: 38 × 50.

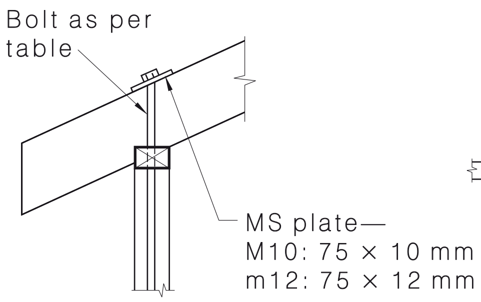
(g)

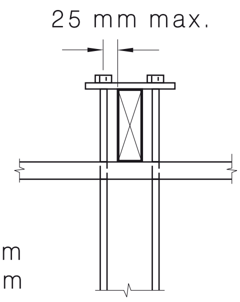




NOTE: Where bolts are connected to top plates, the top plate shall be designed for uplift.

(h)



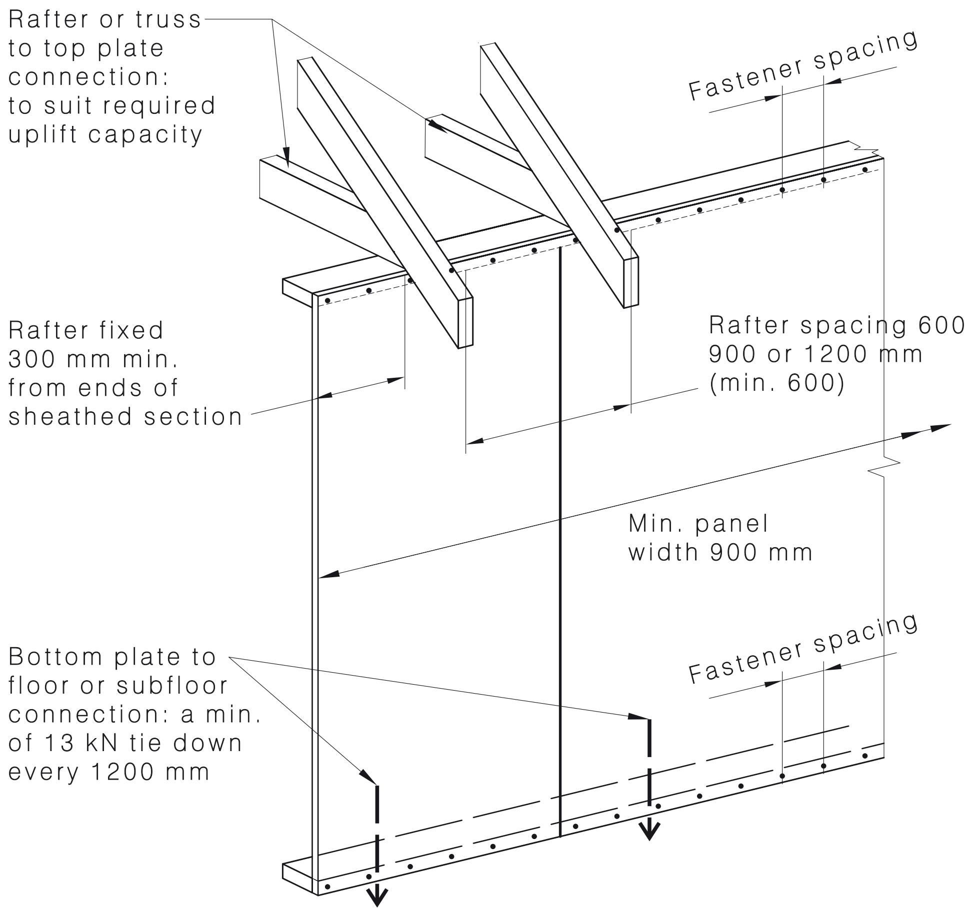


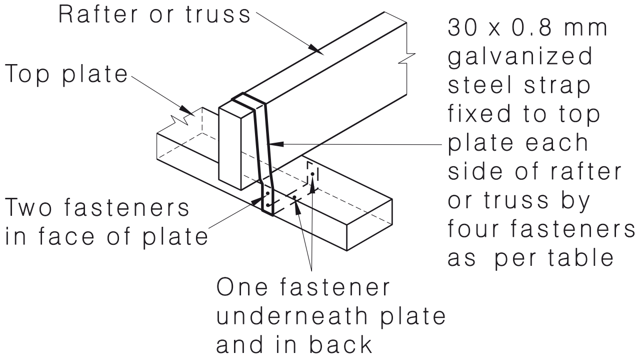
(*continued*)

TABLE 9.21 (*continued*)

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 (not applicable for tie-down at sides of openings)*





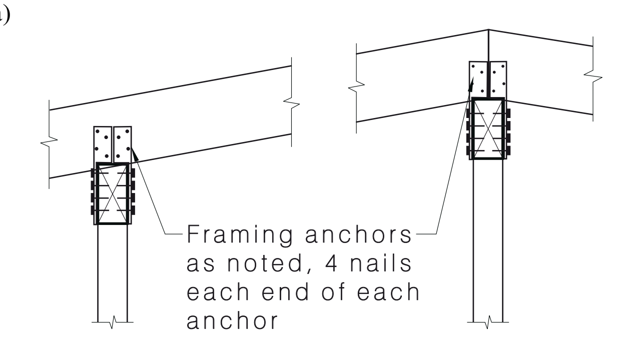
Fastener spacing mm		Uplift capacity
Hand or machine-driven nails	Staples	kN/rafter
50	33	16.7
150	100	10.4

TABLE 9.22

UPLIFT CAPACITY OF RAFTER TIE-DOWN CONNECTIONS

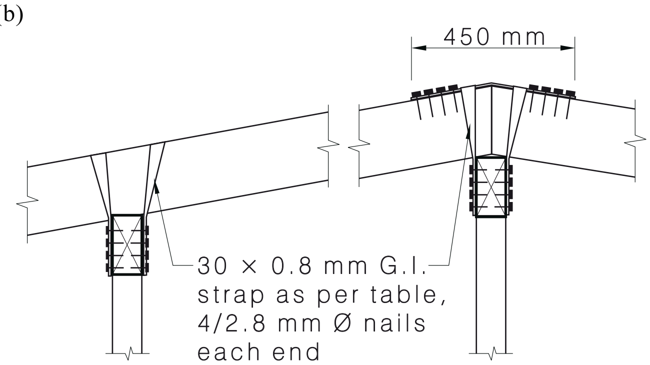
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**

(a)



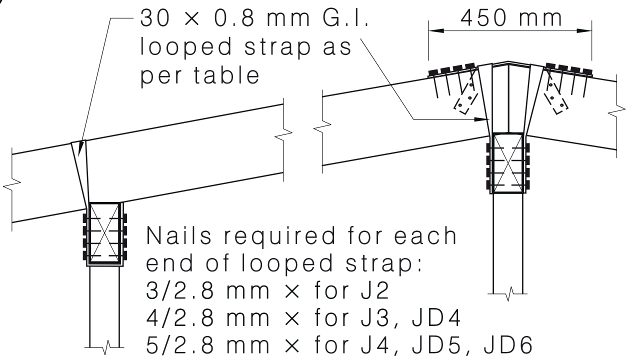
No. of framing anchors	J2	J3	J4	JD4	JD5	JD6
1	4.9	3.5	2.5	3.5	2.9	2.2
2	8.3	5.9	4.2	5.9	4.9	3.7
4	15	11	7.7	11	9.0	6.8

(b)



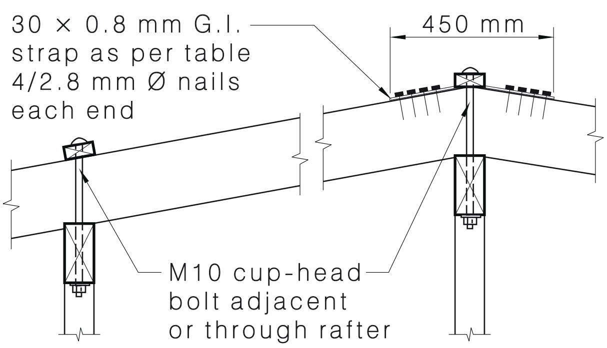
No. of straps	J2	J3	J4	JD4	JD5	JD6
1	8.3	5.9	4.2	5.9	4.9	3.7
2	15	11	7.7	11	9.0	6.8

(c)



No. of straps	J2	J3	J4	JD4	JD5	JD6
1	13	13	13	13	13	13
2	25	25	25	25	25	25

(d)

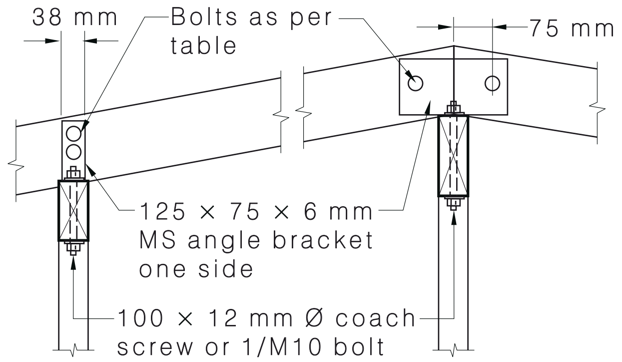
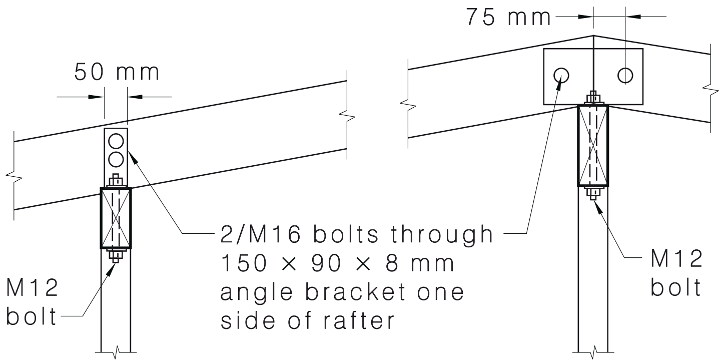
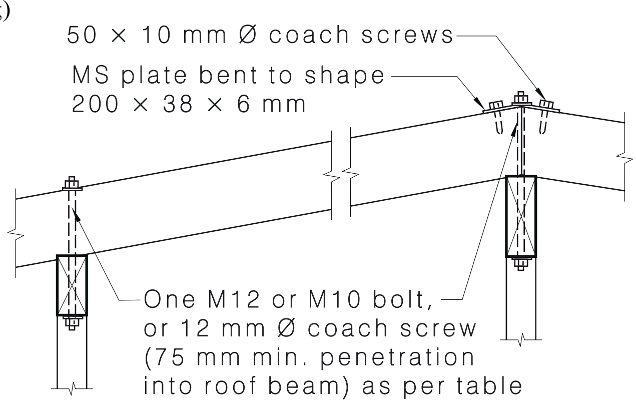
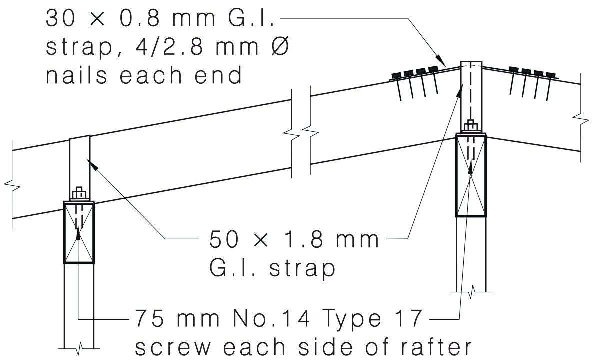


No. of bolts	J2	J3	J4	JD4	JD5	JD6
1	16	14	10	10	7.0	5.0

Min. roof batten size—
Up to F7: 35 × 70 mm
F8 and better: 38 × 50 mm

(continued)

TABLE 9.22 (*continued*)

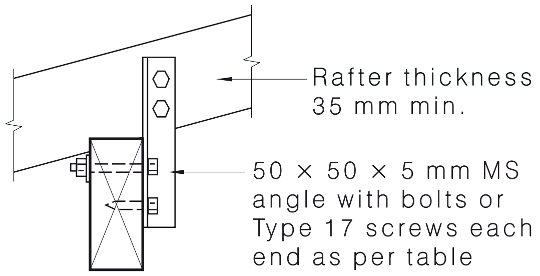
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(e) 	No. of bolts						
	2/M10	14	9.2	5.9	8.8	7.2	4.9
	2/M12	14	11	7.0	8.8	7.2	5.1
(f) 		23	15	9.2	17	12	8.0
(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
(h) 		14	11	6.4	8.0	5.2	3.6

(*continued*)

TABLE 9.22 (*continued*)

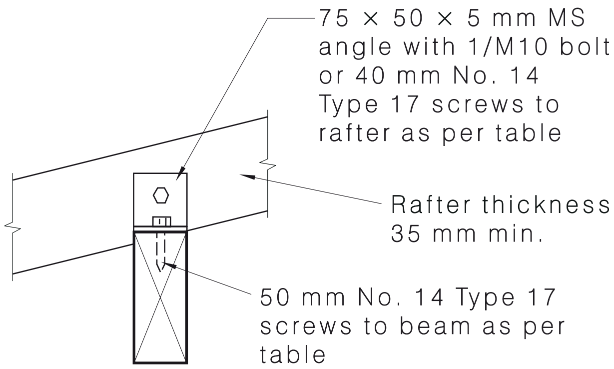
Position of tie-down connection		Uplift capacity, kN					
		Unseasoned timber			Seasoned timber		
Rafters to beams, lintels, ring beams, verandah beams		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**

(i)



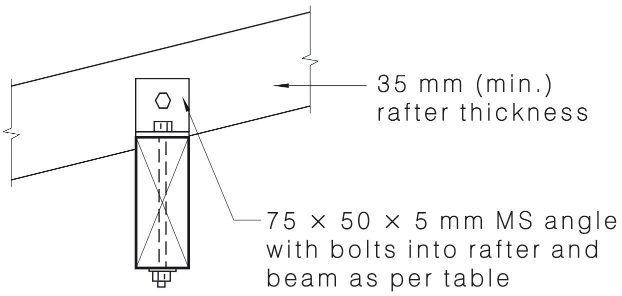
(i)		J2	J3	J4	JD4	JD5	JD6
	Bolts						
	2/M10	14	9.2	5.9	10	7.3	4.9
	2/M12	18	11	7.0	12	8.7	6.1
	Screws						
	2/40 mm No.14	12	8.3	5.9	8.3	5.9	4.3

(j)



(j)		J2	J3	J4	JD4	JD5	JD6
	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

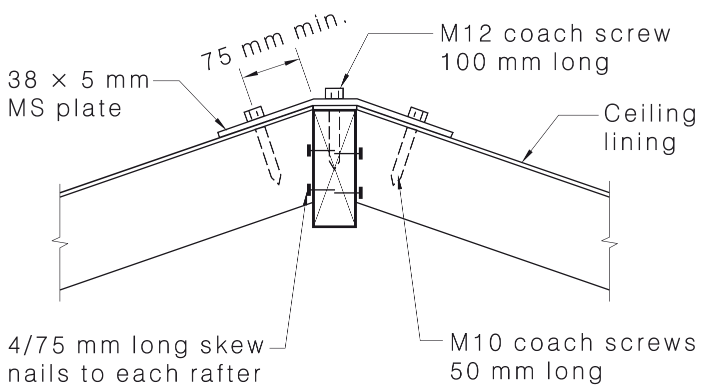
(k)



Beam shall be a minimum of 70 mm thick for M16 bolts.

(k)		J2	J3	J4	JD4	JD5	JD6
	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

(l)



(l)	J2	J3	J4	JD4	JD5	JD6
	14	11	7	8.8	7.2	5.1

(*continued*)

TABLE 9.22 (*continued*)

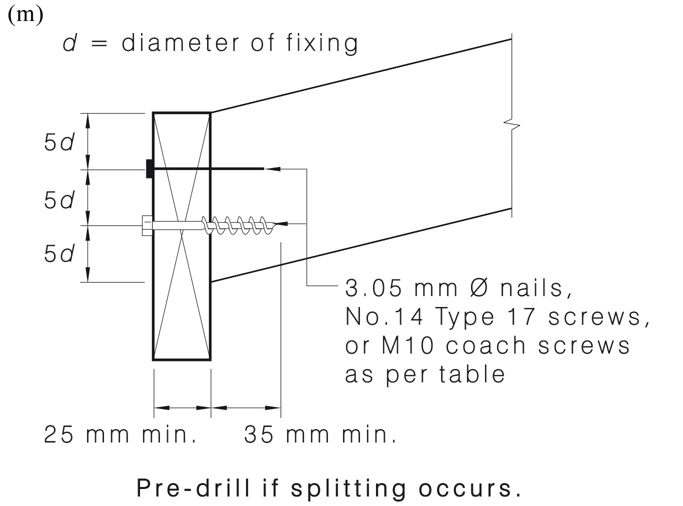
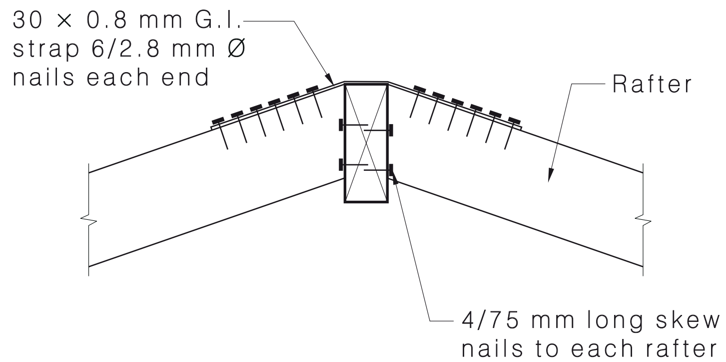
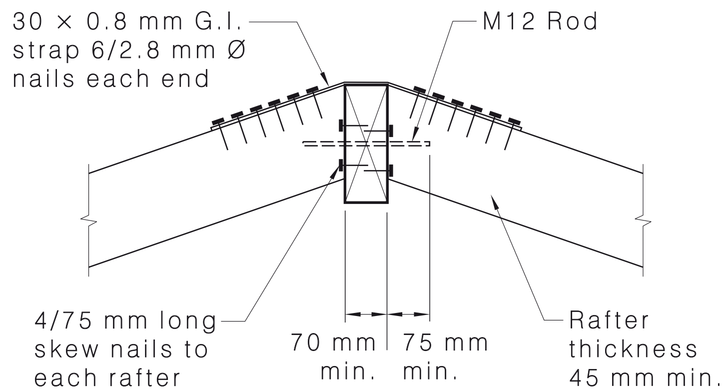
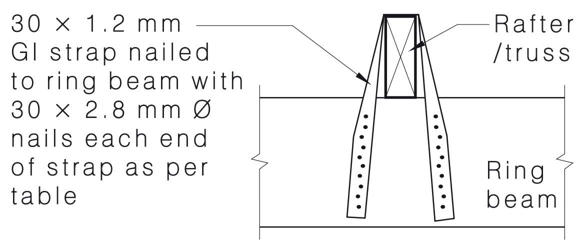
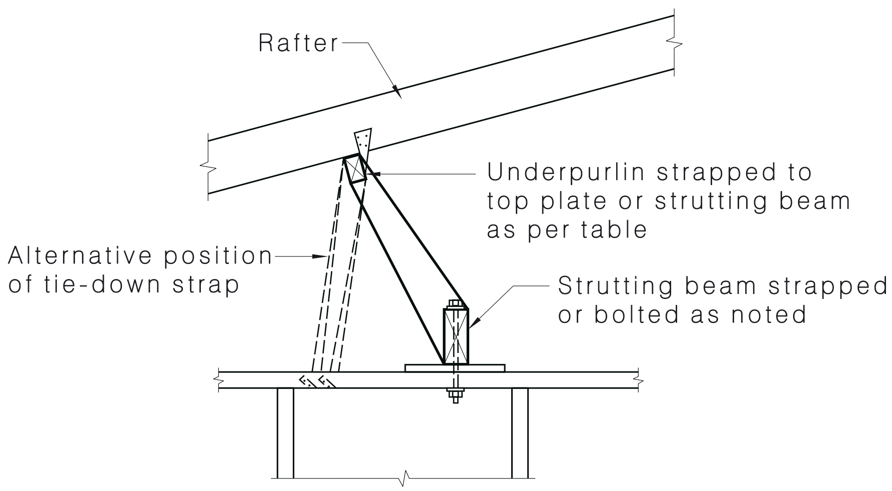
<table>
<tr><th rowspan="3" colspan="2">Position of tie-down connection</th><th colspan="6">Uplift capacity, kN</th></tr>
<tr><th colspan="3">Unseasoned timber</th><th colspan="3">Seasoned timber</th></tr>
<tr><th>J2</th><th>J3</th><th>J4</th><th>JD4</th><th>JD5</th><th>JD6</th></tr>
<tr><th colspan="8">Rafters to beams, lintels, ring beams, verandah beams</th></tr>
<tr><td rowspan="12">(m)

</td><td colspan="7">3.05 mm dia. nails</td></tr>
<tr><td>2</td><td>1.5</td><td>1.1</td><td>0.77</td><td>1.1</td><td>0.90</td><td>0.66</td></tr>
<tr><td>3</td><td>2.3</td><td>1.6</td><td>1.2</td><td>1.6</td><td>1.4</td><td>0.99</td></tr>
<tr><td>4</td><td>3.0</td><td>2.2</td><td>1.5</td><td>2.2</td><td>2.0</td><td>1.3</td></tr>
<tr><td colspan="7">Type 17 screws</td></tr>
<tr><td>2/No14</td><td>5.8</td><td>4.2</td><td>2.9</td><td>4.2</td><td>2.9</td><td>2.2</td></tr>
<tr><td>3/No14</td><td>8.7</td><td>6.2</td><td>4.4</td><td>6.2</td><td>4.4</td><td>3.2</td></tr>
<tr><td>4/No14</td><td>12</td><td>8.3</td><td>5.9</td><td>8.3</td><td>5.9</td><td>4.3</td></tr>
<tr><td colspan="7">Coach screws</td></tr>
<tr><td>2/M10</td><td>8.2</td><td>5.2</td><td>3.3</td><td>5.8</td><td>4.1</td><td>2.8</td></tr>
<tr><td>3/M10</td><td>12</td><td>7.8</td><td>5.0</td><td>8.8</td><td>6.2</td><td>4.2</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="2">(n)

</td><td>3.0</td><td>2.2</td><td>1.5</td><td>2.2</td><td>2.0</td><td>1.3</td></tr>
<tr><td colspan="2">(o)

</td><td>9.0</td><td>5.5</td><td>3.5</td><td>6.0</td><td>4.3</td><td>3.1</td></tr>
<tr><td rowspan="5">(p)

</td><td colspan="7">No. of nails</td></tr>
<tr><td>6</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>8</td><td>15</td><td>11</td><td>7.6</td><td>11</td><td>8.8</td><td>6.7</td></tr>
<tr><td>10</td><td>18</td><td>13</td><td>9.3</td><td>13</td><td>11</td><td>8.3</td></tr>
<tr><td colspan="7">NOTE: See also Table 9.21, Items (d) and (e).</td></tr>
</table>

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:
3/2.8 mm ∅ for J2
4/2.8 mm ∅ for J3 and JD4
5/2.8 mm ∅ for J4, JD5 and JD6

Top plate shall be tied down to floor frame

TABLE 9.24(A)

UPLIFT CAPACITY OF RAFTERS TO RAFTERS AT RIDGE TIE-DOWN CONNECTIONS

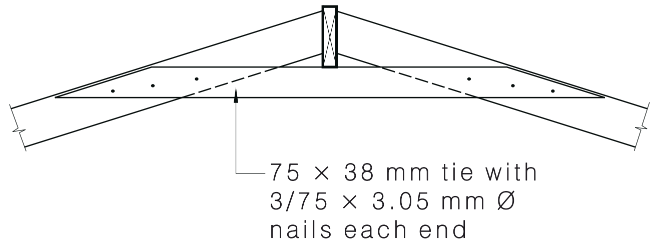
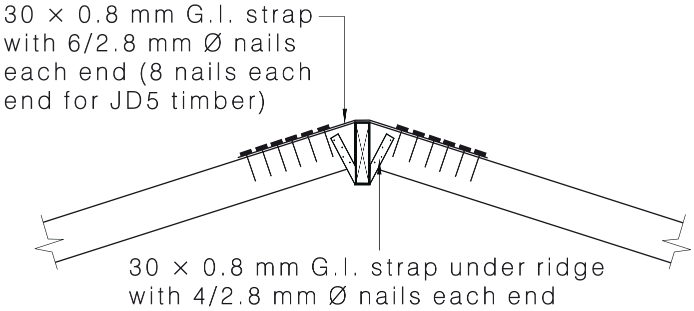
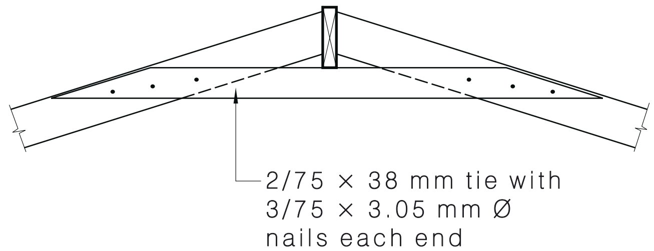
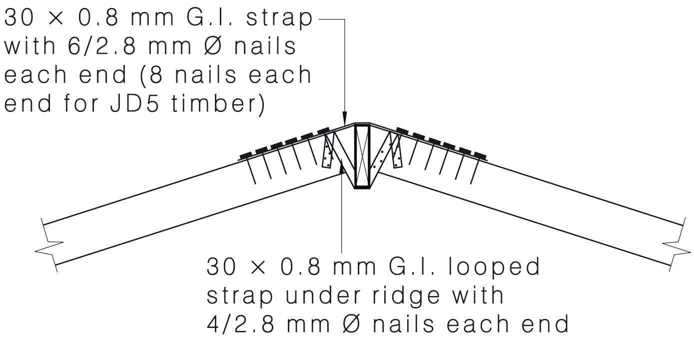
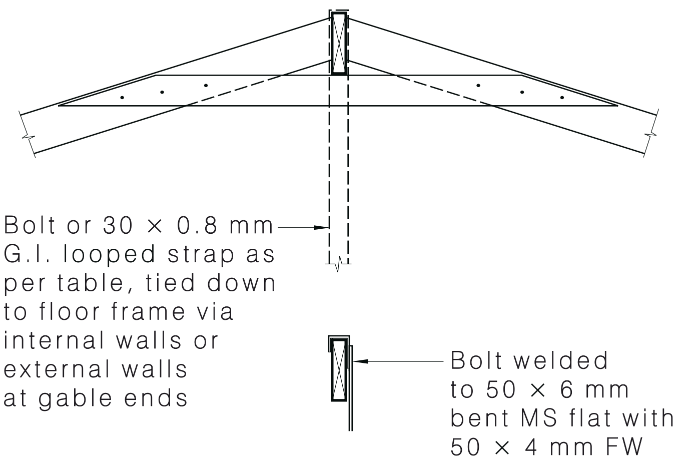
Position of tie-down connection	Uplift capacity, kN					
	Unseasoned timber			Seasoned timber		
Rafters to rafters at ridge	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(a) 	7.0	5.0	3.6	5.0	4.2	3.1
(b) 	9.8	7.0	5.0	7.0	5.8	4.4
(c) 	14	10	7.2	10	8.4	6.2
(d) 	13	13	10	13	11.6	8.8

TABLE 9.24(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

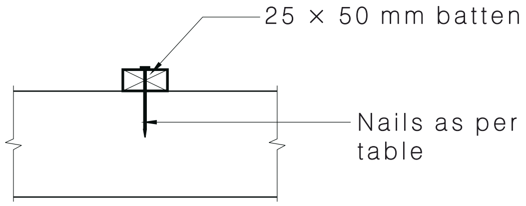
TABLE 9.25

UPLIFT CAPACITY OF ROOF BATTEN TIE-DOWN CONNECTIONS

Position of tie-down connection — **Uplift capacity, kN** (Unseasoned timber: J2, J3, J4; Seasoned timber: JD4, JD5, JD6)

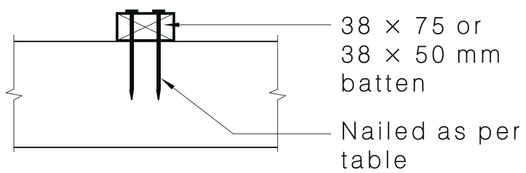
Roof battens to rafters/trusses

(a)



	J2	J3	J4	JD4	JD5	JD6
Plain shank						
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

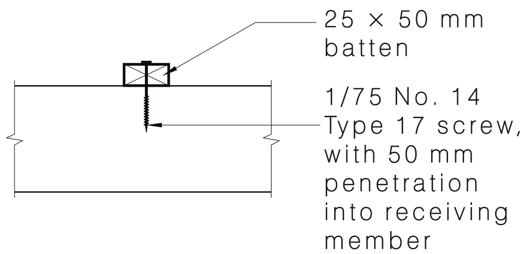
(b)



Two screws shall be used only with 75 mm wide batten

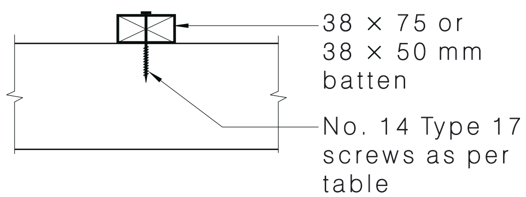
	J2	J3	J4	JD4	JD5	JD6
Plain shank						
1/75 × 3.05	0.61	0.52	0.45	0.32	0.21	0.15
2/75 × 3.05	1.2	1.0	0.90	0.64	0.42	0.30
Deformed shank						
1/75 × 3.05	1.2	1.0	0.90	0.65	0.43	0.30
2/75 × 3.05	2.5	2.1	1.8	1.3	0.86	0.60
2/75 × 3.75	2.8	2.5	2.2	1.7	1.0	0.72

(c)



	J2	J3	J4	JD4	JD5	JD6
(c)	7.4	5.5	3.2	6.0	4.7	3.6

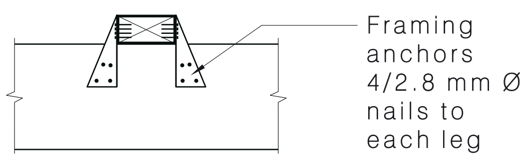
(d)



Two screws shall be used only with 75 mm wide batten

Screws (length)	J2	J3	J4	JD4	JD5	JD6
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

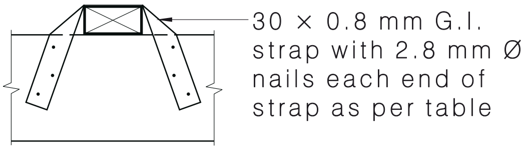
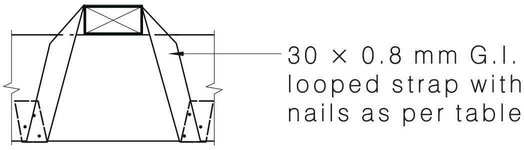
(e)

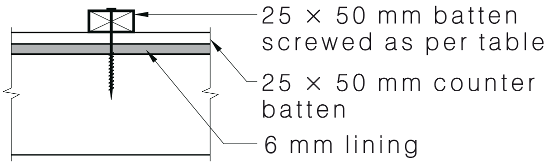
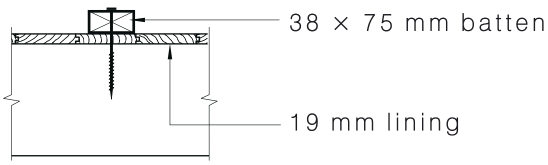
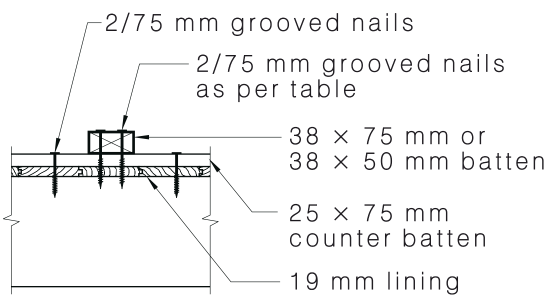
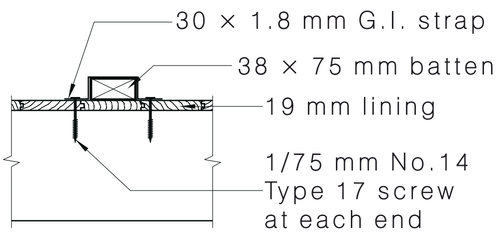


Framing anchors	J2	J3	J4	JD4	JD5	JD6
1	4.9	3.5	2.5	3.5	2.9	2.2
2 placed on alt. sides of batten	8.3	5.9	4.2	5.9	4.9	3.7

(*continued*)

TABLE 9.25 (*continued*)

<table>
<tr><th 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 colspan="7">Roof battens to rafters/trusses</td></tr>
<tr><td rowspan="3">(f)

</td><td colspan="6">No. of nails each end of strap</td></tr>
<tr><td>3</td><td>6.5</td><td>4.7</td><td>3.3</td><td>4.7</td><td>3.8 / 2.9</td></tr>
<tr><td>4</td><td>8.3</td><td>5.9</td><td>4.2</td><td>5.9</td><td>4.9 / 3.7</td></tr>
<tr><td>(g)


<table><tr><th>Timber</th><th>No. of 2.8 mm ∅ nails each end of strap</th></tr><tr><td>J2</td><td>3</td></tr><tr><td>J3 and JD4</td><td>4</td></tr><tr><td>J4, JD5 and JD6</td><td>5</td></tr></table></td><td>13</td><td>13</td><td>13</td><td>13</td><td>13</td><td>13</td></tr>
<tr><td rowspan="3">(h)

</td><td colspan="6">No. 14 Type 17 screws</td></tr>
<tr><td>1/90 mm long</td><td>4.9</td><td>3.6</td><td>2.1</td><td>3.9</td><td>3.1 / 2.4</td></tr>
<tr><td>1/100 mm long</td><td>6.4</td><td>4.8</td><td>2.7</td><td>5.1</td><td>4.0 / 3.1</td></tr>
<tr><td rowspan="2">(i)

</td><td colspan="6">No. 14 Type 17 screws</td></tr>
<tr><td>1/100 mm long</td><td>6.4</td><td>4.8</td><td>2.7</td><td>5.1</td><td>4.0 / 3.1</td></tr>
<tr><td rowspan="3">(j)

</td><td colspan="6">Deformed shank nails</td></tr>
<tr><td>2/3.06 mm</td><td>2.5</td><td>2.1</td><td>1.8</td><td>1.3</td><td>0.86 / 0.6</td></tr>
<tr><td>2/3.75 mm</td><td>2.8</td><td>2.5</td><td>2.2</td><td>1.7</td><td>1.0 / 0.72</td></tr>
<tr><td>(k)

</td><td>15</td><td>11</td><td>6.4</td><td>12</td><td>9.4</td><td>7.2</td></tr>
</table>

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 C1, 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 C1, nominal fixings only shall be provided in accordance with Table 9.4.

For wind classification C2, 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.

For wind classification C3, bottom plates shall be fixed to concrete slabs using hammered, fired, screwed or expansion masonry anchors at 600 mm centres maximum along all bottom plates.

9.7.3 Floor joists to bearers/walls

For wind classifications C1, nominal fixings only shall be provided in accordance with Table 9.4.

For wind classifications C2 and C3, 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 C1 to C3, 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 9.28 and Table 9.27.

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* of projected height at the floor line, kN/m									
	Joist spacings or bearer spans, mm									
	300	450	600	1200	1800	2400	3000	3600	4500	6000
C1	0.42	0.63	0.84	1.7	2.5	3.4	4.2	5.0	6.3	8.4
C2	0.63	0.95	1.3	2.5	3.8	5.0	6.3	7.6	9.5	13
C3	0.96	1.4	1.9	3.8	5.8	7.7	9.6	12	14	19

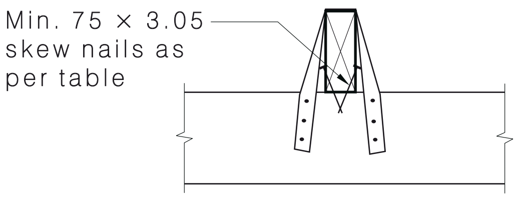
* Interpolation is permitted

TABLE 9.27

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
(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
(c)	M10 cup-head	6.0	3.8	2.4	4.3	3.0	2.0

(a)

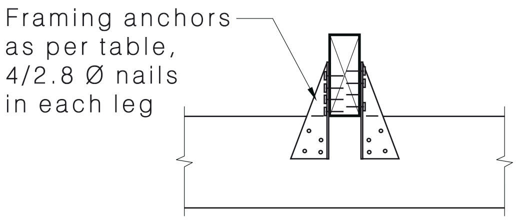


NOTES:

1 This connection does NOT provide rotational restraint to the top of the bearers.

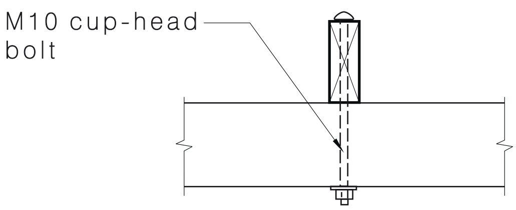
2 The same lateral strength applies, whether joists are strapped or not strapped to the bearers or supports.

(b)



NOTE: This connection does provide rotational restraint to the top of bearers.

(c)

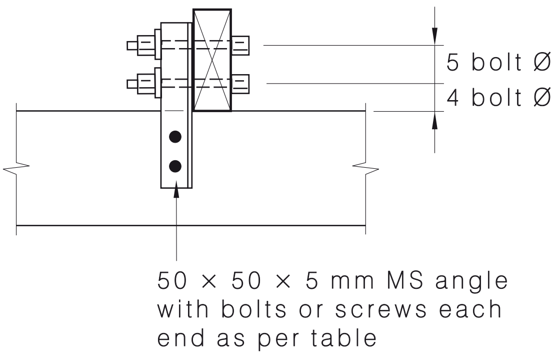


NOTE: This connection does provide rotational restraint to the top of bearers.

(*continued*)

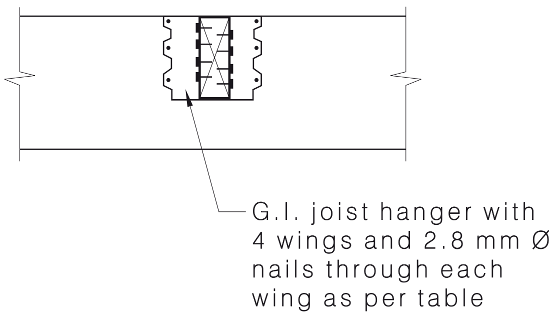
TABLE 9.27 (*continued*)

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.

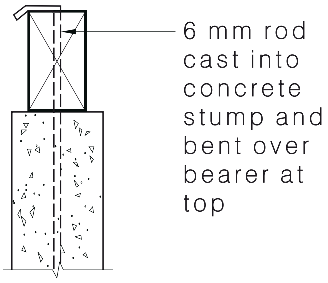
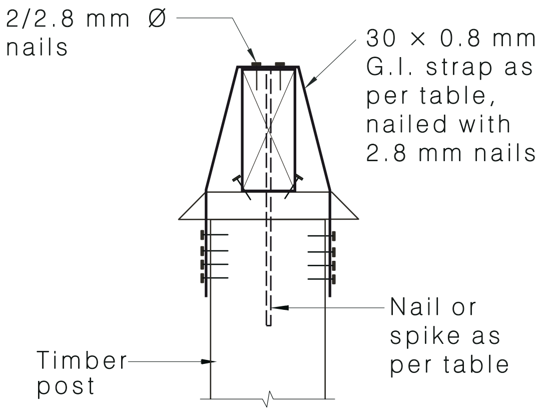
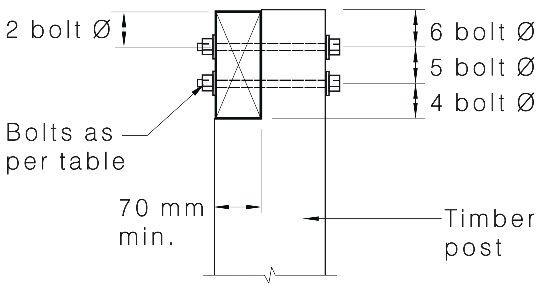
Position of shear connection	No. of nails per wing	J2	J3	J4	JD4	JD5	JD6
(e)	3	6.5	4.7	3.3	4.7	3.8	2.9
	4	8.3	5.9	4.2	5.9	4.9	3.7
	5	9.9	7.1	5	7.1	5.8	4.4
	6	12	8.4	5.9	8.4	6.9	5.2



NOTE: This connection does provide rotational restraint to the top of bearers.

TABLE 9.28

SHEAR CONNECTIONS FOR BEARERS

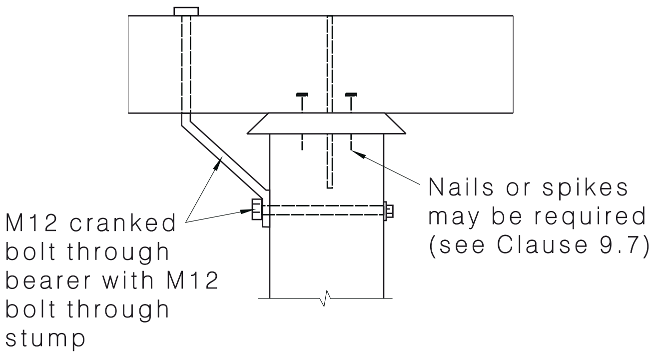
Position of shear connection		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**
(a) 	Bearer not restrained by joist						
		0.5	0.5	0.5	0.5	0.5	0.5
	Bearer restrained by joist						
		3.0	2.4	1.7	3.0	2.5	1.8
(b) 	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
NOTE: Values apply irrespective of joist connection.	1/M16	11	6.9	4.4	7.9	5.5	3.8
(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
NOTE: Values apply irrespective of joist connection.	2/M16	12	12	8.2	12	9.6	6.6

(*continued*)

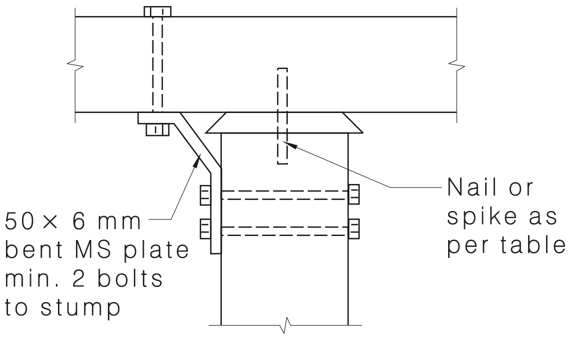
TABLE 9.28 (*continued*)

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
(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
(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

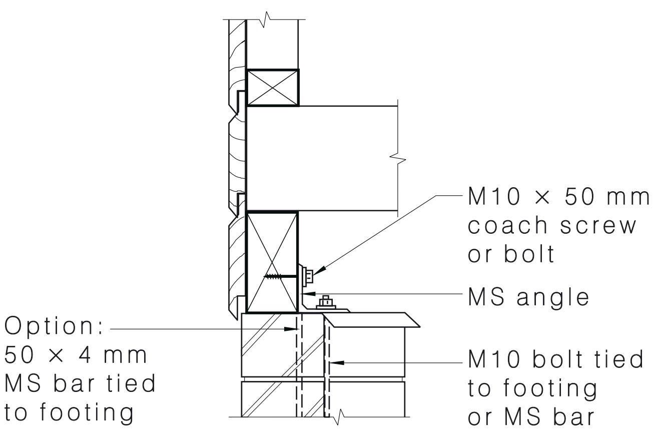
(d)



(e)



(f)



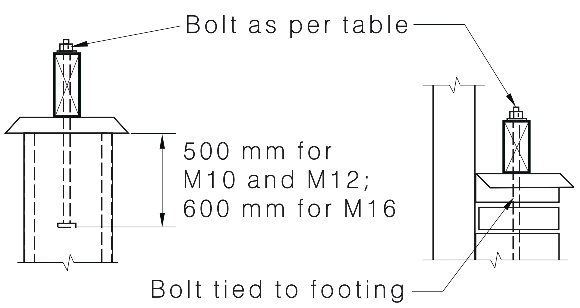
NOTE: Values apply irrespective of joist connection.

(*continued*)

TABLE 9.28 (*continued*)

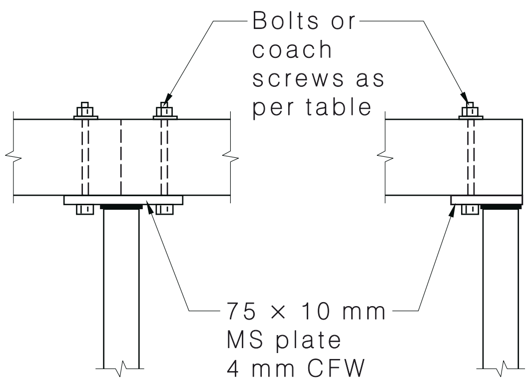
Position of shear connection		Shear capacity, kN					
		Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers		**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**

(g)



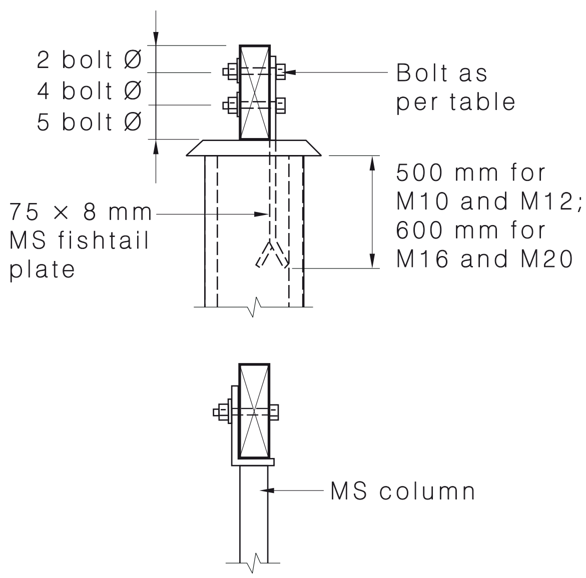
Bolts	J2	J3	J4	JD4	JD5	JD6
Bolts (bearer not restrained by joist)						
M10	4.8	3.9	2.6	4.5	3.2	2.2
M12	5.8	4.4	2.8	4.9	3.5	2.4
M16	7.9	5.1	3.3	5.9	4.2	2.9
M20	9	5.7	3.6	6.4	4.5	3.1
Bolts (bearer restrained by joist)						
M10	6.4	5.2	3.4	6.0	4.3	2.9
M12	7.7	5.9	3.7	6.5	4.7	3.2
M16	11	6.9	4.4	7.9	5.5	3.8
M20	12	7.6	4.8	8.5	6.0	4.2

(h)



Bolts	J2	J3	J4	JD4	JD5	JD6
Bolts (bearer not restrained by joist)						
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
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
2/M10	13	10	6.8	12	8.6	5.9
2/M12	15	12	7.4	13	9.3	6.3

(i)



Bolts	J2	J3	J4	JD4	JD5	JD6
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

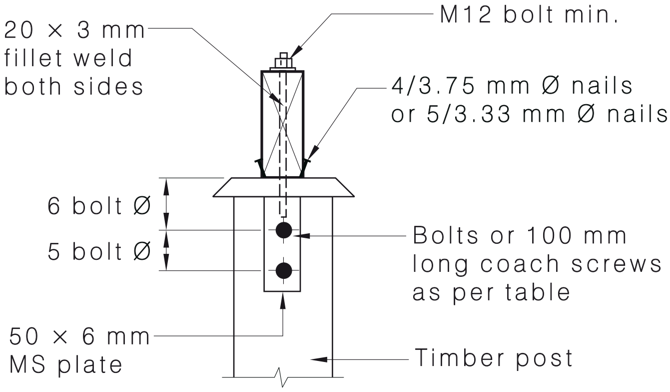
NOTE: Values apply irrespective of joist connection.

(*continued*)

TABLE 9.28 (*continued*)

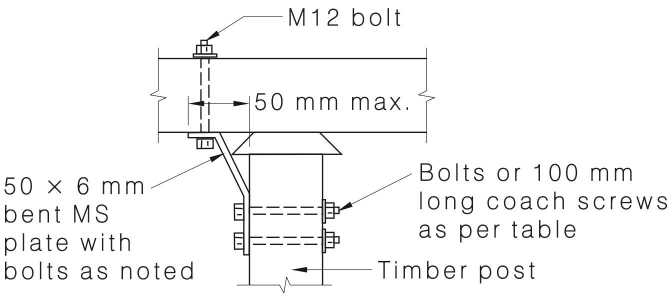
Position of shear connection	Shear capacity, kN					
	Unseasoned timber			Seasoned timber		
Bearers to stumps, posts, piers	**J2**	**J3**	**J4**	**JD4**	**JD5**	**JD6**

(j)



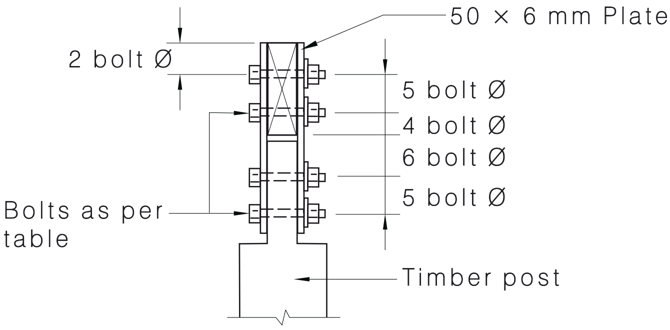
Bearer not restrained by joist	J2	J3	J4	JD4	JD5	JD6
Nails						
2/75x3.05	1.4	1.1	0.77	1.1	0.90	0.66
4/75x3.05	2.8	2.1	1.5	2.1	1.8	1.3
4/75x3.33	3.3	2.4	1.7	2.4	2.0	1.5
Bolts						
1/M10	3.2	2.6	1.7	3.0	2.1	1.5
1/M12	3.9	2.9	1.8	3.2	2.3	1.6
1/M16	5.3	3.4	2.2	3.9	2.8	1.9
Bolts (bearer restrained by joist)						
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

(k)



Bolts (bearer not restrained by joist)	J2	J3	J4	JD4	JD5	JD6
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

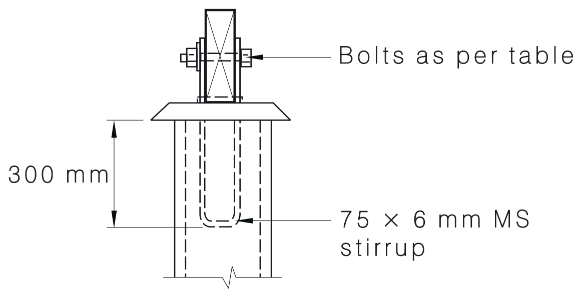
(l)



No. of bolts	J2	J3	J4	JD4	JD5	JD6
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

NOTE: Values apply irrespective of joist connection.

(m)



No. of bolts	J2	J3	J4	JD4	JD5	JD6
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 3000 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 2700 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	1200	1800	2400	3000
C1	2.7	1.2	1.6	2.4	3.2	4.9	6.5	8.1
C2	4.1	1.8	2.5	3.7	4.9	7.4	9.8	12
C3	6.0	2.7	3.6	5.4	7.2	11	14	18

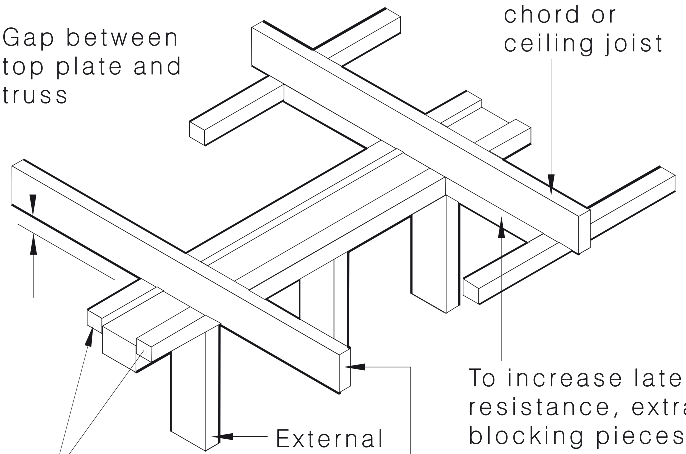
NOTES:

1 For 2400 mm high external walls multiply the above values by 0.91.

2 For 3000 mm high external walls, multiply the above values by 1.1.

TABLE 9.30

SHEAR SUPPORT FOR EXTERNAL NON-LOADBEARING WALLS



Spacing between nails in blocking shall be greater than 60 mm

Shear connection of external Non-loadbearing walls	Shear capacity, kN: Unseasoned timber J2	J3	J4	Seasoned timber JD4	JD5	JD6
Capacity per batten fixing						
1 nail per batten	1.3	0.90	0.64	0.90	0.75	0.56
1 screw per batten	4.8	3.5	2.5	3.5	2.5	1.8
Additional capacity per block						
2 nails per block	2.5	1.8	1.3	1.8	1.5	1.1
3 nails per block	3.7	2.7	1.9	2.7	2.3	1.7
4 nails per block	5.0	3.6	2.5	3.6	3.0	2.2
1 screw per block	4.8	3.5	2.5	3.5	2.5	1.8
2 screws per block	9.6	7.0	5.0	7.0	5.0	3.6

APPENDIX A

TYPICAL CONSTRUCTION MASS

(Informative)

A1 MASS OF ROOF MATERIALS

Tables A1.1 and A1.2 may be used to determine the mass of roof and ceiling components with respect to the use of relevant Span Tables given in the Supplements.

Paragraph A2 provides examples of the determination of roof masses.

TABLE A1.1

MASS OF TYPICAL ROOF CONSTRUCTIONS

Mass of roof* kg/m²	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†	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†	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

* The mass of the member being considered has been included in the calculations for the Span Tables in the Supplements.

† Interpolation within tables is required (see Section 1).

TABLE A1.2

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 × 38	at 600 mm spacing	7.0
	100 × 50	at 450 mm spacing	12.0
	50 × 25	at 330 mm spacing	4.0
	38 × 50	at 600 mm spacing	3.0
	38 × 50	at 900 mm spacing	2.0
	38 × 75	at 900 mm spacing	3.5
Seasoned hardwood	35 × 42	at 900 mm spacing	1.3
	90 × 35	at 600 mm spacing	4.0
Seasoned softwood	32 × 32	at 330 mm spacing	2.0
	90 × 35	at 900 mm spacing	2.0
	38 × 50	at 450 mm spacing	2.5
	38 × 50	at 600 mm spacing	2.0
Unseasoned softwood	150 × 38	at 900 mm spacing	4.0
	200 × 50	at 1000 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

A2 EXAMPLES

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 × 25 mm unseasoned hardwood battens (330 mm centres), 13 mm plaster ceiling lining with 50 × 38 mm unseasoned hardwood ceiling battens at 600 mm centres, sarking (*RFL*) and bulk insulation.

The masses are listed in Table A2.1.

TABLE A2.1

MASSES FOR EXAMPLE 1

Material	Mass, kg/m^2	Source of information
Concrete tiles	54.0	Table A1.2
Tile battens	4.0	Table A1.2
Plaster ceiling	10.0	Table A1.2
Ceiling battens	3.5	Table A1.2 (half value for 100 × 38 mm)
Sarking and insulation	1.0	Table A1.2
Total	72.5	Adopt 75 kg/m^2

NOTE: Similarly, using Table A1.1, 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 × 90 mm seasoned softwood battens at 900 mm centres, 0.53 mm sheet roofing and reflective foil (*RFL*).

The masses are listed in Table A2.2.

TABLE A2.2

MASSES FOR EXAMPLE 2

Material	Mass, kg/m^2	Source of information
Rafters	—	No input required
Battens	2.0	Table A1.2
Sheet roofing	5.0	Manufacturer's specification
Sarking	about 0.5	Table A1.2
Total	7.5	Adopt 10 kg/m^2

NOTE: Similarly, using Table A1.1, a mass of 10 kg/m^2 would be appropriate.

APPENDIX B

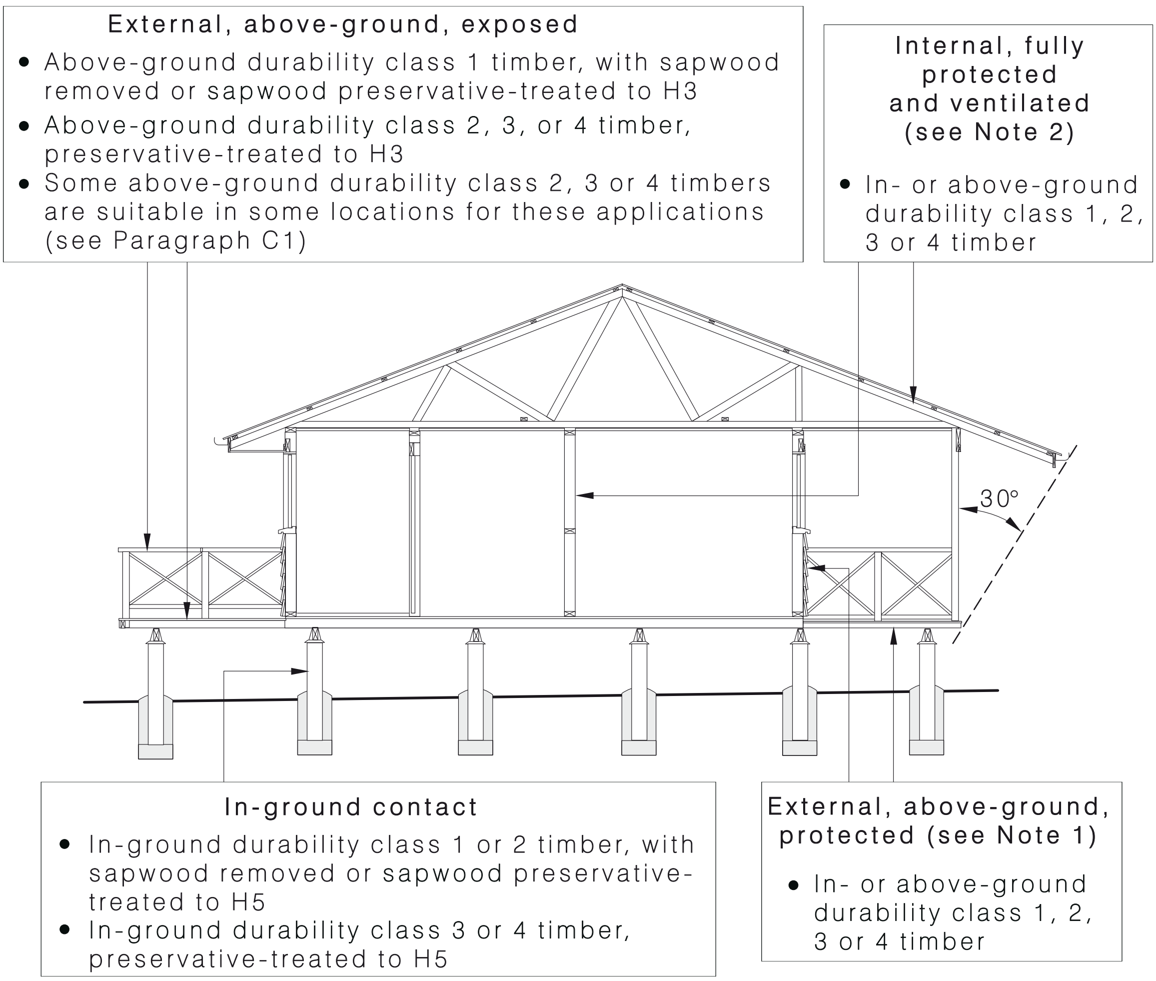
DURABILITY

(Informative)

B1 DURABILITY

Timber used for house construction should have the level of durability appropriate for the relevant climate and expected service life and conditions; that is exposure to insect attack or to moisture, which could cause decay. Figure B1 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, refer to Paragraph B7.

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 B1 could be used.



NOTES:

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).

2 Framing in extremely damp or unventilated locations should have the durability required for external above-ground situations.

FIGURE B1 SPECIES SELECTION FOR DURABILITY

B2 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.

B3 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 to Table B1).

TABLE B1

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

NOTES:

1 Examples shown in this Table are not exhaustive. Reference should be made to AS 1604.1.

2 The attention of specifiers and users of treated timber in a marine situation is especially drawn to the Section for hazard class 6 in AS 1604.1.

3 It is recommended that specifiers nominate the minimum hazard class level appropriate to the specific exposure and service conditions.

B4 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.

Attention is drawn to the consumer protection provisions of the Queensland Timber Utilisation and Marketing Act and the New South Wales Timber Marketing Act regarding the sale and use in those States of timber containing Lyctid-susceptible sapwood and which may limit Lyctid-susceptible sapwood. The requirements of these Acts may be more stringent than those of the grading standards.

B5 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.

B6 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 B2). 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).

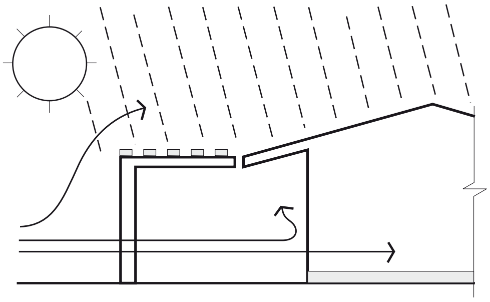
B7 SPECIFIC DURABILITY DESIGN

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.

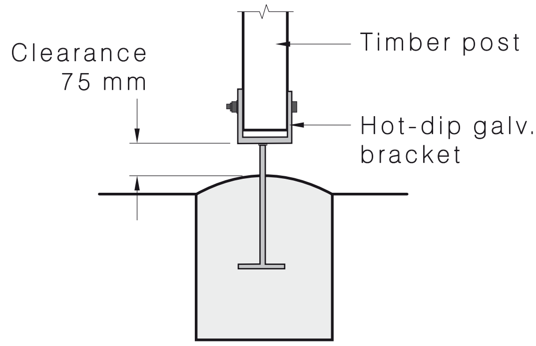
For detailed information on designing for durability refer to the following:

(a) Forest and Wood Products Australia, *Timber service life design guide*, December 2007, www.fwpa.com.au.

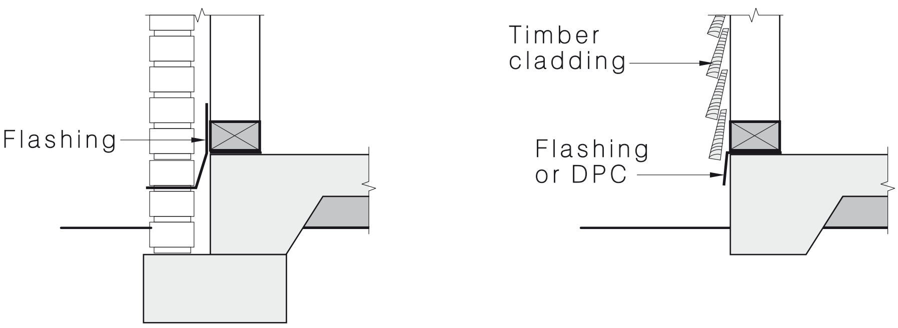
(b) Department of Primary Industries and Fisheries, Queensland Government, *Construction timbers in Queensland*, 2006.



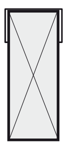
(a) Screens and pergolas
(reduce exposure and allow air circulation)



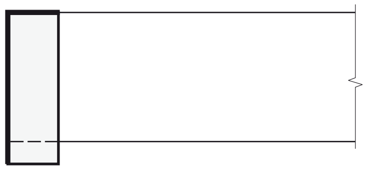
(b) Above-ground posts
(isolation from moisture and termites)



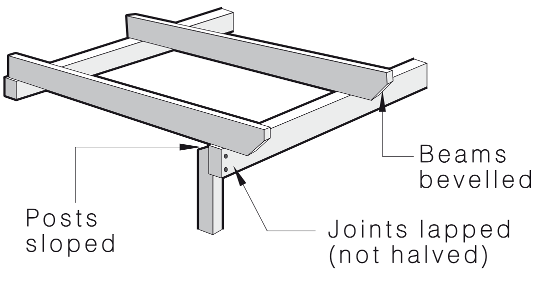
(c) Flashings or DPC (isolation from moisture)



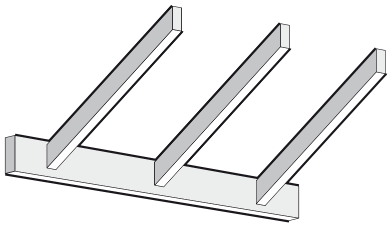
(d) Beam capping
(protecting horizontal surface and joints)



(e) Protecting end grain



(f) Reducing end grain exposure



(g) Fascias and bargeboards
(protecting end grain)

FIGURE B2 IMPROVING DURABILITY

APPENDIX C

INTERPOLATION

(Normative)

C1 INTERPOLATION

Throughout this Standard, including the Span Tables in the Supplements, direct linear interpolation shall be permitted to obtain table values for spacings, spans, stud heights, roof load width (*RLW*), roof masses, and similar parameters, intermediate to those listed.

C2 EXAMPLE

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 MGP 10 seasoned pine (see Table C1).

TABLE C1

RAFTERS—INTERPOLATION

Beam size depth × breadth	Mass of roof	Rafter spacing, mm							
		450		600		900		1200	
		Maximum rafter span and overhang, mm							
mm	kg/m^2	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 shall be as follows:

$$\text{Span required} = \frac{90-80}{90-60}\times(3000-2600)+2600 = 2730$$

$$\text{Overhang} = \frac{90-80}{90-60}\times(1000-900)+900 = 930$$

APPENDIX D

EXAMPLES—FOUNDATION BEARING AREA AND EVEN DISTRIBUTION OF BRACING

(Informative)

D1 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 .... $5 \times 0.9 = 4.5$ kN.

  (ii) Upper floor.. $9 \times 0.5 = 4.5$ kN.

  (iii) Lower floor .... $3 \times 0.3 = 0.9$ kN.

  (iv) Walls.. $(9 + 3) \times 0.4 = 4.8$ 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) = $(9 + 3) \times 1.5$ =...................................... 18.0 kN.

(e) The total load combination (*P*) is determined as follows (see Clause 3.6.5):

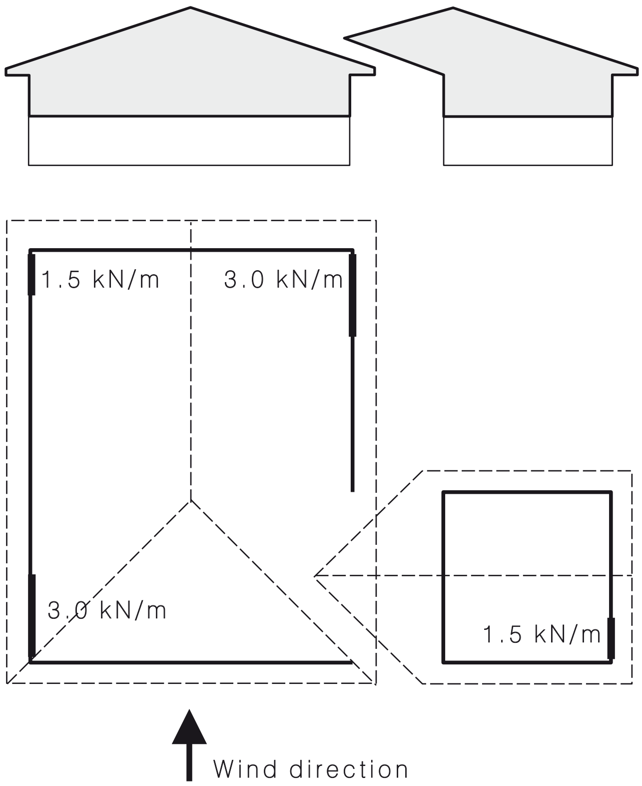
  $P = G + 0.5\,Q = 14.7 + 0.5 \times 18 = 14.7 + 9 =$ .... 23.7 kN.

(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.

D2 EVEN DISTRIBUTION OF BRACING

Figure D1 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.



NOTES:

1 The sections of the house have been separated to illustrate the distribution required.

2 The projected area of eaves up to 1000 mm wide may be ignored in the calculation of area of elevation.

FIGURE D1 EXAMPLE OF EVEN DISTRIBUTION OF BRACING

D3 SHEAR FORCE

D3.1 Example 1

Floor joists are spaced at 450 mm centres, in wind classification N4 area (see Figure D2).

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).

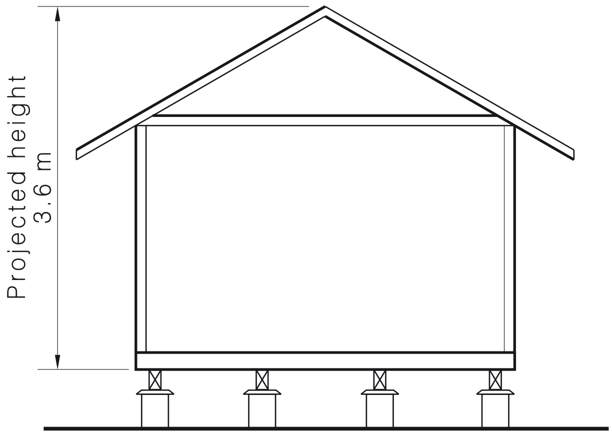


FIGURE D2 SHEAR FORCE—EXAMPLE 1

D3.2 Example 2—Bearers to stumps

Bearer spans 3600 mm, in wind classification N3 area (see Figure D3).

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)

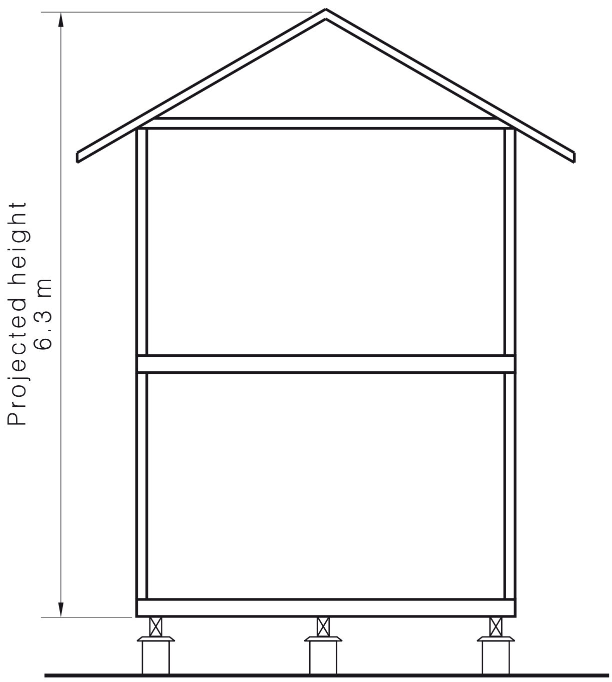


FIGURE D3 SHEAR FORCE—EXAMPLE 2

APPENDIX E
MOISTURE CONTENT AND SHRINKAGE
(Informative)

E1 MOISTURE CONTENT

Timber should have a moisture content appropriate to its use.

Structural timber may be either seasoned (moisture content 15% or lower) 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 for the location. Table E1 lists the equilibrium moisture contents (EMCs) likely to be encountered.

TABLE E1

MOISTURE CONTENT OF FLOORING

Climatic zone	Average indoor EMC %	Seasonal EMC range %	Recommended average moisture content at installation
Coastal (Zone 3)	12	10 to 15	12
Inland (Zones 1 and 2)	9	7 to 12	9
Airconditioned	9	7 to 12	9

NOTE: For a map of climate zones, refer to the subfloor ventilation requirements in the Building Code of Australia.

E2 DIMENSIONAL STABILITY

Allowance should be made for timber movement.

See Paragraph E3 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.

E3 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 E1).

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 E2.

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 E2

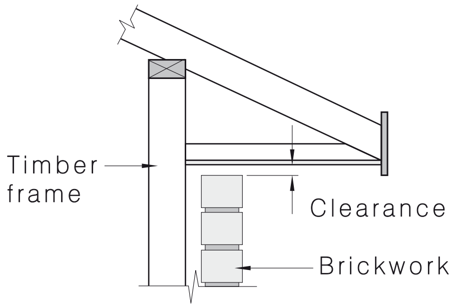
TYPICAL SHRINKAGE RATES

Member	Depth, mm	Typical shrinkage (see Note 1), mm		
		Unseasoned softwood	Unseasoned hardwood	Seasoned timber
Top plates	2 at 35	2.8	5.6	0
Lintel (see Note 2)	1 at 250	10	20	0
Bottom plate	2 at 45	3.6	7.2	0
Floor joist	1 at 200	8	16	0

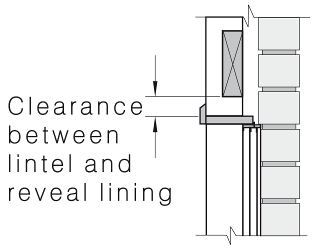
NOTES:

1 The shrinkage values determined above are based on typical values for softwood of 4.0% and typical values for hardwood of 8%.

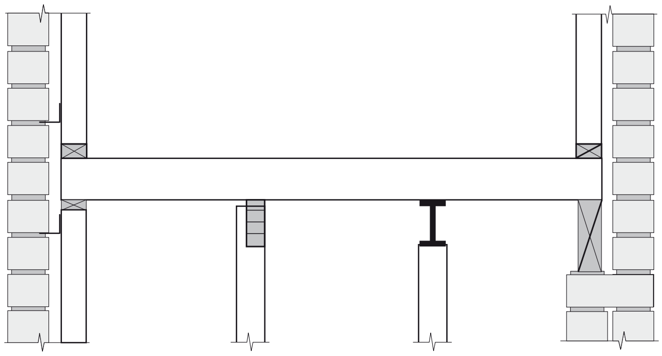
2 Lintel shrinkage will be local to the position of the lintel and may not be reflected in total shrinkage for the full height of the building.



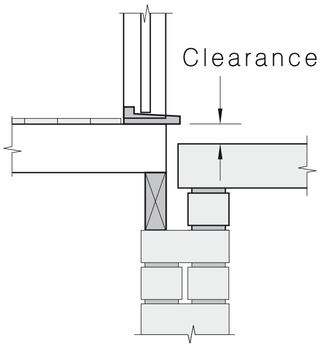
(a) Brick veneer to be kept clear of unseasoned framing



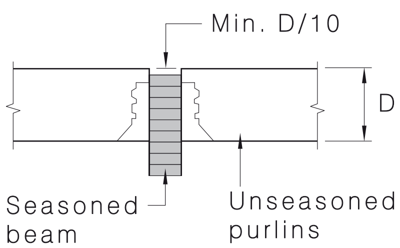
(b) Clearance at door and window heads



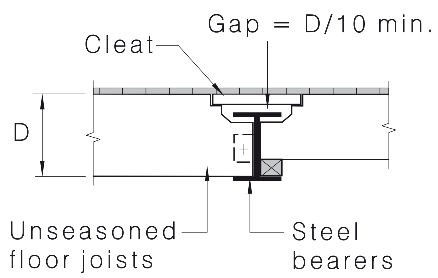
(c) Using material with different shrinkage characteristics cause uneven floors, etc.



(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 E1 ALLOWANCE FOR SHRINKAGE

APPENDIX F

RACKING FORCES—ALTERNATIVE PROCEDURE

(Normative)

Racking forces determined from Tables F1(A) to F3(C) for wind classifications C1 to C3 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.

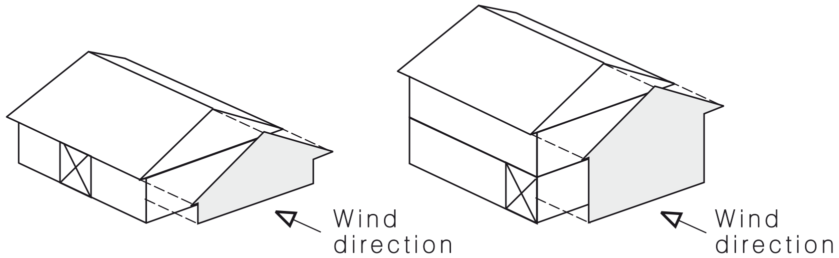
All the other provisions of Section 8 shall apply for the use of the racking forces determined from this Appendix.

Tables F1(A) to F3(C) are only applicable to a maximum wall height of 2700 mm. For wall heights exceeding 2700 mm up to 3000 mm, the forces shall be increased by 15 %.

Interpolation of the values given in Tables F1(A) to F3(C) is permitted.

TABLE F1(A)

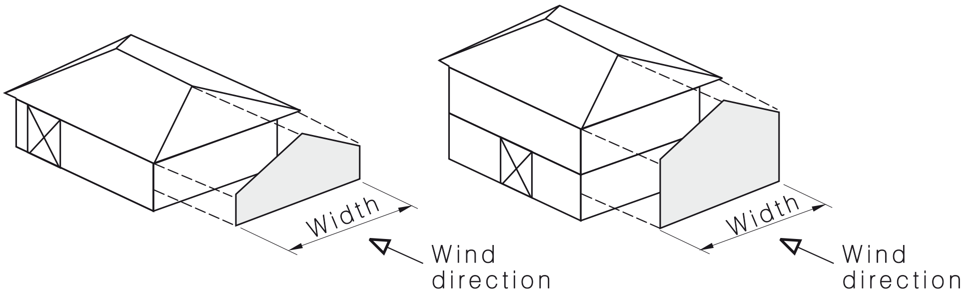
WIND CLASSIFICATION C1—WIND FORCE (kN) TO BE RESISTED BY GABLE ENDS



Level of applied racking force	Building width	Wind force to be resisted by gable ends, kN							
		Roof slope, degrees							
	m	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. 1000 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
Subfloor of single storey (max. 1800 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. 1000 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. 1800 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 F1(B)

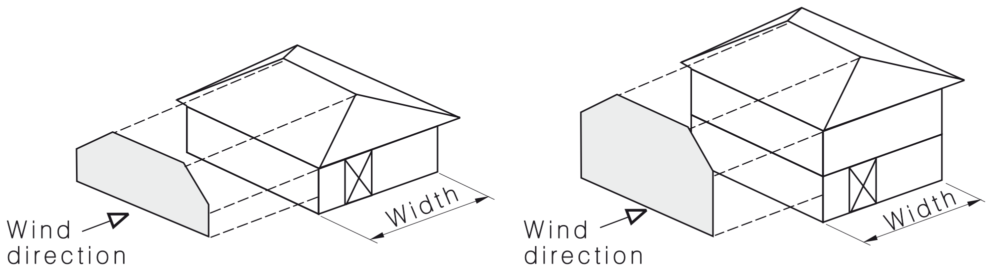
WIND CLASSIFICATION C1—WIND FORCE (kN) TO BE RESISTED BY HIP ENDS



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	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
	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. 1000 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. 1800 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. 1000 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
Subfloor of two storeys or highset (max. 1800 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 F1(C)

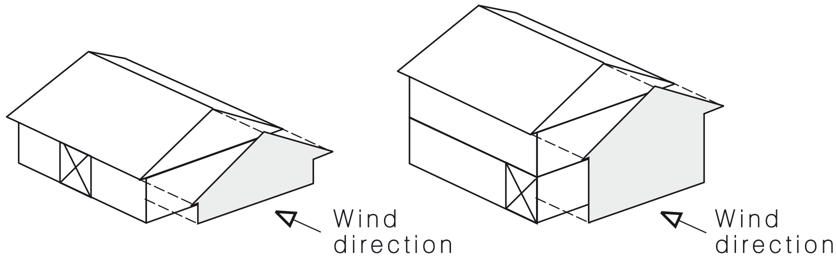
WIND CLASSIFICATION C1—WIND FORCE PER UNIT LENGTH (kN/m) TO BE RESISTED AT RIGHT ANGLES TO BUILDING LENGTH (HIP OR GABLE END BUILDINGS)



Level of applied racking force	Building width	Wind force to be resisted by building length, kN/m total force = length (m) × force (kN/m)							
		Roof slope, degrees							
	m	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. 1000 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. 1800 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
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. 1000 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. 1800 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 F2(A)

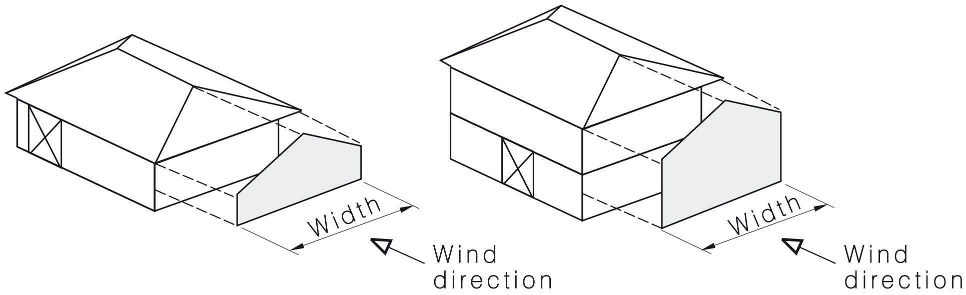
WIND CLASSIFICATION C2—WIND FORCE (kN) TO BE RESISTED BY GABLE ENDS



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
Subfloor of single storey (max. 1000 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. 1800 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. 1000 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. 1800 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 F2(B)

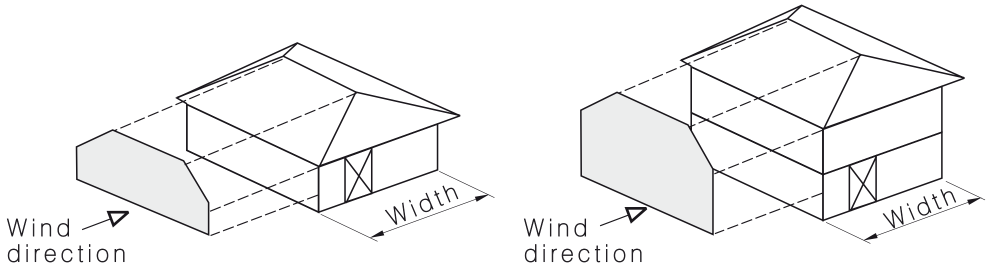
WIND CLASSIFICATION C2—WIND FORCE (kN) TO BE RESISTED BY HIP ENDS



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. 1000 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. 1800 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. 1000 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
Subfloor of two storeys or highset (max. 1800 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 F2(C)

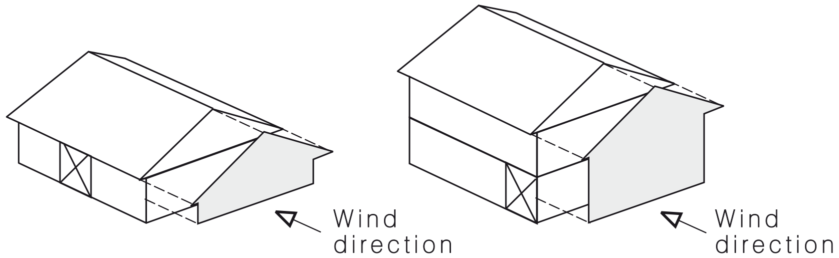
WIND CLASSIFICATION C2—WIND FORCE PER UNIT LENGTH (kN/m) TO BE RESISTED AT RIGHT ANGLES TO BUILDING LENGTH (HIP OR GABLE END BUILDINGS)



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. 1000 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. 1800 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
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. 1000 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. 1800 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

TABLE F3(A)

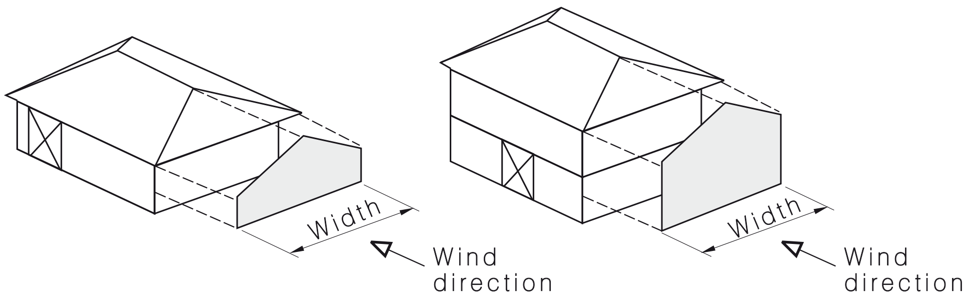
WIND CLASSIFICATION C3—WIND FORCE (kN) TO BE RESISTED BY GABLE ENDS



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	17	18	19	20	22	23	24	26
	6	26	28	31	33	36	39	42	45
	8	34	38	43	48	52	58	63	69
	10	43	49	56	64	71	79	88	98
	12	51	61	71	82	92	104	117	131
	14	60	73	87	101	116	132	149	168
	16	68	86	104	122	142	162	185	209
Subfloor of single storey (max. 1000 mm off ground)	4	43	44	45	47	48	49	50	52
	6	65	67	70	72	75	78	81	85
	8	86	91	95	100	105	110	115	122
	10	108	115	122	129	137	145	153	163
	12	129	139	149	160	171	182	195	209
	14	151	165	178	192	207	223	240	259
	16	173	190	208	227	246	267	289	314
Subfloor of single storey (max. 1800 mm off ground)	4	48	49	50	52	53	54	55	57
	6	72	75	77	80	83	86	89	92
	8	96	101	105	110	115	120	126	132
	10	120	127	134	142	149	157	166	176
	12	145	155	165	175	186	198	210	224
	14	169	182	196	210	225	241	258	277
	16	193	210	228	247	266	287	309	334
Lower storey of two storeys or highset	4	55	56	57	58	59	61	62	64
	6	82	85	87	90	93	96	99	102
	8	110	114	119	123	128	133	139	145
	10	137	144	151	158	166	174	183	192
	12	165	175	185	195	206	218	230	244
	14	192	206	219	234	248	264	281	300
	16	220	237	255	274	293	314	336	361
Subfloor of two storeys or highset (max. 1000 mm off ground)	4	81	82	83	84	86	87	88	90
	6	121	124	127	129	132	135	138	141
	8	162	166	171	176	180	186	191	197
	10	202	209	216	224	231	239	248	257
	12	243	253	263	273	284	296	309	323
	14	283	297	311	325	340	356	373	392
	16	324	342	360	378	397	418	441	465
Subfloor of two storeys or highset (max. 1800 mm off ground)	4	86	87	88	89	91	92	93	95
	6	129	132	134	137	139	142	145	149
	8	172	177	181	186	190	196	201	207
	10	215	222	229	236	244	252	261	270
	12	258	268	278	289	299	311	324	338
	14	301	315	328	343	357	373	390	409
	16	344	362	380	398	418	438	461	486

TABLE F3(B)

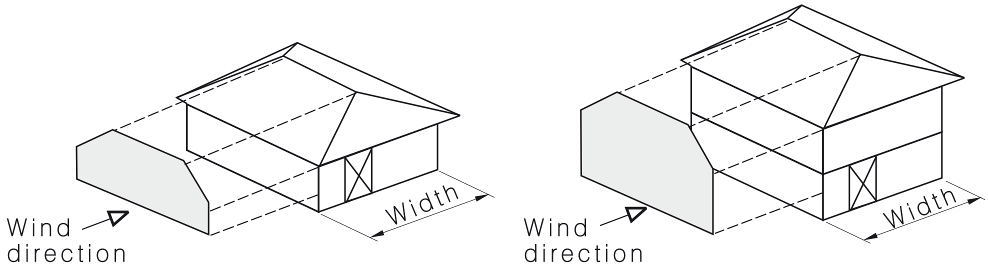
WIND CLASSIFICATION C3—WIND FORCE (kN) TO BE RESISTED BY HIP ENDS



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	17	17	17	17	19	21	22	23
	6	26	26	26	27	31	35	37	41
	8	34	34	34	39	45	51	55	62
	10	43	43	43	51	61	70	76	88
	12	51	51	51	64	79	91	100	117
	14	60	60	60	77	97	114	127	150
	16	68	68	68	91	117	139	156	186
Subfloor of single storey (max. 1000 mm off ground)	4	43	43	43	43	44	46	48	49
	6	65	65	65	66	69	73	76	79
	8	86	86	87	89	96	102	106	113
	10	108	108	109	114	124	134	140	151
	12	129	129	130	140	155	168	177	194
	14	151	151	151	167	187	204	217	240
	16	173	173	173	195	222	243	260	290
Subfloor of single storey (max. 1800 mm off ground)	4	48	48	48	48	49	51	53	54
	6	72	72	73	73	76	80	83	86
	8	96	96	97	98	105	111	116	122
	10	120	120	122	125	135	145	151	162
	12	145	145	146	153	168	182	191	207
	14	169	169	169	182	203	221	233	256
	16	193	193	193	213	240	262	278	308
Lower storey of two storeys or highset	4	55	55	55	55	56	58	60	61
	6	82	82	83	83	85	89	93	96
	8	110	110	111	112	117	124	129	135
	10	137	137	138	140	151	161	168	178
	12	165	165	166	170	186	200	209	225
	14	192	192	194	203	224	242	254	277
	16	220	220	221	236	263	287	303	332
Subfloor of two storeys or highset (max. 1000 mm off ground)	4	81	81	81	81	82	84	86	87
	6	121	121	122	122	124	128	132	135
	8	162	162	163	163	168	175	181	186
	10	202	202	204	205	214	225	233	242
	12	243	243	245	248	262	277	287	302
	14	283	283	286	291	312	332	343	365
	16	324	324	326	337	364	389	404	433
Subfloor of two storeys or highset (max. 1800 mm off ground)	4	86	86	86	86	87	89	91	92
	6	129	129	129	130	132	136	140	142
	8	172	172	173	173	177	184	192	196
	10	215	215	216	218	226	236	245	254
	12	258	258	260	262	276	291	302	316
	14	301	301	303	308	328	348	361	381
	16	344	344	347	354	382	407	423	451

TABLE F3(C)

WIND CLASSIFICATION C3—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	3.9	3.9	4.0	4.1	4.9	6.0	6.7	7.4
	6	3.9	3.9	4.0	4.5	5.7	7.3	8.0	9.3
	8	3.9	3.9	4.0	5.0	6.7	8.5	9.5	11
	10	3.9	3.9	3.9	5.6	7.7	9.7	11	13
	12	3.9	3.9	3.9	6.0	8.5	11	12	15
	14	3.9	3.9	3.9	6.4	9.3	12	14	17
	16	3.9	3.9	3.9	6.7	10	13	15	19
Subfloor of single storey (max. 1000 mm off ground)	4	9.9	9.9	10	10	10	12	13	14
	6	9.9	9.9	10	10	11	14	14	16
	8	9.9	9.9	10	10	12	15	16	17
	10	9.9	9.9	10	11	13	16	17	19
	12	9.9	9.9	10	12	14	17	19	21
	14	9.9	9.9	9.9	12	15	18	20	24
	16	9.9	9.9	9.9	13	16	20	22	26
Subfloor of single storey (max. 1800 mm off ground)	4	11	11	11	11	12	14	14	15
	6	11	11	11	11	12	15	16	17
	8	11	11	11	12	13	16	17	19
	10	11	11	11	12	14	17	18	20
	12	11	11	11	12	15	18	20	22
	14	11	11	11	13	16	19	21	24
	16	11	11	11	14	17	21	23	27
Lower storey of two storeys or highset	4	13	13	13	13	13	15	16	17
	6	13	13	13	13	14	16	17	18
	8	13	13	13	13	14	17	19	20
	10	13	13	13	13	15	18	20	22
	12	13	13	13	14	16	20	21	24
	14	13	13	13	14	17	21	23	26
	16	13	13	13	15	18	22	24	28
Subfloor of two storeys or highset (max. 1000 mm off ground)	4	19	19	19	19	19	22	23	23
	6	19	19	19	19	19	22	24	25
	8	19	19	19	19	20	23	25	26
	10	19	19	19	19	21	25	26	28
	12	19	19	19	19	22	26	28	30
	14	19	19	19	20	23	27	29	32
	16	19	19	19	20	24	28	30	34
Subfloor of two storeys or highset (max. 1800 mm off ground)	4	20	20	20	20	20	23	24	24
	6	20	20	20	20	21	24	25	26
	8	20	20	20	20	21	25	26	27
	10	20	20	20	20	22	26	28	29
	12	20	20	20	20	23	27	29	31
	14	20	20	20	21	24	28	30	33
	16	20	20	20	21	24	29	31	35

APPENDIX G

TIMBER SPECIES AND PROPERTIES

(Informative)

G1 GENERAL

Table G1 provides a range of 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 G1 are taken from AS 1720.2; any changes to AS 1720.2 should be taken to supersede the data cited herein.

G2 NOTES TO THE TABLE

G2.1 Column 1—Standard trade name

The Standard names are defined in AS/NZS 1148.

G2.2 Column 2—Botanical name

The botanical names are defined in AS/NZS 1148.

G2.3 Column 3—Strength group

Strength Groups are given for unseasoned (U/S) and seasoned (S) timber in accordance with AS 2878.

G2.4 Column 4—Joint group

The joint group is a classification of the strength of a species in joint design. A relationship between species density and joint group is given in Table G2.

G2.5 Column 5—Density

Density is given for unseasoned (U/S) 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.

G2.6 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.

G2.7 Column 7—Toughness

Toughness is a measure of the 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 scheduled in AS 1720.2.

G2.8 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.

G2.9 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.

G2.10 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 G2 used both in ground and above ground (see 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 G2

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

* The ratings in this Table are based on expert opinions and the performance of the following test specimens:

(a) In-ground: 50 × 50 mm test specimens at four sites around Australia.

(b) Above-ground: 35 × 35 mm test specimens at eleven sites around Australia.

NOTES:

1 As further reliable evidence becomes available, these ratings may require amending.

2 The heartwood of an individual piece of timber may vary from the species' nominated classification.

3 Above-ground conditions equate to outside above-ground subject to periodic moderate wetting when ventilation and drainage are adequate.

G2.11 Column 11—Lyctid susceptibility of sapwood

Lyctid susceptibility of sapwood is classified as follows (see also AS 5604):

(a) S—Susceptible.

(b) NS—Not susceptible.

NOTE: 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.

G2.12 Column 12—Termite-resistance of heartwood

Termite resistance of heartwood is classified as follows (see also AS 5604):

(a) R—Resistant to termite.

(b) NR—Not resistant to termite.

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.

G2.13 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.

G2.14 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.

G2.15 Column 15—Common uses

This Column lists common uses of species and not necessarily all uses for which a species is suitable. The listing does not include uses where an individual species is used in a species mix. It assumes that normal good design, workmanship, finishing and maintenance practices will be followed. The common uses of species are classified as follows:

(a) *In-ground* Conditions of use include in or on the ground, or in persistently damp or badly ventilated situations (e.g. embedded poles or posts, landscaping timber).

(b) *Framing above-ground—Exposed* Conditions of use include framing exposed to the weather (or not fully protected), but clear of the ground and well ventilated (e.g. subfloor framing to decks).

(c) *Framing above-ground—Protected* Fully protected from the weather and other dampness, and well ventilated (e.g. wall framing with weatherproof cladding).

(d) *Decking* Exposed to weather, clear of the ground and well ventilated (e.g. verandah flooring).

(e) *Cladding* Exposed to the weather and clear of the ground.

(f) *Internal flooring* Fully protected from the weather. Consideration may need to be given to species hardness and toughness relative to the specific application.

(g) *Panelling* Fully protected from the weather.

(h) *External joinery* Exposed to the weather, or not fully protected (e.g. external joinery frames, windowsills).

(i) *Internal joinery* Fully protected from the weather (e.g. door jambs, mouldings, staircases, railings).

Uses are indicated as follows:

(A) O = commonly used.

(B) P = commonly used but preservative treated.

(C) S = commonly used but should be seasoned.

G2.16 Column 16—Availability

This schedule provides guidance on availability. This will vary in local areas and with time. Specific advice should be sought from local Timber Advisory Services or timber suppliers.

Availability is indicated as follows:

(a) R = readily.

(b) L = limited.

TABLE G1

TIMBER SPECIES AND PROPERTIES

1	2	3		4		5		6	7		8	9	10		11	12	13			14	15									16
Standard trade name	Botanical name	Strength group		Joint group		Density (Kg/m^3)		Hardness (seasoned)	Toughness		Tangential shrinkage %	Unit tangential movement %	Natural durability class		Lyctid susceptibility	Termite-resistance	Early fire hazard			Colour	Common uses									Availability
		Unseasoned	Seasoned	Unseasoned	Seasoned	Unseasoned	Seasoned		Unseasoned	Seasoned			In-ground contact	Outside above-ground			Ignitability	Spread of flame	Smoke development		In-ground	Framing above-ground, exposure	Framing above-ground, protected	Decking	Cladding	Internal flooring	Panelling	External joinery	Internal joinery	
ash, alpine	Eucalyptus delegatensis	S4	SD4	J3	JD3	1050	650	5.0	M	M	8.5	0.35	4	3	*	NR	14	8	3	W	—	—	S	—	—	O	O	—	O	R
ash, crows	Flindersia australis	S2	SD3	J1	JD1	1050	950	11.0	M	M	4.2	—	1	1	S	R	—	—	—	W	—	—	—	—	—	O	—	—	—	L
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	—	—	—	—	—	O	O	—	O	R
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	—	—	O	—	—	—	—	—	—	L
balau (selangan batu)	Shorea spp.	S2	SD3	J2	JD2	1150	900	—	—	—	7.0	—	2	1	S	NR	—	—	—	R	—	O	O	O	O	O	O	—	—	L
Bangkirai	Shorea laevifolia	—	SD3	—	—	—	850	—	—	—	5.0	—	2	—	S	—	—	—	—	W	P	O	—	O	—	O	O	—	—	L
beech, myrtle	Nothofagus cunninghamii	S4	SD5	J3	JD3	1100	700	5.9	—	—	4.7	0.32	4	3	S	NR	—	—	—	P	—	—	O	—	O	O	O	—	O	L
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	—	O	O	O	O	O	O	—	—	R

* See AS 5604.

(*continued*)

TABLE G1 (*continued*)

1	2	3		4		5		6	7		8	9	10		11	12	13			14	15									16
		Strength group		**Joint group**		**Density (Kg/m^3)**			**Toughness**				**Natural durability class**				**Early fire hazard**				**Common uses**									
Standard trade name	**Botanical name**	**Unseasoned**	**Seasoned**	**Unseasoned**	**Seasoned**	**Unseasoned**	**Seasoned**	**Hardness (seasoned)**	**Unseasoned**	**Seasoned**	**Tangential shrinkage %**	**Unit tangential movement %**	**In-ground contact**	**Outside above-ground**	**Lyctid susceptibility**	**Termite-resistance**	**Ignitability**	**Spread of flame**	**Smoke development**	**Colour**	**In-ground**	**Framing above-ground, exposure**	**Framing above-ground, protected**	**Decking**	**Cladding**	**Internal flooring**	**Panelling**	**External joinery**	**Internal joinery**	**Availability**
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	—	O	O	—	—	—	—	—	—	L
Blackbutt, W.A.	Eucalyptus patens	S4	SD5	J2	JD2	1100	850	6.9	L	L	10.0	—	2	1	S	R	—	—	—	B	—	—	S	O	O	O	O	—	—	L
Blackwood	Acacia melanoxylan	S4	SD4	J3	JD3	1050	650	4.9	—	—	3.9	0.27	3	—	S	—	13	9	3	B	—	—	O	O	O	O	O	—	O	R
box, brush	Lophosteman confertus	S3	SD3	J2	JD2	1100	900	9.1	M	M	9.7	0.38	3	3	NS	R	14	7	3	B	—	—	O	O	O	O	O	—	—	R
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	O	—	—	—	—	—	—	—	—	R
Brownbarrell	Eucalyptus fastigata	S4	SD4	J3	JD3	1100	750	5.5	M	M	11.8	0.34	4	3	S	NR	—	8	3	W	—	—	O	—	—	—	—	—	—	L
Calantas (kalantas)	Toona calantas	S6	SD7	—	JD4	—	500	—	L	L	7.0	—	2	—	S	—	—	—	—	R	—	—	—	—	—	—	O	O	O	L
Candlebark	Eucalyptus rubida	S5	SD5	J3	JD3	1100	750	5.9	M	L	12.2	0.34	3	3	S	NR	—	—	—	P	—	—	O	—	—	—	—	—	—	L
cedar, western red	Thuja plicata	S7	SD8	—	JD6	—	350	—	L	L	3.0	—	3	2	NS	R	15	10	4	W-B	—	—	—	—	O	—	O	O	O	R
cedar, yellow	Chamaecyparis nootkatensis	S6	SD6	—	—	640	480	—	L	L	6.0	—	1	1	NS	R	—	—	—	W	—	—	—	O	—	—	—	O	—	L

(*continued*)

TABLE G1 (*continued*)

1	2	3		4		5		6	7		8	9	10		11	12	13			14	15									16
Standard trade name	Botanical name	Strength group		Joint group		Density (Kg/m^3)		Hardness (seasoned)	Toughness		Tangential shrinkage %	Unit tangential movement %	Natural durability class		Lyctid susceptibility	Termite-resistance	Early fire hazard			Colour	Common uses									Availability
		Unseasoned	Seasoned	Unseasoned	Seasoned	Unseasoned	Seasoned		Unseasoned	Seasoned			In-ground contact	Outside above-ground			Ignitability	Spread of flame	Smoke development		In-ground	Framing above-ground, exposure	Framing above-ground, protected	Decking	Cladding	Internal flooring	Panelling	External joinery	Internal joinery	
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	—	—	O	—	—	—	O	—	O	R
gum, blue, southern	Eucalyptus globulus	S3	SD2	J2	JD2	1150	1000	11.5	M	H	7.7	0.40	3	2	S	NR	—	—	—	W	—	—	O	—	—	—	—	—	—	L
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	—	—	O	O	—	O	O	—	—	R
gum, grey	Eucalyptus propinqua	S1	SD2	J1	JD1	1250	1050	14.0	M	M	7.0	—	1	1	NS	R	—	—	—	R	O	O	—	—	—	—	—	—	—	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	—	—	—	—	—	O	O	—	O	R
gum, manna	Eucalyptus viminalis	S4	SD4	J3	JD2	1100	800	5.8	M	M	12.0	0.34	4	3	S	NR	—	—	—	P	—	—	—	—	—	O	O	—	O	L
gum, mountain	Eucalyptus darympleana	S4	SD5	J3	JD3	1100	700	5.7	M	M	11.5	0.35	4	3	S	NR	—	—	—	P	—	—	O	—	—	O	—	—	O	L
gum, red, forest	Eucalyptus tereticornis	S3	SD4	J1	JD1	1150	1000	11.3	M	M	8.6	0.34	1	1	NS	R	—	—	—	R	O	O	O	—	O	—	—	—	—	L
gum, red, river	Eucalyptus camaldulensis	S5	SD5	J2	JD2	1150	900	9.7	M	L	8.9	0.31	2	1	S	R	—	3	3	R	O	O	O	O	O	O	O	O	—	L
gum, rose	Eucalyptus grandis	S3	SD4	J2	JD2	1100	750	7.3	M	M	7.5	0.30	3	2	NS	NR	—	7 8‡	3	P	—	—	O	—	—	—	—	—	—	L

‡ The value is for plywood.

(*continued*)

TABLE G1 *(continued)*

1	2	3		4		5		6	7		8	9	10		11	12	13			14	15									16
		Strength group		Joint group		Density (Kg/m^3)			Toughness				Natural durability class				Early fire hazard				Common uses									
Standard trade name	Botanical name	Unseasoned	Seasoned	Unseasoned	Seasoned	Unseasoned	Seasoned	Hardness (seasoned)	Unseasoned	Seasoned	Tangential shrinkage %	Unit tangential movement %	In-ground contact	Outside above-ground	Lyctid susceptibility	Termite-resistance	Ignitability	Spread of flame	Smoke development	Colour	In-ground	Framing above-ground, exposure	Framing above-ground, protected	Decking	Cladding	Internal flooring	Panelling	External joinery	Internal joinery	Availability
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	—	—	O	—	—	O	—	—	—	R
gum, spotted	Eucalyptus maculata	S2	SD2	J1	JD1	1200	1100	10.1	H	H	6.1	0.38	2	1	S	R	13	3 7‡	3	B	—	O	O	O	O	O	—	—	—	R
Hardwood, Johnstone River	Backhousia bancroftii	S2	SD3	J1	JD1	1150	950	—	—	—	6.4	0.39	3	2	S	NR	—	—	—	B		—	—	—	—	O	—	—	—	L
Hemlock, western	Tsuga heterophylla	S6	SD6	J4	JD4	800	500	2.7	L	L	5.0	—	4	4	NS	NR	14	9	3	W	—	—	O	—	—	—	O	—	O	L
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	O	O	O	O	—	—	—	—	—	R
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	O	O	—	O	—	—	—	—	—	L
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	O	O	O	O	O	O	O	O	O	R
Kapur	Dryobalanops spp.	S3	SD4	J2	JD2	1100	750	5.4	L	M	6.0	—	3	2	NS	NR	13	7	3	WPR	—	—	O	—	—	—	—	—	—	L
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	—	O	O	O	—	O	O	O	O	R

‡ The value is for plywood.

(*continued*)

TABLE G1 (*continued*)

1	2	3		4		5		6	7		8	9	10		11	12	13			14	15									16
		Strength group		Joint group		Density (Kg/m^3)		Hardness (seasoned)	Toughness		Tangential shrinkage %	Unit tangential movement %	Natural durability class		Lyctid susceptibility	Termite-resistance	Early fire hazard			Colour	Common uses									Availability
Standard trade name	Botanical name	Unseasoned	Seasoned	Unseasoned	Seasoned	Unseasoned	Seasoned		Unseasoned	Seasoned			In-ground contact	Outside above-ground			Ignitability	Spread of flame	Smoke development		In-ground	Framing above-ground, exposure	Framing above-ground, protected	Decking	Cladding	Internal flooring	Panelling	External joinery	Internal joinery	
Keruing	Dipterocarpus spp.	S3	SD3	J2	JD2	950	750	4.6	H	H	9.5	—	3	3	S	NR	—	—	—	R	P	P	O	—	—	—	—	—	—	L
kwila (merbau)	Intsia bijuga	S2	SD3	J2	JD2	1150	850	8.8	M	M	2.5	—	3	2	S	R	—	0	5	R	—	O	O	O	—	O	O	—	—	L
Mahogany, Philippine, red, dark	Shorea spp.	S5	SD6	—	JD3	—	650	3.2	—	—	4.0	—	3	—	S	—	—	—	—	R	—	—	—	—	—	—	—	O	O	R
Mahogany, Philippine, red, light	Shorea, Pentacme, Parashorea spp.	S6	SD7	—	JD4	—	550	2.6	—	—	6.5	—	4	4	S	NR	—	—	—	W	—	—	—	—	—	—	O	—	O	R
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	—	O	O	—	—	—	—	—	—	L
Mahogany, southern	Eucalyptus botryoides	S2	SD3	J2	JD2	1100	900	9.2	M	M	9.8	0.37	3	2	NS	R	—	—	—	R	—	—	O	—	—	O	—	—	—	L
Meranti, red, light	Shorea spp.	S6	SD7	—	JD5	—	400	2.4	—	—	4.4	—	4	3	S	NR	14	9	4	P	—	—	—	—	—	—	O	—	O	R
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	—	—	O	—	—	O	—	O	O	R
Messmate, Gympie	Eucalyptus cloeziana	S2	SD3	J1	JD1	—	955	—	—	—	6.0	—	1	1	NS	R	—	—	—	W	O	O	O	O	—	—	—	—	—	L

(*continued*)

TABLE G1 (*continued*)

1	2	3		4		5		6	7		8	9	10		11	12	13			14	15										16
Standard trade name	Botanical name	Strength group		Joint group		Density (Kg/m^3)		Hardness (seasoned)	Toughness		Tangential shrinkage %	Unit tangential movement %	Natural durability class		Lyctid susceptibility	Termite-resistance	Early fire hazard			Colour	Common uses										Availability
		Unseasoned	Seasoned	Unseasoned	Seasoned	Unseasoned	Seasoned		Unseasoned	Seasoned			In-ground contact	Outside above-ground			Ignitability	Spread of flame	Smoke development		In-ground	Framing above-ground, exposure	Framing above-ground, protected	Decking	Cladding	Internal flooring	Panelling	External joinery	Internal joinery	
oak, American	Quercus spp.	S6	SD6	—	—	—	750	—	—	—	5.0	—	4	—	S	NR	—	—	—	W	—	—	—	—	—	O	O	—	O	L
Peppermint, narrow-leaved	Eucalyptus australiana	S4	SD4	J3	JD2	1100	800	7.5	L	L	13.2	0.36	4	3	S	NR	—	—	—	P	—	—	O	—	—	—	—	—	—	L
pine, caribbean	Pinus caribaea	S6	SD6	J4	JD5†	—	550	—	—	—	5.0	0.34	4	4	NS	R	—	—	—	W	P	P	S	P	P	O	O	—	—	R
pine, celery-top	Phyllodadus asplenifolius	S4	SD5	J3	JD3	1050	650	4.5	—	—	3.1	0.19	4	2	NS	R	—	—	—	W	O	O	—	O	O	—	O	—	O	L
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	—	O	O	O	O	O	O	—	—	R
pine, hoop	Araucaria cunninghamii	S6	SD5	J4	JD4	800	550	3.4	L	L	3.8	0.23	4	4	NS	NR	14	7 9‡	2 3‡	W	P	P	S	P	P	O	O	P	O	R
pine, radiata	Pinus radiata	S6	SD6	J4	JD5†	800	550	3.3	M	L	5.1	0.27	4	4	NS	NR	14	8	3	W	P	P	S	P	P	O	O	P	O	R
pine, slash	Pinus elliottii	S5	SD5	J4	JD5†	850	650	3.4	L	L	4.2	0.30	4	4	NS	R	—	8	3	W	P	P	S	P	P	O	O	P	O	R
pine, Scots	Pinus sylvestris	S7	SD6	—	JD5	—	510	—	L	L	—	—	4	4	NS	NR	—	—	—	W	—	—	S	—	—	O	O	—	—	R
Ramin	Gonystylus spp.	S4	SD4	—	JD3	—	650	5.8	—	—	5.5	—	4	—	S	NR	14	7	3	W	—	—	—	—	—	O	O	—	O	L

† Where the timber does not contain heart-in material, the joint group may be rated JD4.

‡ The value is for plywood.

(*continued*)

TABLE G1 (*continued*)

1	2	3		4		5		6	7		8	9	10		11	12	13			14	15									16
Standard trade name	Botanical name	Strength group		Joint group		Density (Kg/m^3)		Hardness (seasoned)	Toughness		Tangential shrinkage %	Unit tangential movement %	Natural durability class		Lyctid susceptibility	Termite-resistance	Early fire hazard			Colour	Common uses									Availability
		Unseasoned	Seasoned	Unseasoned	Seasoned	Unseasoned	Seasoned		Unseasoned	Seasoned			In-ground contact	Outside above-ground			Ignitability	Spread of flame	Smoke development		In-ground	Framing above-ground, exposure	Framing above-ground, protected	Decking	Cladding	Internal flooring	Panelling	External joinery	Internal joinery	
Satinay	Syncarpia hillii	S3	SD3	J2	JD2	1100	800	8.3	M	L	10.0	0.35	2	2	NS	R	—	—	—	R	—	—	—	O	—	O	—	—	—	L
Stringybark, Blackdown	Eucalyptus sphaerocarpa	S3	SD3	J1	JD1	—	1000	—	—	—	7.0	—	2	1	NS	R	—	—	—	B	—	O	O	—	—	—	—	—	—	L
Stringbark, brown	Eucalyptus baxteri	S3	SD3	J2	JD2	1100	850	7.5	M	M	10.4	0.33	3	2	NS	NR	—	—	—	B	—	—	O	—	—	—	—	—	—	L
Stringbark, white	Eucalyptus eugenioides	S3	SD3	J2	JD2	1100	1000	9.0	M	M	10.6	0.36	3	2	NS	R	—	—	—	P	—	O	O	O	—	—	—	—	—	L
Stringbark, yellow	Eucalyptus muellerana	S3	SD3	J2	JD2	1150	900	8.6	M	M	7.5	0.37	6	3	NS	R	—	—	—	W	—	O	O	O	—	—	—	—	—	L
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	O	O	O	O	O	O	—	—	—	R
Taun	Pometia pinnata	S4	SD4	—	JD3	—	700	—	—	—	5.5	—	3	2	S	NR	—	—	—	R	—	—	O	—	—	O	—	—	—	R
Turpentine	Syncarpia glomulifera	S3	SD3	J2	JD2	1050	950	11.6	M	M	13.0	0.35	5	3	NS	R	—	—	—	PB	—	—	—	O	—	O	—	—	—	L

(*continued*)

TABLE G1 (*continued*)

1	2	3		4		5		6	7		8	9	10		11	12	13			14	15									16
Standard trade name	Botanical name	Strength group		Joint group		Density (Kg/m^3)		Hardness (seasoned)	Toughness		Tangential shrinkage %	Unit tangential movement %	Natural durability class		Lyctid susceptibility	Termite-resistance	Early fire hazard			Colour	Common uses									Availability
		Unseasoned	Seasoned	Unseasoned	Seasoned	Unseasoned	Seasoned		Unseasoned	Seasoned			In-ground contact	Outside above-ground			Ignitability	Spread of flame	Smoke development		In-ground	Framing above-ground, exposure	Framing above-ground, protected	Decking	Cladding	Internal flooring	Panelling	External joinery	Internal joinery	
Commercial species groups																														
ash, Victorian oak, Australian oak, Tasmanian	Eucalyptus spp.	S4	SD4	J3	JD3	1050	650	4.9	M	M	13.3	0.36	4		S		—	—	—	W	—	—	O	—	—	O	O	—	O	R
Hardwood, mixed (Qld/Nth. NSW)	Eucalyptus spp.	S3	SD3	J2	JD2	1150	750	—	M	M	—	—	3		S		—	—	—	WPRB	—	O	O	O	O	O	—	—	—	R
Hemfir	—	—	SD7	—	JD5	—	—	—	L	L	—	—	4		NS		—	—	—	W	—	—	O	—	—	—	—	—	—	R
Softwoods, imported (unidentified)	—	S7	SD8	J6	JD6	850	400	—	L	L	—	—	4		NS		—	—	—	W	—	—	O	—	—	—	—	—	—	R
Softwoods, mixed Australian grown pinus spp.	—	—	SD7	—	JD5†	850	550	—	L	L			4		NS		—	—	—	W	—	—	O	—	—	—	—	—	—	R
Spruce pine fir (SPF)	—	—	SD7	—	JD6	—	—	—	L	L			4		NS		—	—	—	W	—	—	O	—	—	—	—	—	—	R
European spruce	Picea abies	—	SD5	—	JD5	—	—	—	—	—	—	—	4	—	NS	—	—	—	—	W	—	—	—	—	—	—	—	—	—	L

† Where the timber does not contain heart-in material, the joint group may be rated JD4.

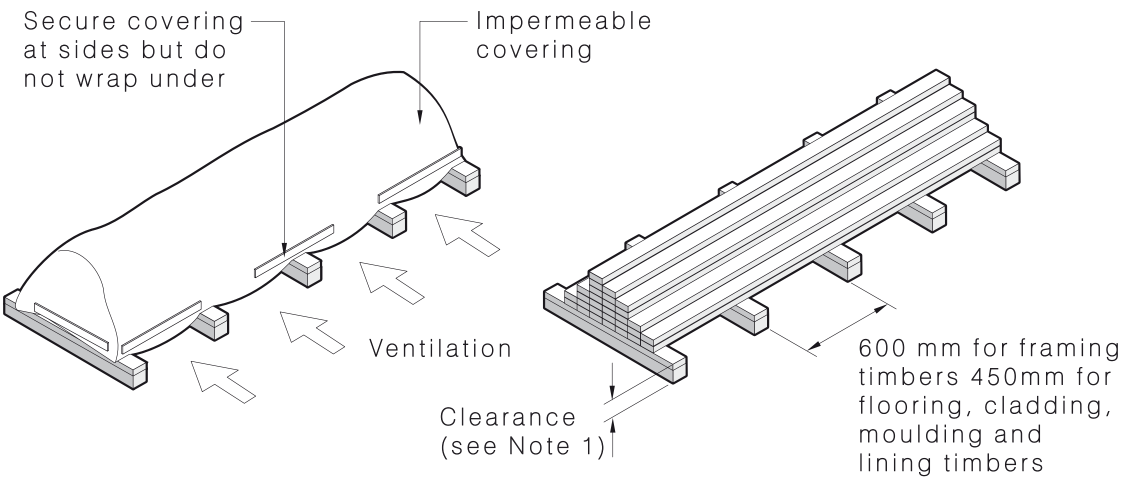
APPENDIX H

STORAGE AND HANDLING

(Informative)

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 I1. 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

NOTES:

1 150 mm clearance for seasoned framing and flooring, cladding, moulding and lining timbers.

2 Unseasoned framing may be stacked on impervious sheeting if ground is reasonably level.

FIGURE H1 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

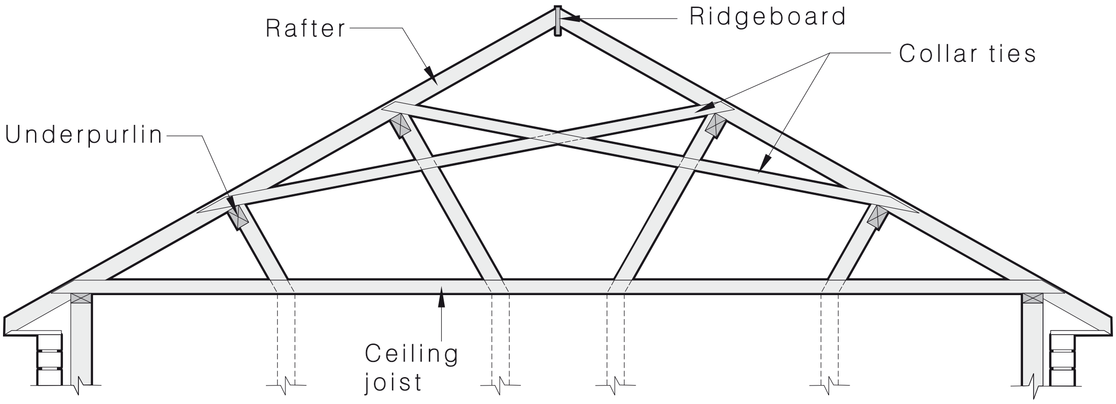
(b) horizontally stacked with sufficient bearers (approximately 2.0 m centres) to prevent bending of the trusses.

APPENDIX I

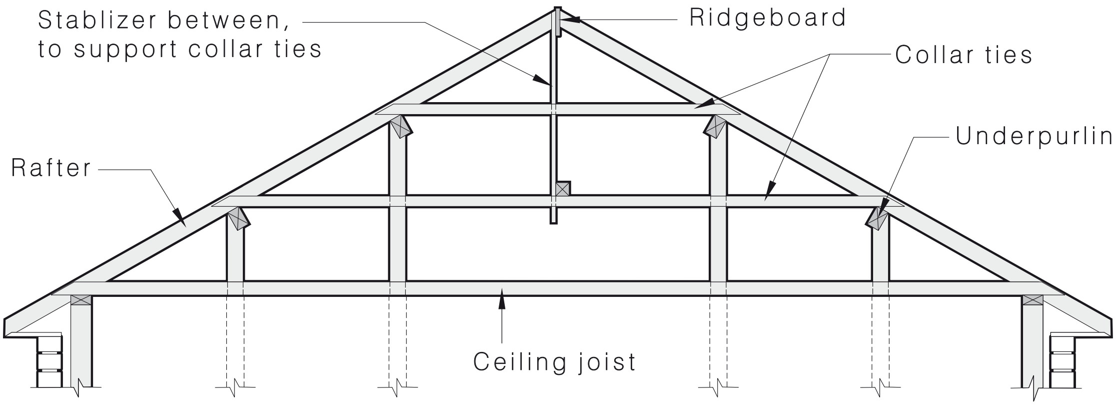
COLLAR TIES WITH MULTIPLE ROWS OF UNDERPURLINS

(Normative)

This Appendix specifies typical fixing details for collar ties with multiple rows of underpurlins, which are given in Figure I1.



(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 I1 FIXING OF COLLAR TIES WITH MULTIPLE ROWS OF UNDERPURLINS

APPENDIX J

BUILDING PRACTICES FOR ENGINEERED WOOD PRODUCTS (EWPs)

(Informative)

J1 GENERAL

This Appendix provides general guidance on building practices that are common to a range of manufactured EWPs; however, it should be noted that EWPs are product specific, and manufacturers may have installation and building practices or special requirements that differ from the guidelines herein. Where the manufacturer's requirements are different from those given in this Appendix, the manufacturer's requirements should apply.

Product specific span tables are also published by manufacturers for the application and use of their EWPs. Where EWPs are used and form part of bracing and tie-down requirements, additional requirements may also apply.

J2 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 utilising EWPs such as LVL, should be undertaken in accordance with the manufacturer's specifications.

J3 FLOOR FRAMING

J3.1 Cuts, holes and notches in bearers and joists

Details for solid, rectangular EWPs (such as LVL, glued laminated timber and 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.

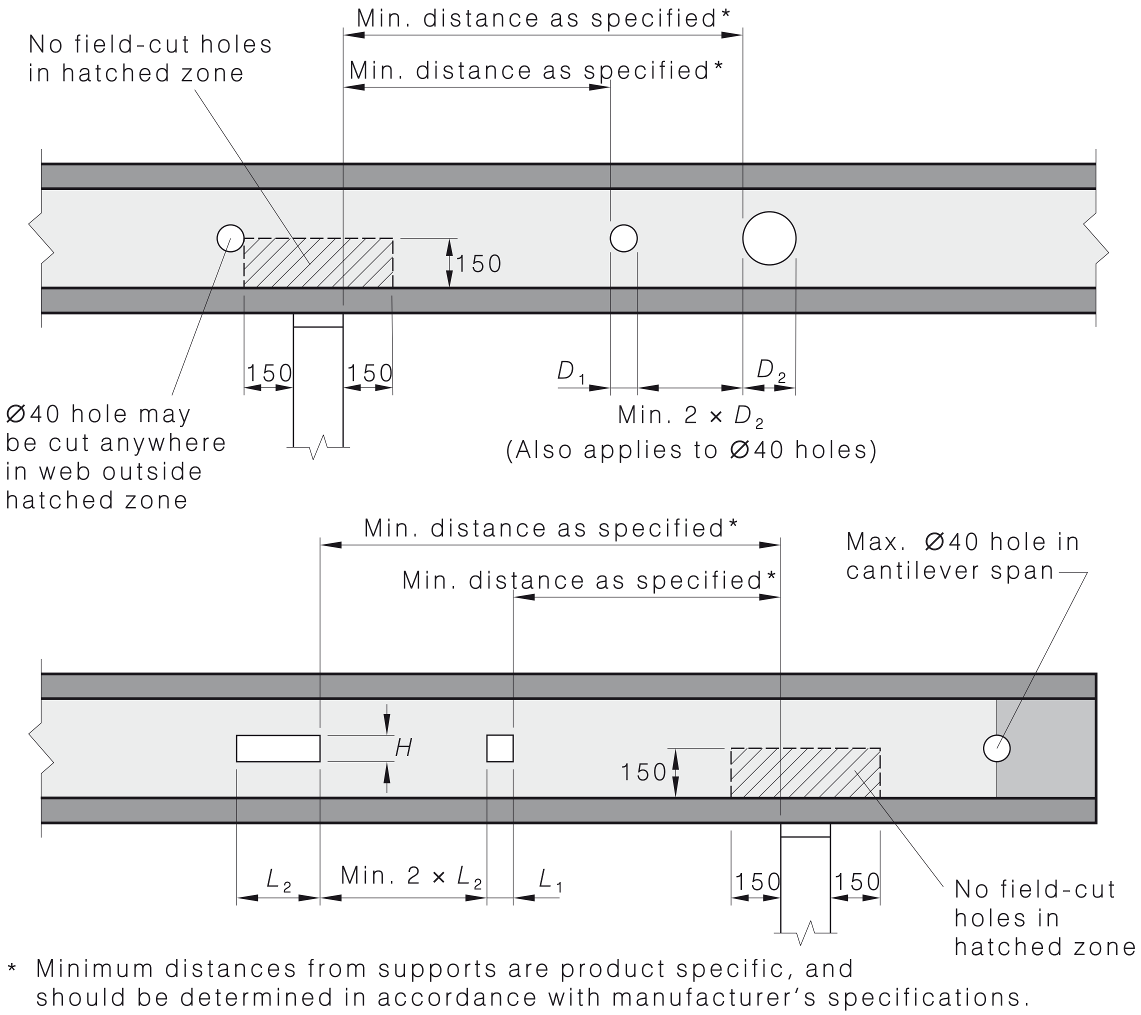
Penetrations (such as holes, cuts or notches) should not be made in the flanges of I-section EWPs used as floor joists (I-joists). Penetrations are permitted in the webs of I-joists, as shown in Figure J1 and as given in Table J1.

TABLE J1

MAXIMUM HOLE-SIZES IN WEBS OF I-JOISTS

millimetres

Nominal depth of I-joist	Max. diameter for circular holes	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



NOTE: All distances to be read from Table J1.

DIMENSIONS IN MILLIMETRES

FIGURE J1 PENETRATIONS IN WEBS OF I-JOISTS

J3.2 Bearers

Details for solid, rectangular EWPs (such as LVL, glued laminated timber and LSL) that are used as floor bearers may 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.

J3.3 Joists

J3.3.1 *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.

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.

J3.3.2 *I-joists*

Installation details for I-section members that are used as floor joists should be in accordance with Paragraphs J3.3 to J3.6.

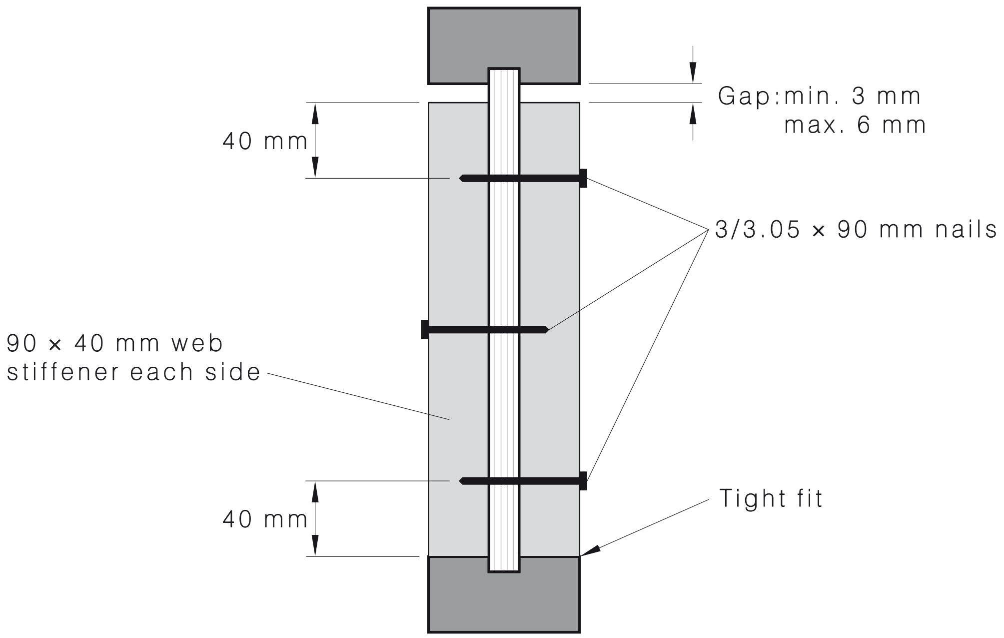
End bearing of I-section floor joists should be in accordance with Table J2.

TABLE J2

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*
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

* Web stiffeners should be installed over the supports in accordance with the manufacturer's specifications. An example of typical web stiffening is shown in Figure J2.



NOTE: Example shown is for an I-joist with 90 mm nominal flange width.

FIGURE J2 TYPICAL WEB STIFFENER ARRANGMENT

J3.4 Notching and cutting over bearing points

The location and size of any web penetrations should be in accordance with Paragraph J3.1. Web penetrations should not occur over bearing or support points.

The following should also apply:

(a) Flanges should not be notched (see Figure J3). Where notching of the bottom flange is permitted in the manufacturer's specification, over-cut should not occur and care should be taken to ensure that splitting does not occur.

(b) Taper or bevel cuts may occur only within the width of a support wall (see Figure J4).

(c) End splitting of flanges, similar to that shown in Figure J5, 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 J5.

(d) Connections to steel support beams are permitted, using construction details similar to those indicated in Figures J6, J7 and J8, or as noted otherwise in the manufacturer's specification.

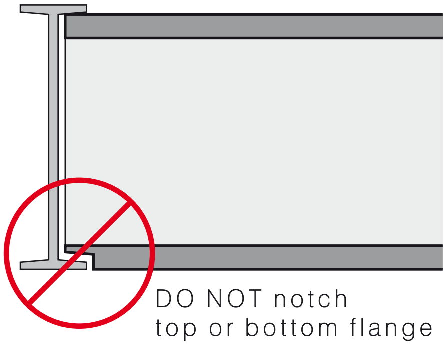


FIGURE J3 FLANGES NOT TO BE NOTCHED

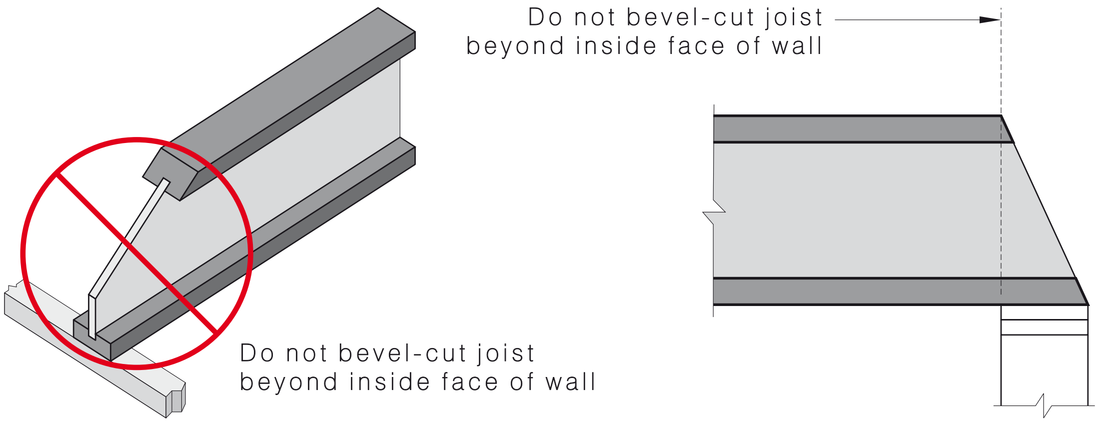


FIGURE J4 BEVEL CUTS ONLY OCCUR WITHIN THE WIDTH OF SUPPORTS

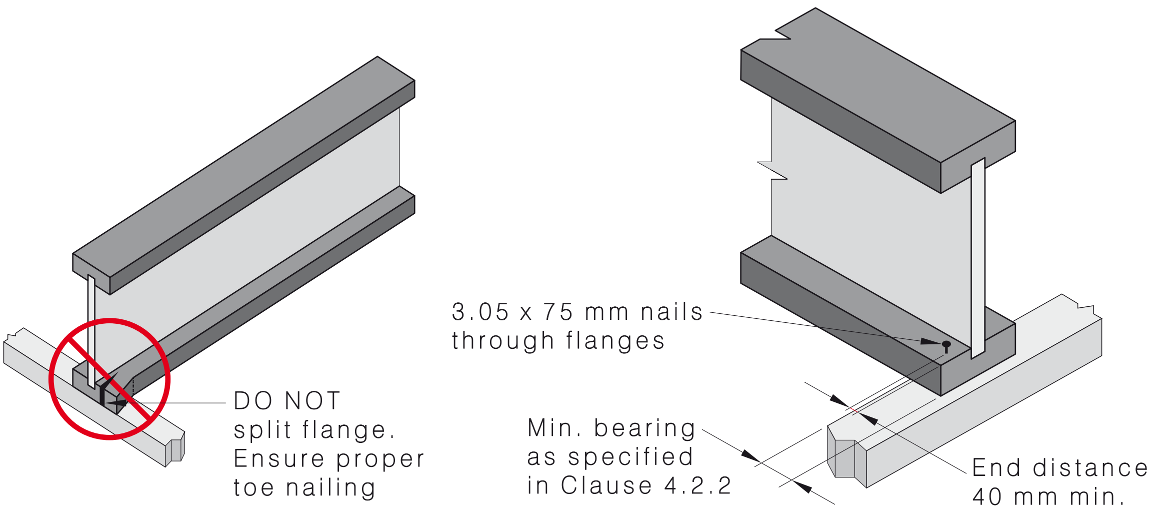


FIGURE J5 NAILING AT SUPPORTS

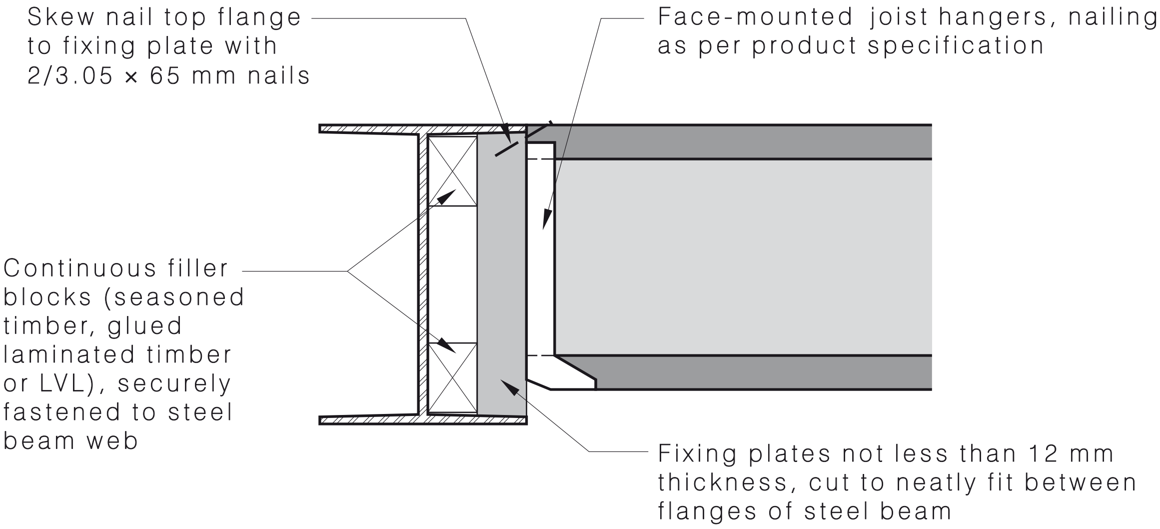


FIGURE J6 CONNECTION OF I-JOISTS TO A STEEL BEAM—METHOD 1

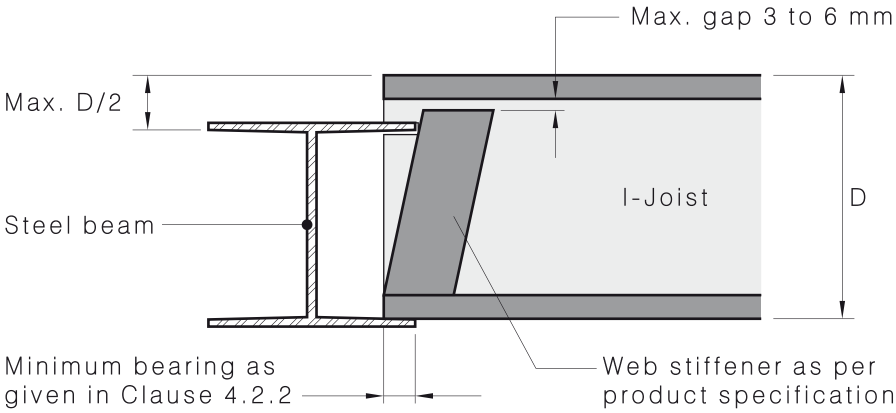


FIGURE J7 CONNECTION OF I-JOISTS TO A STEEL BEAM—METHOD 2

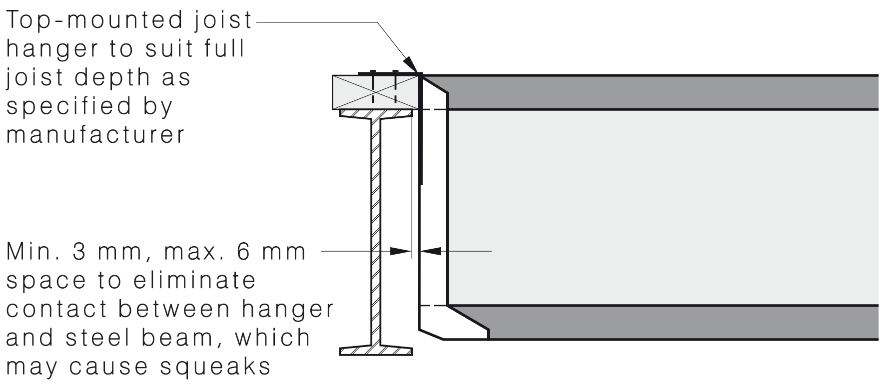
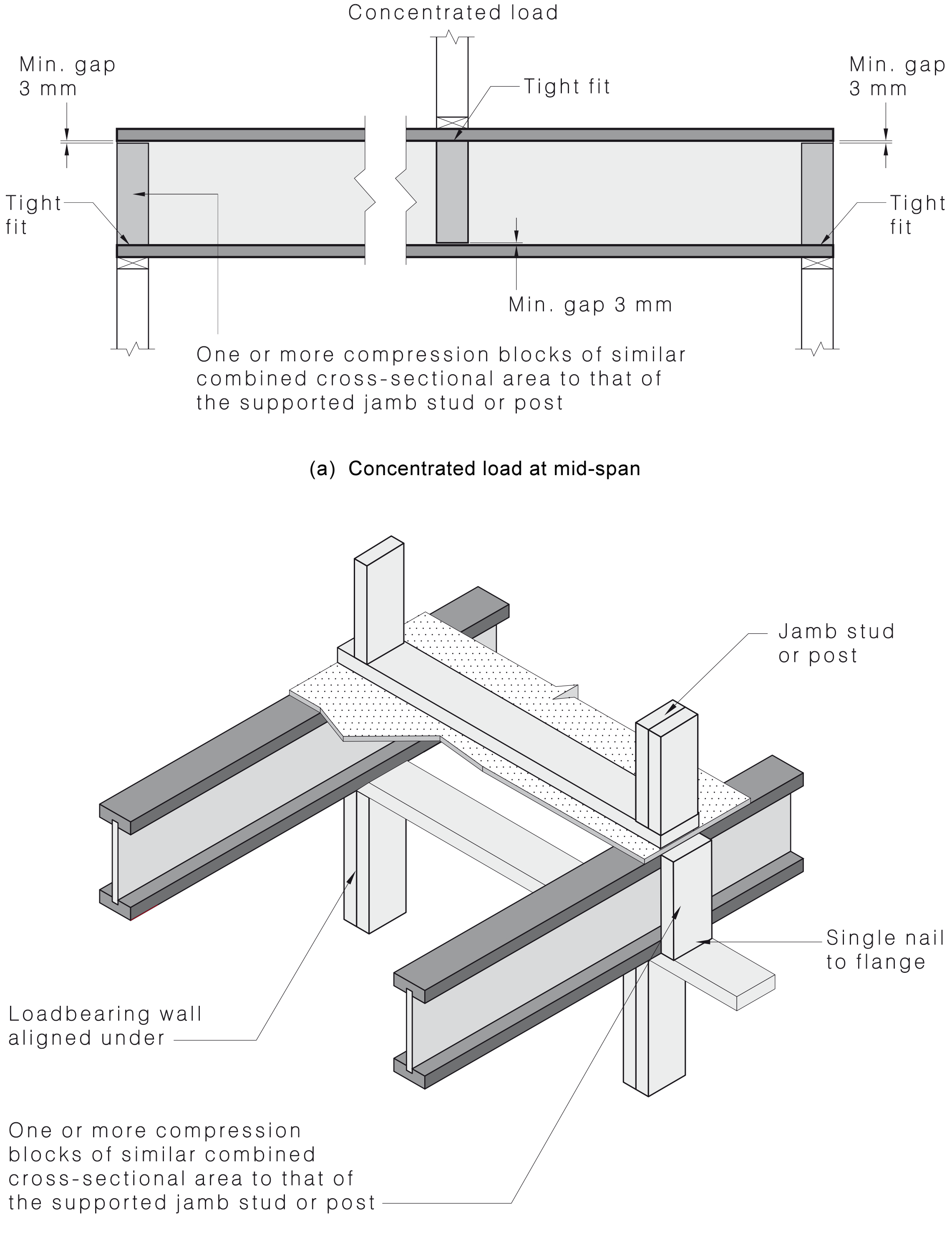


FIGURE J8 CONNECTION OF I-JOISTS TO A STEEL BEAM—METHOD 3

J3.5 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, using construction details similar to those indicated in Figures J2 and J9, or specifically noted otherwise in the manufacturer's specification.



(a) Concentrated load at mid-span

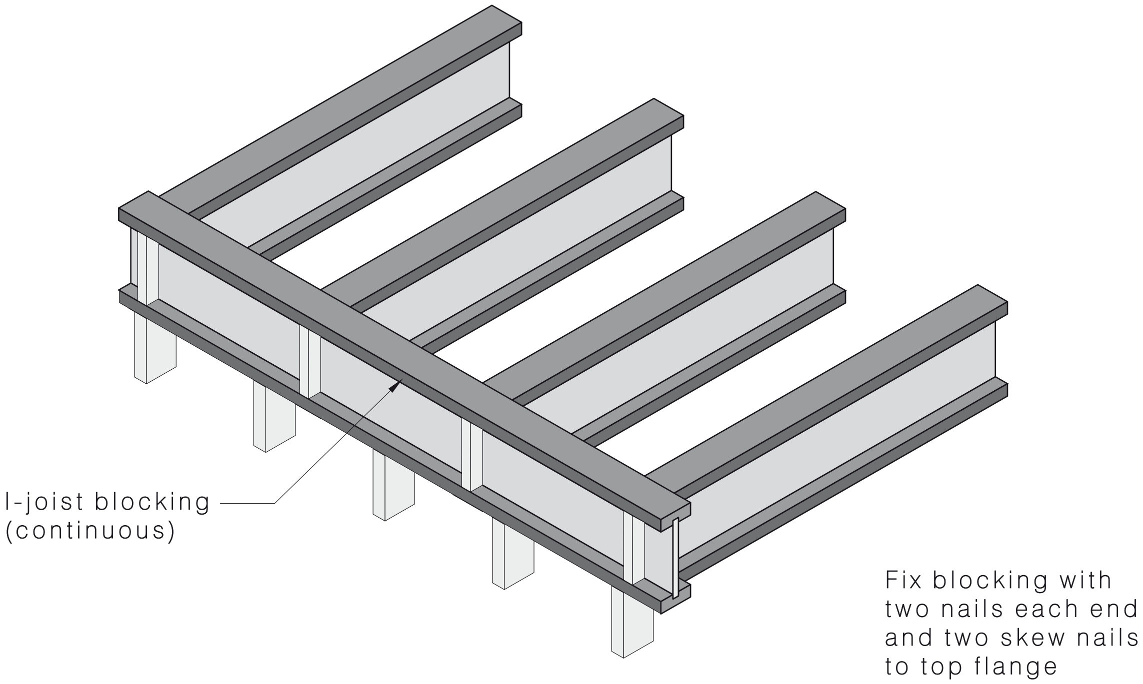
(b) Concentrated load at support

FIGURE J9 BEARING AT POINTS OF CONCENTRATED LOAD

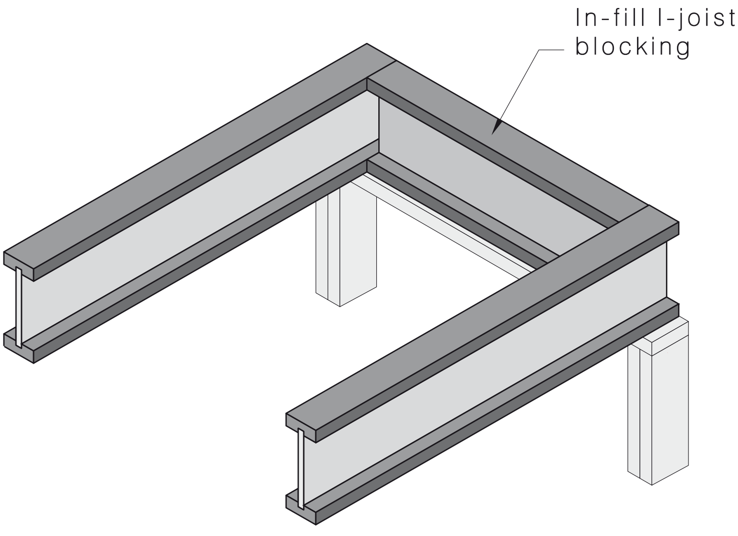
J3.6 Deep joists—Lateral restraint

J3.6.1 *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 indicated in Figures J10 and J11.



(a) Continuous I-joist blocking



(b) Infill I-joist blocking

FIGURE J10 BLOCKING OF I-JOISTS—USING I-JOIST

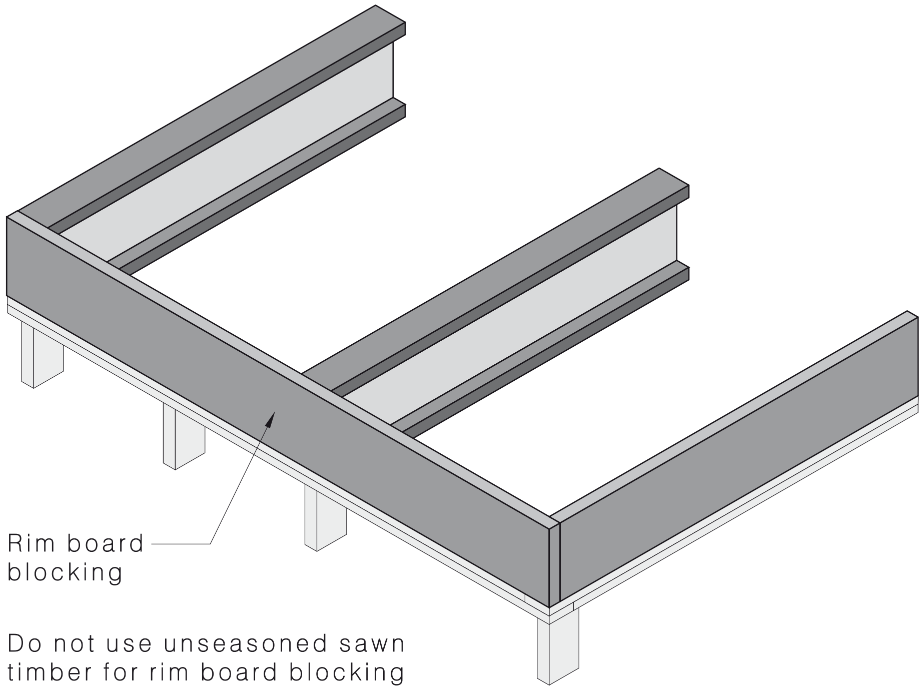


FIGURE J11 BLOCKING OF I-JOISTS—USING RIM BOARD

Rim boards and blocking should be constructed from seasoned timber to minimize the effects of shrinkage. Rim boards are permitted to 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 J12.

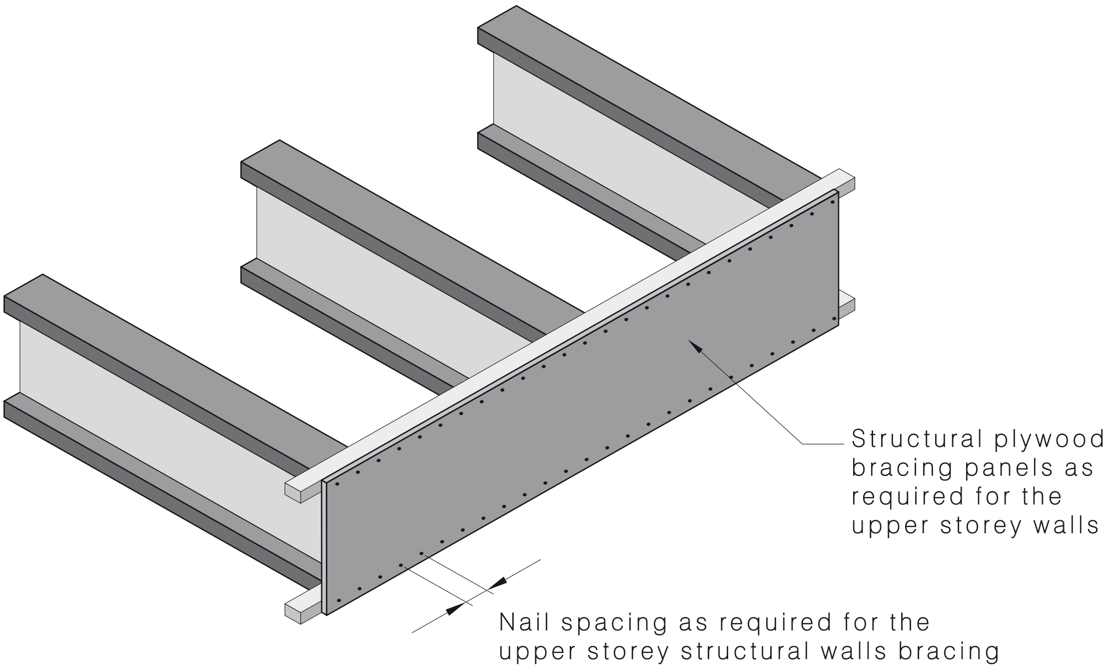
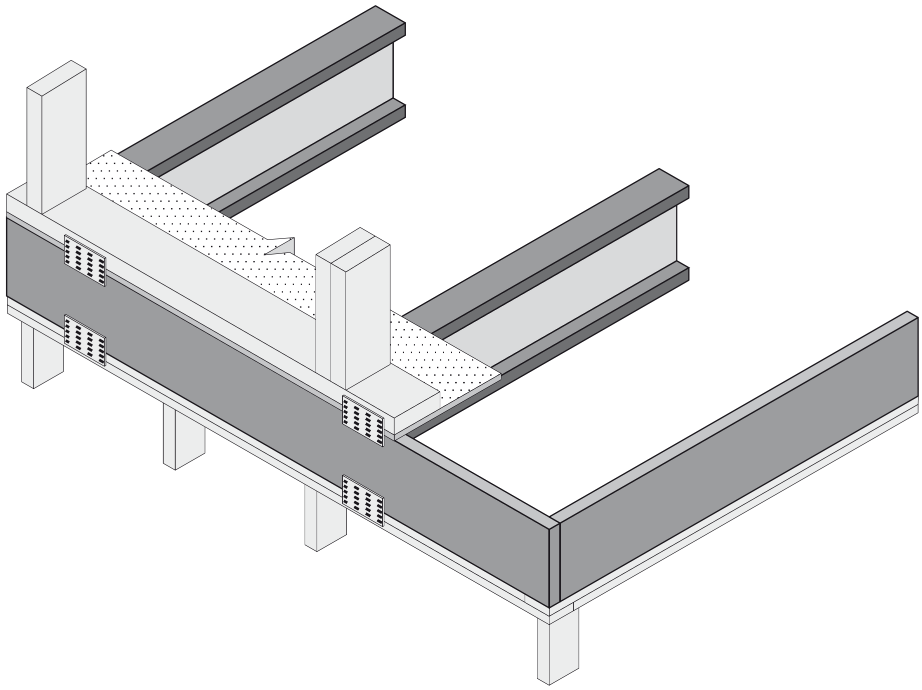


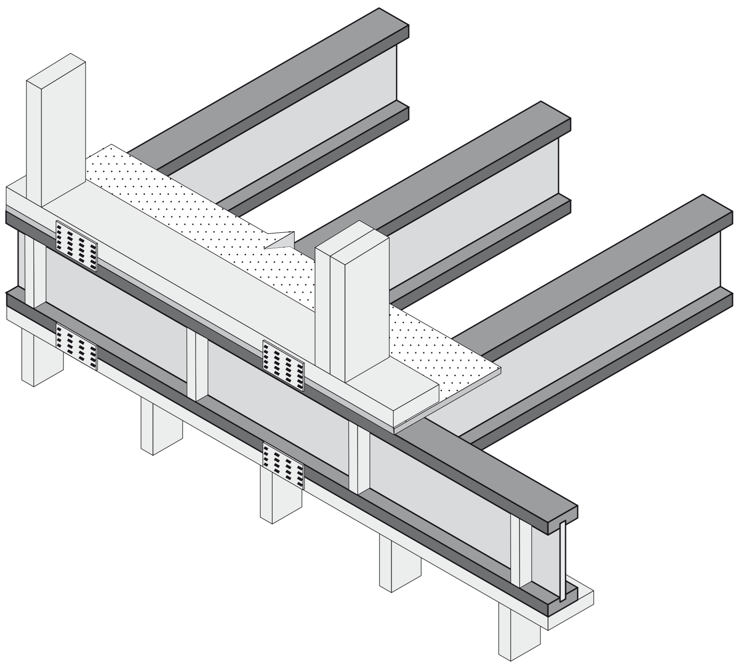
FIGURE J12 PLYWOOD LATERAL BRACING OF I-JOISTS—COMBINED BLOCKING AND RACKING LOAD TRANSFER

J3.6.2 *Nailplate connectors*

Where it is not practicable to install adequate structural plywood bracing to transfer lateral loads as shown in Figures J11 and J12, the use of nailplate connectors is permitted as shown in Figure J13(a) or J13(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 J13 EQUIVALENT NAILPLATE DETAIL TO TRANSFER BRACING FORCES THROUGH EXTERNAL WALLS

J3.6.3 *Intermediate blockings*

Non-continuous or intermediate blocking, as shown in Figure J14, should be designed to resist lateral loads and should only be used where permitted in the manufacturer's specification.

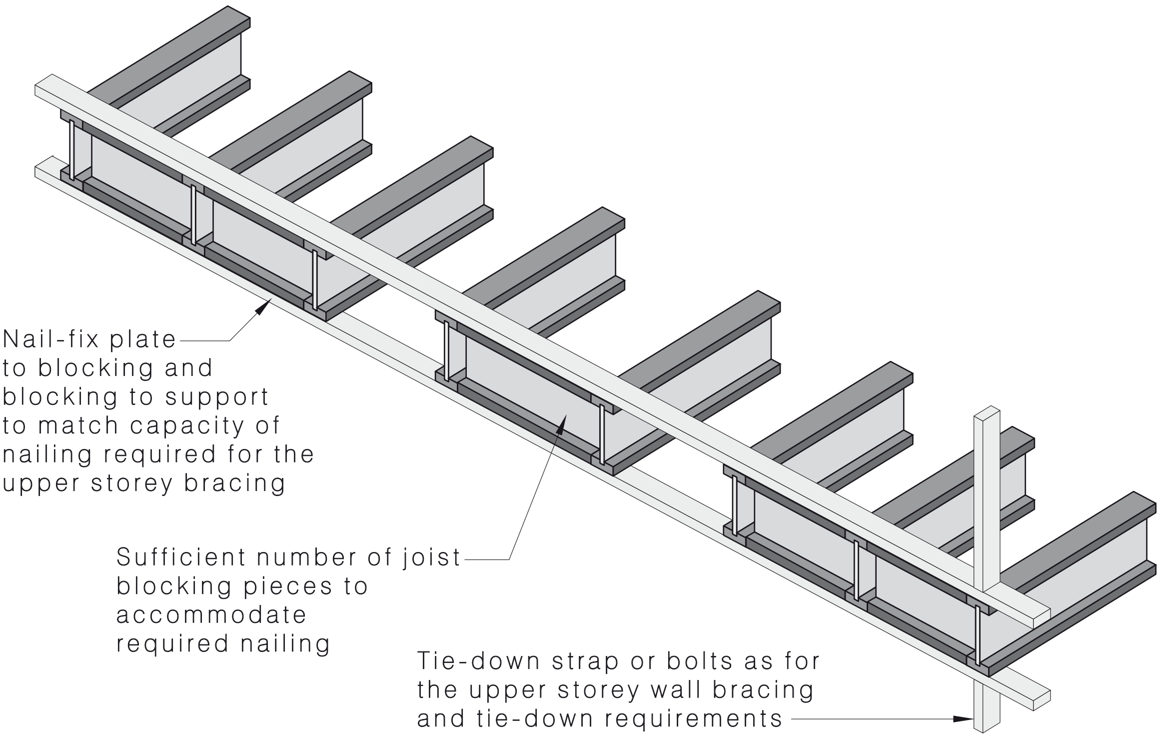


FIGURE J14 EXAMPLE OF NON-CONTINUOUS BLOCKING OF I-JOISTS

J4 ROOF FRAMING

J4.1 Roof bracing

Roof bracing details should be installed in accordance with the requirements for timber trussed roof given in AS 4440.

J4.2 Rafters

In general, rafter details for solid timber joists may be used with I-beams and should be in accordance with the requirements of Clause 7.3.13. Birdsmouth cuts for seating rafters should be as shown in Figure J15 and are permitted only on the lower end of the rafter.

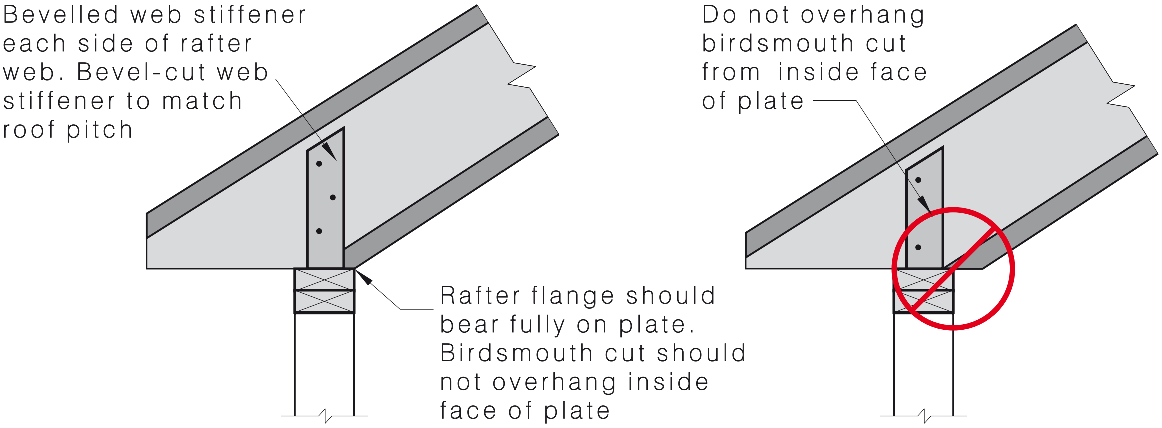


FIGURE J15 DETAIL FOR BIRDSMOUTH SEATING OF I-BEAM RAFTERS

Ventilation holes are permitted for blocking, provided lateral restraints to I-beam are used as rafters, and provided they do no exceed the size and location limitations shown in Figure J16.

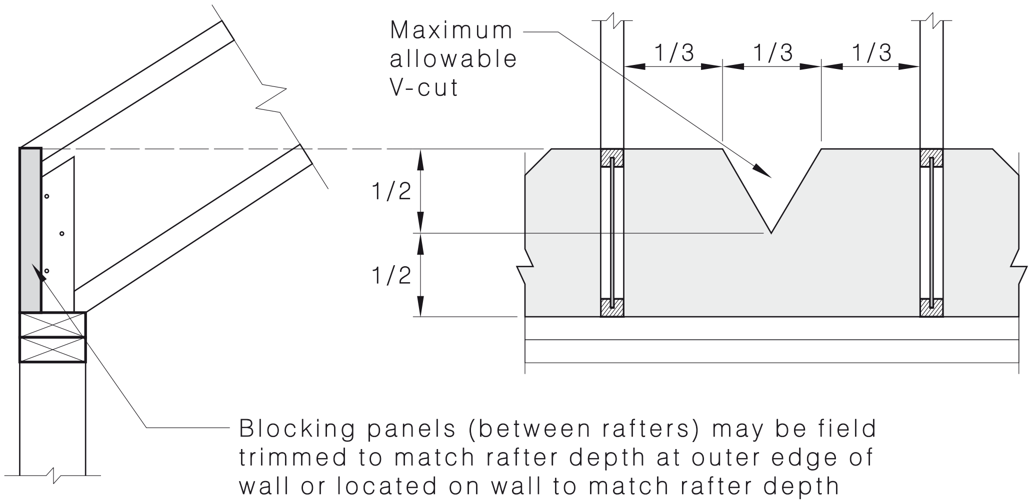
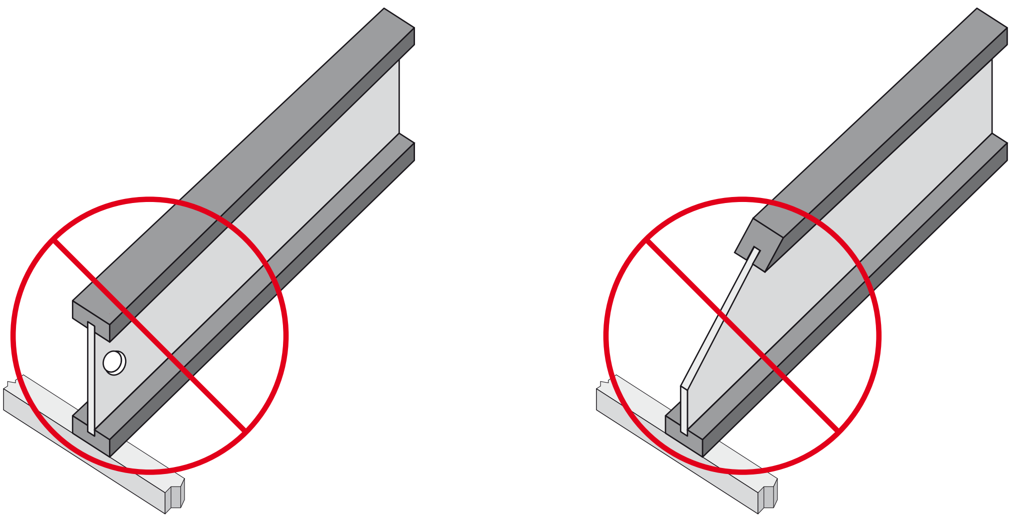


FIGURE J16 VENTILATION HOLES IN RAFTER BLOCKING

General restrictions on rafter cuts are shown in Figure J17.



(a) Do not cut holes too close to support

(b) Do not bevel cut joist beyond inside face of wall

FIGURE J17 GENERAL RESTRICTIONS ON CUTS AND PENETRATIONS TO ENDS OF RAFTERS

J4.3 Ceiling joists

In general, ceiling joist details for solid timber joists may be used with I-beams and 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 in Figure J18).

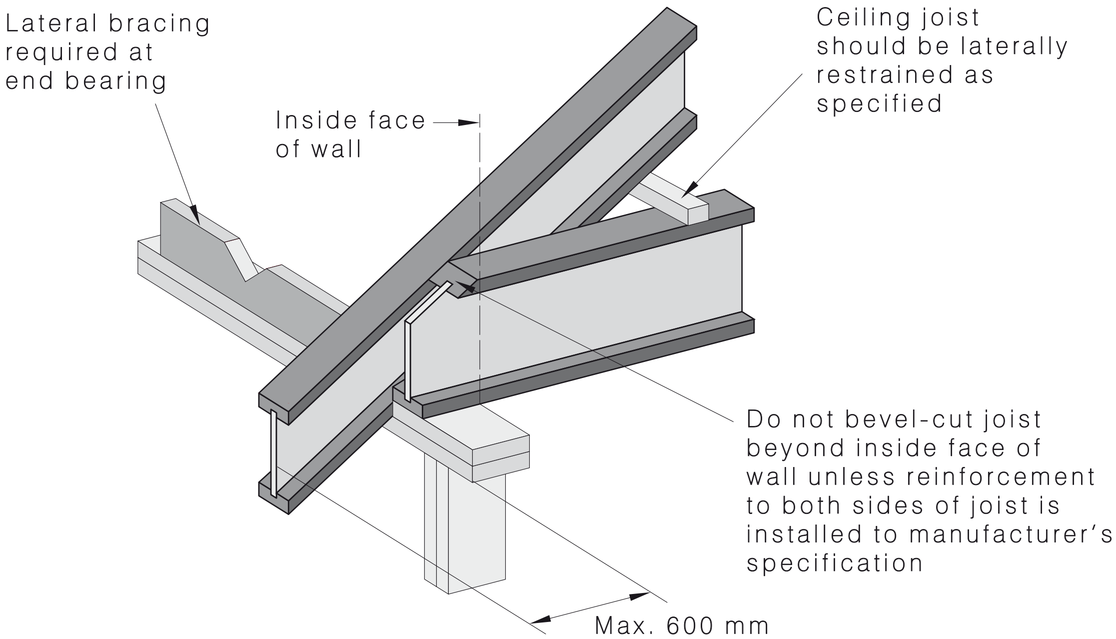


FIGURE J18 BEVEL CUTS ON CEILING JOISTS

J5 BRACING DETAILS AND SHEAR FORCES

J5.1 Bracing details for I-joists and 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, Item (b), which is reproduced in Figure J19.

For internal walls supporting I-joists, an equivalent detail using Z-clips is shown in Figure J20. 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 J19.

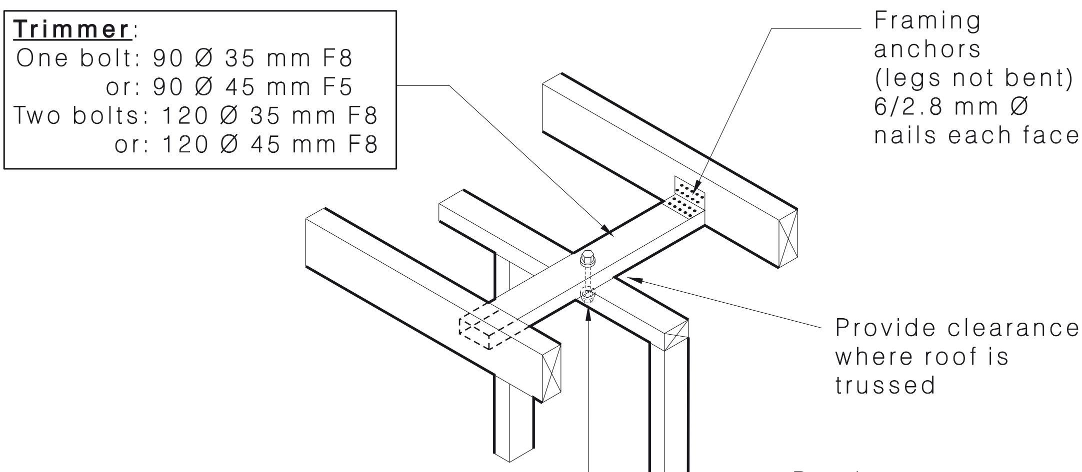


FIGURE J19 BRACING DETAIL FOR I-JOIST TO INTERNAL WALL

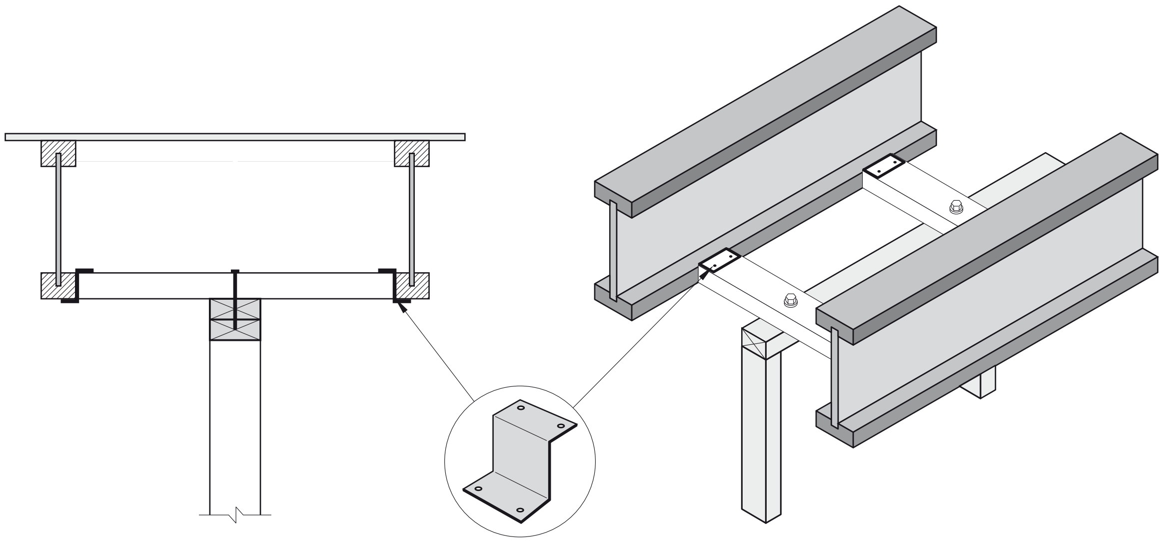
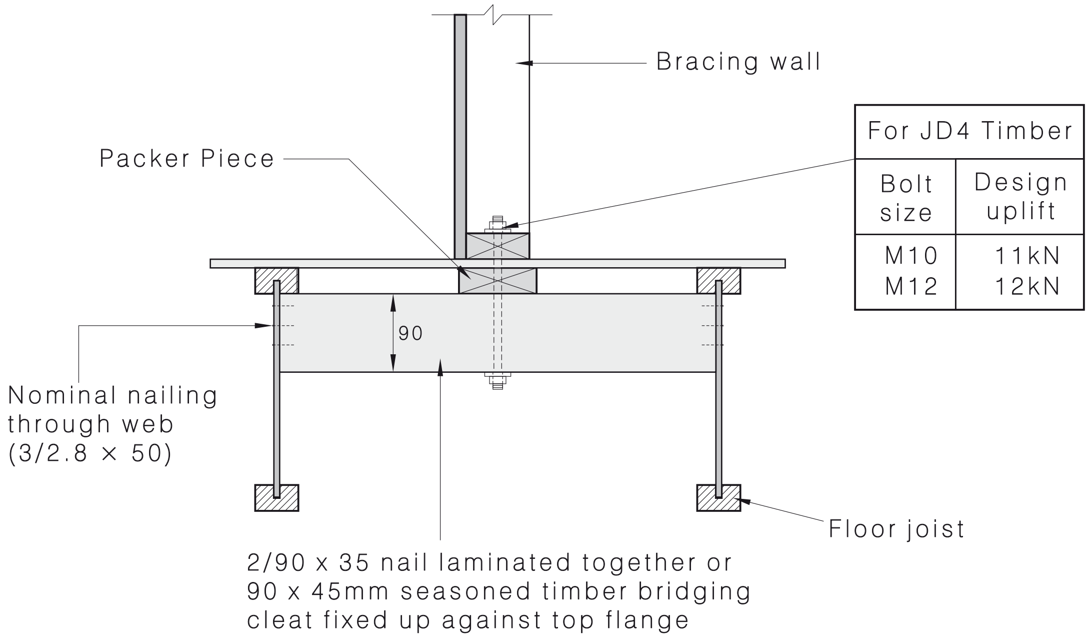


FIGURE J20 EQUIVALENT Z-CLIP DETAIL TO TRANSFER BRACING FORCES THROUGH INTERNAL WALLS

J6 FIXINGS AND TIE-DOWN DESIGN

In general, tie-down details for solid timber joists may be used with I-beams and 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 J21.



NOTES:

1 Unless joist is fully supported along its length, the flange should not be driledl through.

2 Joists should be tied down at the supports

FIGURE J21 DETAIL FOR DISCONTINUOUS TIE-DOWNS

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AS 1684.3—2010

Amendment No. 1 (2012)

CORRECTION

SUMMARY: This Amendment applies to Figure 6.9(e).

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NOTES

NOTES

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