ADVISORY NOTE FOR NZS 3604:2011 AND SNZ HB 3604:2011

On 1 August 2011, the Department of Building and Housing announced changes to the B1 Structure and E2 External Moisture Building Code documents. This announcement was made in the Building Controls Update Bulletin No. 116. The changes to the Structure documents include the referencing of NZS 3604:2011 *Timber-framed buildings*, which was published in February 2011.

These changes took effect immediately with a transition period through to 31 January 2012. During the transition period, both NZS 3604:1999 and NZS 3604:2011 will be Acceptable Solutions. From 1 February 2012, only NZS 3604:2011 will apply.

The Department also announced the following modifications to its referencing of NZS 3604:2011.

- **Modifications for the Canterbury earthquake region**
  On 19 May 2011, the Department made changes to Acceptable Solution B1/AS1, which applies to the Canterbury earthquake region. These changes took effect immediately. The definition of 'good ground' was changed to exclude ground subject to liquefaction and/or lateral spread, and stronger foundations were required for that region. These modifications to the referencing of NZS 3604:1999 have been carried forward to the referencing of NZS 3604:2011.

  The changes for Canterbury were made to allow homeowners in the region to quickly progress with their repairs or rebuilding. Details on the changes for Canterbury can be found in the Department's information sheet.

- **Modifications for all New Zealand for concrete slab floors and foundations**
  On 1 August 2011 the Department extended the requirement for stronger foundations to the rest of New Zealand. The Department modified its referencing of NZS 3604:2011 to exclude unreinforced slabs. All concrete floor slabs on 'good ground' are required to have reinforcing steel mesh and all perimeter foundations are required to be tied to the concrete slab with reinforcing steel.

  This modification has been made to provide the rest of New Zealand with the same readily administered, effective, and robust Acceptable Solution requirements for foundations as those already made in the Canterbury earthquake region.

To read the Building Controls Update Bulletin No. 116 and the Department's questions and answers on the changes, please go to the Department's website – www.dbh.govt.nz/bc-update-116.

It is important to review the modifications to the referencing of NZS 3604:2011 when using the Standard as the basis of compliance with the New Zealand Building Code.

If you have any questions about the Department's modifications, please contact the Department on 0800 242 243 or email info@dbh.govt.nz.

This Advisory Note was issued by Standards New Zealand on 6 October 2011.

NZS 3604:2011

New Zealand Standard

Timber-framed buildings

Superseding NZS 3604:1999

NZS 3604:2011

COMMITTEE REPRESENTATION

This Standard was prepared under the supervision of the P 3604 technical committee the Standards Council established under the Standards Act 1988. The committee consisted of the following:

Nominating Organisation	Nominee
Architectural Designers New Zealand Inc.	Colin Hill
BRANZ	Eddie Bruce and Roger Shelton
Building Officials' Institute of New Zealand	Colin Clench
Cement & Concrete Association of New Zealand	David Barnard
Certified Builders' Association New Zealand	Richard Merrifield
Construction Information Limited	Don Bunting
Department of Building and Housing	Graeme Lawrance
Design Association of New Zealand	Allan Walters
Frame and Truss Manufacturers' Association of New Zealand	Mark Ash
Institution of Professional Engineers New Zealand	Ernest Lapish and Ian Garrett
New Zealand Building Industry Federation	Stephen Walker
New Zealand Institute of Architects	Michael Middlebrook
New Zealand Institute of Building Surveyors Inc.	Hans Gerlich
New Zealand Metal Roofing Manufacturers Inc.	Stuart Hayman
New Zealand Timber Industry Federation	Bruce Anderson
Registered Master Builders' Federation	Jamie O'Leary
Scion	Doug Gaunt
Window Association of New Zealand	John Yolland
Wood Processors' Association of New Zealand	Warwick Banks

ACKNOWLEDGEMENT

Standards New Zealand is the main sponsor of this limited technical revision of NZS 3604:2011 and acknowledges the sponsorship provided by the Department of Building and Housing and the Earthquake Commission.

We gratefully acknowledge the contribution of time and expertise from all involved in developing this Standard. Special thanks to the P 3604 Technical Committee, the P 3604 Leadership Group, and the members of the various committee workgroups.

Thanks also to the management and staff at Stonewood Homes Wellington Limited for their participation in cover photography. Photographer: Nick Servian.

Published by Standards New Zealand, the trading arm of the Standards Council, Private Bag 2439, Wellington 6140. Telephone: (04) 498 5990, Fax: (04) 498 5994. Website; http://www.standards.co.nz

AMENDMENTS

No.	*Date of issue*	*Description*	*Entered by, and date*

NZS 3604:2011

Timber-framed buildings

Superseding NZS 3604:1999

ISBN 978-1-86975-143-2

CONTENTS

REFERENCED DOCUMENTS

Reference is made in this document to the following:

NEW ZEALAND STANDARDS

NZS 1170:---- Part 5:2004	Structural design actions – Earthquake actions – New Zealand
Part 5: Supplement 1:2004	Structural design actions – Earthquake actions – New Zealand – Earthquake actions – New Zealand Commentary
NZS 3101:2006 Parts 1 and 2	Concrete structures Standard
NZS 3104:2003	Specification for concrete production
NZS 3109:1997	Concrete construction
NZS 3601:1973	Metric dimensions for timber
NZS 3602:2003	Timber and wood-based products for use in building
NZS 3603:1993	Timber structures Standard
NZS 3605:2001	Timber piles and poles for use in building
NZS 3622:2004	Verification of timber properties
NZS 3631:1988	New Zealand timber grading rules
NZS 3640:2003	Chemical preservation of round and sawn timber
NZS 4210:2001	Masonry construction: Materials and workmanship
NZS 4229:1999	Concrete masonry buildings not requiring specific engineering design
NZS 4402:---- Test 2.2:1986	Methods of testing soils for civil engineering purposes – Soil classification tests – Test 2.2 Determination of the liquid limit
Test 2.6:1986	Methods of testing soils for civil engineering purposes – Soil classification tests – Test 2.6 Determination of the linear shrinkage
Test 6.5.2:1988	Soil strength tests – Determination of the penetration resistance of a soil – Test 6.5.2 Hand method using a dynamic cone penetrometer
NZS 4404:2010	Land development and subdivision infrastructure
NZS 4431:1989	Code of practice for earth fill for residential development

JOINT AUSTRALIAN/NEW ZEALAND STANDARDS

AS/NZS 1170:---- Part 0:2002	Structural design actions – General principles
Part 1:2002	Structural design actions – Permanent, imposed and other actions
Part 2:2002	Structural design actions – Wind actions
Part 3:2003	Structural design actions – Snow and ice actions
Part 3 Supplement 1:2003	Structural design actions – Snow and ice actions – Snow and ice actions – Commentary (Supplement to AS/NZS 1170.3:2003)
AS/NZS 1328:---- Part 1:1998	Glued laminated structural timber – Performance requirements and minimum production requirements
Part 2:1998	Glued laminated structural timber – Guidelines for AS/NZS 1328: Part 1 for the selection, production and installation of glued laminated structural timber
AS/NZS 1393:1996	Coach screws – Metric series with ISO hexagon heads
AS/NZS 1860 Part 1:2002	Particleboard flooring – Specifications
AS/NZS 2269:---- Part 0:2008	Plywood – Structural – Specifications
Part 1:2008	Plywood – Structural – Determination of structural properties – Test methods
Part 2:2007	Plywood – Structural – Determination of structural properties – Evaluation methods
AS/NZS 2699 Part 2:2000	Built-in components for masonry construction – Connectors and accessories
AS/NZS 2728:2007	Prefinished/prepainted sheet metal products for interior/exterior building applications – Performance requirements
AS/NZS 4357:---- Part 0:2005	Structural laminated veneer lumber – Specifications
Part 1:2005	Structural laminated veneer lumber – Method of test for measurement of dimensions and shape
Part 2:2006	Structural laminated veneer lumber – Determination of structural properties – Test methods
Part 3:2006	Structural laminated veneer lumber – Determination of structural properties – Evaluation methods

Part 4:2005	Structural laminated veneer lumber – Determination of formaldehyde emissions
AS/NZS 4455 Part 1:2008	Masonry units, pavers, flags and segmental retaining wall units – Masonry units
AS/NZS 4534:2006	Zinc and zinc/aluminium-alloy coatings on steel wire
AS/NZS 4671:2001	Steel reinforcing materials
AS/NZS 4680:2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

INTERNATIONAL STANDARD

ISO 9223:1992	Corrosion of metals and alloys – Corrosivity of atmospheres – Classification

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM E96/E96M-05	Standard test methods for water vapor transmission of materials

AUSTRALIAN STANDARDS

AS 1111:---- Part 1-2000	ISO metric hexagon bolts and screws – Product grade C – Bolts
Part 2-2000	ISO metric hexagon bolts and screws – Product grade C – Screws
AS 1214-1983	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
AS ISO 1302-2005	Geometrical product specifications (GPS) – Indication of surface texture in technical product documentation
AS 1397-2001	Steel sheet and strip – Hot-dipped zinc-coated or aluminium/zinc-coated
AS 2870-1996	Residential slabs and footings – Construction
AS 3566:---- Part 2-2002	Self-drilling screws for the building and construction industries – Corrosion resistance requirements

OTHER PUBLICATIONS

BRANZ, P21, A wall bracing test and evaluation procedure, Wellington: BRANZ, 2010

BRANZ, Evaluation Method 1 (EM1) – Structural joints – Strength and stiffness evaluation, Wellington: BRANZ, 1999

BRANZ, Good practice guide – Concrete floors and basements, Wellington: BRANZ, 1998

New Zealand Geotechnical Society Inc., Field description of soil and rock – Guideline for the field classification and description of soil and rock for engineering purposes, Wellington: New Zealand Geotechnical Society, 2005

NEW ZEALAND LEGISLATION

Building Act 2004, New Zealand Building Code (NZBC) Handbook and Compliance Documents

Resource Management Act 1991

WEBSITES

Department of Building and Housing	http://www.dbh.govt.nz
GNS Science	http://www.gns.cri.nz
New Zealand Legislation	http://www.legislation.govt.nz
New Zealand Geotechnical Society Inc.	http://www.nzgs.org

LATEST REVISIONS

The users of this Standard should ensure that their copies of the above-mentioned New Zealand Standards are the latest revisions. Amendments to referenced New Zealand and Joint Australian/ New Zealand Standards can be found on www.standards.co.nz.

REVIEW OF STANDARDS

Suggestions for improvement of this Standard are welcomed. They should be sent to the Chief Executive, Standards New Zealand, Private Bag 2439, Wellington 6140.

OUTCOME STATEMENT

NZS 3604:2011 *Timber-framed buildings* sets a minimum standard for the design and construction of timber-framed buildings. When applied by architects, designers, builders, engineers, apprentices, building consent authorities and building industry regulators, NZS 3604 provides these users with a cost effective means of compliance and practical guidance for designing and building to meet New Zealand Building Code requirements, without the need for specific engineering design.

NZS 3604 provides prescribed methods for the design and construction for timber-framed domestic dwellings, most other residential buildings, and some commercial buildings up to three storeys in height.

The use of NZS 3604 during design and building provides consumers with assurance that their home has been built to meet the legislative requirements of the New Zealand Building Code.

FOREWORD

This Standard provides methods and details for the design and construction of timber-framed structures not requiring specific engineering design (SED).

NZS 3604 is used by a wide range of people in the building industry such as builders, architects, engineers, designers and students. However, due to the requirement for building consent documentation to show how the performance-based requirements of the *New Zealand Building Code* (NZBC) will be met, users of the document will predominantly be fulfilling the role of a designer. Consequently, the Standard continues to be set out generally in the sequence for the design of buildings.

NZS 3604 is a core resource for building consent authorities determining compliance with the NZBC and gives guidance to builders and others involved in the construction of light timber-framed buildings. The Standard is also an important teaching resource for tertiary and trade training organisations.

Since the publication of NZS 3604:1999 and later Amendments No. 1 and No. 2, building practices have moved on significantly and NZS 3604 has been updated to reflect this. The 'user friendliness' of the original Standard's format has been retained, but with a number of changes to layout and the presentation of tables and figures to ensure that NZS 3604 remains a core resource for the design, construction, and maintenance of timber-framed buildings. This limited technical review has focused on five main areas:

(a) AS/NZS 1170 *Structural design actions* is referenced in clause B1/VM1. NZS 3604 has been updated to reflect the provisions of AS/NZS 1170.

(b) Section 4 on durability has been brought into line with the NZBC. Cladding has been omitted in line with the updating of E2/AS1. Text has been added on recent product development, durability of fixings and adjustments to the exposure zone maps.

(c) The coverage of bracing in section 5 has been reviewed to improve readability and clarify requirements previously open to interpretation.

(d) The Department of Building and Housing's Acceptable Solution E2/AS1 has superseded section 11 in NZS 3604. With E2/AS1 being updated and extended in parallel with NZS 3604, the original content of section 11 has been replaced by a small section addressing the interface between NZS 3604 and E2/AS1. Accordingly all design information on cladding has been removed from NZS 3604. It is important that designers consider specific requirements for claddings in conjunction with timber framing and concrete foundation design. Depending on claddings selected, specific wall and roof framing spacing and sizes, foundation details, bracing and set outs will be required.

(e) Requirements have been added on new building techniques and materials, in particular engineered timber products and trussed roof framing now commonly used in buildings.

The section on statutory information has been removed as there is growing familiarity in the building industry with the requirements of the Building Act and Regulations.

The Building Act requires all new building work to comply with the performance requirements of the NZBC. It is intended that NZS 3604:2011 will be referenced as an Acceptable Solution, meeting the relevant performance requirements of Clauses B1 'Structure' (for loads arising from gravity, earthquake, snow, wind and human impact, differential movement, non-structural elements and contents, and creep and shrinkage), B2 'Durability' (for timber and wood-based building components, steel fixings and fastenings, concrete foundations, concrete floor slabs, concrete masonry and reinforcing steel), E2 'External moisture', E3 'Internal moisture', and H1 'Energy efficiency'.

Since the Canterbury earthquake on 4 September 2010 there has been much discussion on liquefiable soils and lateral spread.

Some building consent authorities publish maps of earthquake hazards (including liquefaction) and these maps may be considered as part of any requirement for further assessment or SED.

There is currently not enough information and evidence-based research to decide if liquefaction should be addressed in the definition of 'good ground'. Several investigative and research projects have been initiated by the wider sector including the formation of a Strategic Advisory Group appointed by the Earthquake Commission to focus on the remedial work in Canterbury.

It is expected that this research, while focusing initially on the remedial work in Canterbury, will inform the wider building and construction sector as a whole, as remedial work progresses and more information is made available. In the meantime the Department of Building and Housing has worked with other agencies on guidance information on liquefaction for remedial work in Canterbury. This guidance document was published in December 2010 and is available on the Department's website.

The Department of Building and Housing and Standards New Zealand have agreed to consider amendments to NZS 3604 or other documents when further information and evidence about liquefaction and lateral spread are available.

SECTION 1

SCOPE AND INTERPRETATION

Table

Figure

1 SCOPE AND INTERPRETATION

1.1 SCOPE

1.1.1 Construction requirements

NZS 3604 sets out construction requirements for timber-framed buildings within the limits specified in 1.1.2.

See figure 1.1 and figure 1.2 for information on determining if a building is covered by NZS 3604.

1.1.2 Buildings covered by this Standard

NZS 3604 shall apply only to buildings within the following limits:

(a) Buildings founded on *good ground*;

(b) Importance Level 1 and Importance Level 2 buildings (see table 1.1);

(c) The total height from the lowest *ground level* to the highest point of the *roof* up to 10 m;

(d) The open ground *snow loading* up to 1 kPa for buildings designed in accordance with the main body of this Standard. For *snow loads* up to 2 kPa see section 15;

(e) Buildings with *floor loads* not exceeding 3 kPa uniformly distributed *load*, or 2.7 kN concentrated *load* on the floor, or 0.25 kPa uniformly distributed *load* on the *roof*. The floor live loadings shall be as given in table 1.2, provided that the *floor loading* does not exceed 1.5 kPa for the uppermost floor of three-*storey* buildings (see figure 1.2);

(f) Single-*storey* buildings may include a *part storey* basement or a *part storey* in the *roof* space. Single-*storey* buildings shall be supported on any one or a combination of the following *foundation* structures:

  (i) *Piles*

  (ii) *Foundation walls*

  (iii) Concrete slab-on-ground;

(g) Two-*storey* buildings shall comprise a timber upper floor and upper *storey* timber *walls*. The lower *storey walls* may be timber, or full height concrete masonry to NZS 4229. The lower floor may be slab-on-ground or suspended timber as follows:

  (i) For buildings with slab-on-ground the lower *storey walls* shall be in timber *framing*, or full height concrete masonry to NZS 4229

  (ii) Buildings with the lower floor of suspended timber and lower-*storey* timber *walls* shall be supported on either or a combination of *foundation walls* and *piles*

  (iii) Buildings with the lower floor of suspended timber and lower *storey* full height concrete masonry *walls* shall be supported on *foundations* to NZS 4229;

C1.1.2

Any building or part of a building that does not comply with 1.1.2 is outside the scope of NZS 3604, unless covered by another Standard for buildings not requiring specific engineering design (SED), e.g. NZS 4229.

(b) Examples of Importance Level 1 buildings are garages (on concrete floor) and sheds. The Standard's requirements are based on AS/NZS 1170 loads and cover Importance Level 1 and 2 buildings only.

(e) Section 14 covers residential and other floor loads for 3 kPa floor loads.

(h) Three-*storey* buildings shall consist of all the following:

(i) No more than two *storeys* supported on timber *framing*

(ii) One *storey* shall be a *part storey* in a *roof* space

(iii) The middle *storey* and *part storey* shall be directly supported on a lower *storey* of concrete masonry *walls* and *foundation walls* to the provisions of NZS 4229

(iv) The ground floor shall be either concrete slab-on-ground or a suspended timber or concrete floor to the provisions of NZS 4229;

(i) The slope of any *roof* plane shall not be steeper than 60° to the horizontal;

(i) The limitation on roof slope means that "A-frame" buildings will generally require SED.

(j) For the purpose of forming a *mansard roof* only, a *wall* of an uppermost *storey* may slope by up to 20°;

(j) See 8.4.2 for mansard roofs.

(k) The building wind zone determined from 5.2.1 and table 5.1 shall be Low, Medium, High, Very high or Extra high (i.e. L, M, H, VH or EH). *Specific engineering design (SED)* in table 5.4 indicates the application is outside the scope of the Standard;

(l) The *plan floor area* shall:

(i) Be unlimited for one or two-*storey* buildings where all *storeys* are of timber frame

(ii) Not exceed 300 m² for two-*storey* buildings of other forms of construction

(iii) Not exceed 250 m² for three-*storey* buildings of other forms of construction;

(m) Buildings with *wings* or *blocks* shall be designed as if the *wing* or *block* was a separate building;

(n) Concrete slab-on-ground floors in accordance with 7.5 may be used for vehicle garages for vehicles up to 2500 kg tare;

(o) Masonry veneer *cladding* shall have:

(i) A mass not exceeding 220 kg/m²

(ii) A height above *finished ground level* not exceeding 7 m

(iii) A maximum height of 4.0 m measured from the top of the concrete masonry *wall*, *foundation wall* or slab edge *foundation*. In the case of a veneer-faced concrete *block wall* or *foundation wall*, the *cladding* shall be measured from the top of that *wall*

(iv) A maximum veneer height of 5.5 m on a *gable* end *wall*.

1.1.3 Buildings not covered by this Standard

The following buildings are excluded from NZS 3604:

(a) Buildings without *external walls*, such as free standing carports and pergolas;

(b) Buildings outside the limitations of 1.1.2 and buildings in table 1.1(b). Such buildings shall be the subject of *SED*, or an alternative solution.

1.1.4 Structural elements not covered by this Standard

Structural elements outside the generic prescriptions and design tables of this Standard including their durability shall be the subject of *SED* taking into account the element as well as the impact of resulting *load* paths on the structure.

Table 1.1 – Classification of buildings (see 1.1.2)

Importance level	AS/NZS 1170 Description	NZS 3604 examples
(a) Buildings covered by this Standard		
1	Structures presenting a low degree of hazard to life and other property	Freestanding, uninhabited garages and buildings with a total floor area of < 30 m^2.
2	Normal structures and structures not in other importance levels	Single family dwellings (houses), buildings and facilities as follows: - Where up to 300 people can congregate in one area; - Day-care facilities with a capacity of up to 150; - Primary school or secondary school facilities with a capacity of up to 250; - Colleges or adult education facilities with a capacity of up to 500; - Healthcare facilities with a capacity of up to 50 resident patients but not having surgery or emergency treatment facilities; - Multi-occupancy residential, commercial (including shops), industrial, office and retailing buildings designed to accommodate up to 5000 people and with a gross area up to 10,000 m^2; and - Public assembly buildings, theatres and cinemas up to 1,000 m^2.
(b) Buildings not covered by this Standard		
3	Structures that as a whole may contain people in crowds or contents of high value to the community or pose risks to people in crowds	Buildings and facilities: - Where more than 300 people can congregate in one area; - Day-care facilities with a capacity greater than 150; - Primary school or secondary school facilities with a capacity greater than 250; - Colleges or adult education facilities with a capacity greater than 500; - Healthcare facilities with a capacity of 51 or more resident patients but not having surgery or emergency treatment facilities; - Airport terminals, principal railway stations with a capacity greater than 250; - Correctional institutions; - Multi-occupancy residential, commercial (including shops), industrial, office and retailing buildings designed to accommodate more than 5000 people and with a gross area greater than 10,000 m^2; - Public assembly buildings, theatres and cinemas greater than 1,000 m^2; - Emergency medical and other emergency facilities not designated as post-disaster; - Power-generating facilities, water treatment and wastewater treatment facilities and other public utilities not designated as post-disaster; and - Buildings and facilities not designated as post-disaster containing hazardous materials capable of causing hazardous conditions that do not extend beyond the boundaries.

4	Structures with special post-disaster functions	- Buildings and facilities designated as essential facilities; - Buildings and facilities with special post-disaster functions; - Medical emergency or surgical facilities; - Emergency service facilities such as fire, police stations and emergency vehicle garages; - Utilities or emergency supplies or installations required as backup for buildings and facilities of Importance Level 4; - Designated emergency shelters, designated emergency centres and ancillary facilities; and - Buildings and facilities containing hazardous materials capable of causing hazardous conditions that extend beyond the property boundaries.

NOTE –
(1) Table 1.1 is based on AS/NZS 1170.0 table 3.2.
(2) NZS 3604 does not cover garage floors constructed of timber.

Table 1.2 – Imposed floor live load reference values (see 1.1.2(e))

Type of activity/occupancy	Specific uses	Floor load (kPa)
A1 Domestic self-contained dwellings	General areas, balconies < 1 m off the ground	1.5
	Balconies and decks > 1 m off the ground	2.0
A2 Residential	General areas, bedrooms, hospital wards, hotel rooms, toilet areas but not balconies and roofs used for floor activities	
C Areas with tables and fixed seats where people can congregate	Public areas with tables (e.g. cafes and restaurants)	
	Reading rooms, classrooms and lecture theatres	3.0 (see Note 3)
A2 Residential	Communal kitchens	
B Offices and work areas	Offices and communal kitchens	

NOTE –
(1) For full details of floor loading requirements see table 3.1 of AS/NZS 1170.1.
(2) Other applications of Type B, C (C2 to C5), D (shopping areas), E (warehousing and storage areas) and G (medium vehicle traffic areas) have load requirements exceeding 3 kPa and are outside the scope of this Standard.
(3) Some 3 kPa applications have concentrated load requirements exceeding 2.7 kN and are outside the scope of this Standard (see AS/NZS 1170.1).

See table 1.1 for Importance Level 1 and 2 buildings

See table 1.2 for imposed floor live loading reference values

Building wind zone from table 5.1

SED: specific engineering design

See section 15 for determination of snow loading

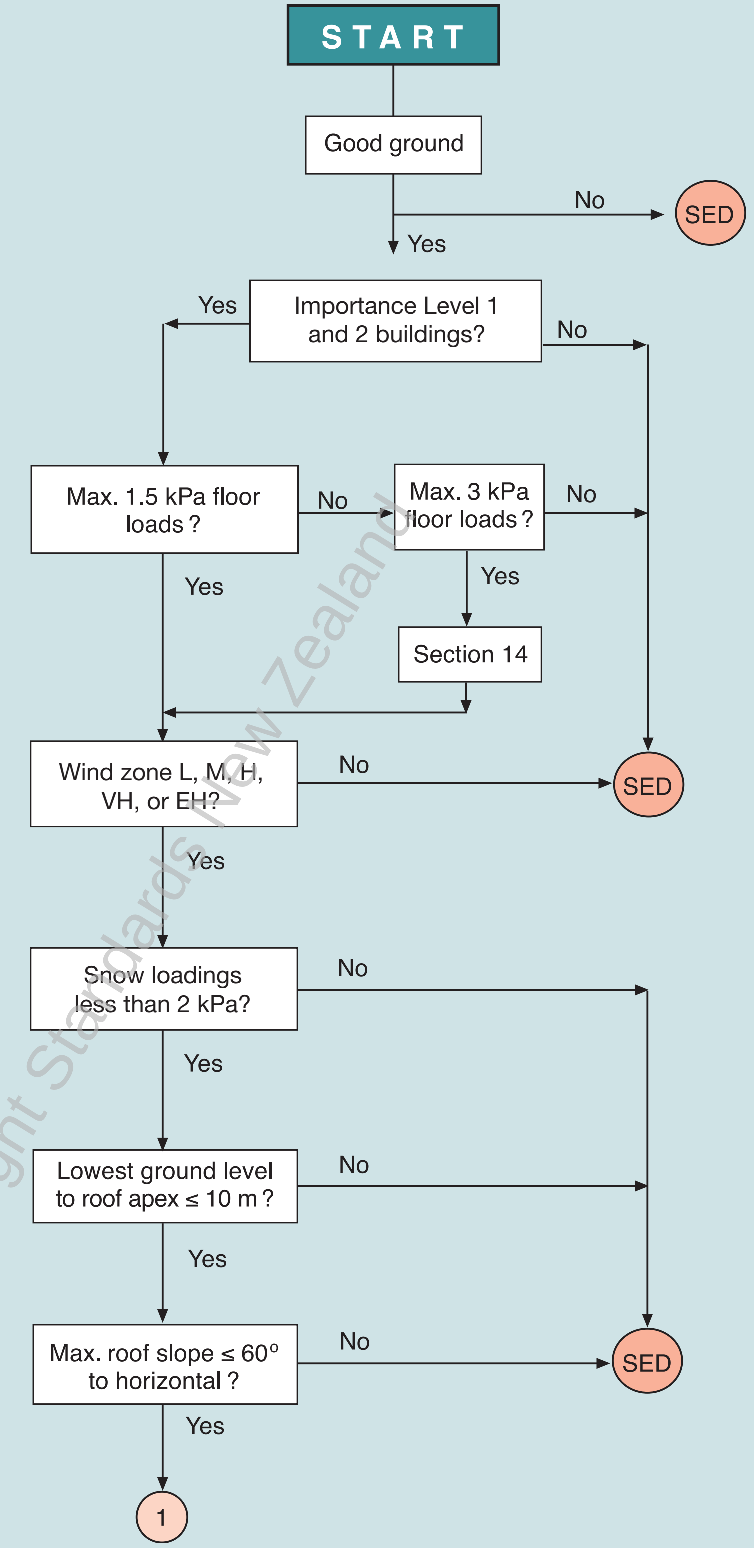


Figure 1.1 – Flow chart for limitations and scope of NZS 3604 (see 1.1.2)

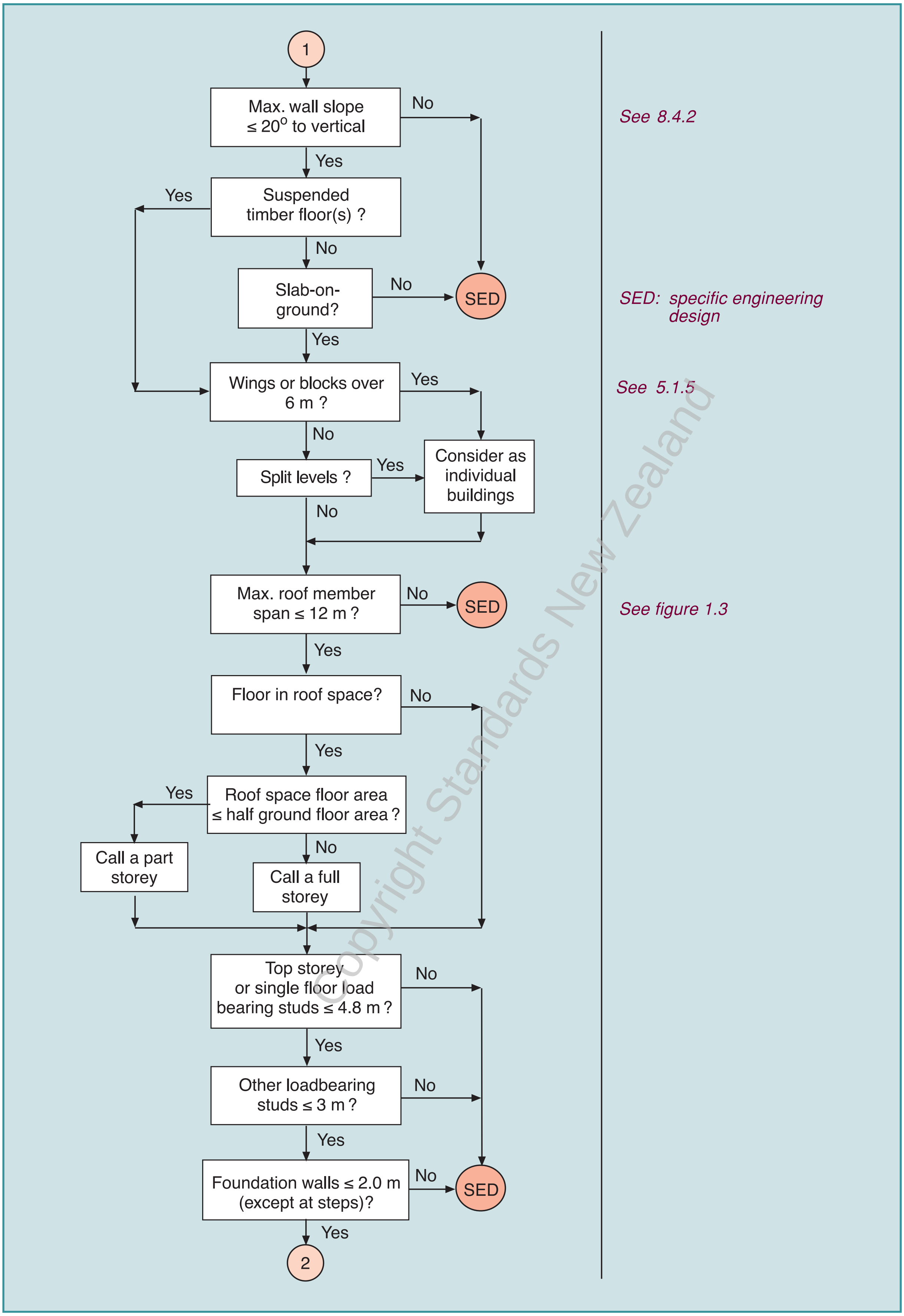


Figure 1.1 – Flow chart for limitations and scope of NZS 3604 (continued) (see 1.1.2)

Foundations

SED: specific engineering design

Combinations of foundation walls, piles and slab-on-ground are permitted

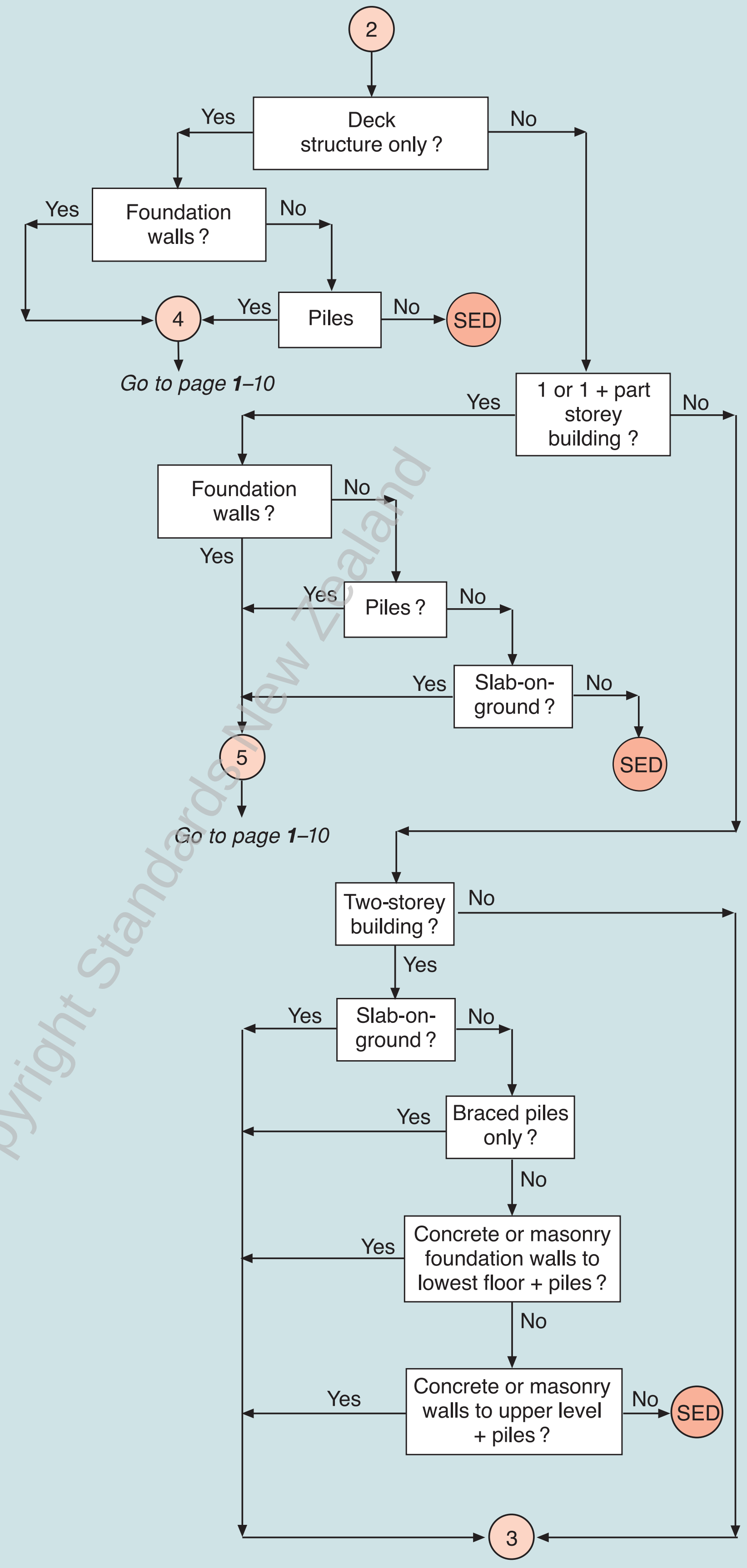


Figure 1.1 – Flow chart for limitations and scope of NZS 3604 (continued) (see 1.1.2)

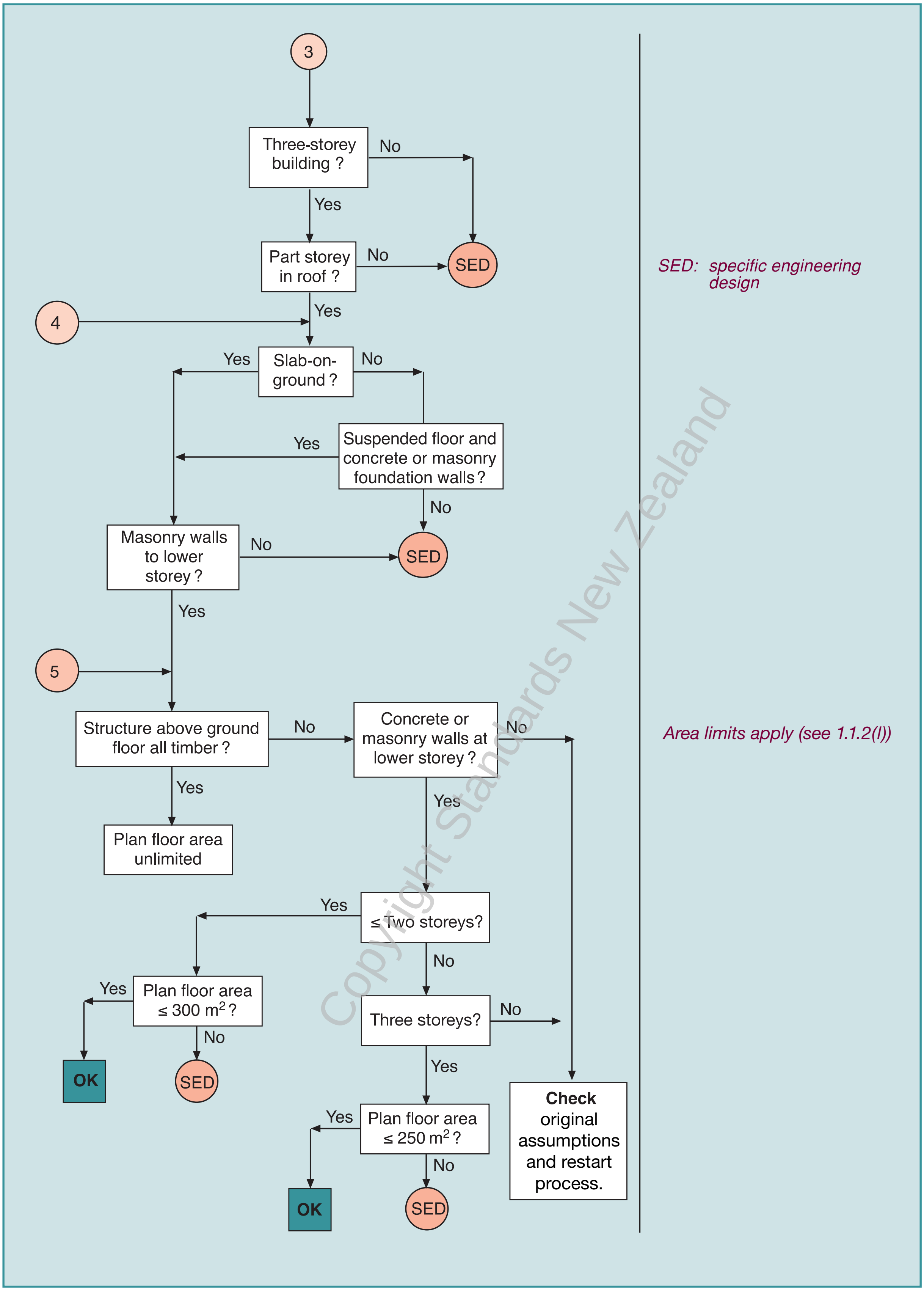


Figure 1.1 – Flow chart for limitations and scope of NZS 3604 (continued) (see 1.1.2)

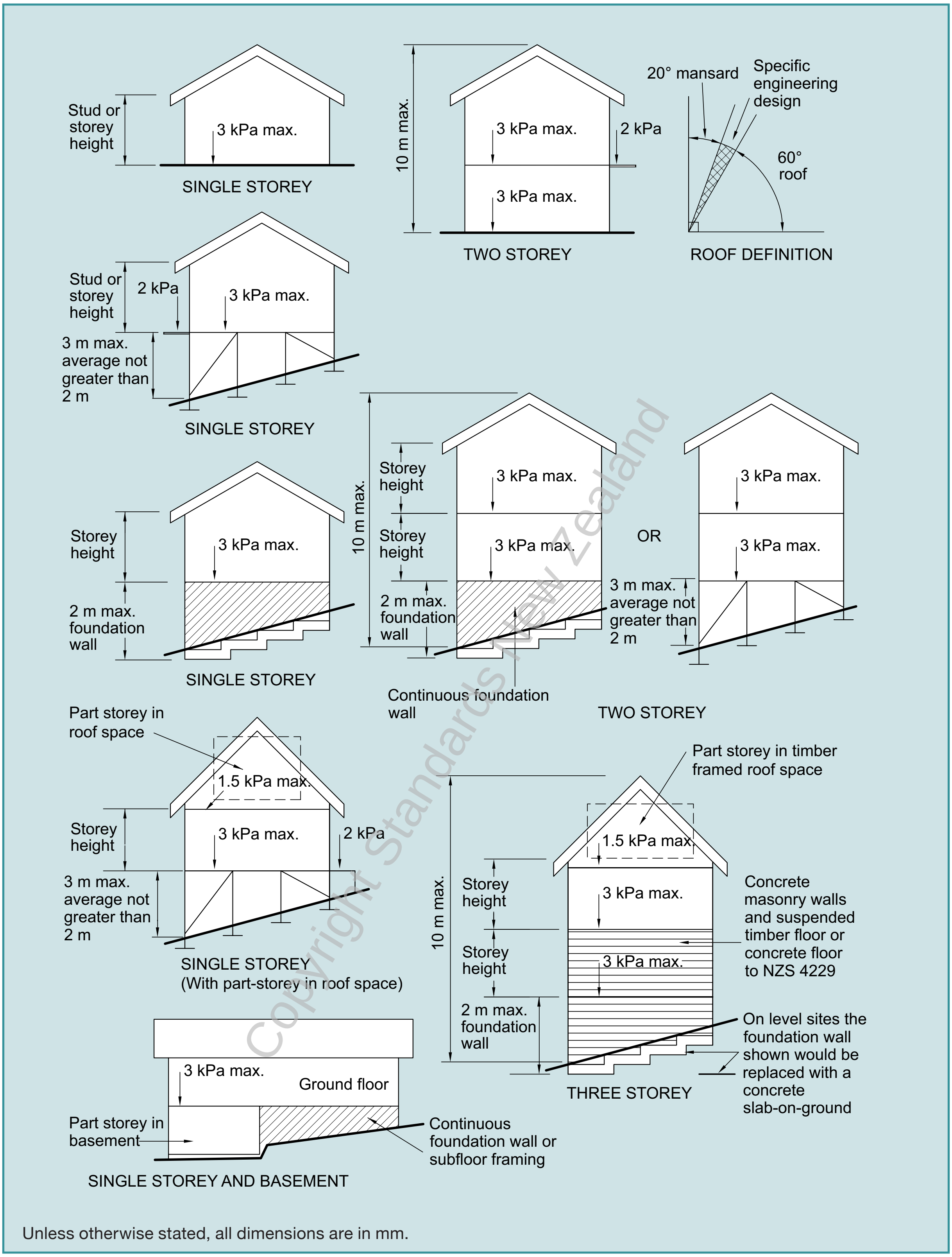


Figure 1.2 – Buildings covered by this Standard

1.2 INTERPRETATION

1.2.1

The word "shall" identifies a mandatory requirement for compliance with NZS 3604. The word "should" refers to practices which are advised or recommended.

The term "normative" identifies a mandatory requirement for compliance with sections 1 to 16 of NZS 3604. The term "informative" identifies information provided for guidance or background which may be of interest to the Standard's users. Section 17 is informative: these provisions do not form part of the mandatory requirements of the Standard.

1.2.2

Where this Standard has non-specific requirements such as the words "suitable", "adequate", "acceptable" or other similar qualifiers such as "as far as reasonably practicable" then the method described is not covered by NZS 3604.

Where reference is made to "the manufacturer's recommendations or instructions" or similar, these are not covered by NZS 3604.

Use only the values set out in NZS 3604 clauses, figures and tables; do not extrapolate the values.

Notes in the tables and figures of the Standard are mandatory.

1.2.3

Clauses prefixed by *"C"* and printed in italic type are intended as comments on the corresponding mandatory clauses. They are not to be taken as the only or complete interpretation of the corresponding clause, nor should they be used for determining the mandatory requirements of NZS 3604. Commentary clauses are "informative" and do not form part of the Standard. NZS 3604 can be complied with if the comment is ignored.

1.2.4

Where any clause in NZS 3604 contains a list of requirements, provisos, conditions, or the like, then each and every item in that list is to be adopted in order to comply with NZS 3604, unless the clause specifically states otherwise.

1.2.5

The full titles of referenced documents cited in NZS 3604 are given in the list of referenced documents preceding the foreword.

1.2.6

Unless inconsistent with the context, and subject to 1.3, terms defined in NZS 3604 shall have the same meaning as in the New Zealand Building Code (NZBC).

1.2.7

Unless otherwise specified all dimensions in the figures of the Standard shall be read as millimetres (mm).

1.2.8

The SG 8 tables have been retained in this Standard. For corresponding SG 6 and SG 10 tables see the appendices in relevant sections.

1.3 DEFINITIONS

For the purposes of NZS 3604, the following definitions shall apply.
The plural of a defined term shall have the same meaning as the singular and vice versa.

ANCHOR PILE. A *pile* directly supporting a *bearer*, and used to resist horizontal as well as vertical *loads*. The *pile* is embedded in concrete to a depth of 900 mm below cleared ground.

BALCONY. An open floor (i.e. no *roof* or *walls*) attached to the exterior of the main structure of a building and supported on cantilevered *joists*.

BATTEN. See CEILING BATTEN, TILE BATTEN or PURLIN.

BEARER. A beam supported on *jack studs, foundation walls, piles*, or piers and carrying *joists, jack studs*, or subfloor *framing*. See also EAVES BEARER.

BLOCK. See WING.

BLOCKING. Solid timber having the same depth as the *joists* and set at right angles between the *joists* to stiffen and prevent them from buckling.

BOND, RUNNING or STRETCHER. The *bond* when the units of each course overlap the units in the preceding course by between 25 % and 75 % of the length of the units.

BOTTOM PLATE. A *plate* other than a *wall plate* placed under the bottom ends of *studs*.

BOUNDARY JOIST or HEADER JOIST. A *joist* running along the outer ends of the floor *joists*.

BRACE or BRACED. See DIAGONAL BRACE, SUBFLOOR BRACE, WALL BRACING ELEMENT.

BRACE or BRACED PILE or BRACED PILE SYSTEM. A group of two *piles*, between which a *diagonal brace* is fixed. Each *pile* is embedded in concrete to a depth of 450 mm below cleared ground. A *braced pile system* is used to resist horizontal as well as vertical *loads*.

BRACE RUNNER. A horizontal member attached to the upper edges of ceiling *joists* or truss bottom chords to which a *diagonal brace* is attached.

BRACING. Any method employed to provide lateral support to a building.

BRACING CAPACITY. Strength of *bracing* of a whole building or of elements within a building. *Bracing capacity* is measured in *bracing units* (BUs), and shall be determined from section 5.

BRACING DEMAND. The horizontal forces resisted by a whole building or by an element within a building. These horizontal forces are a result of wind or earthquake action. *Bracing demand* forces are measured in *bracing units* (BUs). They shall be determined as set out in 5.2 (wind) or 5.3 (earthquake).

BRACING ELEMENT. See WALL BRACING, WALL BRACING ELEMENT.

BRACING LINE. A line along or across a building for controlling the distribution of *wall bracing elements*.

C1.3

Terms defined in 1.3 are used throughout this Standard in italics except in the foreword, headings, tables, figures, the index or in notes including notes to tables or figures.

BRACING RATING. The lateral *load* resistance assigned to a subfloor or *wall bracing* system, when tested in accordance with BRANZ Technical Paper P21.

BRACING UNIT (BU). A *bracing unit* is a measure of:

(a) The horizontal force *(bracing demand)* on the building (1 kilo Newton is equal to 20 *bracing units)*;
(b) The resistance to horizontal force *(bracing capacity)* of building elements.

BUILDING CONSENT AUTHORITY. A *building consent authority* as defined in the Building Act and includes a *territorial authority* or private body acting within the scope of their approval.

CALL SIZE. The dimensions as given by NZS 3601 and by which timber is referred to in commercial transactions.

CANTILEVER PILE. A *driven timber pile* directly supporting a *bearer*, and used to resist horizontal as well as vertical *loads*.

CANTILEVERED FOUNDATION WALL. A *foundation wall* receiving lateral support only by means of cantilever action from its *footing*.

CAPACITY. The *load* resistance of a connector or fixing determined in accordance with 2.4.7.

CEILING BATTEN. A horizontal timber member fixed below *rafters*, ceiling *joists*, or truss bottom chords to which the ceiling *lining* is attached.

CEILING RUNNER. A beam supporting ceiling *joists*.

CLADDING. The exterior weather-resistant surface of a building.

CLEARED GROUND LEVEL (CGL). The *ground level* after completion of site excavation and removal of all harmful material, but before excavation for *foundations*.

CLEAT. A short member used in *roof* construction to tie a pair of *rafters* together immediately below the *ridge board.*

COLLAR TIE. A horizontal member connecting paired *rafters* together at intermediate points between the ceiling level and the level of the *ridge board*. A *collar tie* is often fixed directly above the *underpurlins*.

CONCRETE BLINDING. Concrete laid over exposed ground, to form a working surface.

CONSTRUCTION JOINT. A joint that results from concrete in one section of the slab being poured up against another vertical section of slab that has already been poured and allowed to harden for 16 hours.

COUPLE-CLOSE ROOF. A *roof* construction in which *roof* timbers consist of a pair of *rafters* tied together at their feet by a ceiling *joist* to prevent spreading.

CURTAILED JOIST. A *joist* not of the full length as other *joists* but cut short and fixed to a *trimmer* at one end.

D. A deformed reinforcing bar of the stated diameter in millimetres.

DAMP-PROOF COURSE (DPC). A strip of durable vapour barrier placed between building elements to prevent the passage of moisture from one element to another.

DAMP-PROOF MEMBRANE (DPM). A sheet material, coating or vapour barrier, having a low water-vapour transmission, and used to minimise water and water-vapour penetration into buildings. Usually applied against concrete in contact with the ground. (Also known as a concrete underlay.)

DECK or DECKING. An open platform projecting from an exterior *wall* of a building and supported by *framing*. A *deck* may be over enclosed internal spaces, or may be open underneath.

DEEP JOIST. A floor *joist* whose depth is 4 or more times its width.

DIAGONAL BRACE. A member of a framed building fixed diagonally and used to resist tension or compression or both.

DIAPHRAGM. A building element such as a floor or ceiling capable of transferring *loads* in its own plane to boundary members.

DRAGON TIE. A member fixed diagonally across the *top plates* at the corner of a building, in the absence of a ceiling *diaphragm*, to support the *top plates* against wind *loads*, act as ceiling *bracing*, and prevent the *walls* from spreading.

DRIVEN TIMBER PILE. A natural round timber driven into the ground to serve as a *braced pile, cantilever pile,* or *ordinary pile.*

DWANG or DWANGING. A short (usually horizontal) member fixed between *framing* timbers. Also known as *nogging*.

EAVES BEARER or SOFFIT BEARER. A horizontal member attached to the end of a truss or a *rafter* and to a *stud*, or a *ribbon board*, or a *soffit plate*, and to which the eaves *lining* is attached. (Also known as a *sprocket*.)

EXTERNAL WALL. Any vertical exterior face of a building consisting of primary and/or secondary elements intended to provide protection against the outdoor environment.

FINISHED GROUND LEVEL (FGL). The level of the ground against any part of a building after all backfilling and/or landscaping and/or surface paving has been completed.

FLAT ROOF. A *roof* having its exterior surface at an angle of less than 10° to the horizontal (that is, at a slope of less than 1 in 6).

FLOOR LOAD or FLOOR LOADING. The uniformly distributed live *load* for floors as specified in table 1.2.

FOOTING. That portion of a *foundation* bearing on the ground and any adjoining portion that is reinforced so as to resist the bearing forces. A *footing* may be spread out to provide an increase in bearing area or an increase in stability.

FOUNDATION. Those parts of a building, transmitting and distributing *loads* to the ground through a *footing*.

FOUNDATION WALL. That part of the *foundation* comprising a concrete masonry or concrete *wall* supporting a building or part of a building, and not extending more than 2 m above the underside of the *footing*.

FRAMING. Timber members to which *lining*, *cladding*, flooring, or *decking* is attached; or which are depended upon for supporting the structure, or for resisting forces applied to it.

FREE JOINT. A construction joint where no *reinforcement* passes through the joint linking both sides of the concrete slab and the vertical faces of the joint are not in bonded contact with each other.

GABLE. Outside *wall* between the planes of the *roof* and the line of the eaves.

GOOD GROUND. Any soil or rock capable of permanently withstanding an ultimate bearing *capacity* of 300 kPa (i.e. an allowable bearing pressure of 100 kPa using a factor of safety of 3.0), but excludes:

(a) Potentially compressible ground such as top soil, soft soils such as clay which can be moulded easily in the fingers, and uncompacted loose gravel which contains obvious voids;

(b) Expansive soils being those that have a liquid limit of more than 50 % when tested in accordance with NZS 4402 Test 2.2, and a linear shrinkage of more than 15 % when tested from the liquid limit in accordance with NZS 4402 Test 2.6; and

(c) Any ground which could foreseeably experience movement of 25 mm or greater for any reason including one or a combination of land instability, ground creep, subsidence, seasonal swelling and shrinking, frost heave, changing groundwater level, erosion, dissolution of soil in water, and effects of tree roots.

GROUND LEVEL, See CLEARED GROUND LEVEL, FINISHED GROUND LEVEL, NATURAL GROUND LEVEL.

HEADER JOIST. See JOIST.

HEAVY ROOF. A *roof* with roofing material (*cladding* and any *sarking*) having a mass exceeding 20 kg, but not exceeding 60 kg/m^2 of *roof* area. Typical examples are concrete tiles, slates and the like.

HEAVY WALL CLADDING. A *wall cladding* having a mass exceeding 80 kg/m^2, but not exceeding 220 kg/m^2 of *wall* area. Typical examples are clay and concrete masonry veneers.

HERRINGBONE STRUTTING. Members set diagonally to form an “x” pattern between the *joists*, to act as *blocking*.

HIP RAFTER. A *framing* timber which conforms to the slope of the intersection of 2 *roof* surfaces, meeting in a hip and into which *jack rafters* are trimmed.

INTERNAL WALL. A *wall* other than an *external wall*.

JACK RAFTER. A short *rafter* extending from the *valley rafter* to the *ridge board* or *hip rafter* or *trimmer*, or from the *top plate* to the *hip rafter* or *trimmer*.

JACK STUD.

Either:

(a) A *stud* of less length than the full height, from *plate* to *plate* of *wall* of which it forms part; or
(b) A *stud* at *pile spacing* forming part of the supporting *framing* under the ground floor of a building.

JOIST. A horizontal *framing* member to which is fixed floor *decking*, or ceiling *linings*, and which is identified accordingly as a floor *joist* or ceiling *joist*. See BOUNDARY JOIST, HEADER JOIST, CURTAILED JOIST, DEEP JOIST, TRIMMING JOIST.

LIGHT ROOF. A *roof* with roofing material (*cladding* and any *sarking*), having a mass not exceeding 20 kg/m^2 of *roof* area. Typical examples are steel, copper, and aluminium *roof claddings* of normal thickness, 6 mm thick cellulose cement tiles, 6 mm thick corrugated cellulose cement, and the like, without *sarking*.

LIGHT WALL CLADDING. A *wall cladding* having a mass not exceeding 30 kg/m^2. Typical examples are weatherboards.

LINING. The rigid sheet covering for a *wall*, ceiling, or other interior surface.

LINTEL. A horizontal *framing* timber spanning an opening in a *wall*.

LOAD. See FLOOR LOAD.

LOADBEARING STUD. A *stud* in a *loadbearing wall.*

LOADBEARING WALL. A *wall* supporting vertical loading from floors, ceiling *joists, roof*, or any combination thereof.

LOADED DIMENSION. A measure of the weight of construction contributing to the member under construction. See figures 1.3(A) to (N).

M. A steel bolt of the stated diameter in millimetres.

MANSARD ROOF. A symmetrical *roof* enclosing a full *storey* with 2 pitches on each side of a ridge, the steeper commencing at the eaves and intersecting with a flatter pitch finishing at the ridge. The steeper pitched part is formed from *wall framing*, sloped at a maximum of 20° from the vertical and the flatter part formed as *roof framing*, with both parts clad with *roof cladding*.

MEDIUM WALL CLADDING. A *wall cladding* having a mass exceeding 30 kg/m^2 but not exceeding 80 kg/m^2 of *wall* area (a typical example is stucco *cladding*).

MEMBER SPAN. The clear distance between supports, measured along the members. See figure 1.3.

METAL ANGLE WALING. A horizontal member manufactured of metal angle, usually steel, checked into a saw cut in the face of *studs*.

NATURAL GROUND LEVEL. The *ground level* before the site has been cleared.

NOG or NOGGING. See DWANG.

NON-LOADBEARING STUD. A *stud* in a *non-loadbearing wall.*

Vertical loadings on non-loadbearing walls which result from the long term creep settlement of loadbearing members, such as trusses, rafters or joists, do not affect the "non-loadbearing" classification of such walls.

NON-LOADBEARING WALL. A *wall* other than a *loadbearing wall* and may contain *bracing elements*.

ORDINARY PILE. A *pile* required to resist vertical *loads* only.

PART STOREY. A basement, or a *storey* in a *roof* space, the floor area of which basement or *storey*, as the case may be, does not exceed 50 % of the area of the ground floor area of the same *wing* or *block* in which the *part storey* occurs.

PILE. A *block* or a column-like member used to transmit *loads* from the building and its contents to the ground. See ANCHOR PILE, BRACED PILE SYSTEM, CANTILEVER PILE, DRIVEN TIMBER PILE, ORDINARY PILE.

PITCHED ROOF. A *roof* having its exterior surface at an angle of 10° or more to the horizontal (that is, at a slope of 1 in 6 or steeper).

PLAN FLOOR AREA. The area of the site covered by the building in plan view not necessarily on one level (the footprint).

PLATE. A timber supported by a *wall* or *bearers* or *joists*, to support and distribute the *load* from floors, *walls*, *roofs* or ceiling. See BOTTOM PLATE, TOP PLATE, WALL PLATE.

POST. An isolated vertical member acting as a support.

PURLIN includes TILE BATTEN. A horizontal member laid to *span* across *rafters* or trusses and to which the *roof cladding* is attached. See also UNDERPURLIN.

R. A plain round reinforcing bar of the stated diameter in millimetres.

RAFTER. A *framing* timber, normally parallel to the slope of the *roof*, providing support for *sarking*, *purlins* or *roof cladding*.

REINFORCEMENT. Any form of reinforcing rod, bar, or mesh that complies with the relevant requirements of NZS 3109.

RIBBON BOARD includes SOFFIT PLATE. A horizontal *framing* timber secured to, or checked into, the edges of *studs* and supporting floor or ceiling *joists* or *eaves bearers*.

RIDGE BEAM. A single or, sometimes, double beam (timber pole construction) supporting the common *rafters* of a framed *roof*.

RIDGE BOARD. The horizontal timber to which *rafters* of *couple-close roofs* are fixed at their upper ends.

ROOF. That part of the building having its upper surface exposed to the outside and at an angle of 60° or less to the horizontal. See COUPLE-CLOSE ROOF, FLAT ROOF, HEAVY ROOF, LIGHT ROOF, PITCHED ROOF, SKILLION ROOF.

ROOF STRUT. See UNDERPURLIN STRUT.

RUNNER. See BRACE RUNNER, CEILING RUNNER.

SARKING. Boarding or sheet material secured to *rafters*, trusses, or *purlins* and which may also serve as the ceiling *lining*.

SHEATHING. Material used as a backing to *cladding* and includes *sarking*.

SHRINKAGE CONTROL JOINT. A line along which the horizontal strength of the slab is deliberately reduced so that any shrinkage in the slab will result in a crack forming along that line.

SILL TRIMMER. A member supporting the *wall framing* beneath an opening and carrying wind *loads* to the *trimmer studs*.

SKILLION ROOF. A *pitched roof* where the ceiling *lining* is parallel and close to the *roof cladding*. The *roof* may be mono-pitch or may consist of more than one *roof* plane. These *roofs* often have *rafters* exposed below the ceiling.

SNOW LOAD or SNOW LOADING. In the context of this Standard, *snow load* refers to the *snow load* on the ground, as defined in AS/NZS 1170.3. A *snow load* of 1 kPa is built into sections 1 to 14. Section 15 covers adjustments required for a *snow load* up to 2 kPa.

SOFFIT BEARER. See EAVES BEARER.

SOFFIT PLATE. See RIBBON BOARD.

SPACING or SPACED. The distance at which members are measured centre to centre.

SPAN. See MEMBER SPAN and SUPPORT SPAN.

SPECIFIC ENGINEERING DESIGN (SED). Requires calculation and design beyond the scope of this Standard.

SPROCKET. See EAVES BEARER.

STOREY. That portion of a building included between the upper surface of any floor and the upper surface of the floor immediately above, except the top *storey* shall be that portion of a building included between the upper surface of the topmost floor, and the ceiling or *roof* above.

STRINGER. A horizontal *framing* timber on edge fixed to the side of a concrete or concrete masonry *wall*, to support the ends of *joists* or *rafters*.

STRUCTURAL GRADE (SG). The grade of timber identified by the modulus of elasticity parameter, E, which has been verified as either machine or visual stress graded timber in accordance with NZS 3622. The grades covered by this Standard are:

(a) Dry timber
   (i) SG 6, to meet the properties specified for No. 1 Framing or MSG 6 in NZS 3603;
   (ii) SG 8, to meet the properties specified for MSG 8 or VSG 8 in NZS 3603; and
   (iii) SG 10, to meet the properties specified for VSG 10 in NZS 3603.

(b) Wet timber
   (i) SG 6 (Wet), to meet the properties specified for wet No. 1 Framing in NZS 3603;
   (ii) SG 8 (Wet), to meet the properties specified for G 8 in NZS 3603.

STRUT. See UNDERPURLIN STRUT.

STRUTTING. Short members fixed between *joists* to stiffen and prevent them from buckling. See HERRINGBONE STRUTTING.

STRUTTING BEAM. A structural beam spanning between *loadbearing walls* from which *underpurlins* may be strutted.

STUD. A vertical *framing* timber.

SUBFLOOR BRACE. A *bracing element* below the ground floor level.

SUPPORT SPAN. The clear distance along a member between supports, measured in plan (horizontally). See figure 1.3.

TERRITORIAL AUTHORITY. Wherever the term *territorial authority* appears replace this with *building consent authority.*

TILE BATTEN. See PURLIN.

TOP PLATE. A *plate* placed over the top ends of *studs*.

TRIMMER. A *framing* timber supported by two *trimming joists, studs* or *rafters,* to which is fixed one or more *curtailed joists, jack studs,* or *jack rafters.*

TRIMMING JOIST. A *joist* which is of the full *span* as other *joists*, but which on one side supports one or more *trimmers*.

TRIMMING STUD. A *stud* located on the side of an opening.

UNDERPURLIN. A horizontal timber member laid underneath *rafters*, supporting the *rafters* at intermediate points along their length.

UNDERPURLIN STRUT. A member used to transfer *load* from an *underpurlin* to a *loadbearing wall* or a *strutting beam*.

VALLEY BOARD. A board laid to support a valley gutter.

VALLEY RAFTER. A *rafter* which conforms to the slope of the intersection of two *roof* surfaces meeting in a valley and into which *jack rafters* are trimmed.

WALING. A horizontal *framing* member secured to, or checked into, the edges of *studs*. See METAL ANGLE WALING.

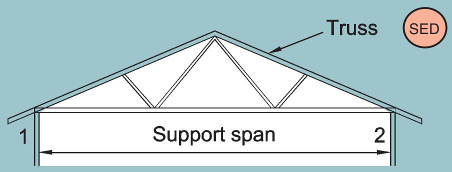
WALL. See EXTERNAL WALL, FOUNDATION WALL, INTERNAL WALL, LOADBEARING WALL, NON-LOADBEARING WALL.

WALL BRACING, WALL BRACING ELEMENT. A section of *wall* above the ground floor level that performs a *bracing* function.

WALL PLATE. A *plate* laid upon a concrete or concrete masonry *foundation wall.*

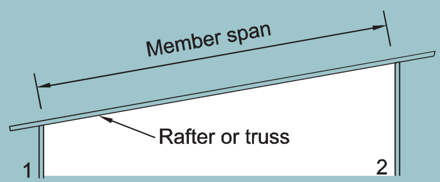
WING or BLOCK. A *wing* or *block* is any part of the building which projects by more than 6 m from the remainder of the building.

WIRE DOG. Galvanized or stainless steel wire, D or Z shaped nail, spiked at each end. Used for fixing timber together to resist uplift. (See figure 2.2.)



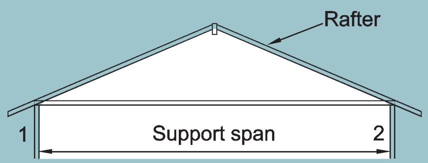
(A) SUPPORT SPAN

(A) For members 1 and 2:
Loaded dimension = $\frac{\text{Support span}}{2}$



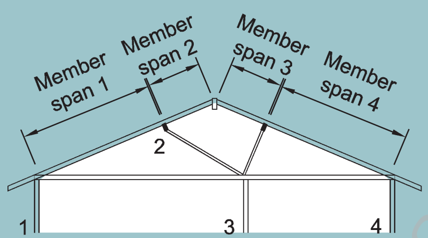
(B) MONOSLOPE ROOF

(B) For members 1 and 2:
Loaded dimension = $\frac{\text{Member span}}{2}$



(C) COUPLE CLOSE ROOF OR TIED RAFTERS

(C) For members 1 and 2:
Loaded dimension = $\frac{\text{Support span}}{2}$



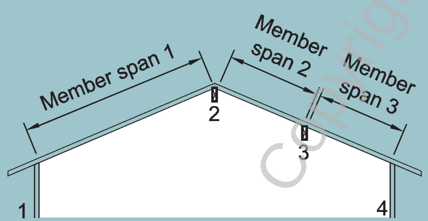
(D) FRAMED OR STRUTTED ROOF

(D) For member 1: Loaded dimension = $\frac{\text{span 1}}{2}$

For member 2: Loaded dimension = $\frac{\text{span 1 + span 2}}{2}$

For member 3:
Loaded dimension = $\frac{\text{span 1}}{2} + \text{span 2} + \text{span 3} + \frac{\text{span 4}}{2}$

For member 4: Loaded dimension = $\frac{\text{span 4}}{2}$



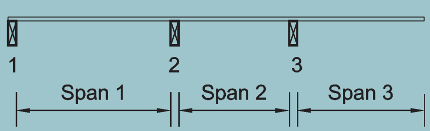
(E) RAFTERS SUPPORTED ON BEAMS OR WALLS

(E) For member 1: Loaded dimension = $\frac{\text{span 1}}{2}$

For member 2: Loaded dimension = $\frac{\text{span 1 + span 2}}{2}$

For member 3: Loaded dimension = $\frac{\text{span 2 + span 3}}{2}$

For member 4: Loaded dimension = $\frac{\text{span 3}}{2}$



(F) FLOOR STRUCTURE

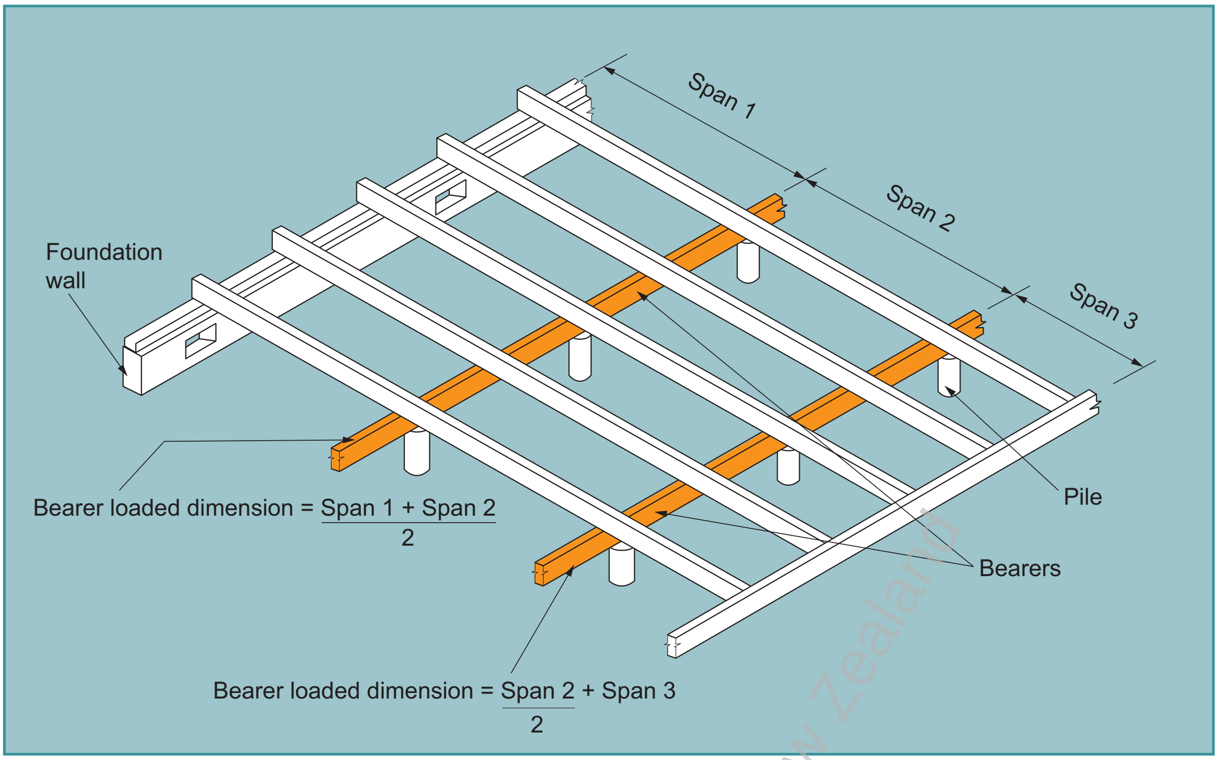
(F) For member 1: Loaded dimension = $\frac{\text{span 1}}{2}$

For member 2: Loaded dimension = $\frac{\text{span 1 + span 2}}{2}$

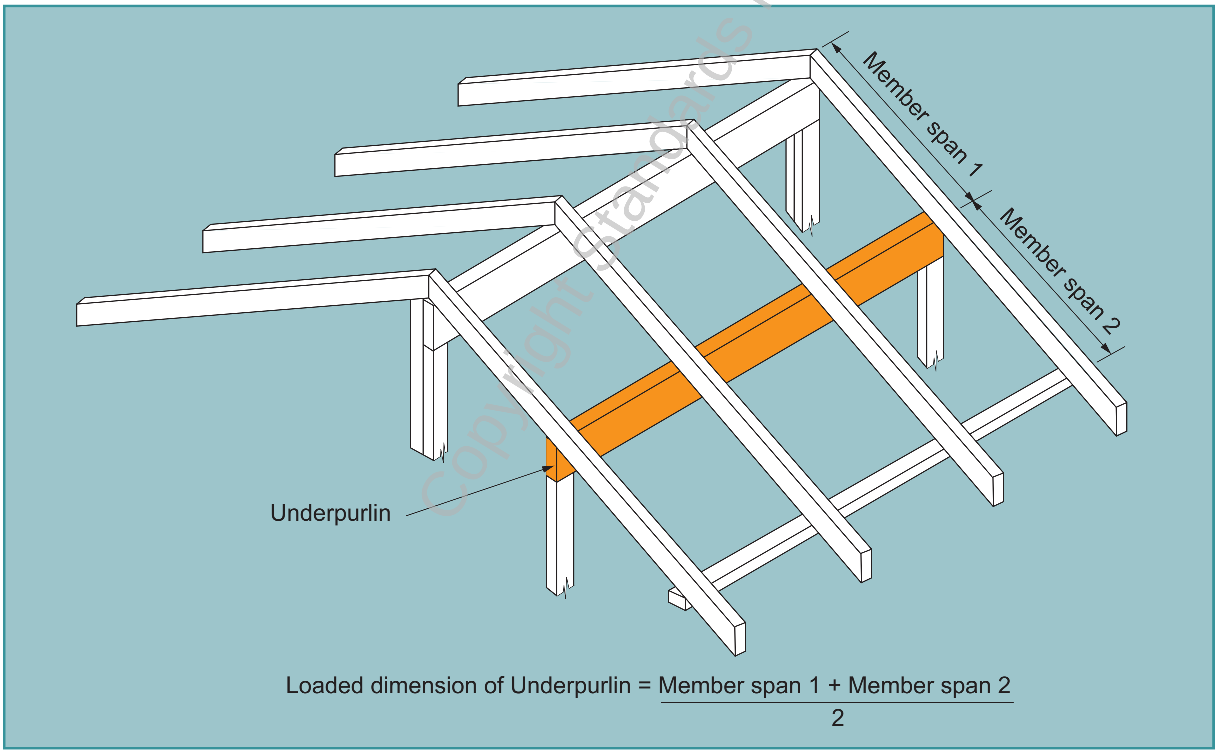
For member 3: Loaded dimension = $\frac{\text{span 2}}{2} + \text{span 3}$

NOTE – Maximum eaves overhang dimension 750. Such overhangs may be ignored when calculating loaded dimensions.

Figure 1.3 – Definitions of spans and loaded dimensions (see 1.3)

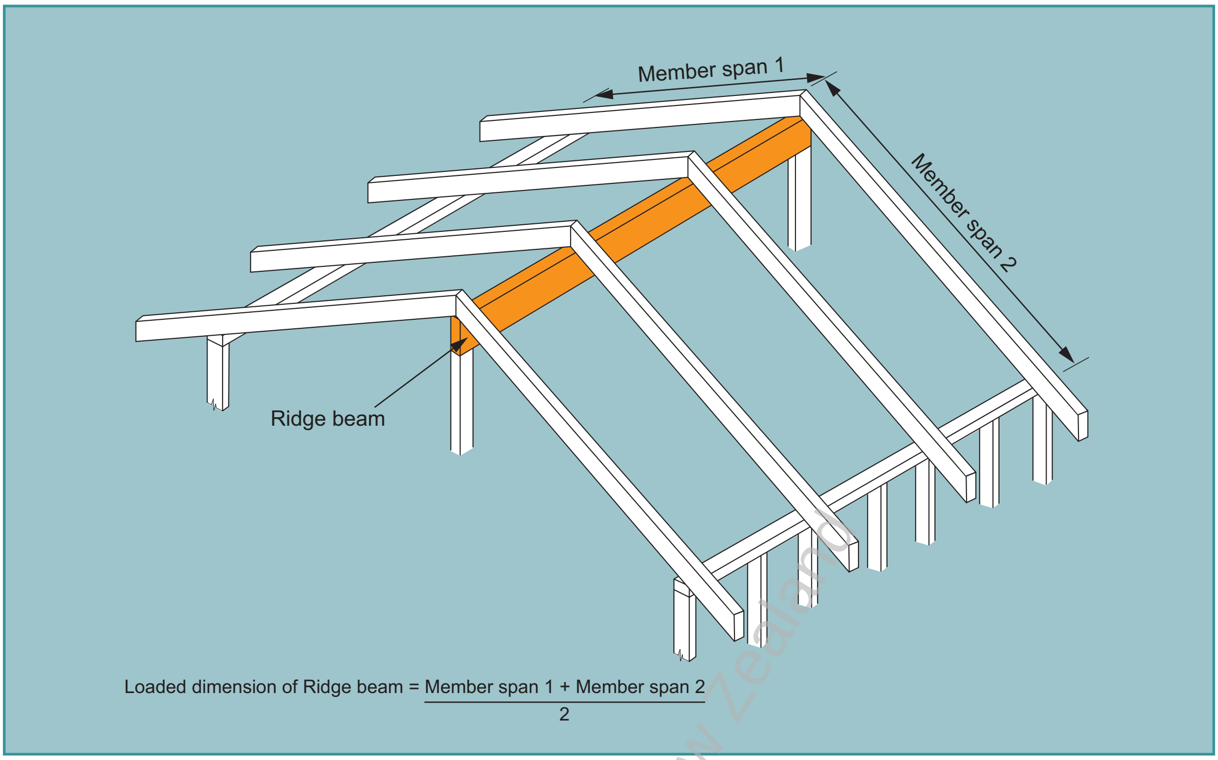


(G) SUBFLOOR BEARERS

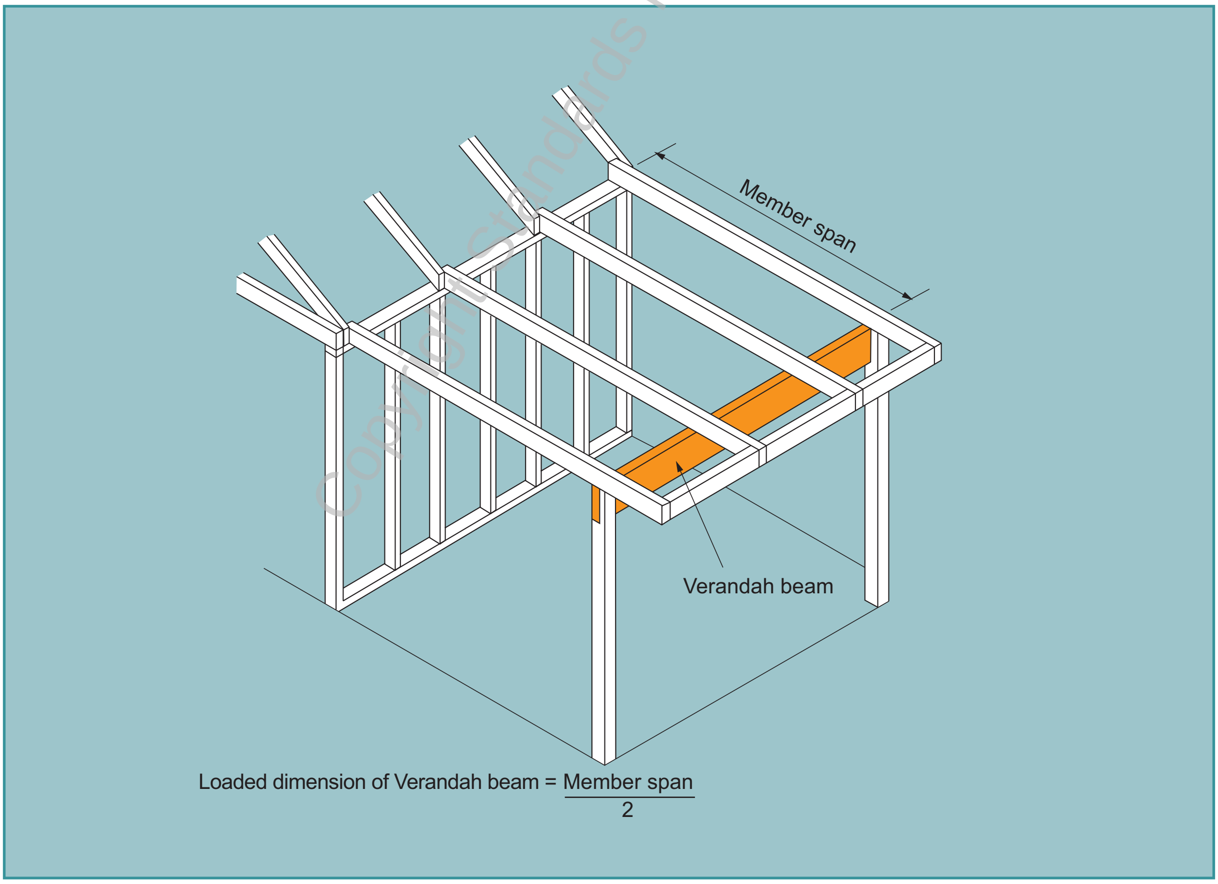


(H) UNDERPURLIN

Figure 1.3 – Definitions of spans and loaded dimensions (continued) (see 1.3)

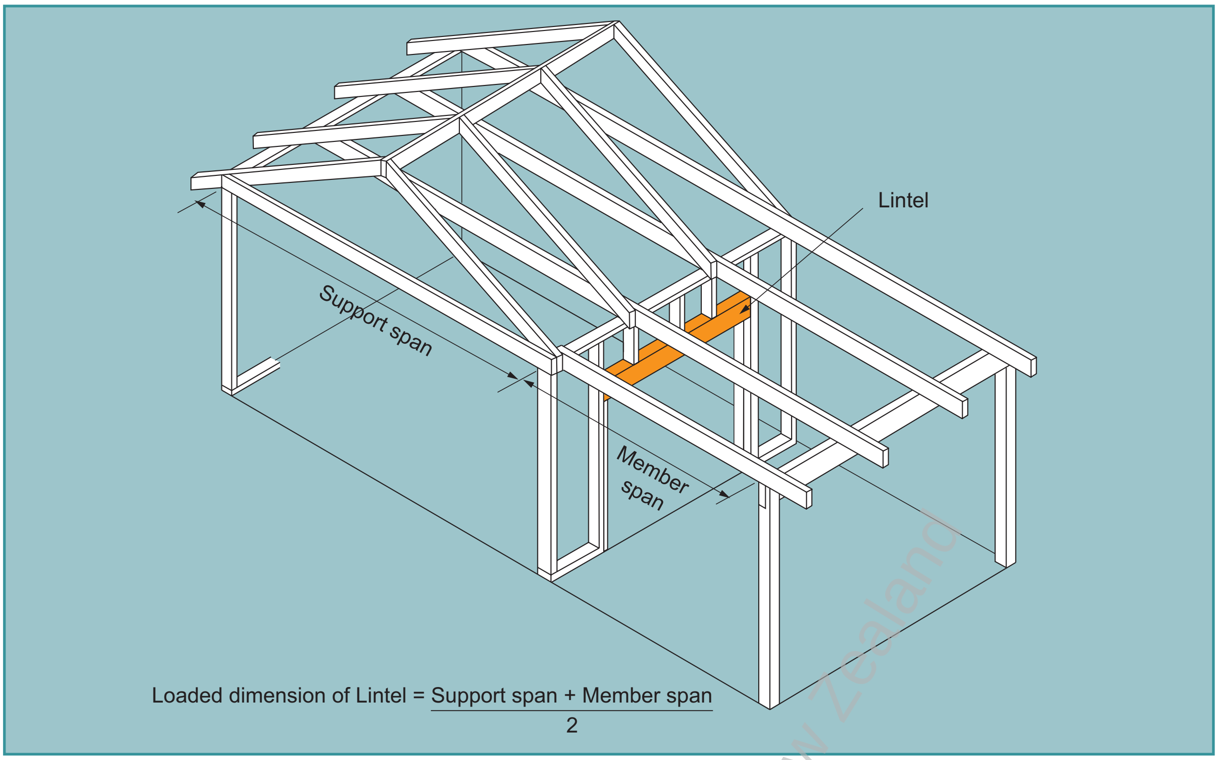


(I) RIDGE BEAM

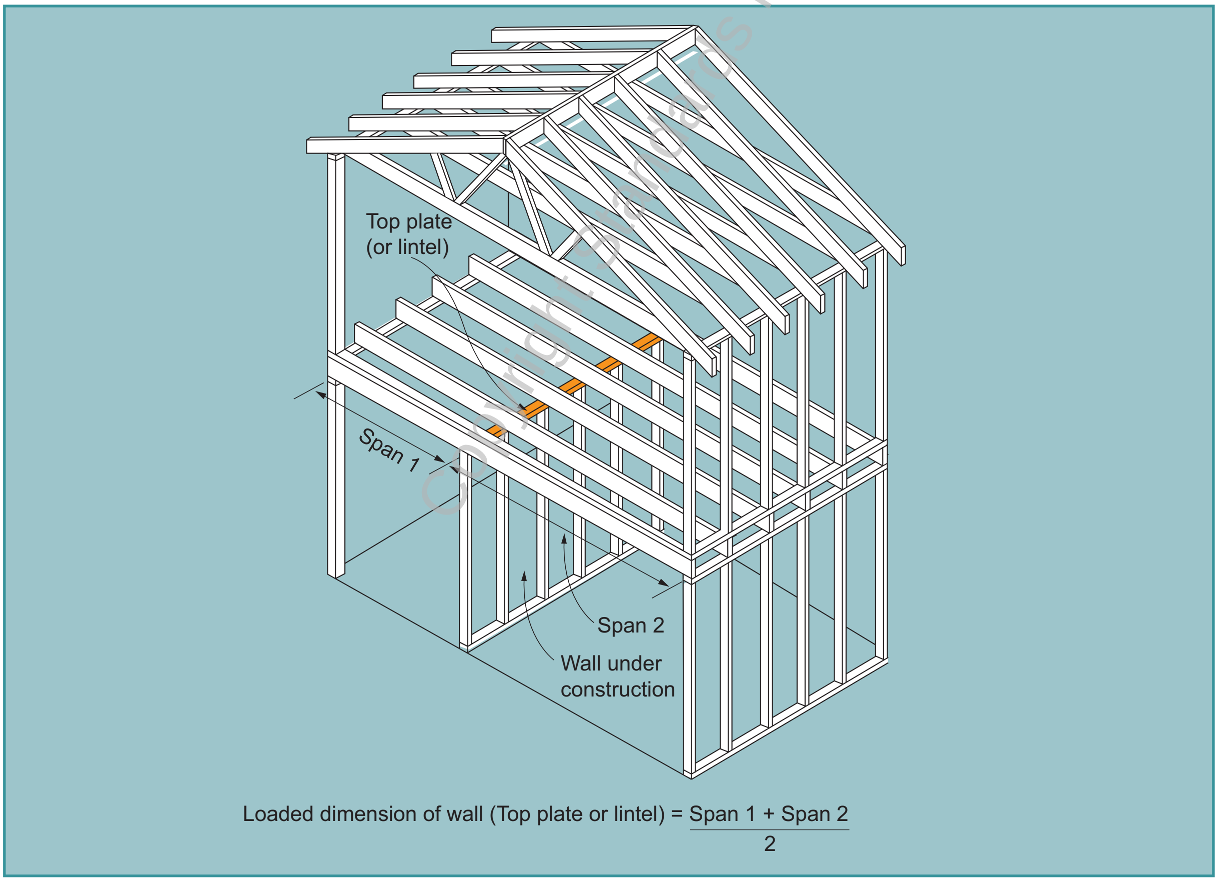


(J) VERANDAH BEAM

Figure 1.3 – Definitions of spans and loaded dimensions (continued) (see 1.3)

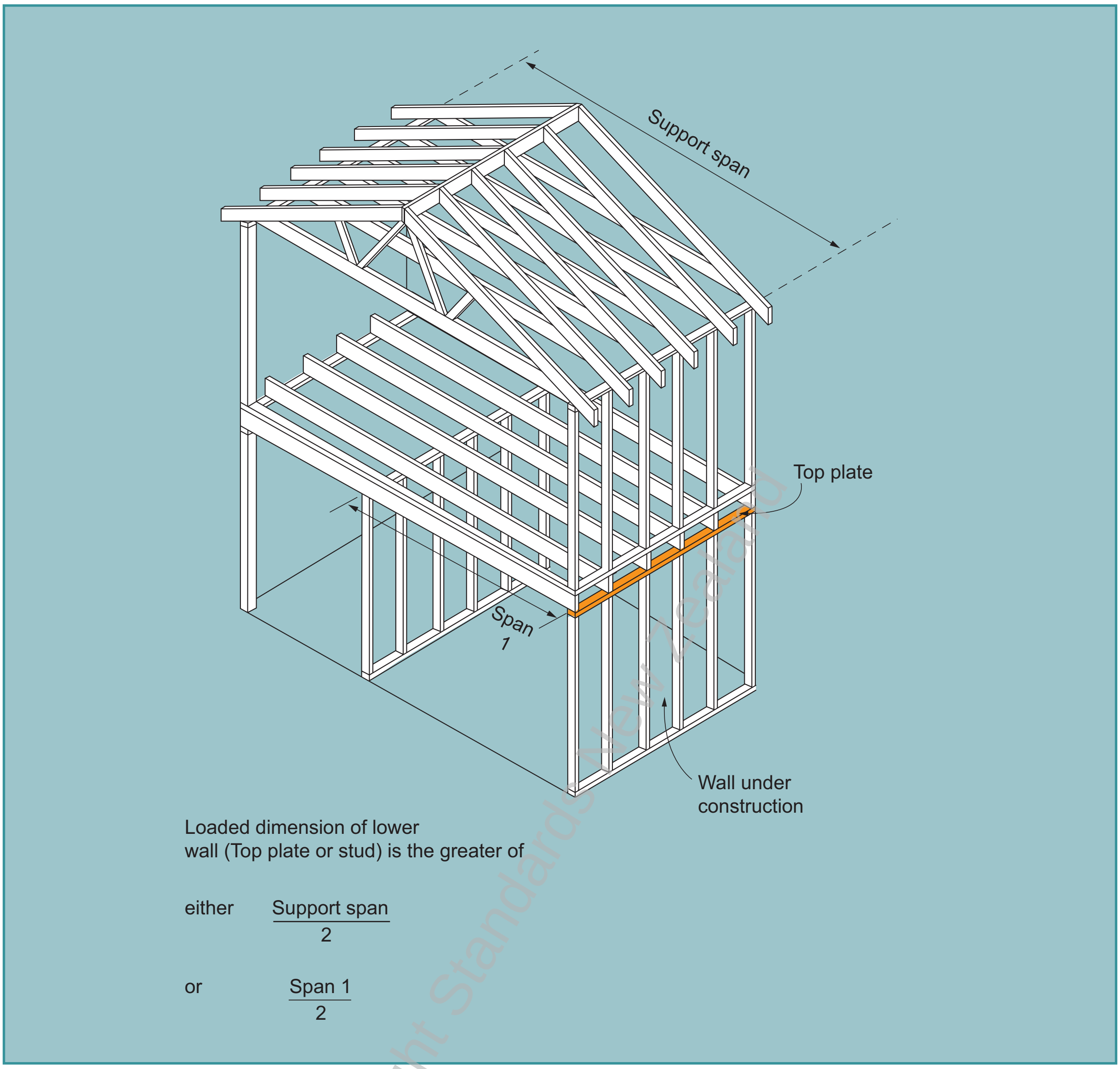


(K) LINTEL SUPPORTING ROOF ONLY



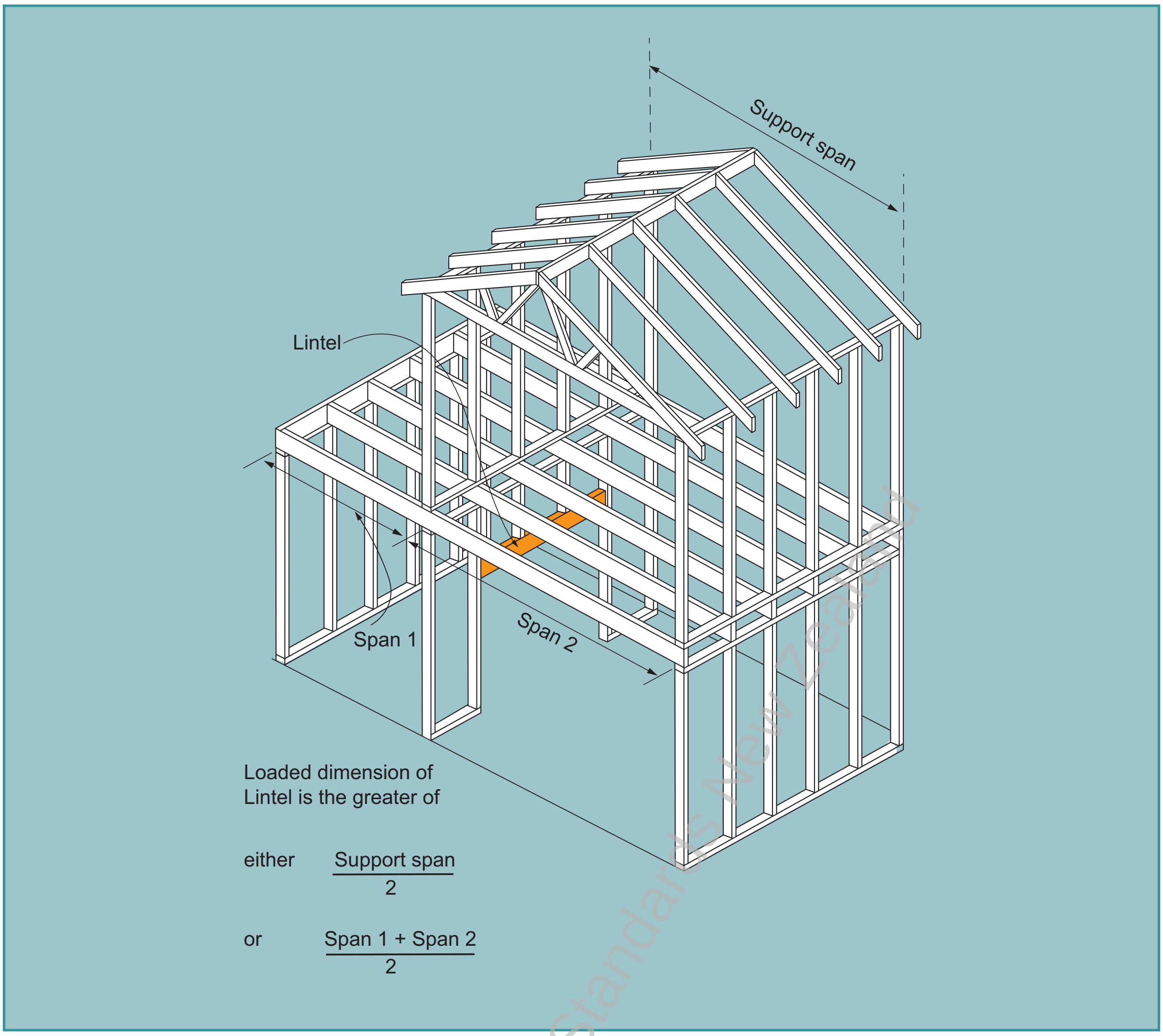
(L) INTERNAL WALL FOR LINTEL SUPORTING FLOOR ONLY

Figure 1.3 – Definitions of spans and loaded dimensions (continued) (see 1.3)



(M) WALL TOP PLATE, LOWER OF TWO STOREYS

Figure 1.3 – Definitions of spans and loaded dimensions (continued) (see 1.3)



(N) LINTEL SUPPORTING ROOF, WALL AND FLOOR

Figure 1.3 – Definitions of spans and loaded dimensions (continued) (see 1.3)

SECTION 2

GENERAL

Table

Figure

2 GENERAL

2.1 DIMENSIONS

The cross section dimensions of components or fixings quoted in this Standard are those deemed to be adequate for the particular application. Identical material of larger dimensions may be used unless specifically excluded.

2.2 TOLERANCES

Tolerances shall be as given in table 2.1.

2.3 TIMBER AND WOOD-BASED BUILDING COMPONENTS

2.3.1 NZS 3602

The timber species, preservative treatment, in-service moisture range and their end use environment shall comply with NZS 3602.

2.3.2 Framing grades

The *framing* grades to be used with this Standard shall be as follows. The properties for these grades, except No. 2 Framing, are as specified in NZS 3603 and as defined in *structural grade (SG)* in 1.3.

(a) Dry Timber
- (i) SG 6;
- (ii) SG 8;
- (iii) SG 10; or
- (iv) No. 2 Framing to NZS 3631 is allowed for *non-loadbearing walls* as given in 8.5.1.1(b).

(b) Wet Timber
- (i) SG 6 (Wet); or
- (ii) SG 8 (Wet).

SG 6 (Wet) Framing can be used as if it was dry SG 6 Framing provided the conditions of 2.3.4 are met. SG 8 (Wet) is for wet-in-service conditions and cannot be used as SG 8 when dry.

Where different member sizes, *spans* or other design properties apply for the different grades, the Standard specifies the different requirements necessary. Where such distinction is not given then the member sizes, *spans* or other design properties given apply equally to all grades.

C2.3.2

All structural grades for house framing are now verified grades in accordance with NZS 3622 and have been renamed SG 6, SG 8, SG 10, SG 6 (Wet) and SG 8 (Wet) with properties meeting those currently specified in NZS 3603. The renaming simplifies structural grading for the market because there will be no distinction between framing timber which is machine graded and verified, MSG, or visually graded and verified, VSG. The renaming replaces No.1 Framing with SG 6.

Table 2.1 – Timber framing tolerances

Item	Tolerances
Deviation from the position shown on plan for a building	15 mm
Deviation from vertical	15 mm per 2 storey height (5 mm per 2.4 m)
Deviation from vertical for buildings in excess of 2 full storeys	20 mm
Relative displacement between loadbearing walls in adjacent storeys intended to be in vertical alignment	5 mm
Deviation from line in plan: (a) In any length up to 10 m (b) In any length over 10 m	 5 mm 10 mm total
Deviation from horizontal: (a) In any length up to 10 m (b) In any length over 10 m	 5 mm 10 mm total
Straightness of corners (where 2 walls meet at right angles) Other studs (gradual bow)	2 mm in 2.4 m in both studs 6 mm in 2.4 m
Wall framing: (a) At mid-height under 3 m long horizontal straight edge (b) At mid-height under 1.3 m long horizontal straight edge	 6 mm gradual bow 1.5 mm out of line

2.3.3 Separation

As shown in figure 2.1 *framing* timbers shall be separated from direct contact with concrete or masonry by either:

(a) A free-draining air space of not less than 12 mm; or

(b) A bituminous *damp-proof course (DPC)* or other suitable impervious material overlapping the timber by at least 6 mm (see also 4.3.3).

2.3.4 Green and dry timber

This Standard applies to Radiata pine and Douglas fir. The design solutions are for timber which is dry (maximum moisture content 18 %) throughout its design life. Timber may be installed green provided non-vertical members are propped and are not subjected to design loadings until they are dry. This does not include SG 8 (Wet).

The exceptions to the requirement that timber remain dry in service are as follows: *piles* to section 6, *bearers* to table 6.4(b), *stringers* to section 6, *joists* to table 7.1(b), cantilevered *balcony* floor *joists* to table 7.2, *posts* to section 9 and timbers under *roof* overhangs (i.e. the exposed ends of *rafters, purlins, battens* and outriggers) to sections 10 and 15. These members can be installed either dry or green and can be wetted in service.

The cross-section dimensions of timber given in the Standard are the actual minimum dried sizes that shall be used. Where green timber is used its dimensions shall be no less than the green gauged equivalent size given below:

Actual minimum dried size (mm)	35	45	70	90	140	190	240	290
Green gauged equivalent size (mm)	37	47	69	94	144	194	244	294

C2.3.4

The Standard's provisions may be applicable to timbers other than Radiata pine and Douglas fir such as other softwood species. Such use however, needs to be subject to demonstration of adequate structural performance and durability.

Over recent years framing practice has moved from predominantly green gauged framing to dry sizes. Further, those dry sizes are based on the Australian dried softwood sizes rather than the dry dressed sizes specified in NZS 3601. There are significant differences between these two sets of dried sizes in sizes 200 mm and over. To avoid confusion, NZS 3604, including its tables, now gives the actual minimum dried size based on the Australian sizes. This brings the tables into line with Australian practice and is simpler for the consumer.

Continued...

The only exceptions to these requirements are for *piles* and *battens* which shall be sawn timber to the sizes required in 6.4 and 10.2.1.16 respectively.

2.3.5 Call sizes

Where the Standard specifies members by call size those sizes shall be read as the actual minimum dried sizes as given below:

Call sizes (mm)	25	40	50	75	100	150	200	250	300
Actual minimum dried size (mm)	19	35	45	70	90	140	190	240	290

2.3.6 Processed components

Wood-based components (e.g. particleboard, fibreboard) shall be manufactured to AS/NZS 1860.

2.3.7 Flooring timber

Wood-based components used for flooring shall be in accordance with AS/NZS 1860. These components shall be no closer to the ground than 550 mm and shall be protected from exterior exposure, and interior moisture.

2.3.8 Plywood

Plywood shall be manufactured to AS/NZS 2269 (Parts 0 to 2).

2.3.9 Engineered wood products

2.3.9.1

Engineered wood products shall be either laminated veneer lumber (LVL), or glue laminated timber manufactured using Radiata pine or Douglas fir.

2.3.9.2

LVL shall be manufactured in accordance with AS/NZS 4357 (Parts 0 to 4).

2.3.9.3

Glue laminated timber shall be manufactured in accordance with AS/NZS 1328 (Parts 1 and 2).

2.3.9.4

The preservative treatment for engineered wood products shall comply with NZS 3602 provided however that where engineered wood products are not already specified, the level of treatment shall be the same as that required for kiln-dried Radiata pine *structural grades* to comply with NZS 3602.

2.3.9.5

Engineered wood products may be used as a direct substitute for SG 6, 8 or 10 provided that they are of the same finished size as the member to be substituted and that the strength and stiffness properties have been verified and marked in accordance with NZS 3622 and are no less than the strength and stiffness properties of the grade to be substituted.

NZS 3604 does not provide design solutions for timber loaded in situations where prolonged high moisture contents can be expected, except for the members specifically noted in 2.3.4. However, timber that is graded and installed green, namely SG 6 (Wet) framing, or timber that has been installed dry and become wet during the building process, may still be used with the Standard, provided it is propped and dried in place before being loaded and remains dry in service from that point on.

C2.3.9.6

The intention of 2.3.9.6 is to allow LVL or glue-laminated product to be used in place of solid timber framing members that are already within the scope of NZS 3604. Such allowance means that smaller or stronger section sizes will be available for use in areas where available space is a limitation.

So long as the resultant load from the member does not exceed the limitations of the clause this should also provide a means of achieving wood-based product lintels for larger span openings such as garage doors.

The expectation is that supporting documentation will include a producer statement (design) from a chartered professional engineer as the supporting documentation for the engineering basis of the selection charts or software used.

2.3.9.6

Proprietary grades and sizes of engineered wood products may be used for *framing* members in this Standard providing that:

(a) The *framing* member is within the scope of this Standard;

(b) The loadbearing reaction of the *framing* member shall not exceed 16 kN in a downwards direction or 16 kN in an upwards direction; and

(c) The selection charts or software used for the selection of the engineered wood product have as a minimum been engineered in accordance with B1/VM1.

Supporting documentation shall be provided by the author of the selection chart or software package to demonstrate compliance with this clause.

2.4 FASTENINGS AND FABRICATION

2.4.1 General

All parts of the building shall be securely fastened in accordance with 2.4.2, in order to resist all forces likely to be encountered during construction, or during the expected life of the building and to ensure that the building as a whole acts as a single structural entity.

2.4.2 Fastenings and connections

Fastenings and connections shall be as specified in the relevant clause of this Standard or have an equivalent *capacity* as specified in the relevant clauses and tables of this Standard.

2.4.3 Tolerances

All timbers shall be set true to the required lines and levels with all mitres, butts, laps, housings, and other functions cut accurately so as to provide full and even contact over all bearing surfaces. Timber *framing* tolerances shall be as given in table 2.1.

2.4.4 Nails (other than those used to attach roofing materials)

C2.4.4.1

The tables and figures of earlier editions of NZS 3604 specified 100 x 3.75 mm hand-driven nails and gave capacities for alternative fixings. The nail fixing capacities in the tables have been updated to reflect the common use of power-driven nails. Recent testing has been based on 90 x 3.15 mm power-driven nails. Where these are specified in the tables, 100 x 3.75 or 100 x 4.0 mm hand-driven nails are an acceptable substitute.

2.4.4.1

Nailing requirements are specified throughout the text, tables and nail schedules by length and diameter, and sometimes by the number and edge clearance. The letters "FH" specify that flathead nails shall be used.

Where 100 mm nails are specified as 100 x 4.0 mm this refers to hot-dipped galvanized (HDG) nails.

Hand-driven nails 100 x 3.75 mm or 100 x 4.0 mm may replace 90 x 3.15 mm power-driven nails unless otherwise specified in the tables or nailing schedules. Other sizes shall be as listed in the tables.

Durability requirements are specified in table 4.3.

See table 2.2 for a guide to fixing types and capacities.

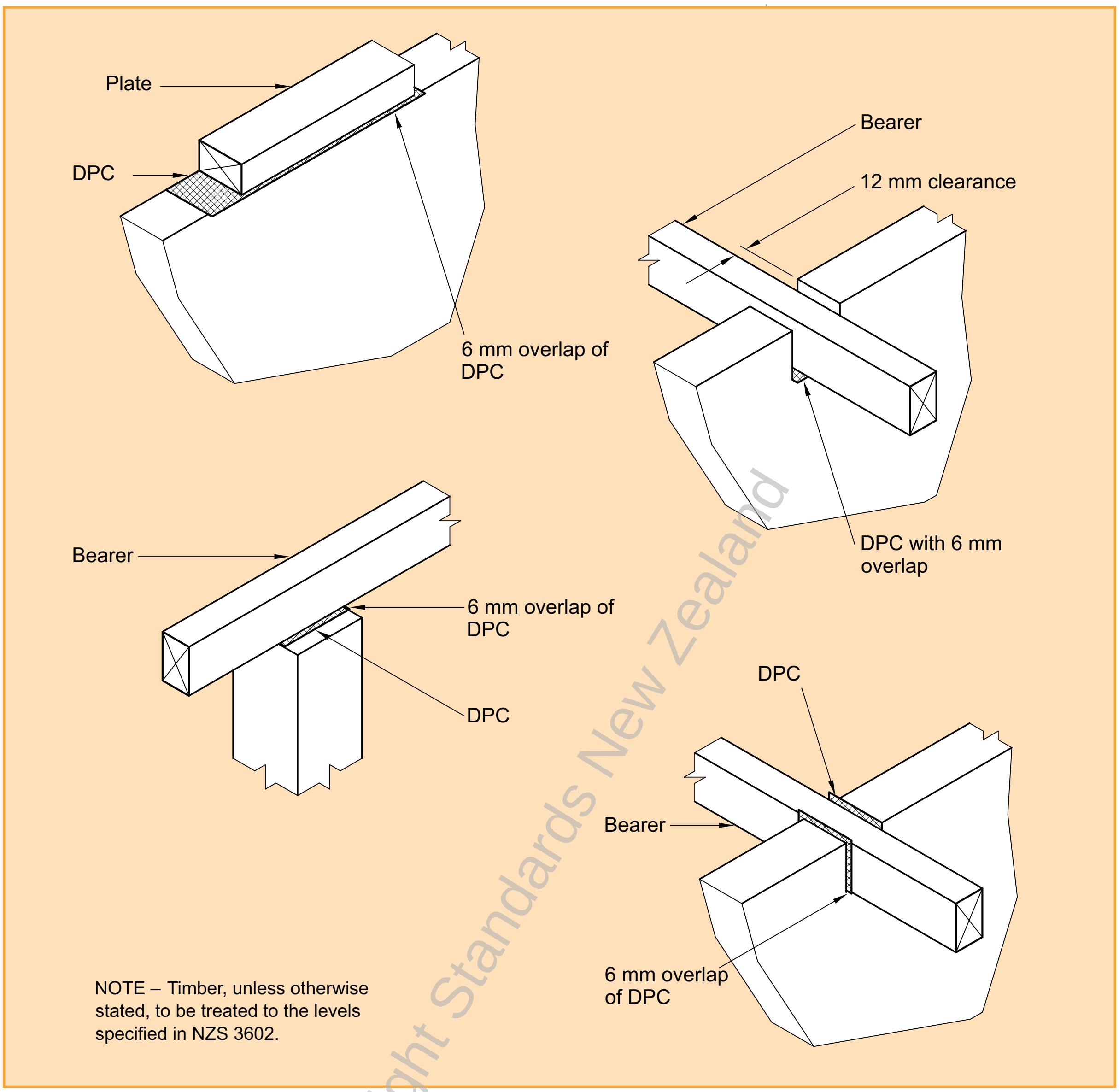


Figure 2.1 – Protection of subfloor framing timber from direct contact with concrete or masonry (see 2.3.3)

Table 2.2 – Fixing type and capacity reference guide (see 2.4.4.1)

Fixing type	Description	Alternative fixing capacity (kN)	See table
A	2 / 90 x 3.15 end nails	0.7	8.18
B	2 / 90 x 3.15 end nails + 2 wire dogs	4.7	
C	2 / 90 x 3.15 end nails + strap fixing (see figure 8.12)	8.5	
D	4 / 90 x 3.15 end nails + 2 strap fixing (double stud)	16.0	
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7	10.1, A10.1 10.7, A10.7 10.11, A10.11 10.14 10.15 15.6, A15.6 15.10, A15.10
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0	
G	10 / 90 x 3.15 nails (5 each side)	4.7	10.2, A10.2 15.7, A15.7
H	1 / M12 bolt	8.5	
I	2 / M12 bolts	16.0	
J	2 / M16 bolts	24.0	
K	6 / 90 x 3.15 nails	3.0	10.5, A10.5
L	2 / M12 bolts	9.8	
M	2 / M16 bolts	13.0	
N	6 / 100 x 4.0 HDG nails (hand driven)	4.7	10.8, A10.8 15.8, A15.8
O	2 / M12 bolts (see figure 9.3 (C))	6.8	
P	2 HDG 'flat' straps (see figure 9.3 (B))	13.7	
Q	2 HDG 'tee' straps (see figure 9.3 (A))	25.5	
R	1 / 90 x 3.15 nail	0.55	10.10, A10.10 10.12, 15.9, A15.9
S	2 / 90 x 3.15 nails	0.8	
T	1 / 10g self-drilling screw, 80 mm long	2.4	
U	1 / 14g self-drilling Type 17 screw, 100 mm long	5.5	

NOTE – Capacities are associated with fixing type, not fasteners. See individual selection tables for the appropriate fixing type for the application.

2.4.4.2
The length of nails passing through sheet material thicker than 10 mm shall be the length specified in the nailing schedules, or three times the sheet thickness, whichever is the greater.

2.4.4.3
The joints listed in the nailing schedule tables shall be made with the number of connectors of the specified type, length, and diameter driven in the specified locations into both pieces of timber at right angles, unless skewed nails are specified.

2.4.4.4
The depth of penetration into the point side piece of timber shall be at least 45 % of the length of the nail.

2.4.4.5
Where the nail size specified would cause splitting, the nail holes shall be pre-drilled to a diameter of 80 % of the nail diameter.

2.4.4.6
Nails in structural joints shall be fully driven.

2.4.4.7
Members in this Standard, except for *jack studs, bottom plates* and *top plates*, may be substituted with built-up members comprising up to six *framing* members nailed together, provided the following conditions are satisfied:

(a) For the individual *framing* members comprising the built-up member:
   (i) All *framing* members match the width and grade of the member being substituted, and
   (ii) The combined thickness of the *framing* members equals or exceeds the thickness of the member being substituted.
(b) For nailing requirements of the built-up member, where the built-up member comprises up to three members:
   (i) *Spacings* of nails along the built-up member shall not exceed six times the thickness of the thinnest *framing* member, and
   (ii) All nails shall penetrate at least three-quarters of the thickness of the last *framing* member and the nails shall be driven alternatively from either face of the built-up member, and
   (iii) For members of width 140 mm or more there shall be at least two rows of nails across the member width at the centres required in (i) above.
(c) For nailing requirements of the built-up member, where the built-up member comprises more than three members (see 8.5.1.2):
   (i) The first three members shall be built up as described in 2.4.4.7. Additional members shall be fixed with nails twice as long, and *spaced* at six times the thickness of the additional member being added.

2.4.5 Bolts and coach screws

In bolted joints, washers shall be provided at each timber surface under the bolt or coach screw head and the nut. For M12 and M16 bolts the washers shall be not less than 50 mm x 50 mm x 3 mm if square or not less than 55 mm diameter x 3 mm if round. (Bolts shall comply with the requirements of AS 1111 Parts 1 and 2 and coach screws to AS/NZS 1393.)

2.4.6 Timber connectors or fixings

2.4.6.1

Manufacturers of a timber connector or fixing shall provide the following information on each package of fixings, or on a label securely attached thereto:

(a) The name, or registered trade name, or make and address of manufacturer;

(b) The materials used in manufacture including fasteners and corrosion protection;

(c) The *capacity* of the timber connector or fixing in kN determined in accordance with 2.4.7;

(d) Fastener's requirements;

(e) Details of intended use.

2.4.6.2

Timber connectors to be tested for compliance with this Standard shall be sampled at random from a particular package and the test results recorded.

2.4.7 Connector capacity and durability

The *capacity* of a connector or fixing shall be calculated in accordance with the following equation:

$$R = \phi \times Q_k \times n \times k$$

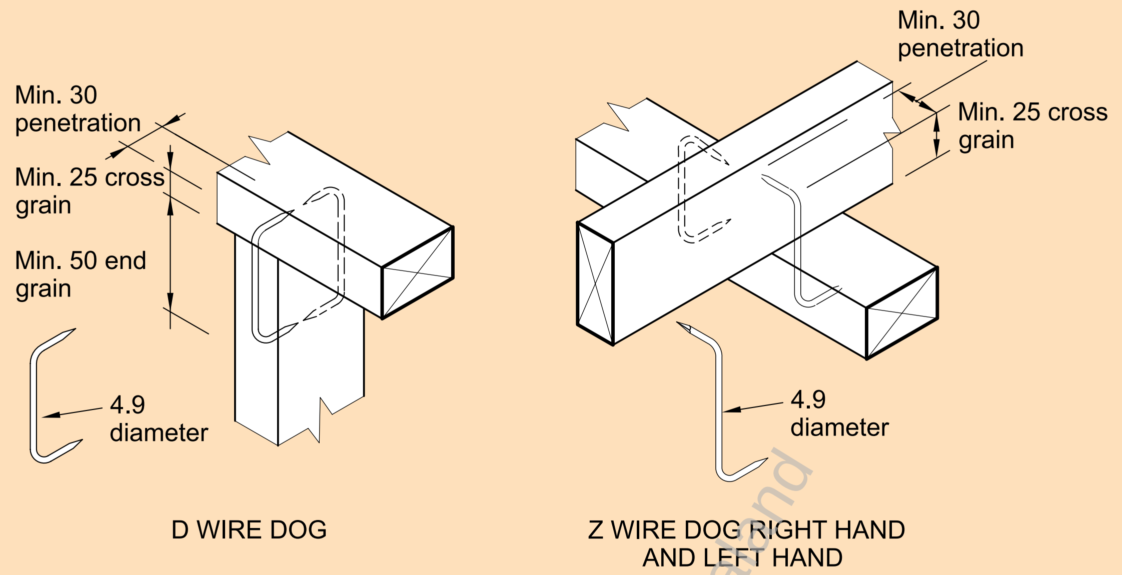
where

R	=	connector *capacity* in kN
ϕ	=	*capacity* reduction factor from NZS 3603
Q_k	=	characteristic value obtained by test in accordance with BRANZ evaluation Method EM1 or AS/NZS 2699: Part 2 as appropriate
n	=	number of tested elements making up the complete joint
k	=	modification factors from NZS 3603 (section 4) as appropriate to the specific application.

In addition to verifying the *load* carrying *capacity* the manufacturer shall also demonstrate that the fixings shall conform with the durability requirements of clause B2 of the NZBC.

2.4.8 Wire dogs

Wire dogs shall be of steel of at least 4.9 mm diameter and shall penetrate at least 30 mm into each piece of timber. Figure 2.2 shows the minimum dimensions required between the edge of the timber and the spike of the *wire dog*.



Unless otherwise stated, all dimensions are in mm.

Figure 2.2 – Wire dogs (see 2.4.8)

2.5 REINFORCING STEEL

Reinforcing bars and steel mesh shall comply with AS/NZS 4671. Reinforcing bars shall be grade 300E. Mesh shall be grade 500N or 500E.

2.6 CONCRETE

Concrete shall comply with NZS 3104 for manufacture and with NZS 3109 for construction.

2.7 CONCRETE MASONRY

Concrete masonry shall comply with AS/NZS 4455 Part 1 for manufacture and with NZS 4210 for construction.

SECTION 3

SITE REQUIREMENTS

Figure

3 SITE REQUIREMENTS

3.1 SOIL BEARING CAPACITY

3.1.1 General

The site requirements of this Standard are concerned with soil conditions under or adjacent to the building.

If a site does not comply with the definition of *good ground*, the *foundations* shall be the subject of *specific engineering design (SED)* and investigation as appropriate (see 1.3).

3.1.2 Foundations

The *foundation* provisions of this Standard shall apply only for building sites such that:

(a) The *foundations* for the building are supported on *good ground* with an ultimate bearing *capacity* of 300 kPa. Determination of *good ground* shall be as given in 3.1.3.

(b) Any *foundation* for a building erected at the top of a bank, shall be 0.6 m behind the ground line shown in figure 3.1. The horizontal distance (H) from the top to the bottom shall not exceed 3 m. The slope beyond the bank shall not exceed 5° for a distance of 10 m.

(c) Fill, including hard fill, placed over undisturbed ground or certified fill, shall not exceed 0.6 m in depth above *natural ground level*, if within 3 m of a *foundation*.

C3.1.1

Section 17 contains information that may assist those designing foundations on expansive soils.

Where the building may influence the neighbouring properties and vice versa, separate investigation by a suitably qualified engineer should be carried out.

C3.1.2

(a) This is to confirm that the provisions of the Building Act section 71 (Building on land subject to natural hazards) have been addressed within the context of this Standard.

(b) These provisions are to guard against erosion or frittering of soil that exposes the foundation on minor banks and to avoid localised slip failures that threaten the foundation. Stability of the site as a whole is covered by 3.1.2(b).

(c) This limitation is required, as moderate depths of earth fill spread over a large area adjacent to the building foundations can cause weak layers of underlying soil to consolidate within a depth of influence of approximately twice the width of the fill. Such consolidation can cause differential settlement of the building foundations and thus cause damage to the building. Typically, earth fill placed adjacent to foundations for the construction of stairs, terraces, landscaping and built-up ground under concrete floor slabs can cause such settlements.

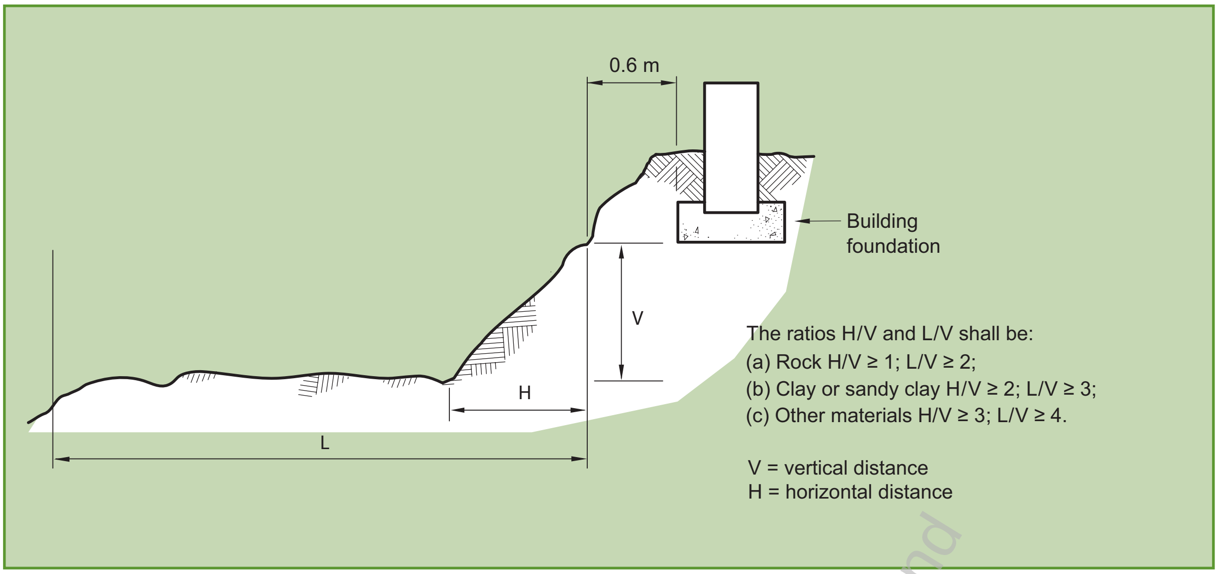


Figure 3.1 – Relationship of foundation to sloping ground surface

C3.1.3

(b) Surface creep is often evident by trees that have leaned over due to surface creep and then continued to grow vertically. Surface creep is also observed by leaning retaining walls. Land slips are often evident by saucer depressions in the landscape.

(g) Geotechnical completion reports generally list the ultimate bearing capacity of the ground of each lot, presence of expansive clay, topsoil depths, any presence of uncertified fill requiring specific site investigation, and stability problems that may define area limits of any building platform.

Project information memorandum (PIM) records may not include geotechnical information from subdivision reports confirming good ground on a site. Geotechnical reports need to be examined separately. Good ground is required for stability and control of settlement of foundations and can most reliably be verified by subsoil investigation, but an appropriate assessment should include the bigger picture.

NZS 4404 requires geotechnical completion reports to identify site subsoil class, areas that provide good ground, and those areas that require SED.

Continued...

3.1.3 Determination of good ground

The soil supporting the *footings* shall be assumed to be *good ground* when all the following conditions are met:

(a) Reasonable inquiry, through project information memorandum (PIM) and site observation show no evidence of buried services and none is revealed by excavation for *footings*;

(b) Reasonable inquiry, of PIM and site observation shows no indication or record of land slips or surface creep having occurred in the immediate locality;

(c) Reasonable inquiry shows no evidence of earth fill on the building site, and no fill material is revealed by the excavation for *footings*. This shall not apply where a certificate of suitability of earth fill for residential development has been issued in accordance with NZS 4431 for the building site, and any special limitations noted on that certificate are complied with; and

(d) Excavation for *footings* does not reveal buried organic topsoil, soft peat, very soft clay, soft clay, or expansive clay (see 3.2.1 and 3.3.8);

And any of the following:

(e) Where indicated by specific site investigation, using the test method for soil bearing *capacity* contained in 3.3;

(f) Where inspection of existing structures on this or neighbouring sites and reasonable enquiry, including *territorial authority* records, local history of the site, and published geological data such as structural geology where appropriate, shows no evidence of erosion (including coastal erosion, bank erosion, and sheet erosion), surface creep, land slippage, or other falling debris (including soil, rock, snow and ice), uncertified fill, fill over original water course, or subsidence having occurred in the immediate locality;

(g) When geotechnical completion reports in accordance with NZS 4404 identify subsoil class and areas that provide *good ground*.

3.2 SOIL TYPES

Tests in accordance with 3.3 offer a comparatively simple method for establishing whether or not an ultimate bearing capacity of 300 kPa may be assumed.

3.2.1

Soil description shall follow the recommendations in the New Zealand Geotechnical Society (NZGS) report "Field description of soil and rock – Guideline for the field classification and description of soil and rock for engineering purposes".

These descriptions are:

(a) Organic soils includes topsoil, organic clay, silt, sand, or peat;

(b) Very soft cohesive soil easily exudes between fingers when squeezed;

(c) Soft cohesive soil is easily indented by finger pressure;

(d) Firm cohesive soil can be indented by strong finger pressure, or by thumb pressure;

(e) Very loose and loose non cohesive granular materials when penetrometer readings are fewer than 3 blows per 100 mm; and

(f) Fill material, except where a certificate of suitability has been issued under NZS 4431.

3.2.2

For the purpose of 3.1.3(d) clays shall be treated as expansive clays if their soil properties in soil mechanics terms exceed the values listed in the definition of *good ground* (see 1.3).

3.3 TEST METHOD FOR SOIL BEARING CAPACITY

3.3.1 Purpose

The Scala Penetrometer test method shall be used to establish that the soil supporting the *foundations* may be assumed to have an ultimate bearing *capacity* of not less than 300 kPa as required by 3.1.2(a).

3.3.2 Scala penetrometer test

The apparatus shall consist of a dynamic cone penetrometer (commonly referred to as a Scala Penetrometer) conforming to the dimensions and masses given in Test 6.5.2 of NZS 4402 (imperial versions of this equipment were commonly referred to as the Scala Penetrometer). This shall be used for coarse grained, non-cohesive soils (sands or coarser) or fine grained (silt size or less) and firm cohesive soils using:

(a) A scale or measuring rod graduated in 50 mm intervals to an accuracy of 1 mm;

(b) A sight board or other suitable datum.

C3.3.2

The Scala Penetrometer provides a "trigger mechanism" to establish if good ground is present. The Scala Penetrometer provides a qualitative determination of the soil profile and its relative strengths.

3.3.3 Testing

The dynamic penetrometer test method for coarse grained, non-cohesive soils (sands or coarser), fine grained (silt size or less) shall be as described in Test 6.5.2 of NZS 4402; either Procedure 1 or 2.

3.3.4 Depth

The tip of the penetrometer shall be driven to a depth below the underside of the proposed *footing* or *pile* of not less than (unless rock is encountered):

(a) 2 m for strip or *pile footings* to the dimensions in section 6;

(b) For short *driven-timber piles*, 600 mm below the actual depth of the *pile*.

3.3.5 Test method

The penetrometer need not be removed during driving. As an alternative to driving, the penetrometer may be used within a probe, or a hole augered for the purpose of penetrometer testing, provided that no account shall be taken of any blow made when the bottom of the probe hole is less than 300 mm above the tip of the penetrometer.

3.3.6 Bore hole log

A bore hole of not less than 50 mm in diameter shall be augered at the site (sufficient to prove ground consistency) of each penetrometer test, according to the depths in 3.3.4 (unless rock is encountered). For each bore hole a soil description log in accordance with NZGS report ("Field description of soil and rock – Guideline") shall be recorded for each 300 mm, or part thereof below the ground surface, stating whether this is original ground level or cleared ground level as appropriate. The log should also include a continuous record of the number of blows per 100 mm, water table level if observed, and the location and level of each bore hole and Scala Penetrometer test should be marked on the site plan.

3.3.7 Ultimate bearing capacity

3.3.7.1

The soil below the underside of the *foundations* shall be assumed to have an ultimate bearing *capacity* of not less than 300 kPa when:

(a) None of the following is encountered below the depth of the *footing* at any test site:
   - (i) Organic topsoil
   - (ii) Soft or very soft peat
   - (iii) Soft or very soft clay
   - (iv) Fill material, except where a certificate of suitability has been issued under NZS 4431;

(b) Scala Penetrometer tests conducted in accordance with 3.3.2(a), where the number of blows per 100 mm depth of penetration below the underside of the proposed *footing* at each test site exceeds:
   - (i) Five down to a depth equal to twice the width of the widest *footing* below the underside of the proposed *footing*;
   - (ii) Three at greater depths; and
   - (iii) Providing the set blow is relatively uniform, the number of blows per 100 mm may be obtained by averaging the number of blows for depths not exceeding 300 mm; and

(c) Comparisons of the results at all test sites show that soil conditions are closely similar at each test site.

C3.3.7.1

(a) Scala results can be subject to climatic conditions, where soils are exposed to excessive drying. The set for each blow should be similar to previous sets. Large sets per blow followed by smaller sets per blow could be due to stony ground. In this case the average reading over 100 mm may give the wrong information.

Very loose and loose non cohesive soils can settle in earthquakes resulting in damaged foundations.

3.3.8 Test sites

Test sites shall be selected so as to give adequate information about the soil over the entire plan area of the proposed building, provided that there shall be a minimum of four test sites for a building up to 200 m^2 plan area, with at least one additional test site for each 100 m^2 additional plan area of the building.

3.3.9 Test record

The position and level of each test site in relation to proposed *foundations* shall be recorded.

3.4 BEARING

3.4.1

All *foundations* shall bear upon solid bottom in undisturbed *good ground* material or upon firm fill for which a certificate of suitability has been issued under NZS 4431 (see 3.1.3(c)).

Where *good ground* is at a depth greater than 0.6 m, the excavation between the *good ground* and the *foundation* base may be filled with mass concrete having a minimum strength of 10 MPa at 28 days.

3.4.2

The minimum depth of *footings* below the *cleared ground level* shall be 200 mm, subject to satisfying expansive soil requirements.

C3.4.2

The depth of the foundation below ground level is not to be confused with the thickness of the footing. "Cleared ground level" is used as the depth datum because this level is not usually altered by future landscaping, thus retaining the lateral support of the building.

3.5 SITE PREPARATION

3.5.1

Before a building is erected on any site, all rubbish, noxious and organic matter shall be removed from the area to be covered by the building.

3.5.2

In suspended floor construction, (not including slab-on-ground construction as in 7.5.8) firm turf and close-cut grass may remain provided that for the purpose of complying with 3.3.5, *cleared ground level* shall be taken as the underside of soil containing organic matter.

3.6 WATER IN SUBFLOOR SPACES

Water shall not be allowed to accumulate in the building's subfloor. Measures to ensure this does not happen are outside the scope of this Standard.

3.7 EFFECTS OF TREE ROOTS ON FOUNDATIONS

3.7.1

Tree roots shall be considered as required in the definition of *good ground* in 1.3.

C3.7.1

Trees remove moisture from the soil for a radius equal to the height of the tree. This causes expansive soils to shrink to varying degrees, and when near houses leads to differential settlement occurring under foundations. The mature height of the tree must be considered in the location of trees near houses. Movement of the foundations may lead to cracks in the building and door jamming.

SECTION 4

DURABILITY

Table

Figure

4 DURABILITY

4.1 GENERAL

This section provides a means of compliance with Clause B2 of the *New Zealand Building Code* (NZBC) for relevant items covered by this Standard.

4.2 EXPOSURE ZONES

4.2.1 Classification

Building sites shall be classified as being in Exposure Zones B, C or D, depending on the severity of exposure to wind-driven sea salt.

4.2.2 Determining exposure zones

When determining the exposure zone to be used (see figure 4.1), the process shall be to refer to figure 4.2 (map) which shall be read in conjunction with 4.2.3 and then in all cases apply any microclimatic considerations.

Zones B and C and some of Zone D are shown in figure 4.2 and Zone D is further described in the note to figure 4.2.

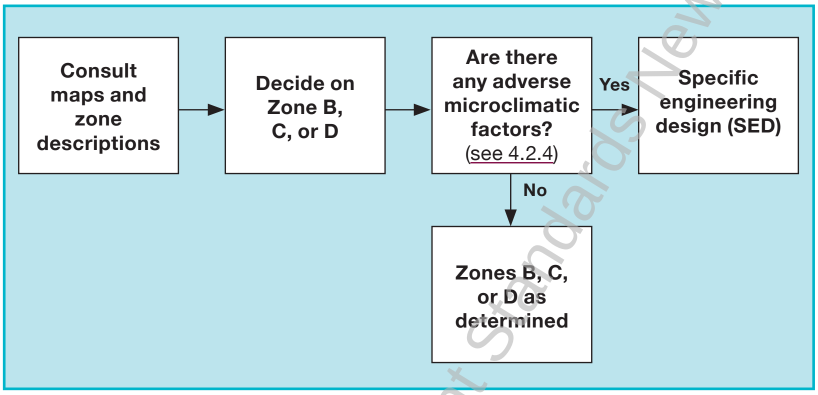


Figure 4.1 – Flow chart of exposure zone determination (see 4.2.2)

4.2.3 Exposure zone descriptions

4.2.3.1 Zone B: Low

Inland areas with little risk from wind blown sea-spray salt deposits.

4.2.3.2 Zone C: Medium

Inland coastal areas with medium risk from wind blown sea-spray salt deposits. This zone covers mainly coastal areas with relatively low salinity. The extent of the affected area varies significantly with factors such as winds, topography and vegetation.

4.2.3.3 Zone D: High

Coastal areas with high risk of wind blown sea-spray salt deposits. This is defined as within 500 m of the sea including harbours, or 100 m from tidal estuaries and sheltered inlets, and otherwise as shown in figure 4.2. The coastal area also includes all offshore islands including Waiheke Island, Great Barrier Island, Stewart Island, the Chatham Islands, and the areas shown in white in figure 4.2.

C4.1

This section classifies environments in New Zealand which affect the durability of elements of the building covered by this Standard so that they will remain intact for the required life. These elements are determined as the structural timber parts, and the fasteners, fixings, brackets etc. made of metal which hold the timber together, and any concrete elements which affect the structure of the building.

When selecting appropriate materials, the overall environment in the location of the intended structure requires consideration. A structure situated in an aggressive environment will require a higher standard of corrosion protection than one in a benign environment. The environment can have an adverse effect on metal fixings and fastenings and to a lesser extent on the timber and concrete.

C4.2

Designers considering claddings in E2/AS1 will note the inclusion of Exposure Zone E with particular requirements especially for metal claddings. Exposure Zone E (conforming with Atmospheric Corrosivity Category E of AS/NZS 2728 and C5 of ISO 9223) is for beachfront regions subject to rough seas and surf beaches. For the purposes of NZS 3604, the corrosion protection requirements for structural fixings in Exposure Zones D and E are identical, therefore only Exposure Zone D is included in this Standard.

Figure 4.2 – Exposure zone map (see 4.2.2)

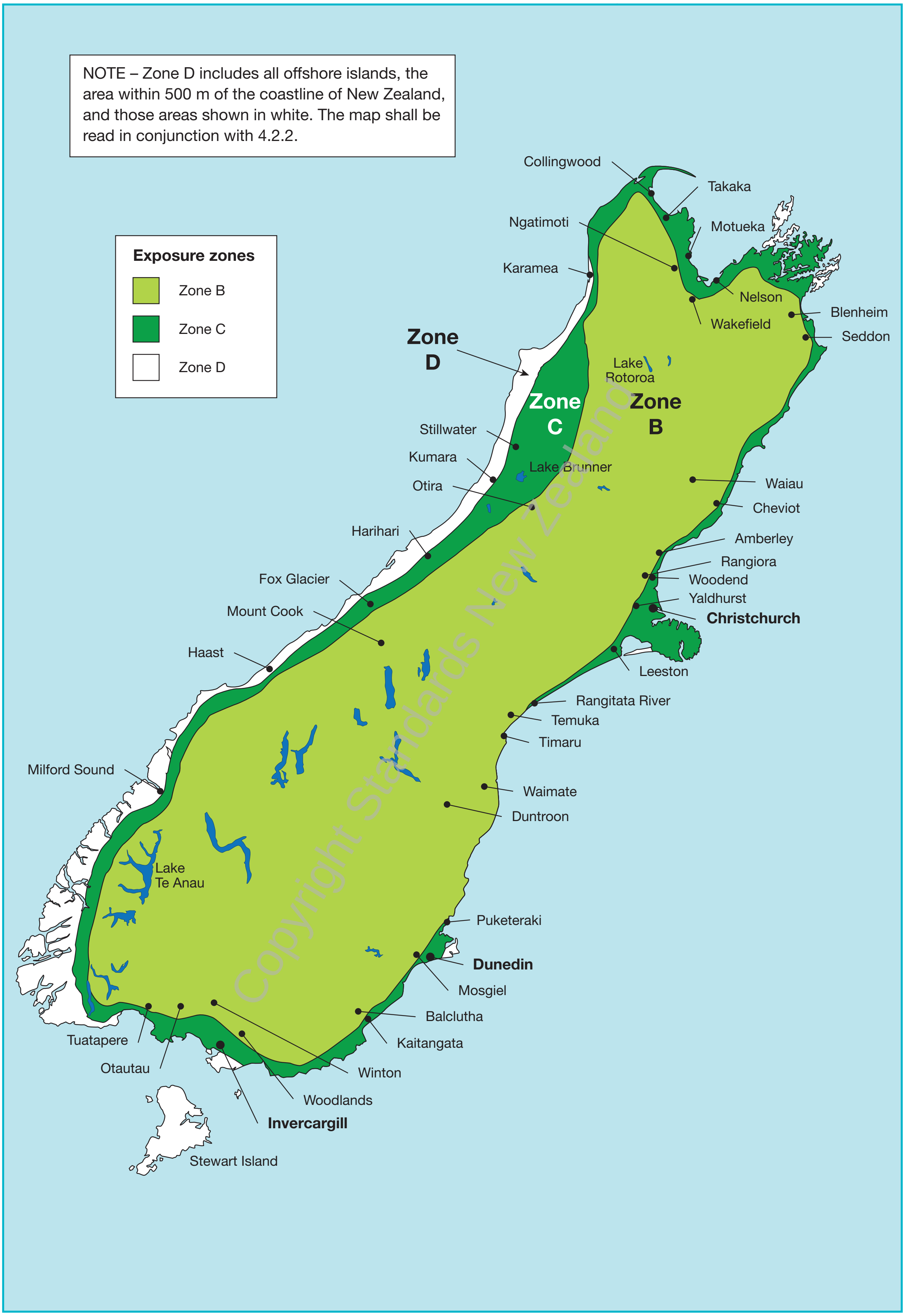


Figure 4.2 – Exposure zone map (continued) (see 4.2.2)

4.2.4 Microclimatic considerations

In addition to exposure zones, evidence of local environmental effects (microclimates), and those produced by the erection of a structure or installation of equipment, shall be considered. Such on-site factors require additional consideration because a mildly corrosive atmosphere can be converted into an aggressive environment by microclimatic effects. Indications of such local conditions may be in the form of corrosion of metal items on adjacent structures. Significant acceleration of the corrosion rate of structural fasteners and fixings beyond what could be expected from the geographical location can occur in the following circumstances:

(a) Industrial contamination and corrosive atmospheres;

(b) Contamination from agricultural chemicals or fertilisers; and

(c) Geothermal hot spots. Hot spots are defined as being within 50 m of a bore, mud pool, steam vent, or other source.

Microclimatic conditions (a) to (c) require *SED.*

4.3 TIMBER AND WOOD-BASED BUILDING COMPONENTS

4.3.1

For wood-based building components, preservative treatment, in-service moisture range and their end use environment shall comply with NZS 3602.

4.3.2

All timber and wood-based building components shall be protected against damage from moisture, and against significant variations of moisture content, both before and after installation or enclosure.

4.3.3 Timber

Framing timber shall be separated from concrete or concrete masonry in accordance with 2.3.3.

4.3.4 Wood-based building components

Wood-based building components used for flooring in areas such as in bathrooms, kitchens, laundries, and toilets shall be protected by an impervious finish or *lining* with sealed joints.

C4.3.4

E3/AS1 has a list of acceptable finishes and linings.

4.3.4.1 Water splash areas

See 2.3.6 to 2.3.8.

4.3.4.2 Medium density components

Medium density wood-based building components shall not be exposed to ground atmosphere or be used externally. They shall not be used for flooring. See 2.3.6 to 2.3.8.

4.3.5 Timber decks

Preservative treatment of members of timber *decks* shall comply with NZS 3602. Metal fixings and fastenings shall be as detailed in 4.4.

4.4 STEEL FIXINGS AND FASTENINGS

4.4.1

Table 4.1 sets out the protection required for steel fixings and fastenings to meet durability requirements. See figure 4.3(a) and figure 4.3(b). The following conditions apply:

(a) For subfloor fixings and fastenings, provide a well drained subfloor area free of ponding;

(b) Components of fixings and fastenings shall be of compatible metals and of durability at least equal to that required.

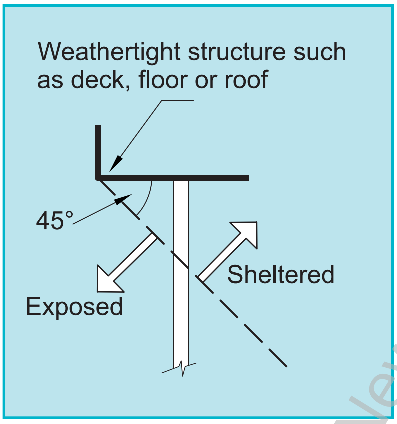


Figure 4.3(a) – Environment definitions "Sheltered" and "Exposed"

C4.4

Corrosion of ferrous fasteners will cause rapid deterioration of adjacent timber.

Manufacturers should clearly label their components to indicate the weight of the galvanizing.

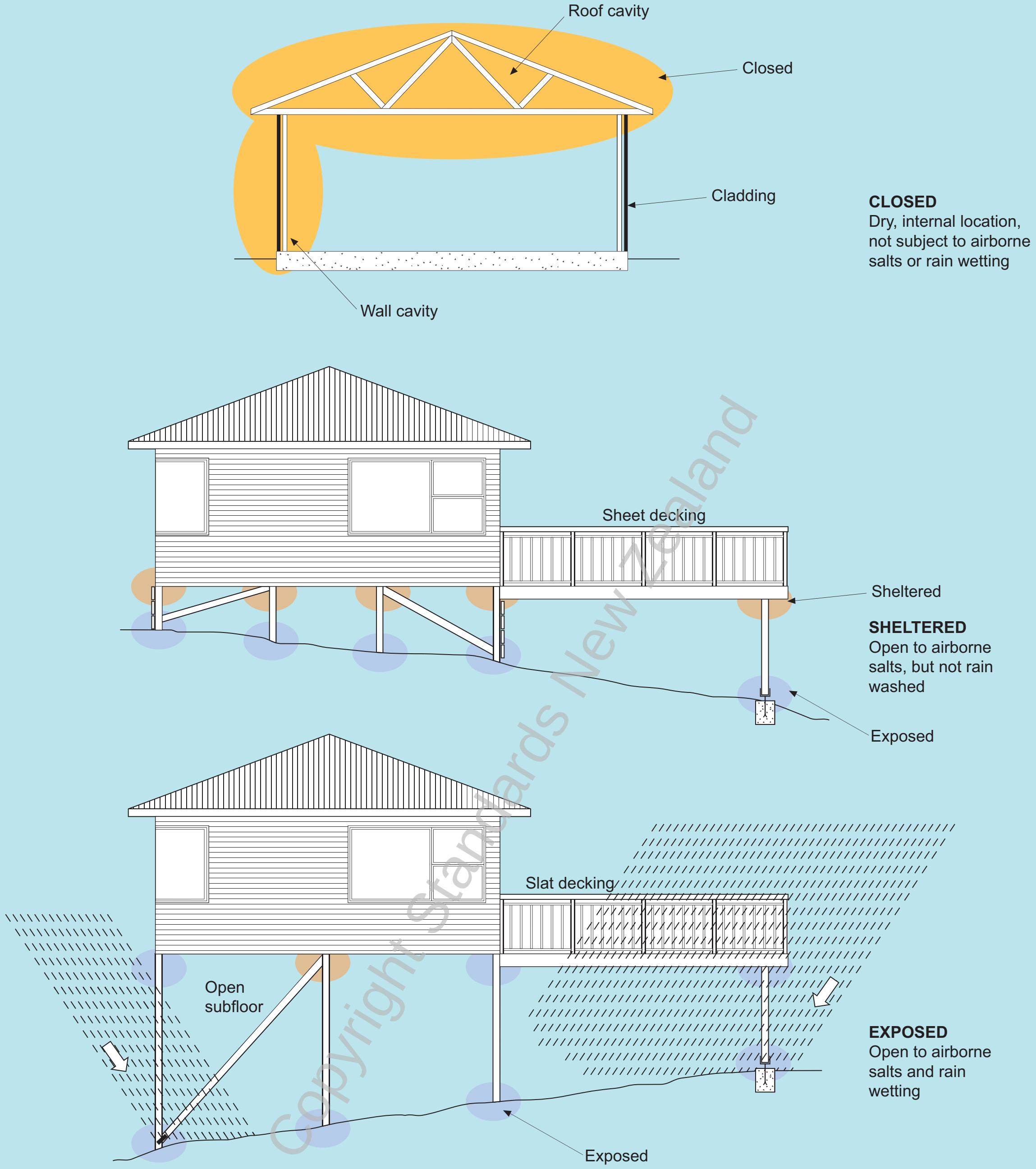


Figure 4.3(b) – Exposure definitions (see table 4.1 and figure 4.3(a))

Table 4.1 – Protection required for steel fixings and fastenings excluding nails and screws[1] (see 4.4.1)

ZONES	FIXING FASTENING	ENVIRONMENT		MATERIAL
ALL ZONES	Nail plates	CLOSED AND ROOF SPACES		Continuously coated galvanized steel[2]
	Wire dogs & bolts			Hot-dipped galvanized steel[2]
	All other structural fixings	CLOSED		Mild steel (uncoated, non-galvanized)[3]
ZONE D	All structural fixings	SHELTERED[4] AND EXPOSED		Type 304 stainless steel[5]
ZONES B AND C	Treated timber pile connections more than 600 mm from the ground and all subfloor connections	Subfloors vented 7000 mm^2 or less	SHELTERED[4]	Hot-dipped galvanized steel[2]
		Subfloors vented more than 7000 mm^2	EXPOSED	Type 304 stainless steel[5]
	Treated timber pile connections within 600 mm of the ground	SHELTERED[4] AND EXPOSED		Type 304 stainless steel[5]
	All other structural fixings, except fabricated brackets[6]	SHELTERED[4]		Hot-dipped galvanized steel[2]
		EXPOSED		Type 304 stainless steel[5]

(1) Items described in this table are steel fasteners required to last not less than 50 years, used for joining timber, such as nail plates, bolts, brackets, wire dogs and similar, but not including nails or screws (which are described in table 4.3).
(2) All galvanizing weights to steel shall be as given in table 4.2.
(3) Steel fixings in timber treated with copper-based timber preservatives shall be as per 4.4.4.
(4) "Sheltered" shall be that above a 45° line drawn from the lower edge of a projecting weathertight structure such as a floor, roof or deck. "Exposed" shall be below that 45° line. See figure 4.3(a) and (b).
(5) Type 304 stainless steel is sufficient to comply with NZBC requirements, but may have surface rust. Type 316 may be used where appearance is a consideration but exceeds the requirements of the NZBC.
(6) "Fabricated brackets" shall be made from 5 mm (minimum thickness) mild steel and shall be hot-dipped galvanized.

4.4.2

Galvanized steel components shall have galvanized coating masses in accordance with table 4.2.

Table 4.2 – Galvanizing of steel components other than nails and screws (see 4.4.2)

Component	Standard	Protection required
Bolts in any location that require galvanizing (see table 4.1)	AS/NZS 4680 and AS 1214	600 g/m^2 average
Nail plates used in sheltered locations Nail plates used in exposed locations	AS 1397 AS/NZS 4680	Z275 pre-galvanized sheet 390 g/m^2
Brackets used in sheltered locations Brackets used in exposed locations	AS/NZS 4680 AS/NZS 4680	390 g/m^2 600 g/m^2
Nail plates used in roof spaces	AS 1397	Z275 pre-galvanized sheet
Wire dogs in any location that require galvanizing (see table 4.1)	AS/NZS 4534	150 g/m^2 (Zn + 5 % Al)

4.4.3 Nails

The materials for nails and screws shall be as given in table 4.3.

Table 4.3 – Steel items such as nails and screws used for framing and cladding (see 4.4.3)

Building location	Nail or screw use				
	Cladding that acts as bracing (50-year durability)	Non-structural cladding (15-year durability)	Framing in "Closed" areas(1) including roof spaces	Framing in "Sheltered" areas(1)	Framing in "Exposed" areas(1)
Zone D	Stainless steel(2) or silicon bronze or protected galvanized steel(3)	Galvanized steel(4)	Mild steel(5)	Galvanized steel(5)	Stainless steel(2)
Zones B & C	Galvanized steel(4)	Galvanized steel(4)	Mild steel(5)	Galvanized steel(5)	Galvanized steel(5)

(1) For definitions of "closed", "sheltered", and "exposed" see table 4.1 and figure 4.3(a) and (b).
(2) Stainless steel nails shall be minimum Type 304 and shall have annular grooves to provide similar withdrawal resistance to hot-dipped galvanized nails.
(3) Protection of galvanized steel nails shall consist of putty and an exterior painting system consisting of a primer undercoat and 2 top coats of oil-based or acrylic paint.
(4) Where the cladding is a corrosive timber, such as western red cedar or redwood, or is treated with copper-based ACQ or CuAz preservatives, use stainless steel (2) or silicon bronze.
(5) Steel fixings in timber treated with copper-based preservatives shall be as per 4.4.4.
(6) Irrespective of the above, nails and screws shall be compatible with any fixing plate that is used with them.
(7) Nails and screws and other fixings into piles within 600 mm of the ground shall be stainless steel.
(8) Galvanized nails shall be hot-dipped galvanized to a minimum of 320 g/m^2; galvanized screws shall be mechanically zinc plated in accordance with AS 3566: Part 2, Class 4.
(9) Type 304 stainless steel is sufficient to comply with NZBC requirements, but may have surface rust. Type 316 may be used where appearance is a consideration but exceeds the requirements of the NZBC.

4.4.4 Copper-based timber preservatives

Steel fixings and fastenings in contact with timber treated with copper-based timber preservatives (H3.2 or higher) shall be as per table 4.1 and table 4.3 but shall also be a minimum of:

(a) Type 304 stainless steel for fixings in contact with timber treated with Copper Azole, or Alkaline Copper Quaternary (ACQ) preservatives, where used in exposed or sheltered locations;

(b) Hot-dipped galvanized for all other locations.

4.5 CONCRETE AND CONCRETE MASONRY

C4.5

The provisions of this clause provide for a life of not less than 50 years. More economic designs could result in some cases if the more detailed provisions of NZS 3101 are followed, but such designs are not within the scope of this Standard.

4.5.1

Minimum concrete cover to steel *reinforcement* shall be:

(a) 75 mm when concrete is placed directly on or against the ground;

(b) 50 mm in all other situations where the concrete is placed in formwork provided the concrete specifications follow the provisions of 4.5.2;

(c) 30 mm from the top of a *wall* or floor slab which is in a closed area or 50 mm from the top of any exposed *wall* or floor slab.

4.5.2

The minimum specified 28-day concrete strength, complying with NZS 3104 and NZS 3109 shall be:

(a) 10 MPa for unreinforced concrete used in mass *foundations*;

(b) 17.5 MPa for unreinforced concrete applications, or reinforced concrete either not exposed to weather or exposed to the weather in Zone B as shown in figure 4.2;

(c) 20 MPa for reinforced concrete exposed to weather in Zone C as shown in figure 4.2;

(d) 25 MPa for reinforced concrete exposed to weather in Zone D as shown in figure 4.2;

(e) Specially selected from NZS 3101 table 5.3 where a direct wearing concrete floor is required;

(f) Geothermal hot spots shall be to SED.

4.5.3

Concrete masonry shall:

(a) Comply with the provisions of NZS 4210;

(b) Have minimum cover to steel *reinforcement* from an uncoated masonry external face and minimum grout strength of:

45 mm and 17.5 MPa for interior conditions and Zone B;
50 mm and 20 MPa for Zone C;
60 mm and 25 MPa for Zone D.

SECTION 5

BRACING DESIGN

Table

Figure

5 BRACING DESIGN

5.1 GENERAL

5.1.1

Foundation systems and *wall bracing* shall be designed and built to provide *bracing capacity* that exceeds the *bracing demand*.

5.1.2 Bracing demand – Determination of horizontal forces

The horizontal wind and earthquake forces are measured in "*bracing units*" (BUs). They shall be determined as set out in 5.2 (wind) and 5.3 (earthquake).

5.1.3 Bracing capacity – Design of bracing to resist horizontal forces

The provision of *bracing capacity* to resist the horizontal *bracing demand* forces is also expressed in BUs and shall be determined from 5.4 and 5.5.

5.1.4 Bracing design objective

Bracing capacity provided by the *bracing* systems designed to 5.4 and 5.5 shall be greater than the *bracing demand* determined from 5.2 and 5.3.

5.1.5 Wings, blocks and discontinuous floor or ceiling levels

When a building consists of *wings* or *blocks* which extend more than 6 m from the remainder of the building, then each such *wing* or *block* shall be required to provide sufficient *bracing* individually.

When a building has split levels, each level shall provide sufficient *bracing* individually and there shall be a *wall* and subfloor *bracing line* at the location of the discontinuity.

When a building has discontinuous floors or ceilings with a step greater than 100 mm in the finished levels, there shall be a *bracing line* in the *storey* below at the location of the discontinuity. *Bracing elements* in the *storey* below shall be continuous up to the underside of the upper levels.

C5.1.1

Wind and earthquake exert horizontal forces on buildings. Bracing design involves the determination of both the extent of these forces, called the bracing demand, and the capacity of the building and its elements to resist these forces, called bracing capacity.

Dragon ties and diaphragms do not contribute to bracing capacity themselves but may be used to achieve greater spacing of wall bracing elements. This section sets out the methodology for design of bracing systems. Bracing of walls is also described in 8.3. Bracing of roofs is covered in section 10.

C5.1.2

Bracing demand is presented as BUs per metre of wall length for wind and per square metre of floor area for earthquake. 1 kilo Newton (kN) equals 20 BUs. 1 BU is approximately equal to a 5 kilogram force.

C5.1.3

Bracing capacity as determined using the BRANZ Technical Paper P21 test is also expressed in bracing units representing the mean ultimate loads recorded for three identical specimens. The use of BUs is intended for NZS 3604 construction and assumes inherent redundancies. BUs do not represent characteristic values and reduction factors may be appropriate when using BUs in specific engineering design (SED). See also 8.3.1.2.

C5.2

Land formations in New Zealand modify the ocean winds flowing over the country. Wind speed (and resulting pressure) increases as the wind passes over and between hills, or through valleys. Wind speed is reduced when passing over rough ground (drag effect). The particular shapes of the hills and valleys (topography) and the extent of shelter in the upwind direction (site exposure) also influence the wind speed at the building site.

5.2 WIND BRACING DEMAND

The wind *bracing demand* on the structure shall be assessed on the basis of the building location, the building size and shape, and the level within the building being considered.

5.2.1 Wind zone

The wind zone shall be determined following the procedures outlined in table 5.1.

Table 5.1 – Procedure for determination of wind zones

Steps	Action	Reference	Values available
1	Determine wind region	Figure 5.1	A, W
2	Determine if in a lee zone	Figure 5.1	See table 5.4
3	Determine ground roughness	5.2.3	Urban terrain Open terrain
4	Determine site exposure	5.2.4	Sheltered / exposed
5	Determine topographic class	From tables 5.2, 5.3 and figure 5.2	Gentle to steep
6	Determine wind zone	Table 5.4	L, M, H, VH, EH

C5.2.2

The wind regions are based on wind speed data supplied by the Meteorological Service of New Zealand Ltd (MetService) and included in AS/NZS 1170. Wind speeds have a 2 % probability of being exceeded in 50 years. Figure 5.1 has been prepared for buildings with an eaves height of 8 m above ground, by considering the modified wind speed as outlined in AS/NZS 1170. Open ground and urban roughness definitions in this Standard correspond respectively to terrain categories 2 and 3 of AS/NZS 1170: Part 2.

5.2.2 Wind regions

Wind regions shall be as indicated in figure 5.1.

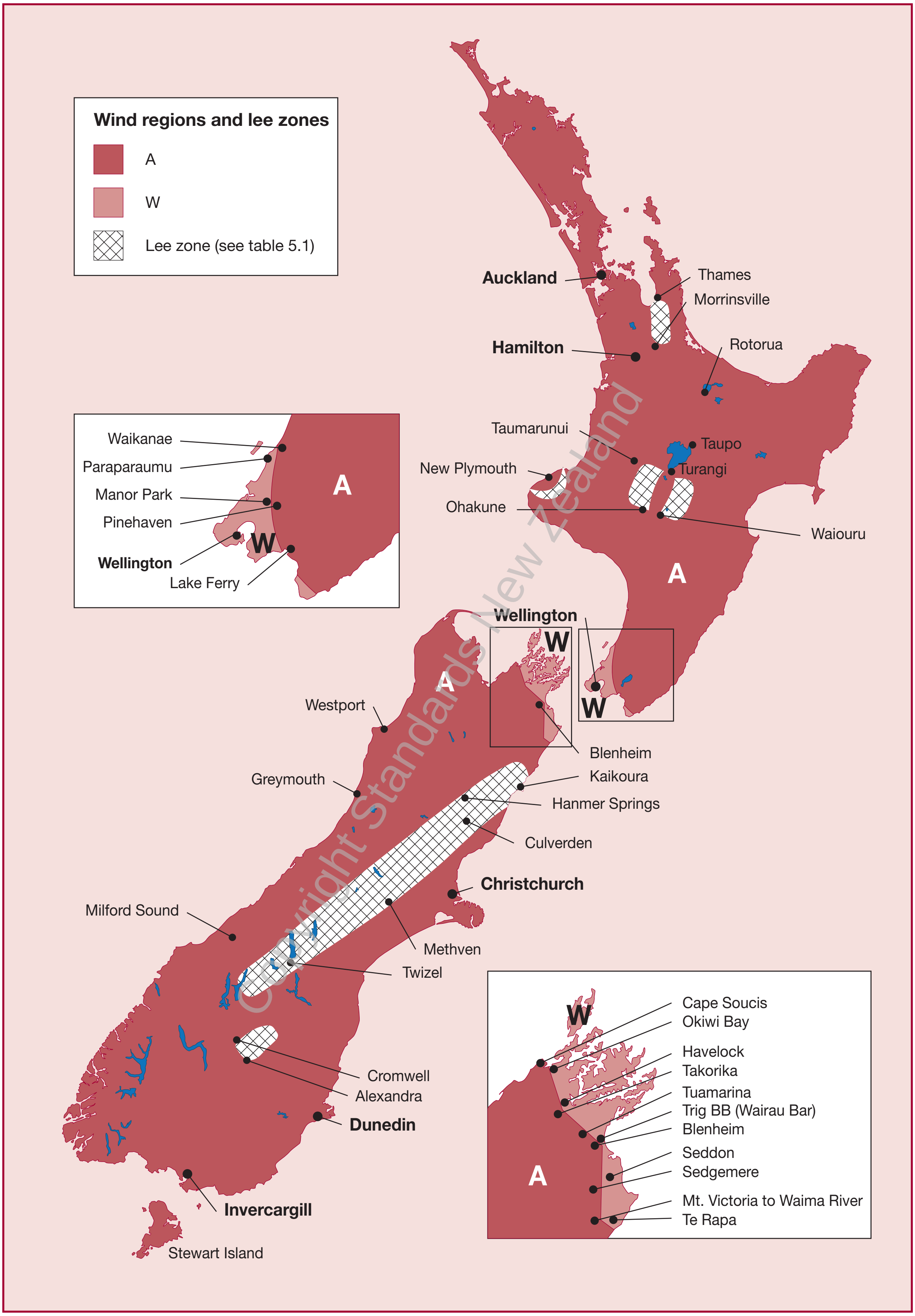


Figure 5.1 – Wind regions and lee zones (see 5.2.2)

5.2.3 Ground roughness

The ground roughness of the site shall be determined by considering the number, type and height of obstructions over which the wind passes as it approaches the site, using the definitions below. The ground roughness shall be considered in all directions, with the most severe condition used to establish the site/ground roughness.

Urban terrain: more than 10 obstructions, houses or trees (3 m high) per hectare.

Open terrain: grazed pastures, cropping, or areas adjacent to beaches and the sea, or airfields and other areas with only isolated trees or shelter.

Sites within a 500 m wide fringe of the boundary between urban and open terrain shall be considered open terrain.

5.2.4 Site exposure

C5.2.4

Typical New Zealand suburban developments on flat or gently undulating ground are usually "sheltered". The wind speeds in AS/NZS 1170 have been modified for this Standard in urban terrain to reflect the shielding effect. Factors of 0.85 have been applied to such "sheltered" and "exposed" sites. No shelter is possible on steep sites as defined in table 5.2.

Site exposure for a building shall be determined by assessing the shielding effects of obstructions to wind flow around the site using the following definitions, and assuming that the wind can come from any direction.

Sheltered: at least 2 rows of similarly sized, permanent obstructions at the same *ground level* all around.

Exposed: steep sites as defined in table 5.2 or sites adjacent to playing fields or other open spaces, beach fronts, large rivers, motorways, or adjacent to wind channels greater than 100 m in width.

5.2.5 Topographic class

C5.2.5

Wind accelerates as it flows over hills, through channels and over mountains. The type of landform (escarpment or hill/ridge) and the character of the formation (steep, moderate, or gentle which is described by the "smoothed gradient") also affect flow.

Slopes should be determined using appropriate contour maps (e.g. Google Earth or similar).

The steps in table 5.2 and categories in tables 5.3 and 5.4 shall be used to determine the topographic class of the site. The "smoothed gradient" (see figure 5.2) shall be measured over an upwind horizontal distance from the crest of the lesser of 3 times the height of the hill (H) or 500 m. The "smoothed gradient" is the ratio of the change of elevation divided by the relevant distance (h/L). See figure 5.2.

An escarpment is defined as the region, beyond a crest, having a rise or fall less than 1:20. See figure 5.2.

Table 5.2 – Procedure for determination of topographic class, T1 – T4

Steps	Action	Reference	Values available
1	Determine hill height and formation	Figure 5.2	Hill, Escarpment
2	Determine smoothed gradient value and class	Figure 5.2	Low to Steep
3	Determine topography	Figure 5.2	Crest / Outer
4	Determine site exposure	5.2.4	Sheltered/exposed
5	Determine topographic class	5.2.5, table 5.3	–

In this table	Gentle =	Gradient	< 0.05	i.e. slope max.	1:20
	Low =	Gradient	0.05 < 0.1	i.e. slope max.	1:10
	Mild =	Gradient	0.1 < 0.15	i.e. slope max.	1:6.7
	Moderate =	Gradient	0.15 < 0.2	i.e. slope max.	1:5
	Steep =	Gradient	> 0.2	i.e. slope max.	1:5

Table 5.3 – Determination of topographic class

Topography	Gentle	Low	Mild	Moderate	Steep
Crest	T1	T2	T3	T4	T4
Outer	T1	T1	T2	T2	T3

All sites outside the outer and crest zones are topographic class T1 except that:

(1) Sites within valleys which are known to have accelerated wind flows within them because of their shape and exposed mouths shall be classed as T4.

(2) Sites in areas with undulations of less than 10 m in height, and gradients less than 1:20 shall be classed as T1.

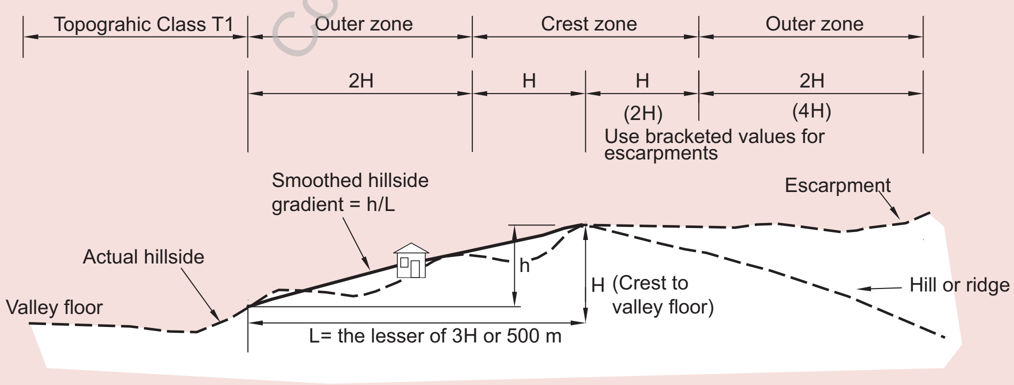


Figure 5.2 – Topography (including escarpment conditions)

Table 5.4 – Determination of wind zone

Region	Ground roughness	Topographic class and site exposure							
		T1		T2		T3		T4	
		Sheltered	Exposed	Sheltered	Exposed	Sheltered	Exposed	Sheltered	Exposed
A	Urban	L	M	M	H	H	H	H	VH
	Open	M	H	H	VH	H	VH	VH	EH
W	Urban	M	H	H	VH	H	VH	EH	EH
	Open	H	VH	VH	EH	VH	EH	SED	SED

NOTE –
Wind speeds below are the maximum ultimate limit state wind speed for each wind zone.
L = Low wind speed of 32 m/s
M = Medium wind speed of 37 m/s
H = High wind speed of 44 m/s
VH = Very high wind speed of 50 m/s
EH = Extra high wind speed of 55 m/s
SED = Specific engineering design (not covered by this Standard)

Winds in lee zones shall be increased as follows:
Low wind becomes High
Medium wind becomes Very high
High wind, and above become SED

C5.2.6

For roof pitches below 25° the horizontal loads on the roof are small compared with the loads on the walls. For this reason the gable overhang and eaves are ignored for calculation purposes.

For steeper roofs the horizontal loads on the roof are significant and the overall roof length (including overhangs) is used for calculations.

5.2.6 Determination of wind bracing demand

The influence on the wind *bracing demand* of the building size and shape and location of *bracing elements* within the building height is incorporated in tables 5.5 to 5.7.

The overall wind *bracing demand* on the building shall be determined by multiplying the value obtained from tables 5.5 to 5.7 (including the factor in the notes) by the building length (for calculating *bracing demand* across) and width (for calculating *bracing demand* along), where length and width are measured perpendicular to the direction of the wind (figure 5.3). The building *wall* length and width shall be used where the *roof* pitch is 25° or less, and the *roof* dimensions where the *roof* pitch is greater than 25°.

5.2.7 Mono-pitch roofs

For buildings with mono-pitch *roofs* the *roof* height above eaves shall be taken as the difference between the lower eaves height and the *roof* apex.

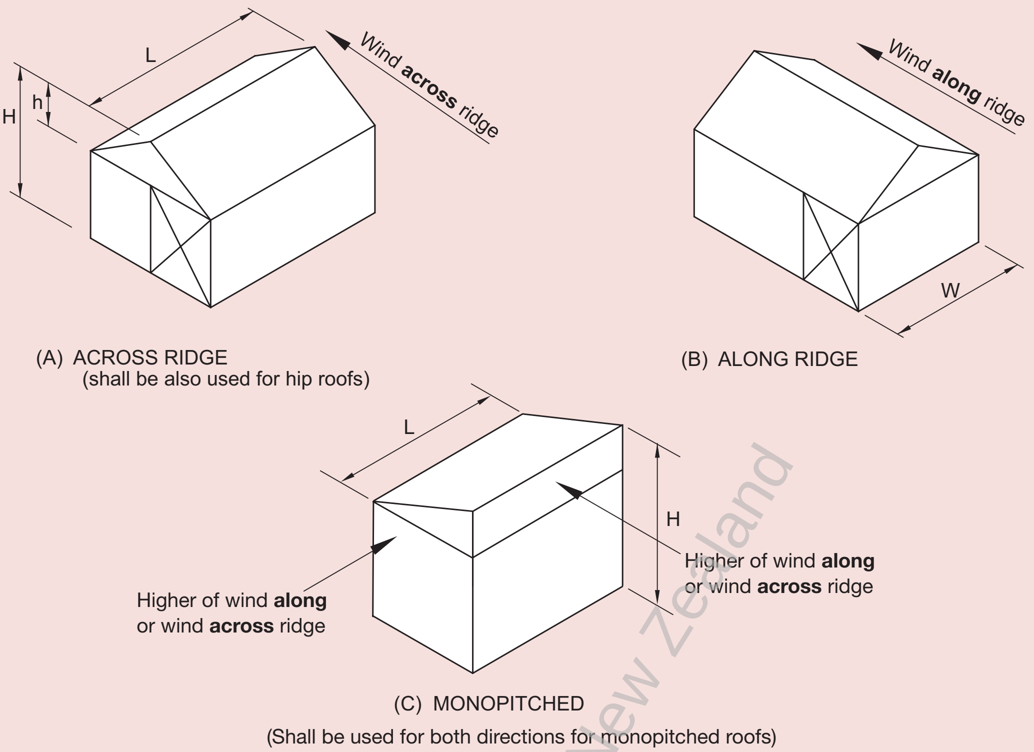
The wind demand in BU/m in both the ALONG and ACROSS directions shall be taken as the higher of the two.

5.2.8 Roofs with hip ends

For buildings with hip *roofs* the ACROSS values in tables 5.5 to 5.7 shall be used to determine the *bracing demand* in both ALONG and ACROSS directions.

5.2.9 Wind bracing demand for decks

Wind *bracing demand* for *decks* may be ignored.



NOTE –
Bracing shall be provided parallel to the wind direction

H = - Average height of finished ground level to apex for subfloor structure see table 5.5.
- Single or upper finished floor level to apex for single or upper storey see table 5.6.
- Lower finished floor level to apex for lower of two storeys see table 5.7.

h = Roof height above eaves.

Figure 5.3 – Direction of wind and braced walls

Table 5.5 – Wind bracing demand for subfloor structure (BU/m)

Average ground to apex (H)	Roof height above eaves (h)	High Wind Zone	
(m)	(m)	Across	Along
4	0 1	80 60	80 70
5	0 1 2	100 80 75	100 90 80
6	0 1 2 3	120 105 95 95	120 115 100 90
7	0 1 2 3 4	155 130 120 115 124	155 135 125 115 100
8	0 1 2 3 4 5	180 150 145 140 145 175	180 160 150 135 125 115
9	0 1 2 3 4 5 6	200 175 165 160 170 220 200	200 180 170 160 150 135 125
10	0 1 2 3 4 5 6 7	220 200 190 185 195 220 220 220	220 205 195 180 170 160 150 140

NOTE –	Wind zone	Factor
(1) These figures relate to **High Wind Zone**. (2) In wind zones other than High, multiply the figure from the table by the appropriate factor given opposite.	Low Medium Very high Extra high	0.5 0.7 1.3 1.6

Table 5.6 – Wind bracing demand for single or upper storey walls (BU/m)

Single or upper floor level to apex (H)	Roof height above eaves (h)	High Wind Zone	
(m)	(m)	Across	Along
3	0	35	35
	1	30	35
4	0	45	45
	1	40	45
	2	40	45
5	0	55	55
	1	50	55
	2	50	55
	3	60	55
6	1	60	65
	2	60	65
	3	75	65
	4	95	65
7	2	75	80
	3	85	80
	4	105	80
	5	135	80
8	3	95	90
	4	115	90
	5	145	90
	6	155	90
9	4	125	100
	5	155	100
	6	165	100
	7	180	100
10	5	165	110
	6	180	110
	7	190	110
	8	200	110

NOTE –		
(1) These figures relate to **High Wind Zone**. (2) In wind zones other than High, multiply the figure from the table by the appropriate factor given opposite.	Low	0.5
	Medium	0.7
	Very high	1.3
	Extra high	1.6

Table 5.7 – Wind bracing demand for lower of two storeys (BU/m)

Lower floor level to apex (H)	Roof height above eaves (h)	High Wind Zone	
(m)	(m)	Across	Along
6	0	100	100
	1	80	90
	2	75	80
	3	75	70
7	0	120	120
	1	105	110
	2	95	100
	3	95	90
	4	105	80
8	0	145	145
	1	125	135
	2	120	120
	3	120	110
	4	125	100
	5	145	90
9	0	165	165
	1	150	155
	2	140	145
	3	140	135
	4	150	120
	5	165	110
	6	165	100
10	0	190	190
	1	170	180
	2	160	165
	3	160	155
	4	170	145
	5	190	135
	6	190	120
	7	190	110

NOTE – (1) These figures relate to **High Wind Zone**. (2) In wind zones other than High, multiply the figure from the table by the appropriate factor given opposite.	Low Medium Very high Extra high	0.5 0.7 1.3 1.6

5.3 EARTHQUAKE BRACING DEMAND

5.3.1 Procedure for determining earthquake bracing demand

The earthquake *bracing demand* on the building structure shall be assessed on the basis of the building location (earthquake zone), subsoil type on which the building is sited, the level of the building under consideration, the building size, the roofing and *cladding* weights and floor live *loads*. This section shall be used to determine the *bracing demand* for buildings with floor live *loads* of 2 kPa or less. Section 14 shall be used for 3 kPa floor live *loads*.

The overall earthquake *bracing demand* shall be determined from tables 5.8, 5.9 and 5.10 (or tables 14.1, 14.2 and 14.3 for 3 kPa *floor loads*). The figure obtained from the table shall be multiplied by the appropriate factor given in the table's note depending on the building's earthquake zone as given in 5.3.2 and site subsoil classification as determined from 5.3.3. This value shall then be multiplied by the gross floor area in square metres, at the level of the building being considered.

5.3.2 Earthquake zone

The earthquake zone shall be determined from figure 5.4.

5.3.3 Site subsoil classification and earthquake multipliers

The site subsoil, classified in accordance with NZS 1170.5, NZS 1170.5 Supplement 1 and 3.1.3 of NZS 3604 shall be that advised by the *territorial authority* recorded in geotechnical completion reports under NZS 4404, or read from GNS Science QMAPS. If this information is not available then the site subsoil classification shall be taken as Class E unless *SED* is conducted.

5.3.4 Additional earthquake bracing demand

Additional earthquake *bracing demand* shall apply in accordance with 5.3.4.1 to 5.3.4.5.

5.3.4.1 Buildings with timber-framed storeys

For all buildings with only timber-framed *storeys* use tables 5.8, 5.9 and 5.10 (or tables 14.1, 14.2 and 14.3 for 3 kPa *floor loads*), except that where there is a *part storey* in a *roof* space, 5.3.4.3 applies and where there is a *part storey* basement, 5.3.4.4 applies.

5.3.4.2 Buildings with a concrete masonry lower storey

Where a building has a concrete masonry lower *storey*, the *bracing demand* for the timber framed upper *storey* shall be calculated as a single-*storey* building using tables 5.8, 5.9 and 5.10 (or tables 14.1, 14.2 and 14.3 for 3 kPa *floor loads*) assuming a heavy subfloor *cladding*.

C5.3.3

The amplification of the surface shaking above the underlying rock subjected to earthquake motions is dependent on the depth and flexibility of the intervening soils.

Site subsoil classifications in accordance with 5.3.3 are as follows:

Class A - Strong rock;

Class B - Rock;

Class C - Shallow soil sites;

Class D - Deep or soft sites; or

Class E - Very soft soil sites

Site subsoil classifications are often held by territorial authorities as part of their natural hazard records as required by section 35 of the Resource Management Act, or GNS Science QMAPS available from the GNS website.

Site subsoil classification enables the calculation of earthquake bracing demand in buildings on different types and depths of soils over rock. The earthquake forces in buildings on Class D and Class E sites can be 65 % greater than on rock sites.

Site classifications determined by SED require geotechnical investigation or specialist knowledge. Such determinations are outside the scope of NZS 3604 and need to be checked by the building consent authority as part of the building consent process.

Table 3.2 of NZS 1170.5 sets out the maximum depth limits, soil types and strengths for Site Subsoil Class C. Once the soil types and depths are known, a judgement can be made on site subsoil class for the level of bracing demand appropriate to the site.

The bracing demand tables are based on Soil Type E (very soft soils) being a catch-all value where no soil classification has been provided or Soil Type E is present.

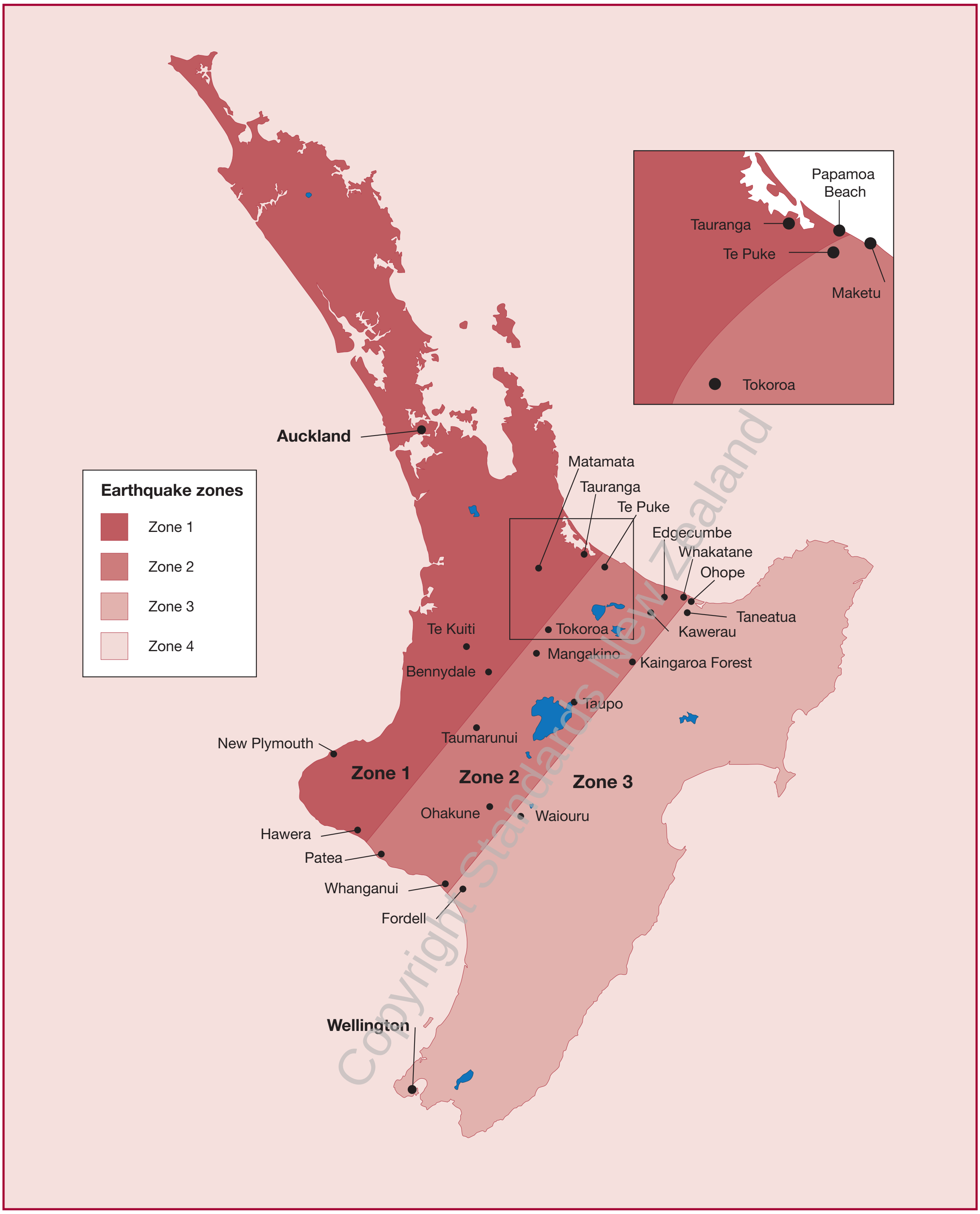


Figure 5.4 – Earthquake zones (see 5.3.2)

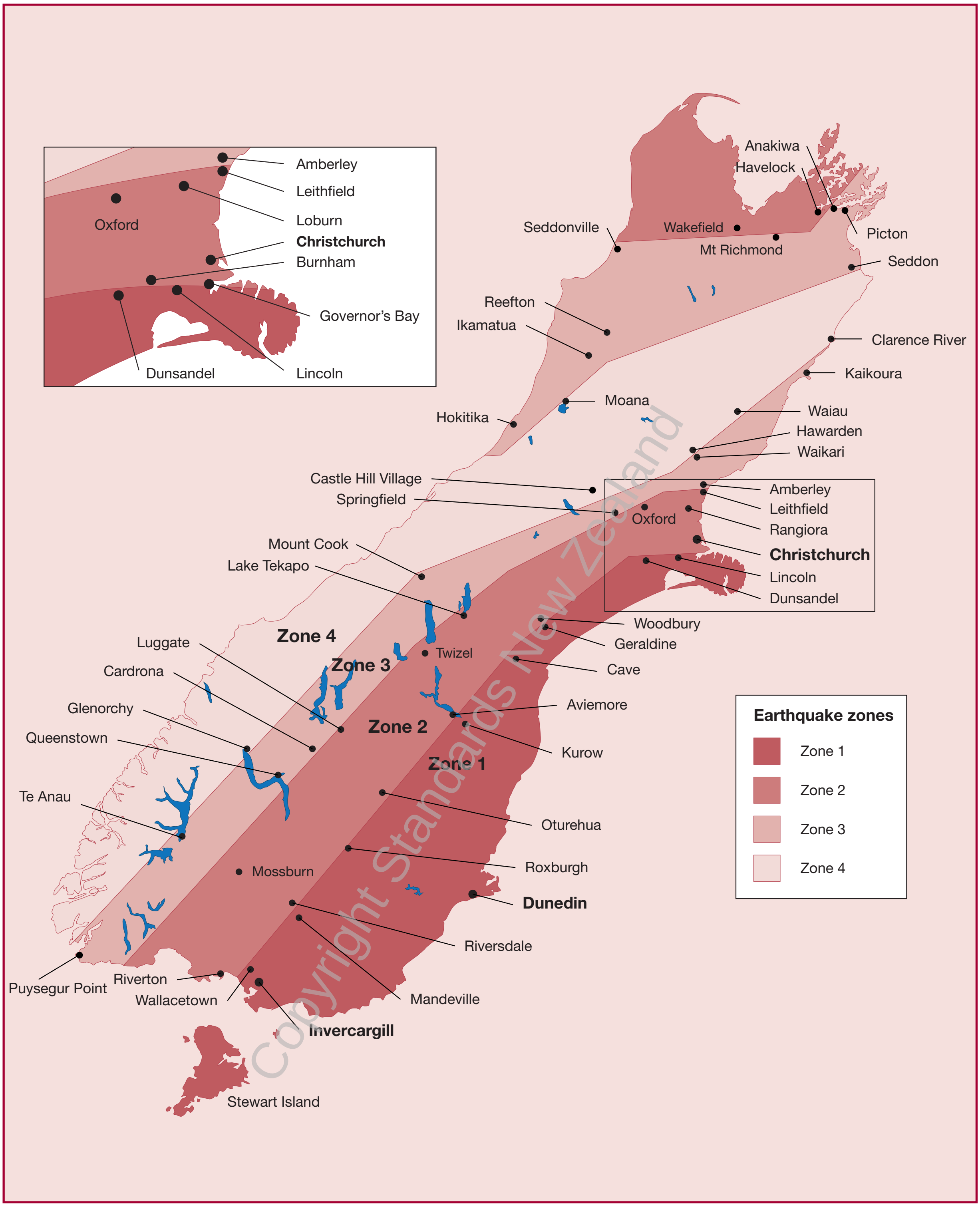


Figure 5.4 – Earthquake zones (continued) (see 5.3.2)

5.3.4.3 Part storey in a roof space

Where a *part storey* is contained in a *roof* space the *bracing demand* values in tables 5.8, 5.9 and 5.10 (or tables 14.1, 14.2 and 14.3 for 3 kPa *floor loads*) shall be increased by 4 BUs/m^2.

5.3.4.4 Part storey basement

Where a *part storey* is contained in a timber-framed basement, then, for the purpose of calculating the *bracing demand*, the building shall be regarded as being two buildings, one of two *storeys* and the other of one *storey*. The demand for each "building" shall be determined as appropriate.

5.3.4.5 Masonry and concrete chimneys

The *bracing demand* shall be increased where a masonry or concrete chimney is reliant on the building structure for lateral support. Where there is a chimney the additional *bracing demand* shall be calculated as described in B1/AS3.

Table 5.8 – Bracing demand for various combinations of cladding on single-storey buildings on subfloor framing (2 kPa floor load, soil type D/E, earthquake zone 3) (see 5.3.1)

Roof cladding	Single-storey cladding	Subfloor cladding	Roof pitch degrees	Subfloor structure	Single-storey walls
				BU/m²	
Light roof	Light	Light and Medium	0-25 25-45 45-60	15 16 17	11 11 13
		Heavy	0-25 25-45 45-60	17 18 19	11 12 13
	Medium	Medium	0-25 25-45 45-60	18 18 19	12 13 14
		Heavy	0-25 25-45 45-60	20 20 22	13 14 15
	Heavy	Heavy	0-25 25-45 45-60	27 28 29	18 19 20
Heavy roof	Light	Light and Medium	0-25 25-45 45-60	19 21 24	15 17 21
		Heavy	0-25 25-45 45-60	21 23 26	16 18 22
	Medium	Medium and Heavy	0-25 25-45 45-60	22 24 27	17 19 23
	Heavy	Heavy	0-25 25-45 45-60	31 33 36	23 25 29

Multiplication factors		EQ zone			
Soil class		1	2	3	4
A & B	Rock	0.3	0.5	0.6	0.9
C	Shallow	0.4	0.6	0.7	1.1
D & E	Deep to Very soft	0.5	0.8	1.0	1.5

NOTE – See 5.3.4 for additional bracing demand.

Table 5.9 – Bracing demand for various combinations of cladding for two-storey buildings on subfloor framing (2 kPa floor load, soil type D/E, earthquake zone 3) (see 5.3.1)

Roof cladding	Upper storey cladding	Lower storey cladding	Subfloor cladding	Roof pitch degrees	Subfloor	Lower storey walls	Upper storey walls
					BU/m²		
Light roof	Light	Light	Light to Heavy	0-25 25-45 45-60	23 24 25	21 21 22	11 12 13
		Medium	Medium and Heavy	0-25 25-45 45-60	26 27 28	23 24 25	11 12 14
		Heavy	Heavy	0-25 25-45 45-60	34 35 36	30 31 32	12 13 15
	Medium	Medium	Medium and Heavy	0-25 25-45 45-60	30 30 31	26 27 28	13 14 15
		Heavy	Heavy	0-25 25-45 45-60	38 39 40	34 34 35	14 15 16
	Heavy	Heavy	Heavy	0-25 25-45 45-60	48 49 50	43 44 45	18 19 21
Heavy roof	Light	Light	Light to Heavy	0-25 25-45 45-60	27 29 32	25 27 30	16 18 22
		Medium	Medium and Heavy	0-25 25-45 45-60	30 32 35	28 29 33	17 19 23
		Heavy	Heavy	0-25 25-45 45-60	39 40 44	35 37 40	18 21 25
	Medium	Medium and Heavy	Medium and Heavy	0-25 25-45 45-60	34 36 39	31 33 36	18 21 25
	Heavy	Heavy	Heavy	0-25 25-45 45-60	52 54 57	47 49 53	24 27 31

Multiplication factors		EQ zone			
Soil class		1	2	3	4
A & B	Rock	0.3	0.5	0.6	0.9
C	Shallow	0.4	0.6	0.7	1.1
D & E	Deep to Very soft	0.5	0.8	1.0	1.5

NOTE – See 5.3.4 for additional bracing demand.

Table 5.10 - Bracing demand for various combinations of cladding for single and two-storey buildings on concrete slab-on-ground (2 kPa floor load, soil type D/E, earthquake zone 3) (see 5.3.1)

Roof cladding	Single or upper storey cladding	Lower storey cladding	Roof pitch degrees	Single storey walls	Lower storey walls	Upper storey walls
				BU/m²		
Light roof	Light	Light	0-25 25-45 45-60	6 6 7	15 16 17	9 9 10
		Medium	0-25 25-45 45-60	N/A N/A N/A	17 18 19	9 10 11
		Heavy	0-25 25-45 45-60	N/A N/A N/A	23 23 24	10 11 12
	Medium	Medium	0-25 25-45 45-60	6 7 8	20 20 21	10 11 12
		Heavy	0-25 25-45 45-60	N/A N/A N/A	25 26 27	11 12 13
	Heavy	Heavy	0-25 25-45 45-60	9 9 11	33 33 34	15 16 17
Heavy roof	Light	Light	0-25 25-45 45-60	10 11 15	19 21 24	13 15 19
		Medium	0-25 25-45 45-60	N/A N/A N/A	21 23 26	14 16 19
		Heavy	0-25 25-45 45-60	N/A N/A N/A	27 29 32	15 17 21
	Medium	Medium and Heavy	0-25 25-45 45-60	11 12 16	24 26 29	15 17 21
	Heavy	Heavy	0-25 25-45 45-60	13 15 18	37 38 42	20 22 26

Multiplication factors		EQ zone			
Soil class		1	2	3	4
A & B	Rock	0.3	0.5	0.6	0.9
C	Shallow	0.4	0.6	0.7	1.1
D & E	Deep to Very soft	0.5	0.8	1.0	1.5

NOTE – See 5.3.4 for additional bracing demand.

5.4 WALL BRACING DESIGN

Wall bracing shall be designed and constructed in accordance with this clause to resist the *bracing demand* for wind and earthquake determined from 5.2 and 5.3. *Wall bracing elements* shall extend from the *bottom plate* at floor level to the *top plate* at ceiling level.

5.4.1 Wall bracing systems

To resist horizontal *loads* in any *storey, wall bracing elements* complying with 8.3 shall be incorporated in the following *walls*:

(a) External *braced walls* as required by 5.4.3 and 5.4.7; and

(b) Internal *braced walls* on *bracing lines* as required by 5.4.3 and 5.4.7;

(c) *Braced walls* connected to the four edges of a *diaphragm* complying with 7.3 or 13.5 as required by 5.6.1.

5.4.2 Wall bracing element bracing capacity values

Wall bracing elements shall be rated for wind and earthquake *bracing capacity* by test (see 8.3) or as set out in table 8.1.

No *wall bracing element*, to be placed on a timber-framed floor (subfloor *framing* or mid-floor *framing*) constructed in accordance with this Standard, shall be rated higher than 120 BU/m.

No *wall bracing element*, to be placed on a concrete slab constructed in accordance with this Standard or connected directly to a concrete perimeter *foundation wall* constructed in accordance with this Standard, shall be rated higher than 150 BU/m.

C5.4.3

Bracing lines in each storey are considered separately and need not coincide with those of the storey below nor with the subfloor lines of horizontal support required by section 6.

5.4.3 Distribution of bracing throughout building

Wall bracing elements shall be located as close as possible to the corners of *external walls* and evenly throughout the building.

Bracing elements shall be evenly distributed along each line as far as is possible.

5.4.4 Braced walls at angles to the bracing lines

Where *braced walls* are at angles to the *bracing lines* they contribute to the *bracing* as follows:

(a) 30° to one direction and 60° in the other direction, 0.87 and 0.5 times the value of the *wall bracing capacity* respectively;

(b) 45° to both directions, 0.7 times the value of the *wall bracing capacity* in both directions;

(c) Values for other angles shall be obtained by multiplying the *bracing capacity* of the element by the cosine of the angle between the element and the *bracing line* being considered.

5.4.5 Alignment of bracing lines

Bracing lines shall be parallel to *external walls* of the main building or *wings* and *blocks*, where these are required to be *braced* separately (see 5.1.5).

5.4.6 Spacing of bracing lines

Bracing lines in any *storey* shall be at not more than 6 m centres in each direction, provided that there need be no *bracing lines* within the area covered by a *diaphragm* complying with 5.6.1 supported by *walls* complying with 5.6.2. Where *bracing lines* are *spaced* between 5 and 6 m and there is a low density (less than 600 kg/m^3) ceiling *lining* then an additional 140 x 35 mm *top plate* of the same grade as the *wall* frame shall be fitted (see figure 8.18). The distance between *bracing lines* may be 7.5 m where *dragon ties* provide lateral support to the *external wall* (see figure 8.1).

5.4.7 Minimum bracing line values

No *bracing line* shall have a *bracing capacity* less than the greater of 100 *bracing units* or 50 % of the total *bracing demand* divided by the number of *bracing lines* in the direction being considered (along or across). For this purpose *bracing lines* less than 1 m apart shall be considered one line. In addition the limits of 5.4.7.1 and 5.4.7.2 apply.

C5.4.7

For example, a building has four bracing lines and a calculated bracing demand of 1200 bracing units (wind) and 1000 bracing units (earthquake) in the along direction. No bracing line in this direction shall have a bracing capacity less than 50 % of 1200/4 = 150 bracing units (wind) and 50 % of 1000/4 = 125 bracing units (earthquake).

The minimum 1 m separation aims to achieve better bracing distribution and avoids multiple bracing lines in close proximity resulting in disproportionate concentrations of bracing resistance.

5.4.7.1 Minimum bracing capacity of internal bracing lines

The minimum *capacity* of internal *bracing lines* shall comply with 5.4.7. Each internal *bracing line* shall have a *bracing capacity* contributed by either of the following or any combination of them:

(a) *Wall bracing elements* in *internal walls* on the *bracing line*;

(b) Pairs of *wall bracing elements* in *internal walls* not more than 2 m apart, one on each side of the *bracing line* and parallel to it.

5.4.7.2 Minimum bracing capacity of external walls

Each *external wall* in any *storey* shall have a total *bracing capacity* no less than the greater of that required by 5.4.7 or 15 *bracing units* per metre of *external wall* length. For *walls* with a *dragon tie* attached see 8.3.3.1 to 8.3.3.4.

Parallel *external walls* offset no more than 2 m from each other may be treated as one *bracing line*.

5.5 SUBFLOOR BRACING DESIGN

5.5.1 Capacity of bracing

Subfloors shall have a *bracing capacity* to resist the *bracing demand* from the greater of wind or earthquake as determined from 5.2 and 5.3.

5.5.2 Distribution of subfloor bracing

5.5.2.1 Subfloor bracing systems – Bracing lines

Bracing lines providing horizontal support shall run in two directions at right angles to each other and be located:

(a) In perimeter *foundation* and subfloor *framing*;

(b) In internal lines parallel to perimeter *foundation* and subfloor *framing*;

(c) At no more than 5 m *spacing*;

(d) So that *bracing elements* are evenly distributed along each line as far as is practicable. When a structural floor *diaphragm* is present no internal *bracing lines* are required within the boundary of the *diaphragm*;

(e) With a *bracing capacity* less than the greater of 100 *bracing units* or 50 % of the total *bracing demand* divided by the number of *bracing lines* in the direction being considered (along or across); and

(f) In compliance with the limits outlined in 5.5.2.2, 5.5.3 to 5.5.7 and 5.6.

C5.5.2.1

It is recommended to space bracing lines to coincide with the line of bearers. In this way the bracing can be uniformly distributed throughout the floor area.

5.5.2.2 Minimum bracing capacity in external subfloor bracing lines

Each external subfloor *bracing line* shall have a total *bracing capacity* of no less than the greater of that required by 5.5.2.1(e) or 15 *bracing units* times the length in metres of the *external wall*.

Parallel subfloor *bracing lines* under *external walls* offset not more than 2 m from each other may be treated as one *bracing line*.

C5.5.2.2

See 7.3 for structural floor diaphragms.

5.5.3 Subfloor bracing components

5.5.3.1 Single-storey buildings with timber ground floors

Subfloor bracing shall consist of one or more of the following components:

(a) Reinforced concrete masonry or reinforced masonry *walls* including corner *foundation walls* (greater than 1.5 m in length);

(b) Exterior grade sheet product tested in accordance with 6.2.3;

(c) *Braced pile system* (consisting of two *piles* and a *diagonal brace*);

(d) *Cantilever piles* in accordance with 6.7;

(e) *Anchor piles* in accordance with 6.9.

5.5.3.2 Two-storey buildings with timber ground floors

Two-*storey* buildings with timber ground floors shall be as follows:

(a) In all wind and earthquake zones, buildings with a height (measured from the underside of the *bottom plate* of the lowest floor to the top of the *roof*) exceeding 1.7 times the width shall be attached to a continuous *foundation wall* around the entire perimeter. The continuous *foundation wall* may be stepped, provided *wall framing* is constructed to directly support the building to the *foundation wall*.

(b) In all wind and earthquake zones, buildings with a height not exceeding 1.7 times the width may be supported by *bracing* systems complying with 5.4.3.

C5.5.3.2

(a) This clause is aimed at providing a substantial mass in the foundations to resist overturning of slender structures subjected to wind and earthquake forces.

(b) It may be necessary in some wind and earthquake zones to use foundation walls to reduce the number of braced piles.

5.5.4 Subfloor bracing element bracing capacity values

Subfloor bracing shall be rated for wind and earthquake *capacity* as set out in table 5.11.

Table 5.11 – Bracing capacity ratings of subfloor bracing elements (see 5.5.4)

Description of bracing element	Bracing capacity in the horizontal direction for earthquake and wind resistance
Reinforced concrete or reinforced masonry walls (greater than 1.5 m in length) If ratio of average wall height is: Wall Less than 0.75 More than 0.75 but less than 1.5 More than 1.5 but less than 3.0 More than 3.0 but less than 4.5 More than 4.5	(BUs) 0 42 BUs per metre of wall 100 BUs per metre of wall 200 BUs per metre of wall 300 BUs per metre of wall
Exterior grade product test P21 Test (see 6.2.3)	As determined by test
Braced pile system (consisting of two piles and a diagonal brace)	120 BUs for earthquake 160 BUs for wind
Cantilever piles, (driven timber piles) rating per pile	30 BUs for earthquake 70 BUs for wind
Anchor piles rating per pile	120 BUs for earthquake 160 BUs for wind
NOTE – Reinforced concrete and reinforced masonry bracing capacities are based on the limitations of fixings between the timber structure and the concrete component. Masonry bracing capacity values from NZS 4229 cannot be used with this Standard unless SED is applied to the connections between the timber structure and the masonry wall.	

5.5.5 Stacked subfloor bracing systems

Where one *bracing* system vertically supports another *bracing* system, the lower *bracing capacity* of either of the *bracing* systems shall be used.

C5.5.5

For example, where weaker cantilever piles support stronger fully sheet lined timber jack stud framing, the bracing capacity of the cantilevered piles shall be used in the contribution to the horizontal support of the building.

5.5.6 Minimum number of subfloor braces

In no case shall any building that has *subfloor bracing* consisting only of *anchor piles* or *braced pile systems* have fewer than four *anchor piles* or four *braced pile systems* placed in each direction symmetrically around the building perimeter.

C5.5.6

Wherever practical, bracing should be placed near the outer corner of buildings to resist torsion loads.

5.5.7 Bracing of decks

For *bracing* of *decks* see 7.4.2.

5.6 DIAPHRAGMS

5.6.1 Diaphragms with a braced wall system

Diaphragms may be used to distribute horizontal *loads*. They shall be no longer than 12 m with an aspect ratio (length divided by width) no greater than 2. *Diaphragms* shall be directly connected to *bracing elements* and consist of either:

(a) A floor *diaphragm* complying with 7.3; or

(b) A ceiling *diaphragm* complying with 13.5.

5.6.2 Diaphragm connections to bracing lines

Diaphragms shall be connected to *bracing lines* as follows:

(a) Each edge of the *diaphragm* shall be connected to a *bracing line* having a *bracing capacity* of not fewer than 15 *bracing units*/m of *diaphragm* dimension, measured at right angles to the line being considered, provided that such a line shall have a *bracing capacity* of not fewer than 100 *bracing units* (see figure 5.5);

(b) Where two *diaphragms* are connected to a *bracing line*, then the *bracing capacity* of that line shall be greater than the sum of those required for each *diaphragm*.

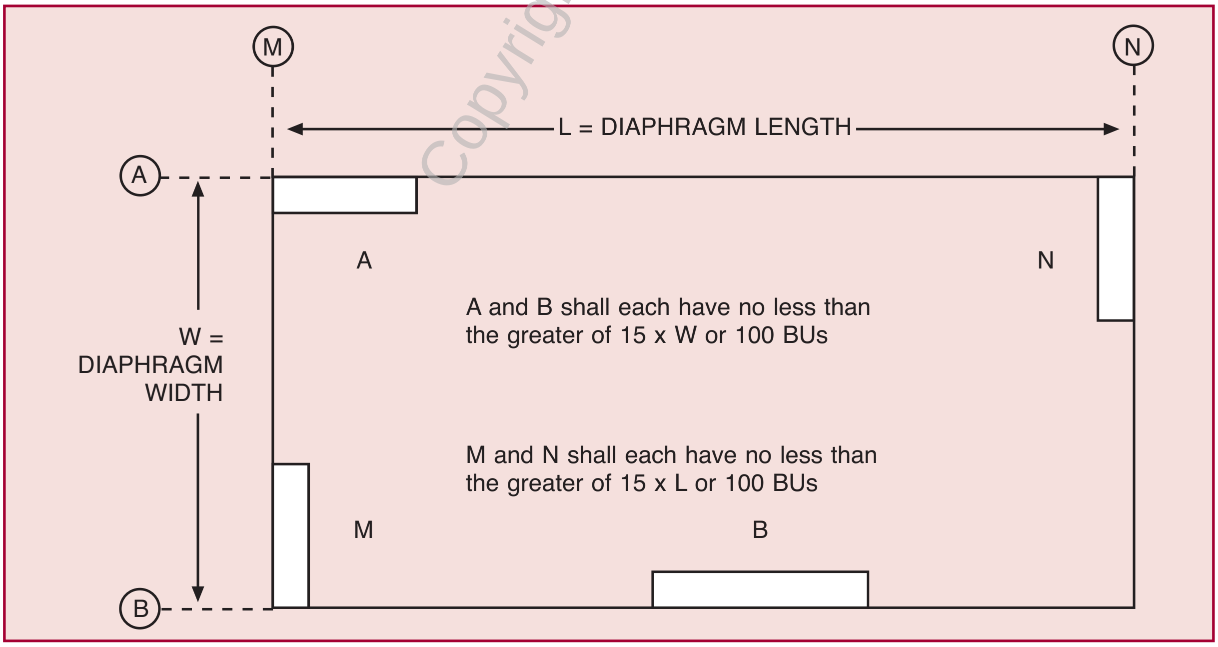


Figure 5.5 – Bracing lines supporting diaphragms

SECTION 6

FOUNDATION AND SUBFLOOR FRAMING

Table

Figure

6 FOUNDATION AND SUBFLOOR FRAMING

6.1 GENERAL

This section contains the requirements for subfloor structures supporting suspended timber floors, for live *loads* up to 2 kPa. Subfloor structures for floor live *loads* of 3 kPa are set out in section 14. *Foundations* for concrete floors are covered in section 7.

NOTE – SG 8 tables are used in this section. For the corresponding SG 6 and SG 10 tables, see the 'A tables' appended to this section.

6.1.1 Relocated buildings

The subfloor *bracing* of relocated buildings shall comply with 5.5.

6.2 SUBFLOOR SYSTEMS

6.2.1 Vertical support

The *joists* of suspended timber floors shall be supported on any of the subfloor systems of the following, or a combination of more than one, provided that at *external walls* of three-*storey* buildings *joists* shall be supported by (f):

(a) A *bearer* directly supported by a row of *piles*;

(b) A *bearer* supported by *jack studs*, supported by a row of *piles*;

(c) A *bearer* supported by *jack studs*, supported by a *foundation wall*;

(d) A timber-framed subfloor *wall* supported by a row of *piles*;

(e) A timber-framed subfloor *wall* supported by a *foundation wall*;

(f) A *stringer* or *wall plate* supported by a *foundation wall*.

NOTE – Rows of piles may consist of any combination of ordinary piles, driven cantilever piles, braced piles, or anchor piles depending on the bracing requirements.

6.2.2 Horizontal support

6.2.2.1

Suspended timber floors and superstructures shall be *braced* against horizontal loadings by the *bracing* systems provided and distributed in accordance with section 5.

6.2.2.2

Subfloor *bracing elements* (*piles*, *walls* etc.) shall be assigned ratings as set out in table 5.11, unless they are a proprietary system tested in accordance with 6.2.3, in which case they shall be assigned the *bracing rating* from those tests.

6.2.3 Proprietary subfloor bracing systems

6.2.3.1

Proprietary subfloor *bracing elements* shall be tested in accordance with BRANZ Technical Paper P21.

6.2.3.2

Such proprietary *bracing* systems shall be identical in all respects to the *bracing elements* tested and shall be installed with the fixings used in the above tests.

C6.1

This section is arranged to follow the decision-making process in the design of a foundation structure, as follows:

(a) Select potentially suitable subfloor systems for the building from 6.2.

(b) Determine the set out of the whole subfloor structure from the plan layout of the super-structure floor loads and roof loads, by using 6.3, and select appropriate spans for bearers and floor joists from section 7.

(c) Determine the wind and earthquake loads to be resisted by the subfloor system from section 5.

(d) Distribute subfloor bracing evenly around the building plan area, by allocating bracing lines to the lines of support, in accordance with the rules in section 5.

(e) Provide the bracing capacity in each direction as determined from section 5.

(f) Design and specify all subfloor elements, the sizes of their footings, member connection details and load performance characteristics, from 6.4 to 6.12.

(g) Ensure the minimum subfloor clearance, access and ventilation requirements of 6.14 are met.

C6.2.1

Temporary bracing needs to be provided until the subfloor bracing work is complete.

6.3 SETTING OUT

6.3.1 General

Lines of vertical support (rows of *piles* or *walls* as selected from 6.2.1) shall be provided at *spacings* to suit the layout of the building superstructure, and the *span* of the floor *joists* and *bearers*.

6.3.2 Support of loadbearing and bracing walls

6.3.2.1

A *bearer* or subfloor *framing wall*, shall be provided within 200 mm, centre-to-centre, of *loadbearing walls* in the *storey* immediately above, and which are at right angles to the *joists* (see figure 6.1 (A)).

6.3.2.2

Where a *bearer* supports a loadbearing or *bracing wall* running parallel to the floor *joists*, it shall itself be supported by a *pile* or *jack stud* within 200 mm, centre-to-centre, of the *loadbearing* or *bracing wall* (see figure 6.1 (B)).

6.3.3 Distribution of subfloor bracing

See section 5.

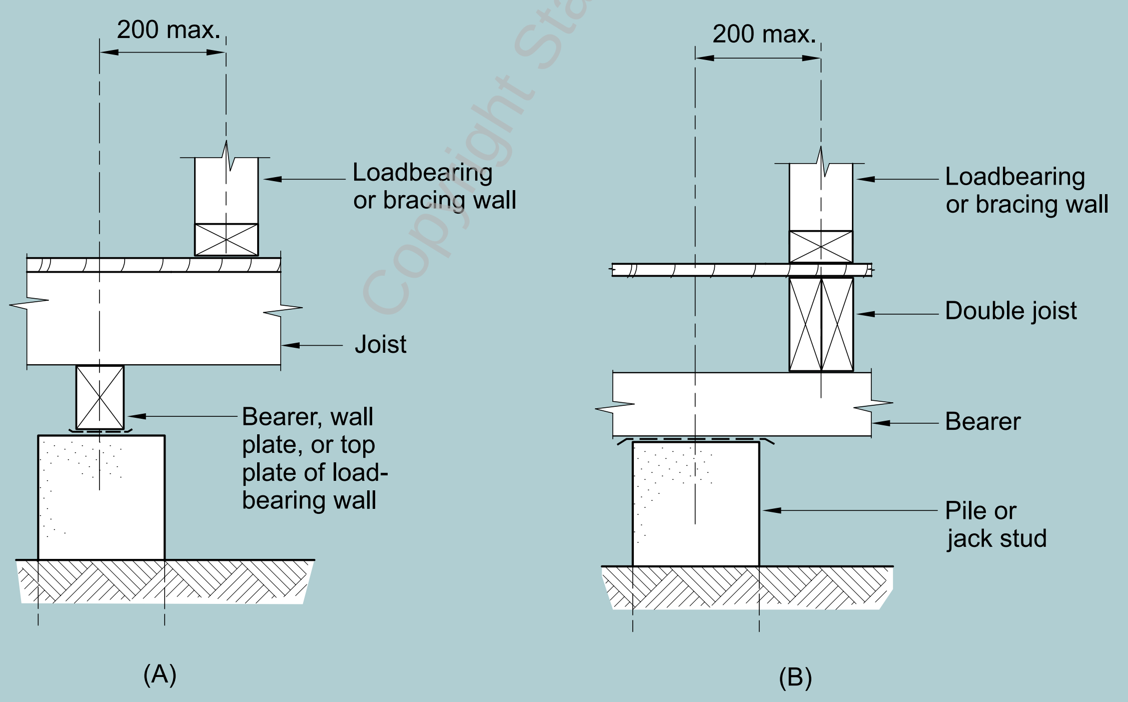
6.4 PILES

6.4.1 Height of piles

6.4.1.1

The height of *piles* shall be:

(a) Above *finished ground level*: not less than 150 mm;



Unless otherwise stated, all dimensions are in mm.

Figure 6.1 – Support of loadbearing wall (see 6.3.2.1 and 6.3.2.2)

(b) Above *cleared ground level*: not more than:

(i) 600 mm for *ordinary piles* directly supporting *jack studs*;

(ii) 1.2 m for *cantilevered piles*;

(iii) 600 mm to the highest connection for *anchor piles*;

(iv) 1.5 m for all other concrete or concrete masonry *braced* or *ordinary piles*;

(v) 3.0 m for timber *ordinary piles* and *braced piles* (see figures 6.6, 6.7 and 6.8), when they directly support *bearers*.

(c) No *timber pile* shall be cut off closer than 300 mm to *finished ground level*. This distance may be reduced to 150 mm where a bituminous *damp-proof course*, or other suitable impervious material is placed between the *pile* and *framing* timbers and overlaps these timbers by at least 6 mm (see figure 6.3). See 6.4.3.3 for *pile* treatment.

6.4.1.2

Pile tops shall be at levels to suit the subfloor *framing*.

6.4.2 Cross sections of piles

The cross section of a *pile* shall have a minimum dimension of:

(a) 200 mm sides or diameter for parallel-sided concrete *piles*;

(b) 150 mm sides or diameter at the top and 200 mm sides or diameter at the bottom for tapered concrete *piles*;

(c) 190 mm sides for concrete masonry *piles*;

(d) 140 mm diameter for round *timber piles*. See NZS 3605;

(e) 125 mm sides for square sawn *timber piles*.

6.4.3 Materials for piles

6.4.3.1

Concrete for *piles* shall be ordinary grade concrete of 17.5 MPa minimum strength, complying with NZS 3109, except as required for durability in 4.5.

6.4.3.2

The materials and workmanship of concrete masonry *piles* shall comply with NZS 4210.

6.4.3.3

Timber piles shall comply with NZS 3605 and be treated to H5 of NZS 3640. Where a *timber pile* has been cut after treatment, the well dried cut surface shall be brush-treated with a liberal application of either creosote, zinc naphthenate, TBTO (bis-(tri-n-butyltin) oxide) or TBTN (bis-(tri-n-butyltin)naphthenate). The surface shall not be cut for fixings and other purposes closer than 150 mm to the *finished ground level*.

6.4.4 Pile reinforcement

Ordinary concrete *piles* and concrete masonry *piles* shall be reinforced with one D10 bar, placed centrally throughout the length of all concrete *piles* exceeding 750 mm long and concrete masonry *piles* exceeding 500 mm long.

6.4.5 Pile footings

6.4.5.1 General

Except for *driven timber piles*, each *pile* shall be provided with a concrete *footing*.

Concrete *footings* shall be:

(a) A precast concrete *footing* not less than 100 mm thick, founded on a compacted granular bedding material to a minimum depth of 25 mm, on undisturbed *good ground*, to obtain even bearing to the excavated surface, together with cast-in-situ concrete embedment; or

(b) A cast-in-situ concrete *footing* against undisturbed *good ground*.

6.4.5.2 Materials

Concrete for *footings* shall be ordinary grade concrete of 17.5 MPa minimum strength, complying with NZS 3109, except as required by 4.5.

6.4.5.3 Minimum depth

The bottom of a *pile footing* shall be at a depth below *cleared ground level* of at least the thickness of the *footing* as given by 6.4.5.4, but not less than 200 mm.

6.4.5.4 Thickness

The thickness of a *pile footing* shall be not less than:

(a) *Ordinary piles*:
  (i) Precast concrete: 100 mm
  (ii) Timber: 200 mm;

(b) *Braced piles*: 450 mm;

(c) *Anchor piles*: 900 mm.

6.4.5.5 Plan size

Footings shall have the minimum plan dimensions given by table 6.1, except that no *footing* to an *anchor pile* (or *braced pile*) shall be less than 350 mm x 350 mm if square, or 400 mm diameter if circular. (See table 14.6 for square *pile footings* for 3 kPa *floor loads*.)

6.4.5.6 Embedment

Each *pile* not cast integrally with its *footing*, shall be embedded in its *footing*, such that there is concrete to a depth of 100 mm (minimum) below the bottom of the *pile*. The *pile* shall be embedded in its *footing* sufficiently, or temporarily *braced*, to provide stability during construction.

6.4.5.7 Loading

Cast-in-situ *piles* or *piles* embedded in a concrete *footing* shall not be fully loaded with the dead weight of the building until the concrete is 24 hours old. The concrete shall not have a slump exceeding 60 mm at the time of placing and the ambient temperature shall not fall below 10 °C throughout the 24 hours. Where such conditions are not met then the waiting period shall be extended to 48 hours.

Table 6.1 – Pile footings (see 6.4.5.5)

1.5 kPa and 2 kPa floor loads									
Span of		Minimum plan dimensions of footing supporting:							
Bearers (m)	Joists (m)	Floor and non-loadbearing walls only		1 storey		2 storey		3 storey	
		Square* (mm)	Circular* (mm)	Square* (mm)	Circular* (mm)	Square* (mm)	Circular* (mm)	Square* (mm)	Circular* (mm)
1.3	2.0	200	230	275	310	325	370	350	400
	3.5	225	260	350	400	425	480	475	540
	5.0	275	310	400	460	500	570	550	620
	6.0	300	340	450	510	550	620	600	680
1.65	2.0	200	230	300	340	375	430	400	460
	3.5	250	290	400	460	475	540	525	600
	5.0	300	340	450	510	575	650	600	680
2.0	2.0	200	230	325	370	400	460	450	510
	3.5	275	310	425	480	525	600	575	650

* Minimum of the value on the table, or 350 mm min. if square or 400 mm min. diameter if circular, for anchor and braced piles.

NOTE – Span is the average of the bearer or joist spans on either side of the pile under consideration.

6.5 ORDINARY PILES

6.5.1 Height of piles

The height of *ordinary piles* shall be as defined in 6.4.1.1 and figure 6.2.

6.5.2 Fixings

Fixings to concrete or *timber piles* shall be as follows:

(a) The fixing of a *bearer* or a *jack stud* to an ordinary concrete *pile* shall be made using 4 mm wire through the *pile* and stapled with 4 staples. At each end of the wire, one staple shall be driven below the hook and the other 2 staples driven over the 2 wires forming the hook (see figure 6.3).

(b) For *timber piles* use 2 / 4.9 mm *wire dogs* together with 2 / 100 x 3.75 nails or 4 / 100 x 3.75 nails, skew driven into the *piles* (see figure 6.3 (C) and (E).

C6.5.2

See 4.4 for durability of fixings.

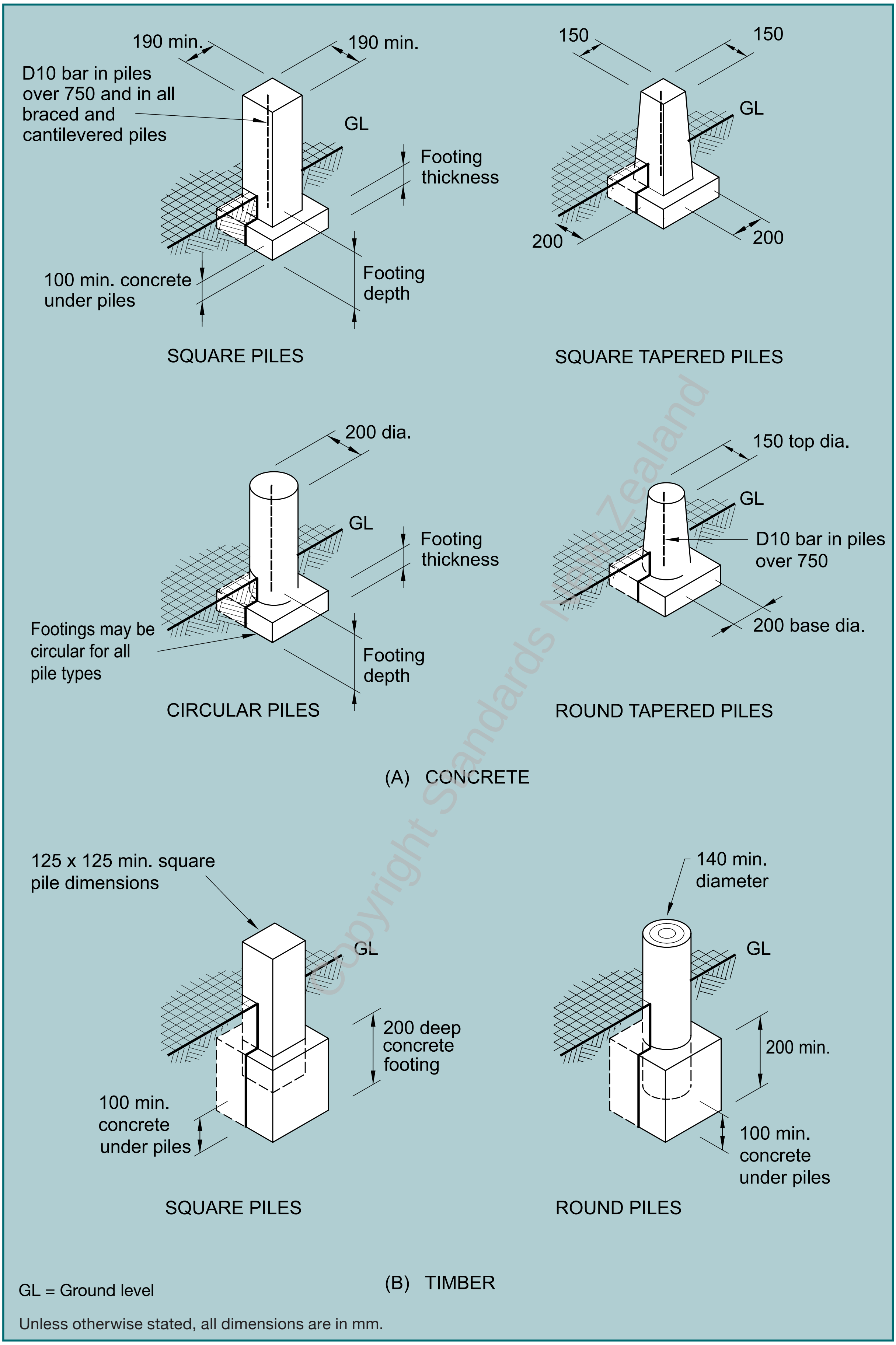


Figure 6.2 – Ordinary piles (see 6.5)

6.6 DRIVEN TIMBER PILES

Driven timber piles may be used as *ordinary piles* (as per 6.5), *cantilever piles* (as per 6.7), or *braced piles* (as per 6.8).

6.6.1 Limitations in length

Driven timber piles consisting of natural rounds shall not exceed 3.6 m long.

6.6.2 Soil bearing capacity

6.6.2.1

Bore holes, complying with the applicable requirements of 3.3.6, shall be augured at sites selected in accordance with 3.3.8 and the information obtained from those bore holes shall be regarded as having been revealed by "excavation for *foundations*", for the purposes of 3.1.3.

6.6.2.2

The requirements of 3.3 shall be modified as set out in 6.6.2.3 to 6.6.2.6 inclusive.

6.6.2.3

Clause 3.3.4 shall be modified to require that the tip of the penetrometer shall be driven to 1.5 m below *cleared ground level*.

6.6.2.4

Clause 3.3.6 shall be modified to require that the bore hole shall be augured to a depth of 800 mm below the base of the proposed adjacent *piles*, or to 2 m below *cleared ground level*, whichever is the deeper.

6.6.2.5

Clause 3.3.7.1 shall be modified to require that the listed unsuitable materials shall not be encountered at a depth greater than 300 mm below *cleared ground level*.

6.6.2.6

Clause 3.3.7.1 shall be modified to require that there shall be more than two blows per 75 mm at depths more than 600 mm below *cleared ground level*.

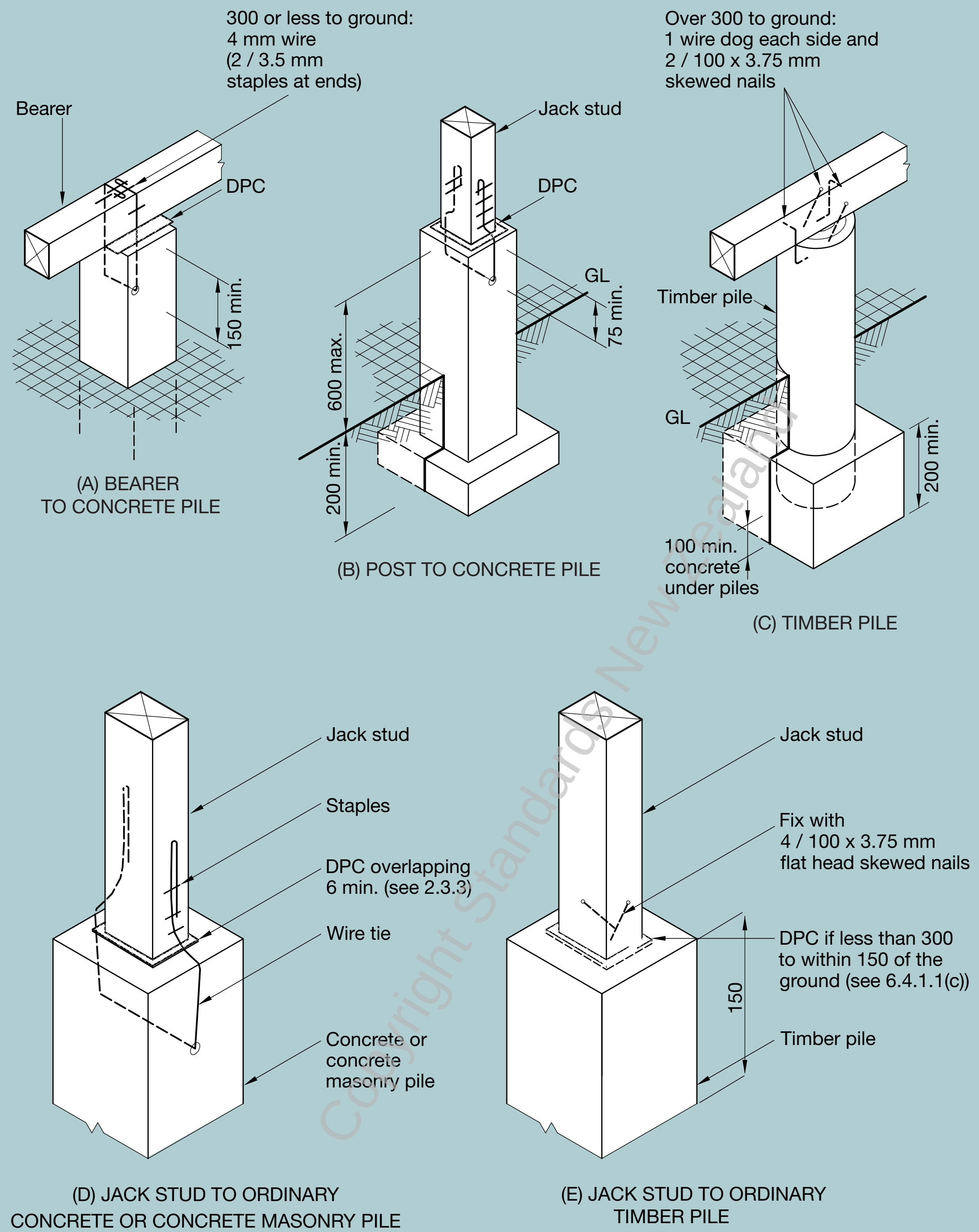
6.6.3 Spacing of piles

6.6.3.1

The maximum *spacing* between *piles* along the line of the *bearer* shall be determined from the driving resistance during the driving of *piles* in accordance with table 6.2, provided that the *spacing* shall not exceed the maximum *span* of *bearer*, as given by table 6.4.

6.6.3.2

In any case where a *pile* top has been driven to the level required by 6.6.6.1 and the set per blow still exceeds the maximum given by table 6.2, that *pile* shall not be regarded as providing support to the *bearer*. It will then be necessary to drive *piles* on either side of it to a depth where the set per blow will be within the maximum given by table 6.2.



NOTE –
(1) See section 4 for durability requirements.
(2) DPC = Damp-proof course.
(3) For ground level clearances and DPC requirements see 6.4.1.1(c).
(4) GL = Ground level

Unless otherwise stated, all dimensions are in mm.

Figure 6.3 – Fixing of bearers and jack studs to ordinary piles (see 6.5.2 and 2.3.3)

Table 6.2 – Spacing of driven round timber piles (see 6.6.3.1)
(a) 1.5 kPa floor load

A Piles supporting floors only

Maximum span* of joists	Maximum spacing of piles (span of bearer) when the maximum set per blow (mm) does not exceed:		
	25	50	100
(m)	(m)	(m)	(m)
1.6	2.00	2.00	2.00
2.0	2.00	2.00	1.60
2.4	2.00	2.00	1.35
2.8	2.00	2.00	1.15
3.2	2.00	2.00	1.00
3.6	2.00	1.80	0.90
4.0	2.00	1.60	–
4.4	2.00	1.45	–
4.8	2.00	1.35	–
5.2	1.85	1.25	–
5.6	1.75	1.15	–

B Piles supporting floors and walls

Maximum span* of joists	Maximum loaded dimension† of wall supporting:		Maximum spacing of piles (span of bearer) supporting:				
	Light roof	Heavy roof	1 storey when the maximum set (mm) per blow does not exceed:			2 storeys when the maximum set (mm) per blow does not exceed:	
			25	50	100	25	50
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
1.2	2.4	1.2	2.00	2.00	1.60	2.00	2.00
1.6	3.2	1.6	2.00	2.00	1.20	2.00	1.70
2.0	4.0	2.0	2.00	2.00	0.95	2.00	1.40
2.4	4.8	2.4	2.00	1.60	–	1.70	1.15
2.8	5.6	2.8	2.00	1.40	–	1.45	1.00
3.2	6.0	3.2	1.80	1.20	–	1.30	0.85
3.6	6.0	3.6	1.60	1.10	–	1.15	–
4.0	6.0	4.0	1.45	0.95	–	1.05	–
4.4	6.0	4.4	1.30	0.90	–	0.95	–
4.8	6.0	4.8	1.20	–	–	0.85	–
5.2	6.0	5.1	1.10	–	–	–	–
5.6	6.0	5.6	1.00	–	–	–	–

* Span is the average of the joist spans on either side of the bearer under consideration.
† For definition of loaded dimension see 1.3.

Table 6.2 – Spacing of driven round timber piles (continued) (see 6.6.3.1)
(b) 2 kPa floor load

C Piles supporting floors only

Maximum span* of joists	**Maximum spacing of piles (span of bearer) when the maximum set per blow** (mm) **does not exceed:**		
	25	**50**	**100**
(m)	(m)	(m)	(m)
1.6	2.00	2.00	1.75
2.0	2.00	2.00	1.40
2.4	2.00	2.00	1.15
2.8	2.00	2.00	1.00
3.2	2.00	1.73	–
3.6	2.00	1.55	–
4.0	2.00	1.40	–
4.4	1.90	1.25	–
4.8	1.75	1.15	–
5.2	1.60	1.05	–

D Piles supporting floors and walls

Maximum span* of joists	**Maximum loaded dimension† of wall supporting:**		**Maximum spacing of piles (span of bearer) supporting:**				
	Light roof	**Heavy roof**	**1 storey when the maximum set** (mm) **per blow does not exceed:**			**2 storeys when the maximum set** (mm) **per blow does not exceed:**	
			25	**50**	**100**	**25**	**50**
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
1.2	3.2	1.6	2.00	2.00	1.35	2.00	2.00
1.6	4.3	2.2	2.00	2.00	1.00	2.00	1.45
2.0	6.0	2.7	2.00	1.65	0.80	1.75	1.20
2.4	6.0	3.2	2.00	1.35	–	1.50	1.00
2.8	6.0	3.8	1.75	1.15	–	1.25	–
3.2	6.0	4.3	1.55	1.05	–	–	–
3.6	6.0	4.8	1.35	0.90	–	–	–
4.0	6.0	5.4	1.25	–	–	–	–
4.4	6.0	5.9	1.10	–	–	–	–
4.8	6.0	6.0	1.00	–	–	–	–
5.2	6.0	6.0	0.95	–	–	–	–

* Span is the average of the joist spans on either side of the bearer under consideration.
† For definition of loaded dimension see 1.3.

6.6.4 Driving of piles

6.6.4.1

In all cases at least one test *pile* shall be driven before delivery of the remaining *piles* to ensure that adequate resistance to driving can be obtained. In cases where it is necessary to make penetrometer tests, and the number of blows per 75 mm of penetrometer penetration lies between two and three, at least four test *piles* should be driven in locations distributed uniformly over the site of the proposed building.

6.6.4.2

Piles shall be driven with the small end diameter at the base.

C6.6.4.2

A suitable rig for driving piles would be a vehicle-mounted fence post driver that provides adequate control of the vertical and horizontal pile alignment during driving. This permits the required free fall of the hammer with free-running ropes, easy rotation of winching draw and pulleys, and clear retraction of the brake.

6.6.4.3

Piles shall be driven without damage to the *pile* until:

(a) The base of the *pile* has reached a depth below *cleared ground level* of not less than:

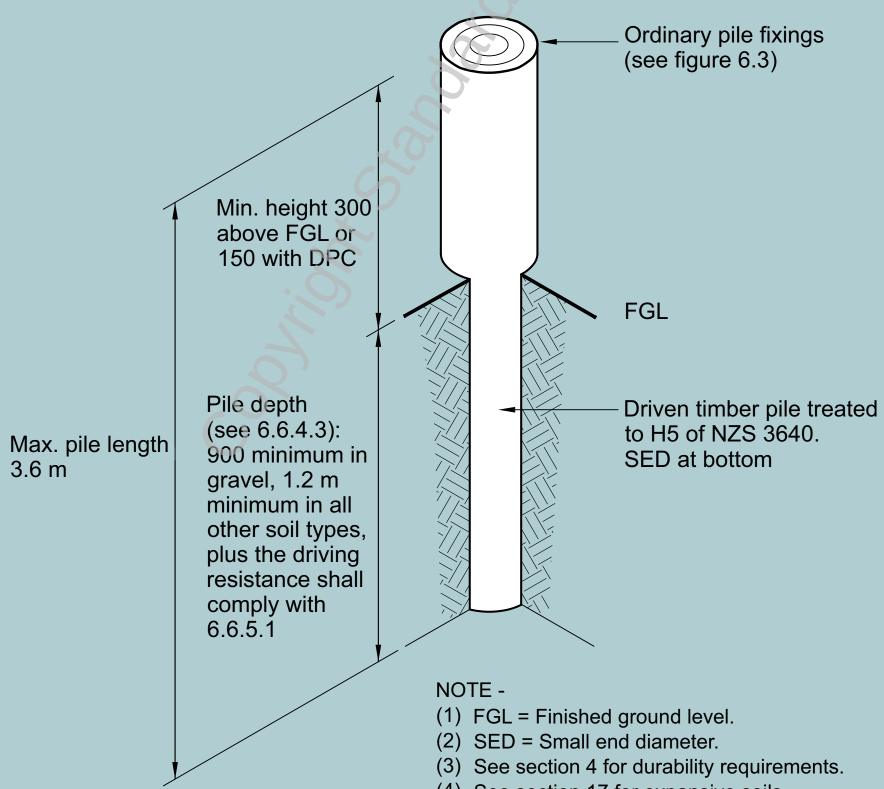
(i) 900 mm through gravel;

(ii) 1.2 m through other types of soil;

and

(b) The driving resistance required by 6.6.5 has been achieved.

See figure 6.4.



NOTE -
(1) FGL = Finished ground level.
(2) SED = Small end diameter.
(3) See section 4 for durability requirements.
(4) See section 17 for expansive soils.

Unless otherwise stated, all dimensions are in mm.

Figure 6.4 – Driven timber piles (see 6.6.4.3)

6.6.5 Driving resistance

6.6.5.1

The driving resistance shall be determined with an energy input of not less than 4800 J per blow. This energy input is delivered by a hammer having a mass *M* of not less than 200 kg, falling freely through a distance *h* of not less than 480/*M* metres (where *M* is in kilograms).

6.6.5.2

The set per blow shall be measured from a datum beam supported at least 1 m clear of the *pile* and the driving rig.

6.6.5.3

The set for each blow over not less than the final 200 mm of driving shall be clearly marked on the *pile*.

6.6.6 Tolerances

6.6.6.1

Pile tops shall be at a level to support *bearers* without packing.

6.6.6.2

Piles shall be in straight rows with a tolerance of 10 mm between the centre of any *pile* top and a straight line which is the centre of the *bearer*.

6.6.6.3

Piles shall be plumb with a tolerance of 15 mm/1 m length of *pile*.

6.7 CANTILEVER PILES

6.7.1 Cantilever piles

Cantilever piles shall be *driven timber piles* constructed in accordance with 6.6. See figure 6.5.

6.7.2 Limitations in size

Driven round *timber piles* shall be regarded as *cantilever piles* only when:

(a) No *pile* top is more than 1.2 m above *cleared ground level*; and

(b) No *pile* top within any 6 m wide strip of building plan area is more than twice the height above *cleared ground level*, of any other *pile* top within that strip.

C6.7.2

Cantilever piles higher than 1.2 m lack adequate stiffness and strength. Cantilever piles differing too much in height and therefore stiffness amongst the group will result in overloading the short piles and inducing damaging torsional loads in the foundation as a whole.

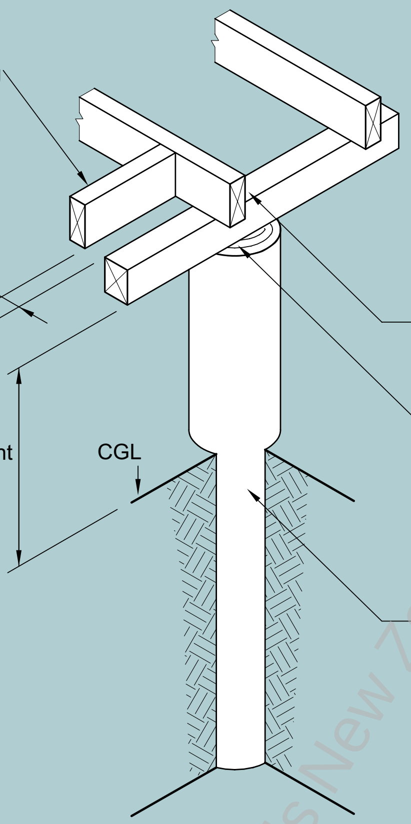
6.7.3 Fixings

6.7.3.1 Bearer fixings to cantilever piles

The fixing of *bearers* to *cantilever piles* shall have a *capacity* of 6 kN in both horizontal directions parallel and perpendicular to the *bearer*.

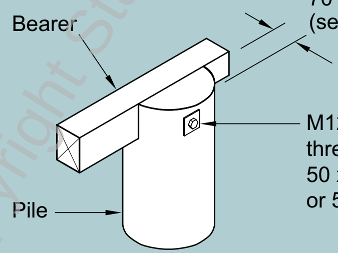
6.7.3.2 Scarfing option

Alternatively to 6.7.3.1, *timber cantilevered piles* may be scarfed to accept the *bearer* and the two shall be fixed together with a M12 bolt or 12 mm diameter threaded rod with either 50 mm x 50 mm x 3 mm square or 50 diameter x 3 mm washers. Not less than 70 mm of the *timber pile* cross section shall remain after scarfing, to support the bolt to the *pile* (see figure 6.5 and section 4 for permitted fixing materials).



NOTE –
(1) On sloping sites no cantilevered pile within any 6 m wide strip of building area shall be more than twice the height of the shortest pile.
(2) CGL = Cleared ground level.
(3) See section 4 for durability requirements for fixings.

Bracing units	
Wind	70
Earthquake	30



ALTERNATIVE
BEARER TO PILE CONNECTION

Unless otherwise stated, all dimensions are in mm.

Figure 6.5 – Cantilever piles (see 6.7)

6.7.3.3 Floor joists

The floor *joist* closest to a *cantilever pile* shall be fixed to a *bearer* with a fixing having a minimum horizontal *capacity* of 6 kN in both directions, at right angles to one another (see figure 6.5).

6.8 BRACED PILE SYSTEMS

6.8.1 General

6.8.1.1

A *braced pile system* consists of 2 *piles*, each with a 450 mm deep *footing*, between which a *diagonal brace* is fixed. The *brace* shall be fixed to the bottom of one *braced pile*, and either the top of the other *braced pile* (see figure 6.6), or to a *bearer* within 200 mm of the other *pile* (see figure 6.7) or to a *joist* within 200 mm of the other *pile* (see figure 6.8).

6.8.1.2

A *braced pile system* may be repeated as a series of *braced piles* with *braces* sloping in the same direction as shown in figure 6.6.

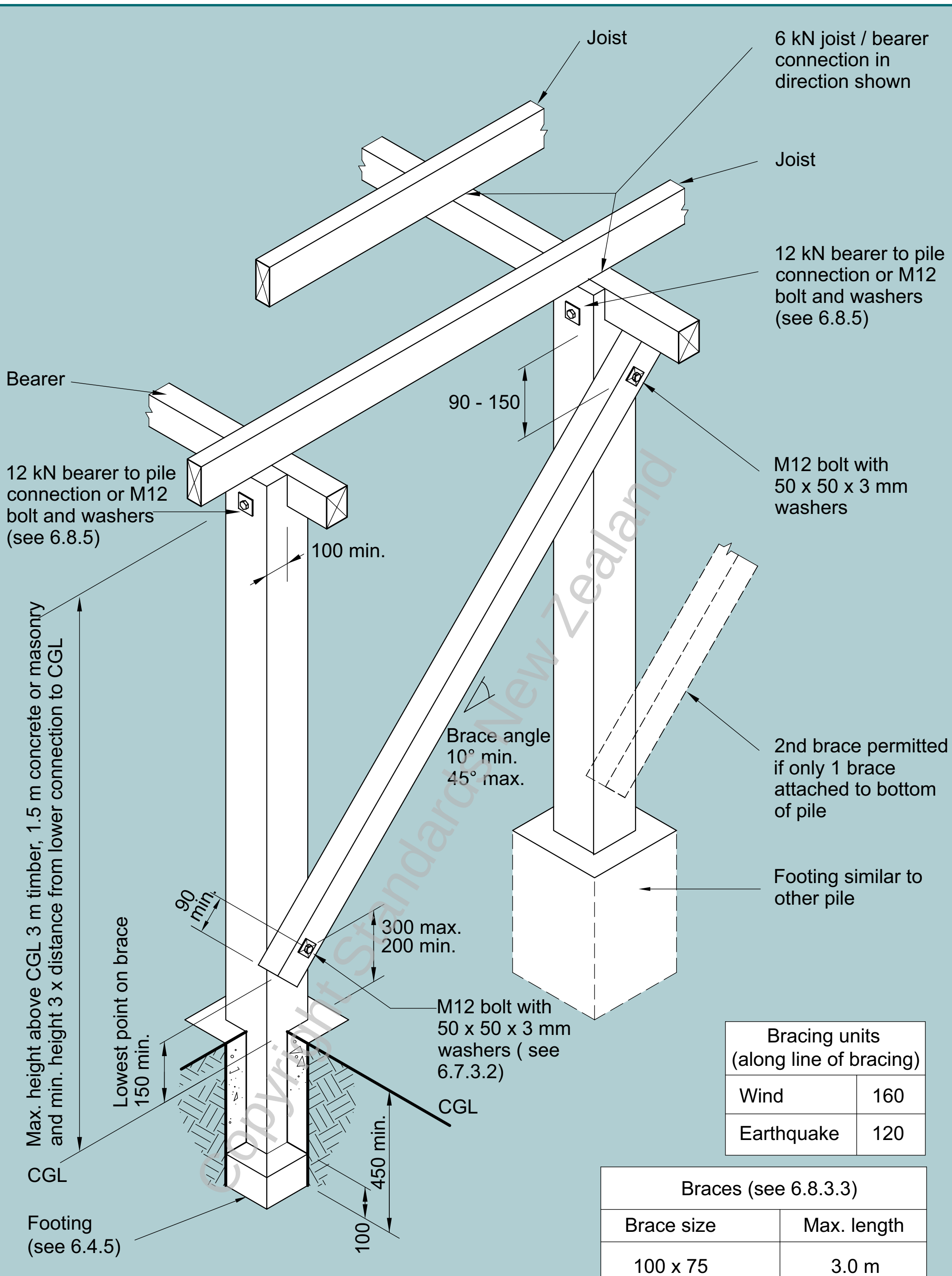
6.8.1.3

Only one *brace* shall be attached to the top of a *braced pile*. Two *braces* may be attached to the bottom of a *braced pile*, but only if they are at right angles to each other and not in line.

C6.8.1.3

Two braces connected to the top of a pile overload the pile to bearer fixing.

Two braces connected in line to the bottom of a pile overload the pile footing.



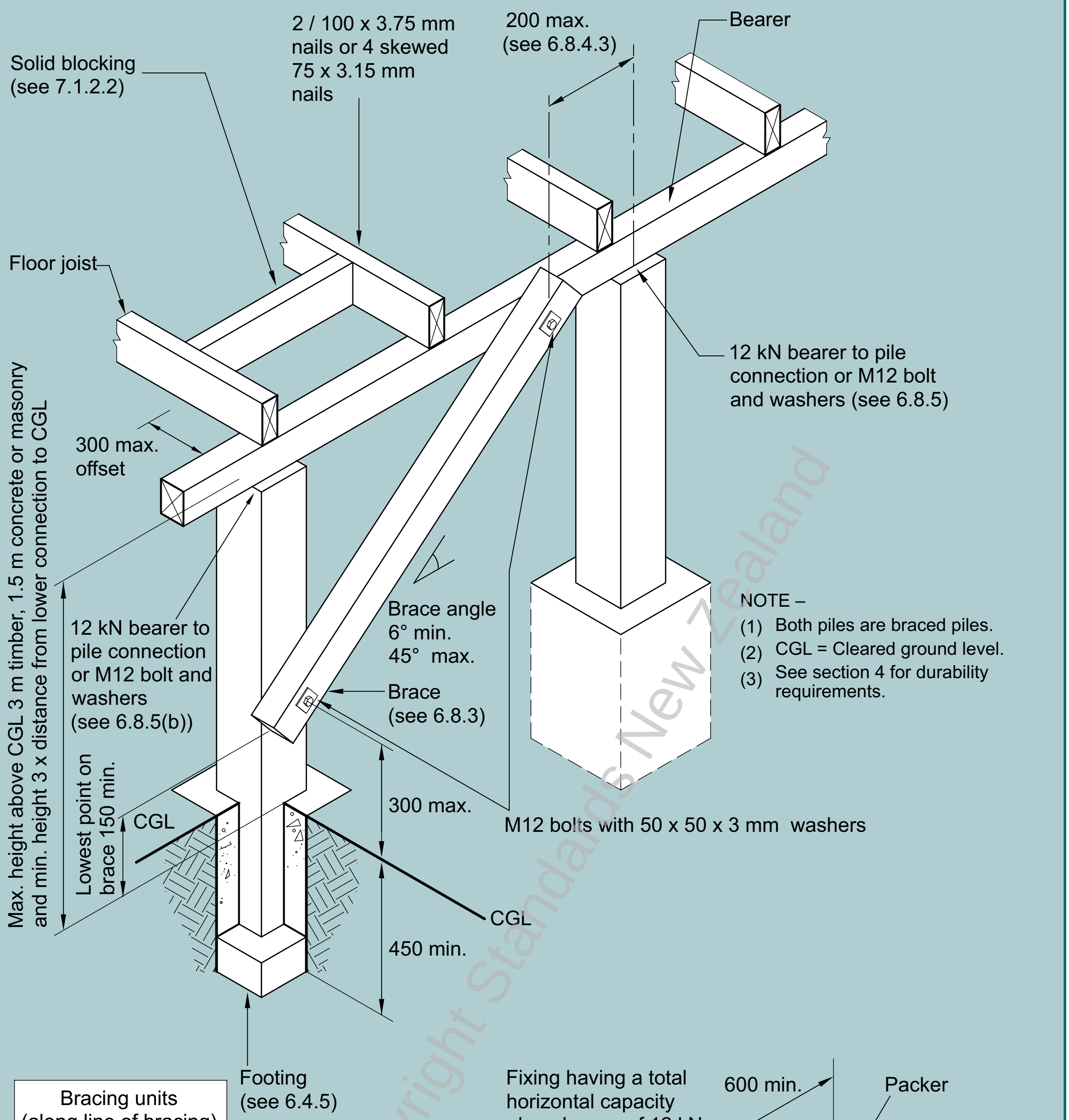
Bracing units (along line of bracing)	
Wind	160
Earthquake	120

Braces (see 6.8.3.3)	
Brace size	Max. length
100 x 75	3.0 m
100 x 100	5.0 m

NOTE –
(1) Both piles are braced piles.
(2) CGL = Cleared ground level.
(3) See section 4 for durability requirements.

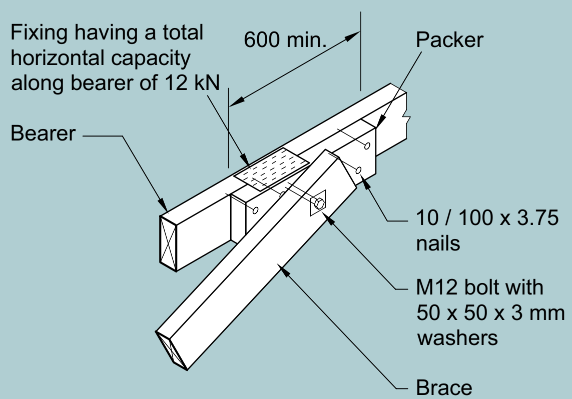
Unless otherwise stated, all dimensions are in mm.

Figure 6.6 – Braced pile system – Brace connected to pile (see 6.8)



Bracing units (along line of bracing)	
Wind	160
Earthquake	120

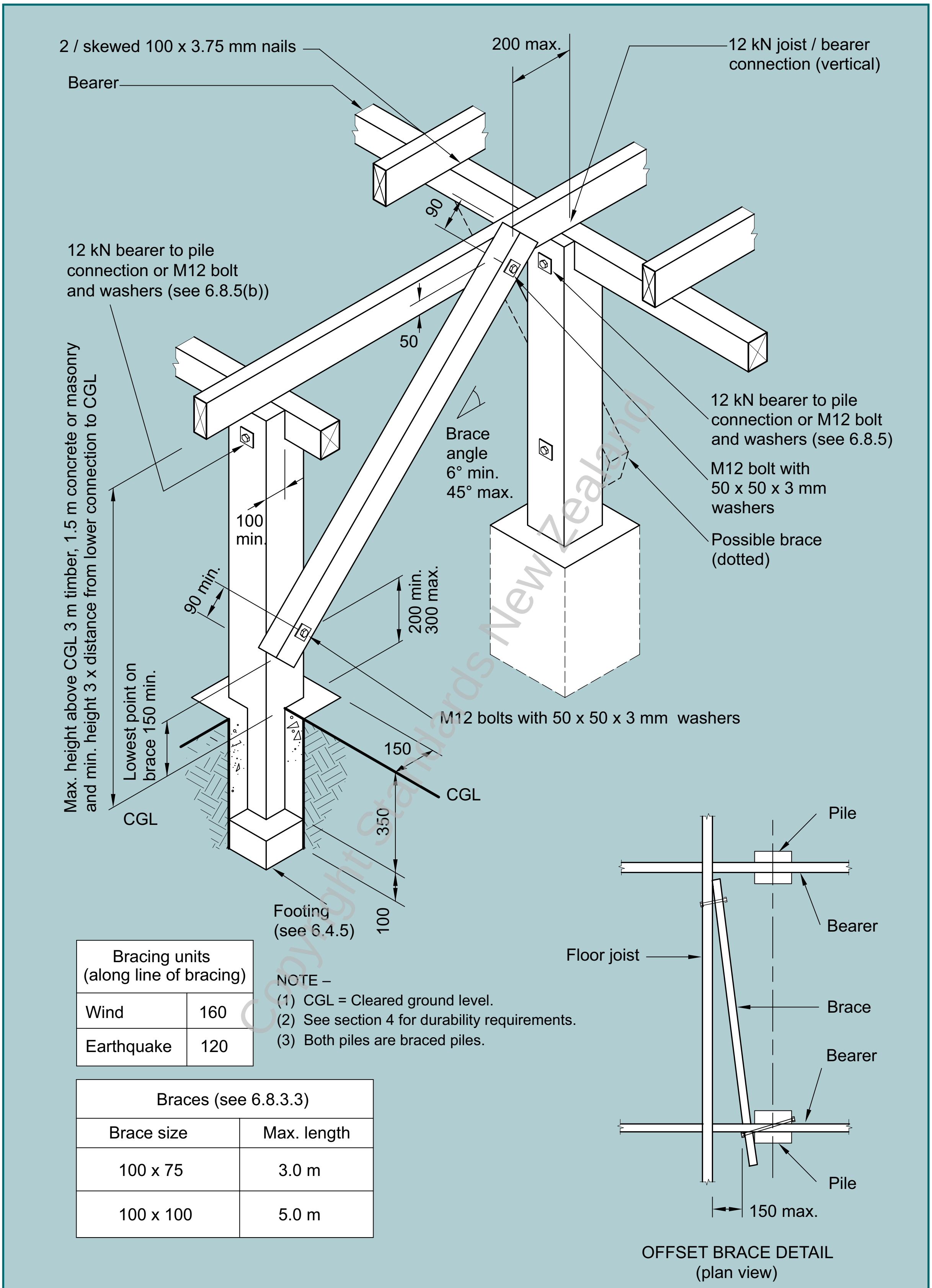
Braces (see 6.8.3.3)	
Brace size	Max. length
100 x 75	3.0 m
100 x 100	5.0 m



PACKER DETAIL
(see 6.8.4.3(b))

Unless otherwise stated, all dimensions are in mm.

Figure 6.7 – Braced pile system – Brace connected to bearer (see 6.8)



Bracing units (along line of bracing)	
Wind	160
Earthquake	120

NOTE –
(1) CGL = Cleared ground level.
(2) See section 4 for durability requirements.
(3) Both piles are braced piles.

Braces (see 6.8.3.3)	
Brace size	Max. length
100 x 75	3.0 m
100 x 100	5.0 m

Unless otherwise stated, all dimensions are in mm.

Figure 6.8 – Braced pile system – Brace connected to joist (see 6.8)

C6.8.2

The minimum height of braced piles attached to long diagonal braces, at slopes in the order of 6° to the horizontal, can be in the order of 600 mm.

6.8.2 Height

The height of *braced piles* shall be as defined in 6.4.1.1 except the minimum height of a *braced pile* above *cleared ground level* shall be 3 times the distance from *cleared ground level* to the lower *brace* fixing (see figure 6.6).

6.8.3 Diagonal timber braces

6.8.3.1

Diagonal timber *braces* shall slope between 10° and 45° to the horizontal except that 6° may be used when the *braces* are connected to a *bearer* or *joist*.

6.8.3.2

A diagonal timber *subfloor brace* shall consist of one continuous length of timber.

6.8.3.3

The dimensions of a diagonal timber *subfloor brace* shall be:

(a) Length not exceeding 3 m: ....100 mm x 75 mm;

(b) Length not exceeding 5 m: ....100 mm x 100 mm.

6.8.3.4

The length of a *diagonal brace* shall be measured along the *brace* between the fixings at the upper and lower ends. If a *brace* passes an intermediate *pile* or *jack stud*, and is bolted to it by a M12 bolt through both centre lines, then the length of the *brace* may be taken as the greater of the distances between that bolt and the fixings at the upper or lower end.

6.8.3.5

The lower end of a diagonal timber *subfloor brace* shall not be closer than 150 mm to the *cleared ground level*.

6.8.4 Brace connections

6.8.4.1 Options

A diagonal timber *brace* shall be connected at each end by a M12 bolt passing through the centre line of the *brace* not less than 90 mm from its end and at right angles to the *brace*. Alternative fixings with a minimum *capacity* of 17 kN in both tension and compression along the *brace* may be used.

6.8.4.2 Brace, lower end connection

The lower end of the diagonal timber *brace* shall be fixed to the bottom of a *braced pile* by a bolt through the centre line of the *pile*, not more than 300 mm above *cleared ground level*. The height from this bolt to the top of the *pile* shall not be less than twice the distance from the bolt to the *cleared ground level*.

6.8.4.3 Brace, upper end connection

The upper end of the diagonal timber *brace* shall be fixed to one of the following members as set out below:

(a) *Braced pile*. The bolt shall pass through the top end of the *pile* not less than 90 mm nor more than 150 mm from the top of the *pile*. The bolt shall pass through the centre line of the *pile* (see figure 6.6).

(b) *Bearer*. The bolt shall pass through the centre line of the *bearer* not more than 200 mm measured along the *bearer* from the centre line of the nearest support (see figure 6.7). Where required for the alignment of the *brace*, the gap between the *bearer* and *diagonal brace* shall be bridged by a timber packer fixed to the *bearer* with nails and a fixing having a *capacity* of 12 kN along the direction of the *bearer*. The packer shall be the same depth as the *bearer* and not less than 600 mm long.

(c) *Joist*. The bolt shall pass through the *joist*, not less than 50 mm from its lower edge and not more than 200 mm measured along the *joist*, from the centre line of the nearest *pile* (see figure 6.8). The top of the diagonal timber *brace* shall not be more than 150 mm horizontally out of line from the bottom of the *brace* (see figure 6.8).

6.8.5 Bearer fixings to braced piles

The *bearer* shall be fixed to each *braced pile* with either:

(a) For timber *braced piles*: A M12 bolt with 50 mm x 50 mm x 3 mm washers or;

(b) An alternative fixing with a *capacity* of:

   (i) 12 kN in the horizontal direction where the *brace* is attached to the *pile*

   (ii) 12 kN in the vertical direction where the *brace* is attached to the *bearer*

   (iii) 12 kN in the vertical direction where the *brace* is attached to the *joist*.

6.8.6 Joist fixings to bearer (where joists are parallel to the brace)

6.8.6.1

Where the *brace* is attached to the *pile*: two floor *joists* in the area immediately above the upper end of the *brace*, shall be fixed to the *bearer* with fixings each having a *capacity* in the horizontal direction of the *brace* of 6 kN.

6.8.6.2

Where the *brace* is attached to the *joist*: the *joist* to *bearer* fixing shall have a *capacity* in the vertical direction of 12 kN.

C6.8.6

Refer to manufacturer's data for fixings providing 6 kN and 12 kN capacities.

6.9 ANCHOR PILES

6.9.1 Height

The height of an *anchor pile* shall be as defined in 6.4.1.1.

6.9.2 Depth

The minimum depth of an *anchor pile* from *cleared ground level* to the *footing* under the surface bearing against the ground shall be 900 mm.

6.9.3 Fixings

The fixings of *bearer* and floor *joists* to *anchor piles* shall be M12 bolts with 50 mm x 50 mm x 3 mm washers or 12 mm diameter threaded rod and washer in the locations as illustrated (see figures 6.9 and 6.10). Alternative fixings having a *capacity* of 12 kN in tension or compression along the *bearer* and timber *joist* may be used.

6.10 FRAMED SUBFLOOR WALLS

C6.10.1

The provisions of section 8 require that subfloor stud walls must be lined or clad, or dwangs provided for lateral support of the studs.

6.10.1 Stud walls

Timber *stud* subfloor *walls* shall comply with the requirements of section 8 for timber *stud walls* within a *storey* except that:

(a) *Wall plates* shall be the same depth as the *studs* above, but not less than 50 mm thick, and continuously supported on a *foundation wall*;

(b) The *bottom plate* may be substituted by a *bearer* supported on *piles*;

(c) A double *stud* shall be provided directly beneath any *bearer* at right angles to the *wall* and supported by the *top plate*.

Wall plates shall be fixed to the *foundation wall* in accordance with 6.11.9.

6.10.2 Jack studs

6.10.2.1 Dimensions

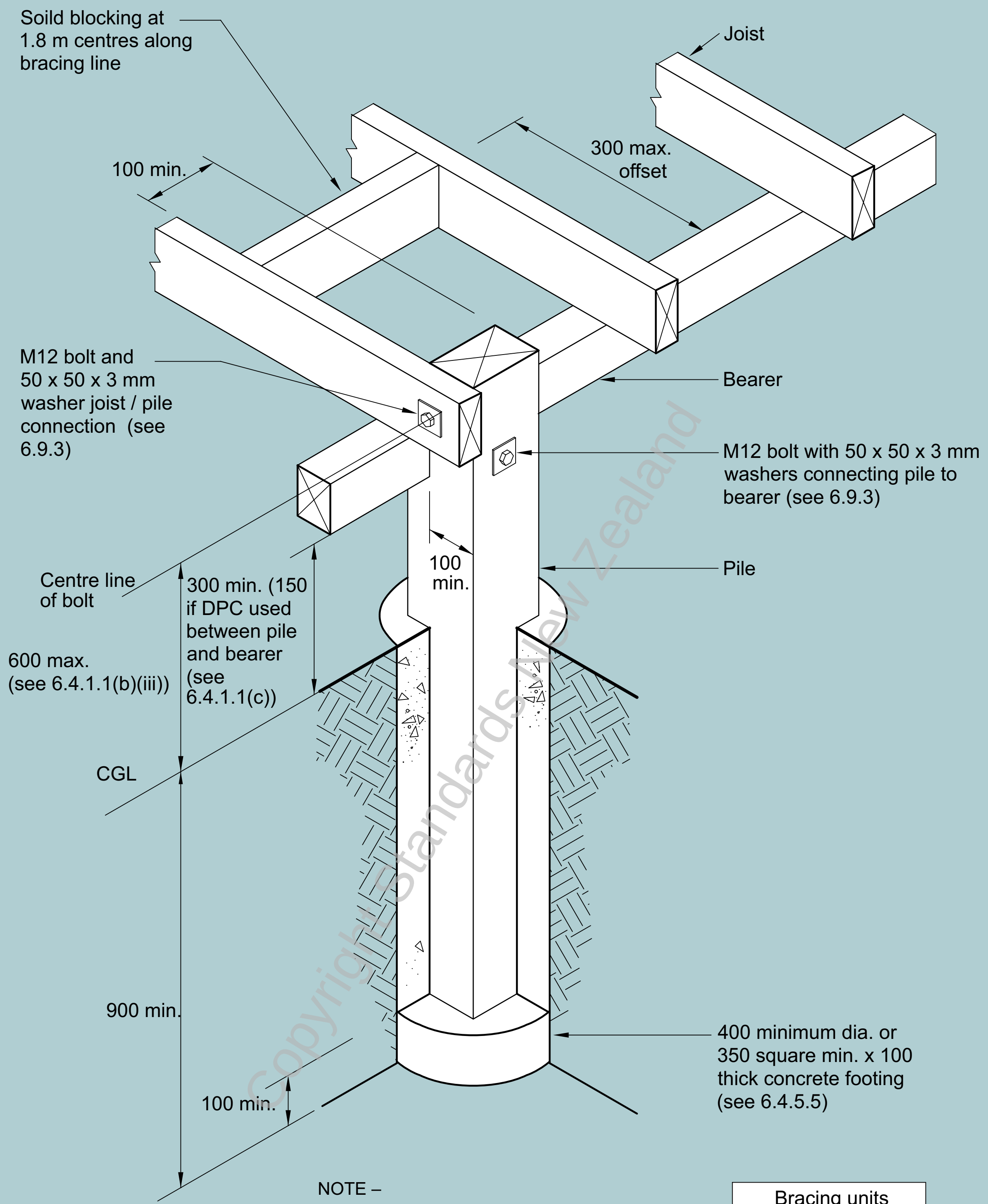
Jack studs shall be of the dimensions given by table 6.3 or table A6.3 (see table 14.5 or table A14.5 for 3 kPa *floor loads*).

6.10.2.2 Location

Jack studs shall be located over supporting *piles* and shall have their greater dimension in the line of the *bearer* supported by the *jack studs*.

6.10.2.3 Fixings

Fixings of *jack studs* to *ordinary piles* shall be in accordance with 6.5.2.



NOTE –

(1) Bearers shall not be joined at an anchor pile.

(2) CGL = Cleared ground level.

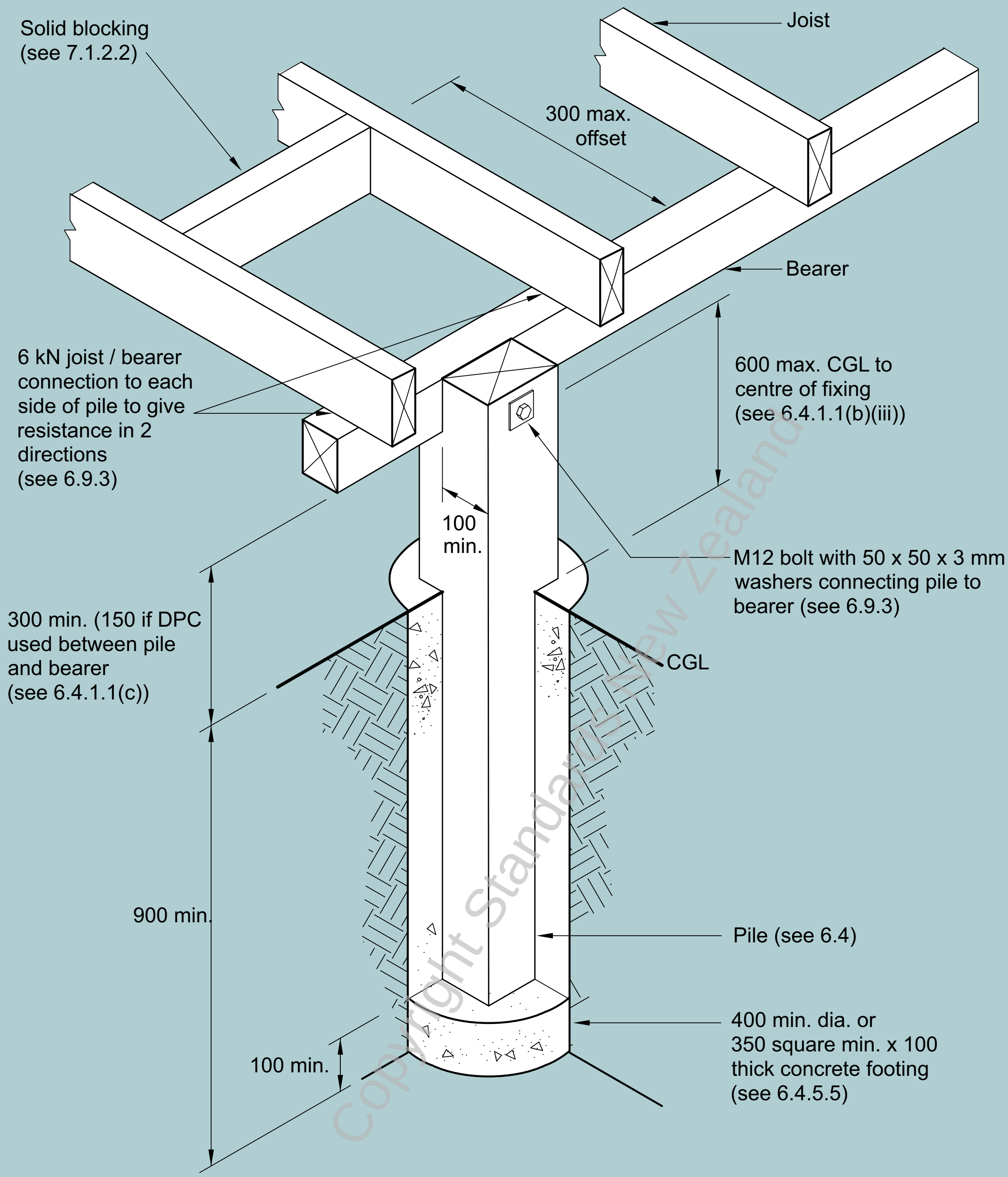
(3) DPC = Damp-proof course

(4) See section 4 for durability requirements.

Bracing units	
Wind	160
Earthquake	120

Unless otherwise stated, all dimensions are in mm.

Figure 6.9 – Anchor pile directly connected to joist and bearer (see 6.9)



NOTE –
(1) Bearers shall not be joined at an anchor pile.
(2) CGL = Cleared ground level.
(3) DPC = Damp-proof course.
(4) See section 4 for durability requirements.

Bracing units	
Wind	160
Earthquake	120

Unless otherwise stated, all dimensions are in mm.

Figure 6.10 – Anchor pile directly connected to bearer only (see 6.9)

Table 6.3 – Subfloor jack studs – SG 8 for up to 2 kPa floor load (see 6.10.2.1)

Maximum span of bearers	Jack stud size	Maximum jack stud height for loaded dimension* of bearer:		
		2.0	3.5	5.0
(m)	(mm x mm)	(m)	(m)	(m)
Supporting 1 storey				
1.30	90 x 70 90 x 90	2.0 3.0	2.0 2.9	1.9 2.7
1.65	90 x 70 90 x 90	1.8 2.7	1.7 2.6	1.6 2.4
2.00	90 x 70 90 x 90	1.6 2.4	1.6 2.3	1.5 2.2
Supporting 2 storeys				
1.30	90 x 70 90 x 90	1.8 2.7	1.6 2.4	1.5 2.2
1.65	90 x 70 90 x 90	1.6 2.4	1.4 2.2	1.3 2.0
2.00	90 x 70 90 x 90	1.4 2.2	1.2 1.9	1.0 1.7
Supporting 3 storeys				
1.30	90 x 70 90 x 90	1.6 2.4	1.4 2.1	1.2 1.9
1.65	90 x 70 90 x 90	1.4 2.1	1.2 1.9	0.9 1.6
2.00	90 x 70 90 x 90	1.2 1.9	0.9 1.6	– 1.3

* For definition of loaded dimension see 1.3.

NOTE – Substitution with built-up members is not allowed.

6.11 FOUNDATION WALLS (CONCRETE AND CONCRETE MASONRY)

6.11.1 General

6.11.1.1

The *foundation wall* provisions of this Standard shall apply only to *foundation walls* that are retaining not more than 600 mm of soil or fill.

C6.11.1.1

It will be necessary for any foundation wall that is a retaining wall to be the subject of specific design or to the provisions of NZS 4229.

6.11.1.2

Foundation walls shall be of reinforced concrete or of reinforced concrete masonry, constructed using *running* or *stretcher bond*.

6.11.1.3

Openings not exceeding 2.8 m wide may occur in *foundation walls*, provided that:

(a) No opening shall occur beneath the end support of a *bearer*;

(b) The *footing* shall be continuous beneath all openings;

(c) Any opening more than 600 mm wide shall be at least 600 mm clear of any *wall* end, or corner, or another opening;

(d) *Lintels* to support *joists* above openings shall be of timber as given by tables 8.10 to 8.12, 14.12 to 14.14 and 15.3 to 15.5. Openings not exceeding 900 mm wide and not less than 150 mm clear of the top of the *foundation wall* do not require a *lintel*;

(e) Reinforcing around openings shall comply with 6.11.7.3.

6.11.1.4

The top surface finish of a *foundation wall* shall provide continuous bearing for timber members.

6.11.1.5

Where *heavy wall claddings* are fixed to the lower *storey* as permitted by E2/AS1, a reinforced concrete or concrete masonry *foundation wall* complying with NZS 3109 or NZS 4229 shall be provided up to the *plate* supporting the floor *joists*.

6.11.2 Height of foundation walls

6.11.2.1

The height of the *foundation wall* shall be at least 225 mm above *finished ground level* (as shown in figure 6.11) and not more than 2.0 m above the bottom of its *footing* except at steps in *footings* where the height may be up to 2.6 m for a length of up to 1.5 m (see figure 6.12).

The height of the *foundation wall* shall be as required to accommodate the ground clearances to floor level and *claddings* as specified in E2/AS1 (see figure 6.11).

6.11.2.2

Where the height may be up to 2.6 m over a maximum 1.5 m length see figure 6.12. *Foundation walls* may be stepped to accommodate variations in *cleared ground level* or to suit the subfloor *framing*.

6.11.2.3

For durability requirements see 4.5.

6.11.2.4

When both the top and bottom surfaces are stepped, then the steppings shall be overlapped both vertically and horizontally not less than 450 mm as shown in figure 6.12.

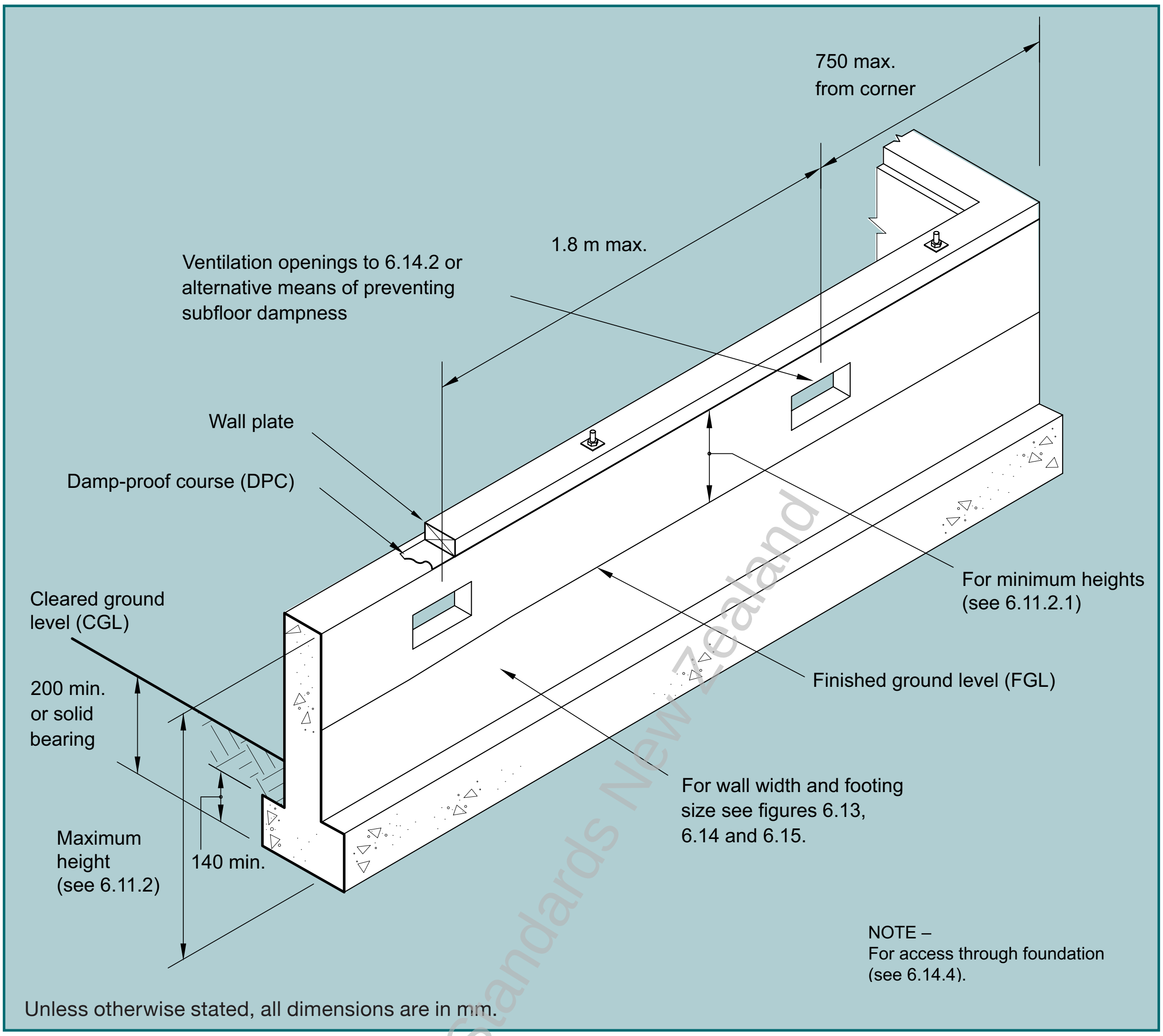


Figure 6.11 – Foundation walls (see 6.11.1 and 6.11.2)

6.11.3 Width of foundation walls

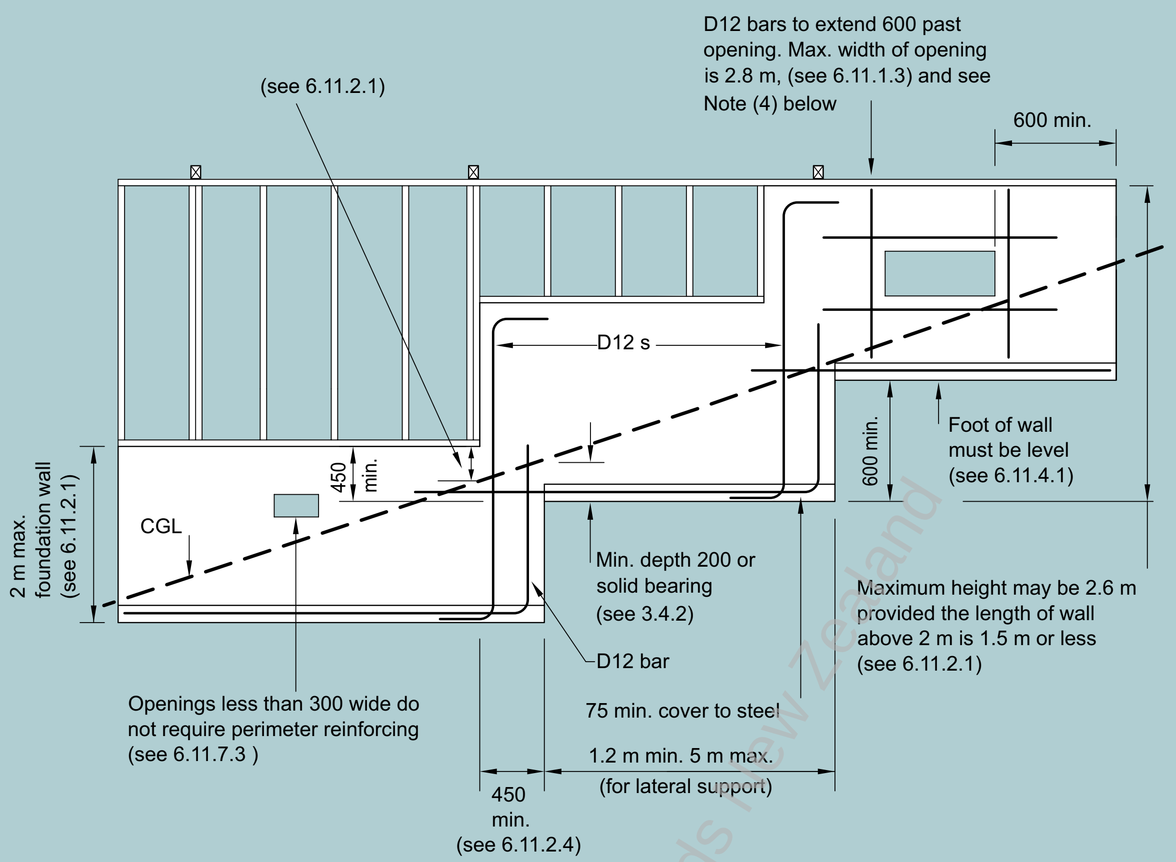
The width of a *foundation wall* shall be not less than shown in:

(a) Figure 6.13 for *cantilevered foundation walls*;

(b) Figure 6.14 for single-*storey foundation walls*; and

(c) Figure 6.15 for two-*storey foundation walls*.

Where the sides of a *foundation wall* are cast against earth, the thickness shall be increased so that there is a minimum cover of 75 mm to the *reinforcement*.



NOTE –

(1) Drawing only shows additional reinforcing required to the steps and openings in the wall. The wall shall be reinforced in accordance with figures 6.13 to 6.15 inclusive.

(2) Bearers shall not be located over openings (see 6.11.1.3(b)).

(3) For openings wider than 900 and within 150 of the top of the wall a lintel shall be provided over the opening to support the floor.

(4) For openings within 650 of the top of the wall vertical trimming bars shall be bent over 60 from top of wall (see 6.11.7.3).

(5) CGL = Cleared ground level.

Unless otherwise stated, all dimensions are in mm.

Figure 6.12 – Foundation walls – Openings and steps (see 6.11.1 and 6.11.2)

6.11.4 Foundation wall footings

6.11.4.1

All soil bearing surfaces of *foundation wall footings* shall be horizontal and may be stepped to accommodate variations in *cleared ground level*. The soil bearing depths of *footings* shall be in accordance with 3.4.2.

6.11.4.2

Sizes of *foundation wall footings* shall be as shown in:

(a) Figure 6.13 for *cantilevered foundation walls*:

(b) Figure 6.14 for single *storey*; or

(c) Figure 6.15 for two *storey*.

6.11.5 Lateral support for foundation walls

Where the top of the *foundation wall* is not connected to the floor *framing*, it shall be one of the following two systems:

(a) A cantilever *foundation wall footing* in accordance with figure 6.13;

(b) A stepped *footing*, not less than 600 mm high, where the length of *wall* on the lower side of the step is not less than 1.2 m (see figure 6.12). Steps shall be at no more than 5 m *spacing* along the line of the *wall*.

6.11.6 Foundation wall materials

Concrete and concrete masonry materials and workmanship shall comply with 2.6, 2.7, and 4.5.

6.11.7 Foundation wall reinforcement

6.11.7.1

Foundation walls shall be reinforced as shown in figures 6.13, 6.14 and 6.15. Where either the top or the *footing* of the *foundation wall* is stepped additional *reinforcement* shall be provided as shown in figure 6.12.

6.11.7.2

Where required, horizontal reinforcing bars shall be lapped with a lap length of not less than 500 mm. At corners and intersections laps shall be as determined in figure 6.15(a).

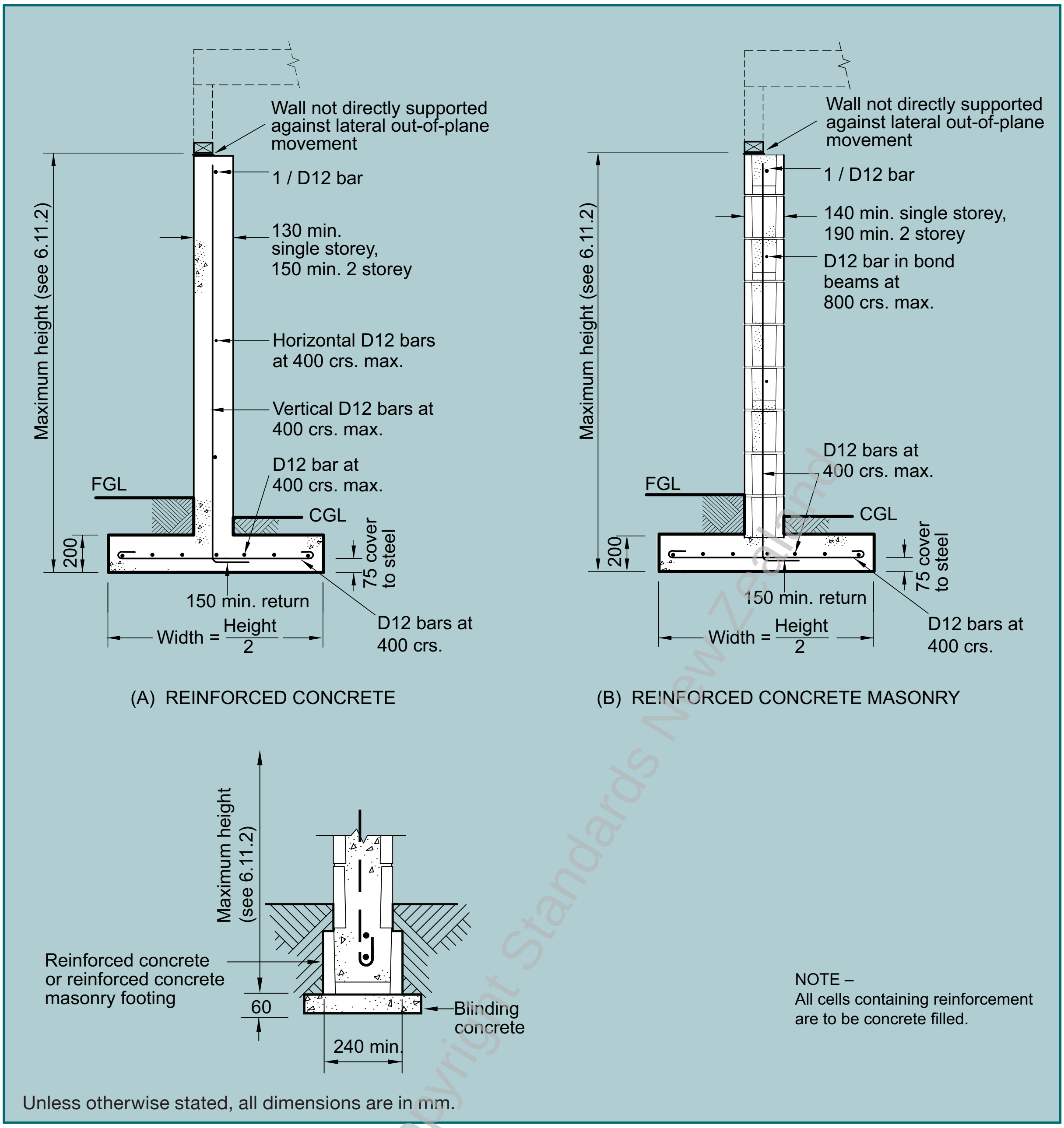


Figure 6.13 – Cantilevered foundation walls (see 6.11.3, 6.11.4.2, and 6.11.7.1)

6.11.7.3

An opening in a *foundation wall* exceeding 300 mm in any direction shall be provided with one D12 trimming bar on every side and extending not less than 600 mm past each corner of the opening. Where a *lintel* is less than 650 mm deep, the jamb trimming bars shall be bent near their tops at 60 mm from the top of the concrete.

6.11.7.4

Where either the top or the *footing* of a *foundation wall* is stepped, additional *reinforcement* shall be provided as shown in figure 6.12.

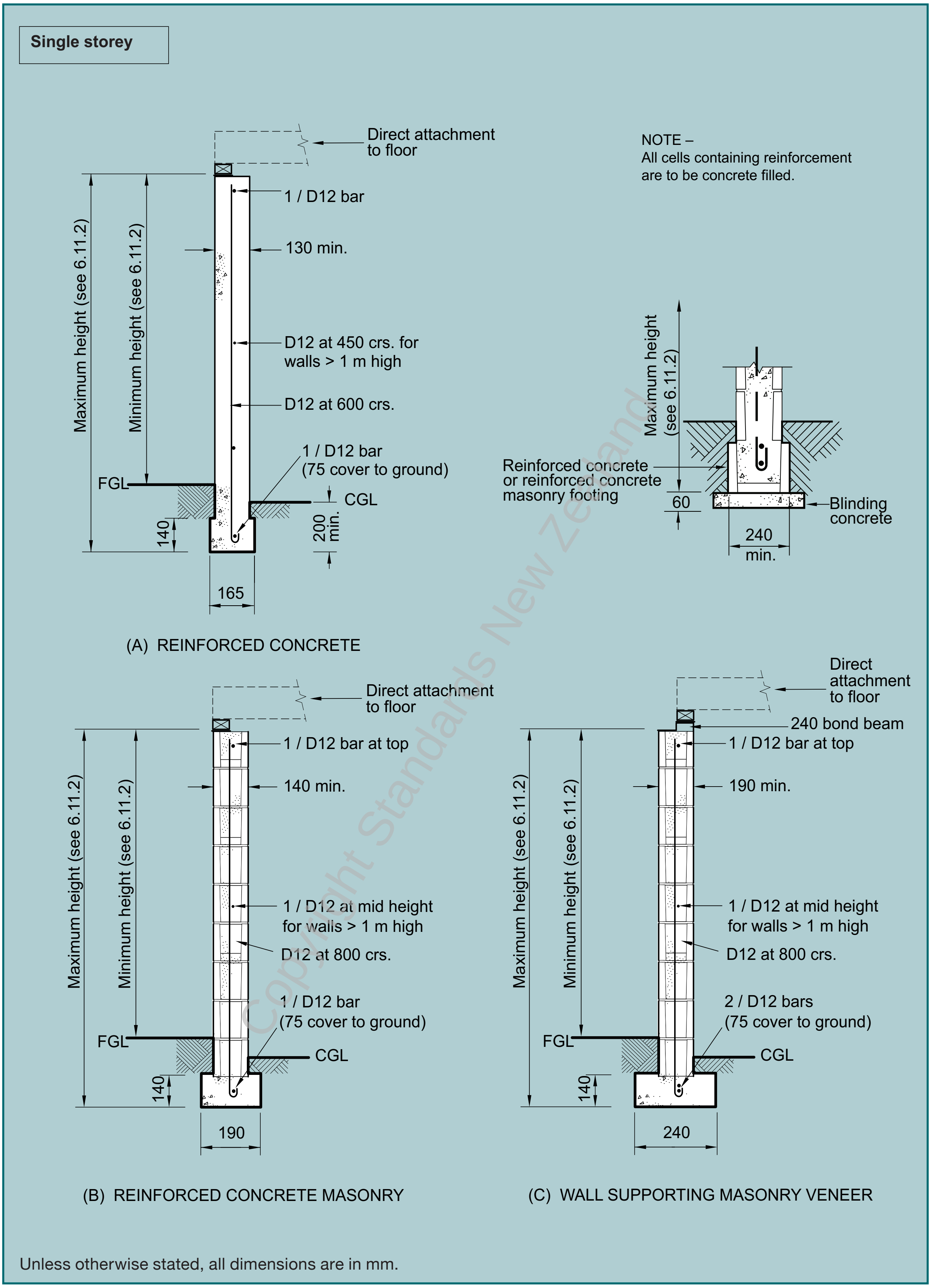


Figure 6.14 – Foundation walls (not cantilevered) for single-storey buildings (see 6.11.3, 6.11.4.2, and 6.11.7.1)

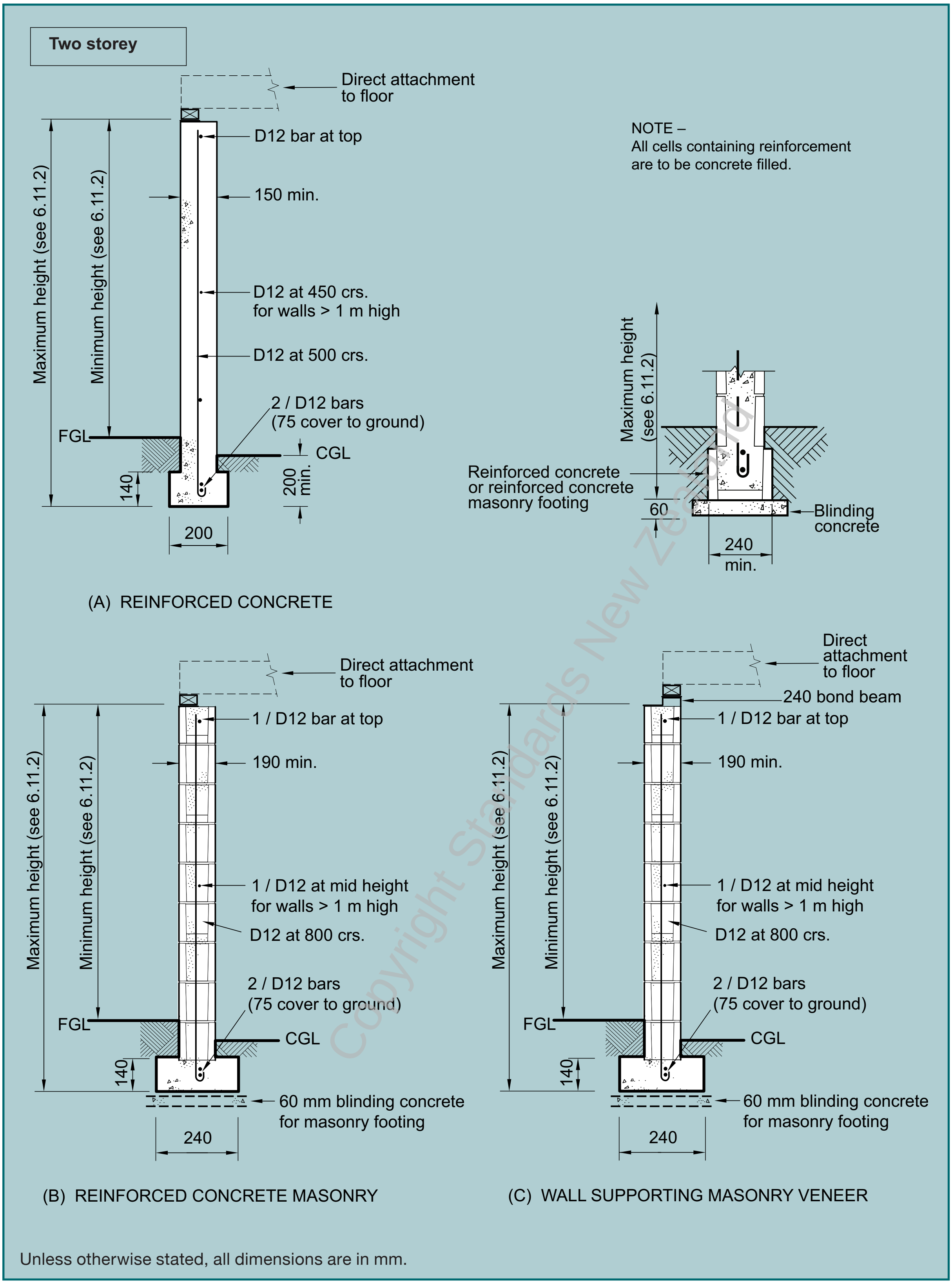


Figure 6.15 – Foundation walls (not cantilevered) for two-storey buildings (see 6.11.3, 6.11.4.2, and 6.11.7.1)

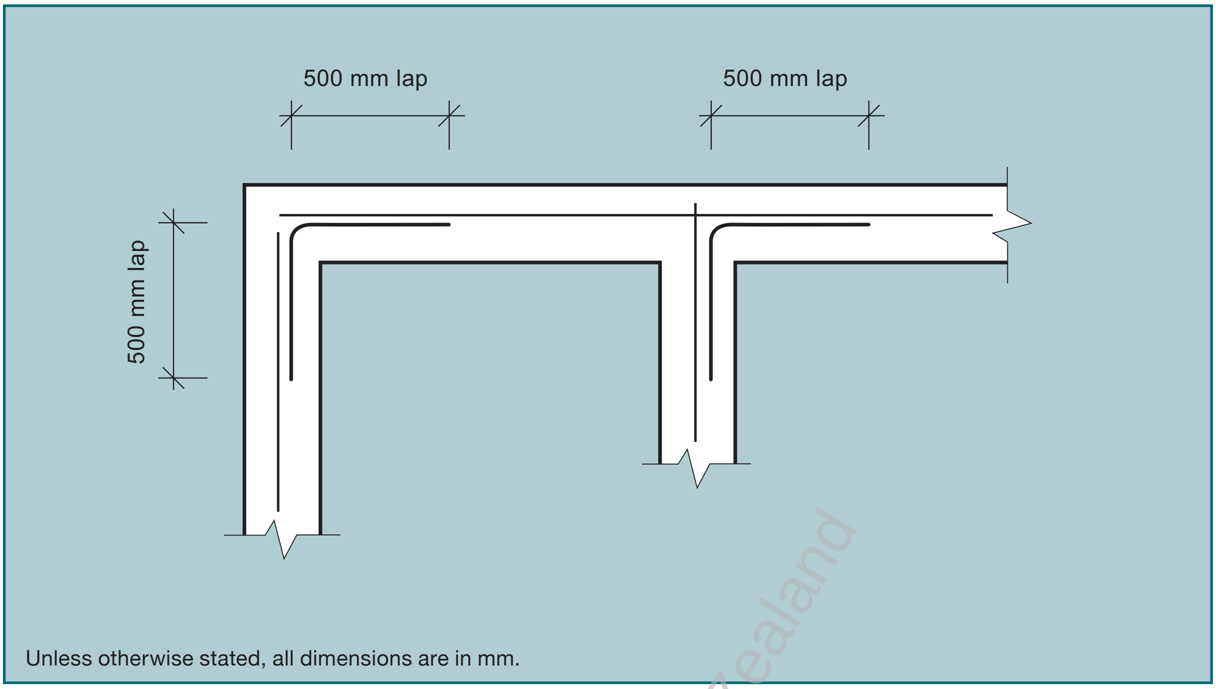


Figure 6.15(a) – Horizontal reinforcing lap length for foundation walls (see 6.11.7.2)

6.11.8 Subfloor bracing using foundation walls

Foundation walls may be used as a subfloor *bracing element* provided that the *wall* length being considered does not have an opening exceeding 600 mm wide. *Bracing capacity* ratings are set out in table 5.11. These *walls* shall be 1.5 m and over in length, and be connected to the *plate* supporting the floor *joists*, or the *wall plate* of a *braced* subfloor timber frame.

6.11.9 Fixing of wall plates to foundation walls

6.11.9.1

Wall plates shall be fixed to *foundation walls* by either:

(a) Cast-in M12 bolts and 50 mm x 50 mm x 3 mm washers within 300 mm from the end of the timber at corners of *foundation walls* and at no more than 1.4 m centres, set no less than 75 mm into the concrete and projecting sufficiently to allow for a washer and a fully threaded nut above the timber as shown in figure 6.16;

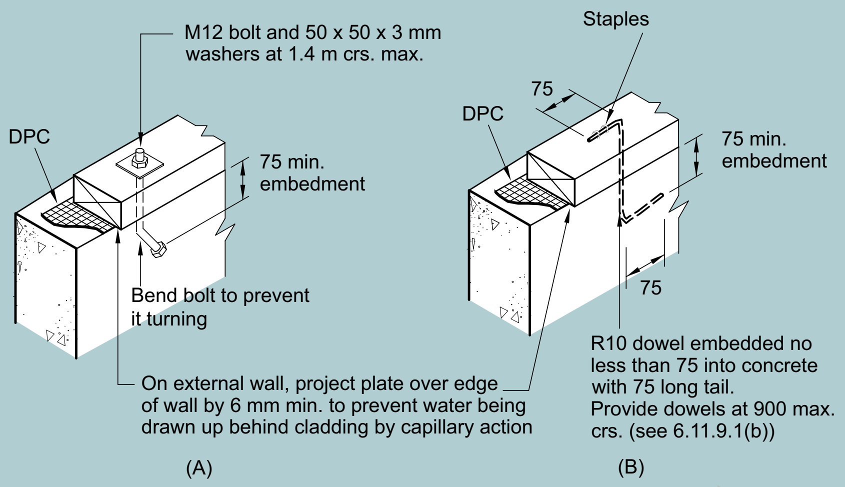
(b) Cast-in R10 steel rods within 300 mm from the end of the timber at corners of *foundation walls* at no more than 900 mm centres, bent at least 90°, set not less than 75 mm into the concrete and projecting sufficiently to allow for not less than a 75 mm length of dowel to be clinched over the timber as shown in figure 6.16; or

(c) Proprietary *post* fixed anchors complying with 7.5.12.2.

Where any length of *foundation wall* is regarded as a *subfloor brace*, each length of *plate* shall be fixed with not less than 2 bolts.

6.11.9.2

On *external walls* the *wall plate* shall overhang the *foundation wall* by 6 mm (see figure 6.16).



NOTE –
(1) Fixings shall be provided within 300 of any corner or change of direction (see 6.11.9.1).
(2) Powder powered fastenings for fixing down plates in walls containing bracing are not permitted.
(3) Bolt minimum cover 40.
(4) See section 4 for durability requirements.

Unless otherwise stated, all dimensions are in mm.

Figure 6.16 – Fixing of wall plates to foundation walls (see 6.11.9)

6.12 BEARERS

Bearers of solid or nailed laminated timber shall be continuous over 2 or more *spans* and be laid in straight lines on edge.

6.12.1 Securing

Bearers directly supported by a *foundation wall* perpendicular to them shall be secured against lateral movement by one of the following methods (see figure 6.17):

(a) For *bearer spacings* not exceeding 2 m: Each *bearer* shall be bolted to the *foundation wall* with a M12 bolt set not less than 150 mm into the *wall* and located centrally on the *bearer* and the *wall*;

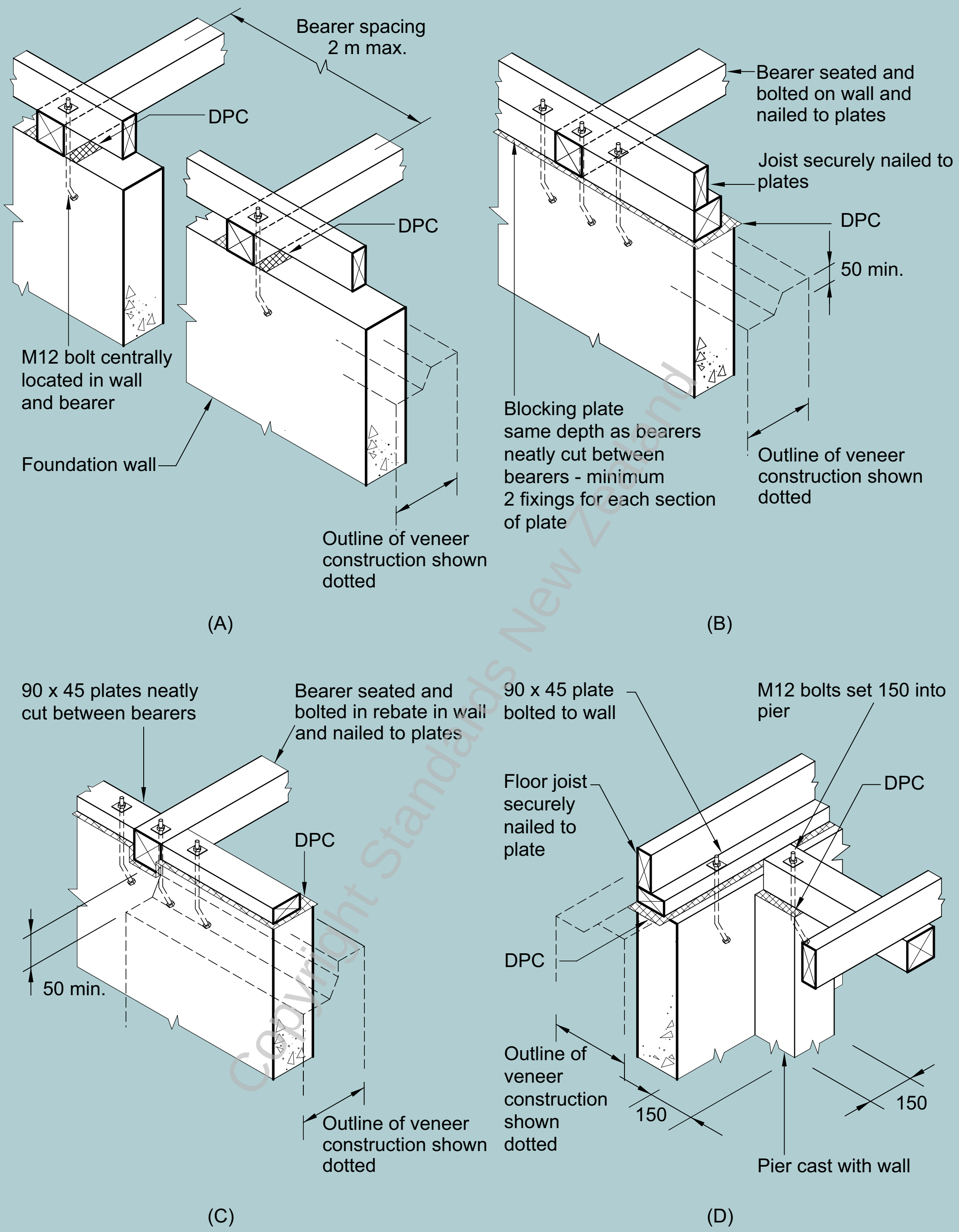
(b) For *bearer spacings* exceeding 2 m:

(i) Fixings as in (a), in conjunction with full depth *blocking* neatly cut between adjacent *bearers*. *Blocking* shall be fixed to the top of the *foundation wall* with a minimum of 2 fixings for each length of *blocking* (see figure 6.17 (B)); or

(ii) Each *bearer* shall be set in a rebate in the top of the *foundation wall* to a depth 50 mm less than the depth of the *bearer*, and a 90 mm x 45 mm *wall plate* neatly cut between adjacent *bearers* shall be fixed to the top of the *foundation wall*, with a minimum of 2 fixings for each length of *wall plate* (see figure 6.17 (C)); or

(iii) Each *bearer* shall be supported by a pier not less than 150 mm x 150 mm cast integrally with the *foundation wall* and extending from the *foundation wall footing* to a height such that the top of the *bearer* is level with the top of the *wall plate*. The *bearer* shall be fixed to the pier with a M12 bolt set not less than 150 mm into the pier (see figure 6.17 (D)).

(c) The end of a *bearer* which lands on a *foundation wall* running in the line of the *bearer* shall be fixed to the *foundation wall* by a M12 bolt, set not less than 50 mm from the edge of the *wall*, and not less than 100 mm from the end of the *bearer* as shown in figure 6.18.



NOTE – See section 4 for durability requirements.

Unless otherwise stated, all dimensions are in mm.

Figure 6.17 – Fixing of bearers perpendicular to foundation walls (see 6.12.1)

6.12.2 Sizes

6.12.2.1

Bearers shall be of the dimensions given in table 6.4 or table A6.4 (1.5 kPa and 2 kPa *floor loads*), table 14.4 or table A14.4 (3 kPa *floor loads*) except as provided by 6.12.2.2 and 6.12.4. The 1.5 kPa and 3 kPa *bearer* tables are for internal situations (i.e. where the timber will remain dry) and the 2 kPa tables for external situations (i.e. for *decks* where the timber will be exposed to wetting).

6.12.2.2

Where a *bearer* in a single-*storey* building runs parallel to, and not more than 200 mm away from a *loadbearing wall* supporting a *heavy roof*, of *loaded dimension* greater than 4.0 m, its size shall be as given in table 6.4, but the *loaded dimension* of the *bearer* shall not be taken as less than 2.7 m.

6.12.3 Built-up bearers

Bearers may be built-up as specified in 2.4.4.7, provided that where a dowel or bolt fixing passes through the depth of such a *bearer* then a M12 bolt shall be located within 50 mm of that fixing, to tie the laminations together.

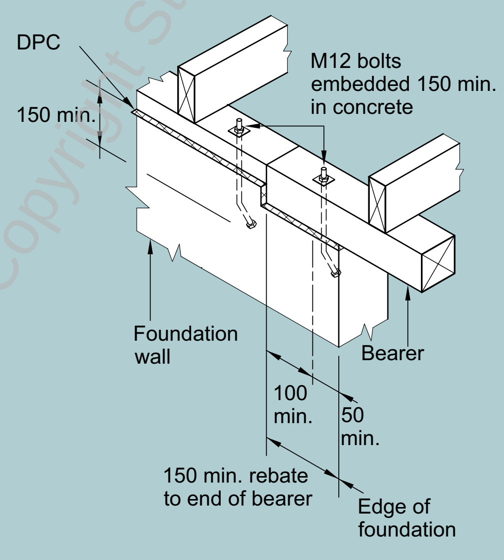
6.12.4 Cantilevered bearers

Bearers may project as *cantilevers* beyond the face of the support to a distance not exceeding:

(a) *Bearers* at *spacings* not exceeding 2 m: 300 mm;

(b) *Bearers* at *spacings* exceeding 2 m: 200 mm.

Cantilevered bearers shall support not more than one floor, and an *external wall* and *roof*.



NOTE – See section 4 for durability requirements.

Unless otherwise stated, all dimensions are in mm.

Figure 6.18 – Fixing of bearers in line with foundation walls (see 6.12.1(c))

Table 6.4 – Bearers – SG 8 for up to 2 kPa floor loads (see 6.12.2.1)

Maximum span of bearer continuous over 2 or more spans	Loaded dimension* of bearer	Bearer size (width x thickness)
(m)	(m)	(mm x mm)
(a) 1.5 kPa floor load SG 8 (dry in service)		
1.30	1.5 1.9 3.6 4.6 6.6	90 x 70 90 x 90 140 x 70 140 x 90 190 x 70
1.65	2.2 2.8 4.1	140 x 70 140 x 90 190 x 70
2.00	1.5 1.9 2.8	140 x 70 140 x 90 190 x 70
(b) 2.0 kPa floor load SG 8 and SG 8 (Wet) (wet in service)		
1.30	1.2 2.3 3.0 4.3	90 x 90 140 x 70 140 x 90 190 x 70
1.65	0.7 1.4 1.8 2.7	90 x 90 140 x 70 140 x 90 190 x 70
2.00	1.2 1.8	140 x 90 190 x 70

* For definition of loaded dimension see 1.3.

NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

6.12.5 Crook (Round)

Bearers shall be laid so that any crook in them will straighten under *load*.

6.12.6 Landing

Bearers shall have a minimum landing on their supports of:

(a) Where *bearers* are butted over the support: 45 mm;

(b) In all other cases: 90 mm.

Any packing necessary beneath *bearers* shall be of a material as durable and as incompressible as the *bearer* itself.

C6.12.6

Packing beneath bearers should be avoided if possible.

6.12.7 Joints

6.12.7.1

Joints in *bearers* shall be made only over supports but shall not occur where the *bearer* is fixed directly to an *anchor pile* or a *braced pile*.

6.12.7.2

A joint in a *bearer* shall be made over a support with a connection having a *capacity* of:

(a) Not less than 12 kN in tension or compression along the line of the *bearer*, or 6 kN each on both sides, if the *bearer* is one piece of timber; or

(b) 6 kN on one side of the joint when one laminate is continued over the support.

See figure 6.19.

6.13 STRINGERS

6.13.1

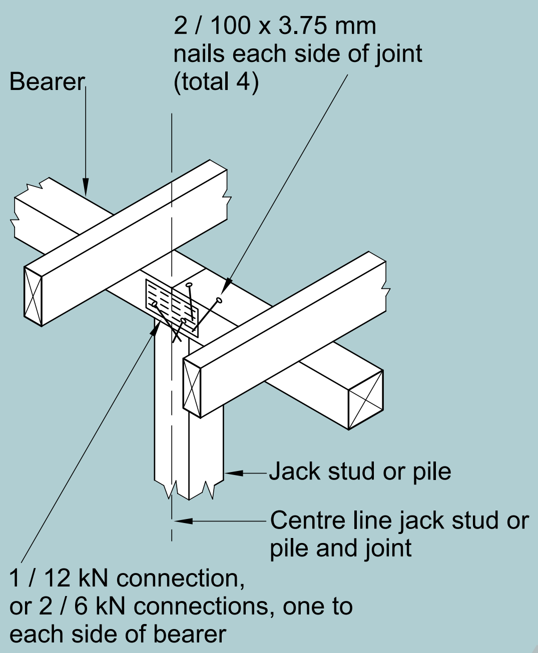
Stringers shall be of the dimensions given by table 6.5, or table 14.7 for 3 kPa *floor loads*. No *stringer* shall support more than one floor and its associated non-*loadbearing walls*.

6.13.2

As shown in figure 6.20 *stringers* shall be fixed to their supporting *foundation walls* with M12 bolts set not less than 100 mm into the *wall* at *spacings* as given by table 6.5. Proprietary bolt system alternatives shall comply with the provisions of 2.4.7 and have a minimum *capacity* of 4.5 kN in the vertical direction, and 7.3 kN parallel to the *stringer*.

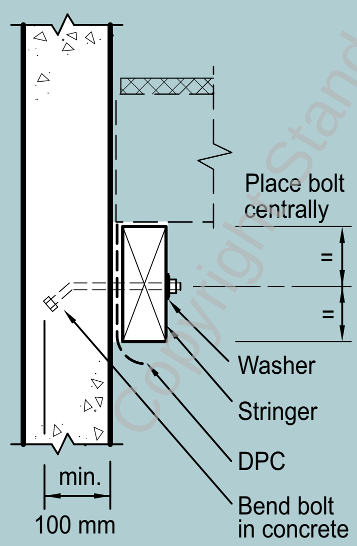
Table 6.5 – Stringer sizes and fixings (see 6.13.1 and 6.13.2)

Stringer nominal size (mm)	**Maximum M12 bolt spacing** (mm) **of:**				
	800	900	1200	1600	2400
	Maximum span of floor joists (m)				
190 x 45	6.0	5.0	4.0	3.0	2.0
140 x 45	6.0	5.0	4.0	3.0	–



NOTE – See section 4 for durability requirements.

Figure 6.19 – Joints in bearers (see 6.12.7.1 and 6.12.7.2)



NOTE – See section 4 for durability requirements.

Figure 6.20 – Fixing of stringers to foundation walls (see 6.13.2)

6.14 PREVENTION OF DAMPNESS

6.14.1 Ventilation opening area required

To prevent subfloor dampness, provide subfloor ventilation openings over the whole subfloor area, unless the provisions of 6.14.3 are applied. Ventilation openings shall be not less than 3500 mm^2 per m^2 of floor area and evenly distributed around the *foundation* perimeter.

6.14.2 Options

Acceptable ventilation methods include:

(a) Ventilators *spaced* regularly, commencing 750 mm from the corner and at intervals not exceeding 1.8 m (see figure 6.11);

(b) Continuous 20 mm wide slots between baseboards;

(c) A 50 mm gap between the *wall plates* and a *boundary joist* at the ends of cantilevered floor *joists* and the *wall plate* and *joist*, where the *bearer* is cantilevered;

(d) Other regularly *spaced* openings that will provide adequate ventilation.

C6.14.3

A 0.25 mm thick polythene sheet lapped 75 mm at the joints and complying with the above conditions is adequate as a ground cover.

6.14.3 Ground cover

Where ventilation openings of 3500 mm^2 per m^2 cannot be provided, or the subfloor airflow is obstructed by party *walls*, attached terraces or similar, or where for larger buildings any part of the subfloor space is more than 7.5 m from the nearest ventilation opening, a damp-proof ground cover over the whole subfloor shall be used. The following conditions shall all apply:

(a) The vapour barrier shall be a ground cover of not less than 50 MNs/g vapour flow resistance held against movement;

(b) It is held in place with rocks or bricks or similar method;

(c) Ventilation openings shall have a net open area of no less than 700 mm^2 for every m^2 of floor level and be located to provide a cross-flow in the subfloor space; and

(d) The ground is shaped to prevent water accumulation on the vapour barrier and to drain to the exterior.

C6.14.4

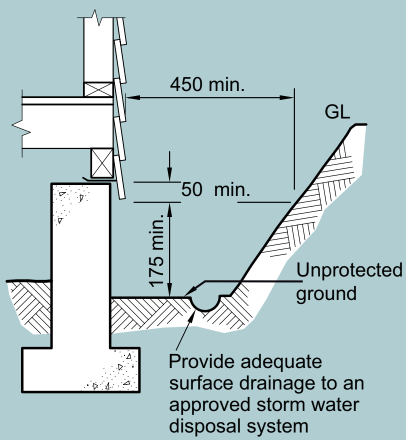
Clause 6.14.4 requires access height not less than 450 mm but does not require all timbers to be 450 mm or more above ground.

6.14.4 Access

Access shall be provided to permit visual inspection of all subfloor *framing* members. A crawl space for this purpose shall be not less than 450 mm high to the underside of the floor *joists*.

6.14.5 Horizontal separation

A clear horizontal separation of not less than 450 mm shall be maintained between the outside of any *wall cladding* and the adjacent ground (see figure 6.21).



Unless otherwise stated, all dimensions are in mm.

Figure 6.21 – Clearance between cladding and adjacent ground
(see 6.14.5 and figure 7.11 (A))

6.15 NAILING SCHEDULE

Table 6.6 specifies the nails to be used in subfloor *framing*. See 2.4.4 for other requirements for nails.

Table 6.6 – Nailing schedule for hand-driven and power-driven nails

Joint	Hand-driven nails		Power-driven nails	
	Length x diameter and type (mm x mm)	**Number/ Location**	**Length x diameter and type** (mm x mm)	**Number/ Location**
Bearer to jack stud	100 x 3.75	2 (skewed)	90 x 3.15	2 (skewed)
Bearer end to cut between plates	100 x 3.75	4 (skewed)	90 x 3.15	4 (skewed)
Bearer to top plate of wall framing	100 x 3.75	4 (skewed)	90 x 3.15	6 (skewed)
Stud or jack stud to plate	100 x 3.75 or 75 x 3.15	2 (end nailed) 4 (skewed)	90 x 3.15	3 (end nailed)

NOTE –
(1) Nail lengths and diameters are the minimum required.
(2) See 4.4 for required protective coatings for metal fasteners.

APPENDIX A – SG 6 AND SG 10 TABLES

(Normative)

Table A6.3 – Subfloor jack studs – SG 6 for up to 2 kPa floor loads (see 6.10.2.1)

Maximum span of bearers	Jack stud size	Maximum jack stud height for loaded dimension* of bearer:		
		2.0	**3.5**	**5.0**
(m)	(mm x mm)	(m)	(m)	(m)
Supporting 1 storey				
1.30	90 x 70 90 x 90	1.9 2.8	1.9 2.7	1.7 2.6
1.65	90 x 70 90 x 90	1.7 2.5	1.6 2.4	1.5 2.3
2.00	90 x 70 90 x 90	1.5 2.3	1.5 2.2	1.3 2.0
Supporting 2 storeys				
1.30	90 x 70 90 x 90	1.7 2.6	1.5 2.3	1.4 2.1
1.65	90 x 70 90 x 90	1.5 2.3	1.3 2.0	1.1 1.8
2.00	90 x 70 90 x 90	1.3 2.0	1.1 1.8	0.8 1.6
Supporting 3 storeys				
1.30	90 x 70 90 x 90	1.5 2.3	1.3 2.0	1.1 1.8
1.65	90 x 70 90 x 90	1.3 2.0	1.0 1.7	– 1.4
2.00	90 x 70 90 x 90	1.1 1.8	– 1.4	– 0.8

* For definition of loaded dimension see 1.3.

NOTE – Substitution with built-up members is not allowed.

Table A6.3 – Subfloor jack studs – SG 10 for up to 2 kPa floor loads (see 6.10.2.1)

Maximum span of bearers	Jack stud size	Maximum jack stud height for loaded dimension* of bearer:		
		2.0	**3.5**	**5.0**
(m)	(mm x mm)	(m)	(m)	(m)
Supporting 1 storey				
1.30	90 x 70 90 x 90	2.2 3.2	2.1 3.1	2.0 2.9
1.65	90 x 70 90 x 90	1.9 2.8	1.8 2.7	1.7 2.6
2.00	90 x 70 90 x 90	1.7 2.5	1.7 2.5	1.5 2.3
Supporting 2 storeys				
1.30	90 x 70 90 x 90	1.9 2.9	1.8 2.6	1.6 2.4
1.65	90 x 70 90 x 90	1.7 2.5	1.5 2.3	1.4 2.1
2.00	90 x 70 90 x 90	1.5 2.3	1.4 2.0	1.2 1.9
Supporting 3 storeys				
1.30	90 x 70 90 x 90	1.7 2.6	1.5 2.3	1.3 2.0
1.65	90 x 70 90 x 90	1.5 2.3	1.3 2.0	1.1 1.8
2.00	90 x 70 90 x 90	1.3 2.0	1.1 1.8	– 1.5

* For definition of loaded dimension see 1.3.

NOTE – Substitution with built-up members is not allowed.

Table A6.4 – Bearers – SG 6 for up to 2 kPa floor loads (see 6.12.2.1)

Maximum span of bearer continuous over 2 or more spans (m)	**Loaded dimension* of bearer** (m)	**Bearer size (width x thickness)** (mm x mm)
(a) 1.5 kPa floor load (dry in service)		
1.30	1.0	90 x 70
	1.3	90 x 90
	2.5	140 x 70
	3.3	140 x 90
	4.7	190 x 70
1.65	1.6	140 x 70
	2.0	140 x 90
	2.9	190 x 70
2.00	1.0	140 x 70
	1.4	140 x 90
	2.0	190 x 70
(b) 2.0 kPa floor load (wet in service)		
1.30	0.8	90 x 90
	1.5	140 x 70
	1.9	140 x 90
	2.7	190 x 70
1.65	0.5	90 x 90
	0.9	140 x 70
	1.2	140 x 90
	1.7	190 x 70
2.00	0.8	140 x 90
	1.1	190 x 70

* For definition of loaded dimension see 1.3.

NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A6.4 – Bearers – SG 10 for up to 2 kPa floor loads (see 6.12.2.1)

Maximum span of bearer continuous over 2 or more spans (m)	Loaded dimension* of bearer (m)	Bearer size (width x thickness) (mm x mm)
(a) 1.5 kPa floor load (dry in service)		
1.30	2.1	90 x 70
	2.7	90 x 90
	5.1	140 x 70
	6.6	140 x 90
1.65	3.2	140 x 70
	4.1	140 x 90
	5.9	190 x 70
2.00	2.1	140 x 70
	2.8	140 x 90
	4.0	190 x 70
(b) 2.0 kPa floor load (wet in service)		
1.30	1.2	90 x 90
	2.3	140 x 70
	3.0	140 x 90
	4.3	190 x 70
1.65	0.7	90 x 90
	1.4	140 x 70
	1.8	140 x 90
	2.7	190 x 70
2.00	1.2	140 x 90
	1.8	190 x 70

* For definition of loaded dimension see 1.3.

NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

SECTION 7

FLOORS

Table

Figure

7 FLOORS

This section sets down requirements for suspended timber framed floors and concrete slab-on-ground floors for live *loads* up to 2 kPa (3 kPa live *loads* are covered in section 14). Floors that are required to be structural floor *diaphragms* in accordance with 5.5.2.2 shall meet the requirements of 7.3, in addition to the other provisions of this section.

NOTE – SG 8 tables are used in this section. For the corresponding SG 6 and SG 10 tables, see the 'A tables' appended to this section.

7.1 FLOOR JOISTS

7.1.1 General

7.1.1.1

Floor *joists* shall be of the dimensions given in tables 7.1 (1.5 kPa and up to 2 kPa *floor loads*) and 14.8 (3 kPa *floor loads*). The 1.5 kPa and 3 kPa *floor joist* tables are for internal situations (that is, where the timber will remain dry) and the 2 kPa table for external situations (that is, for *decks* where the timber will be exposed to wetting).

7.1.1.2

Floor *joists* shall have their top surfaces set to a common level to support flooring and shall be laid in straight lines on edge.

7.1.1.3

Floor *joists* shall be laid so that any crook in them will straighten under *load*. They may be cut through to the centre line and over supports only to correct the crook, and in such cases they shall be considered as being jointed over those supports, for the purpose of determining the *span*.

C7.1.1.3

'Green' floor joists spanning more than 3 m should be propped level until their moisture content is 20 % or less.

7.1.1.4

Floor *joists* shall have minimum bearing on their supports of 32 mm.

7.1.1.5

Joints in floor *joists* shall be made only over supports, but not where the *joist* is cantilevered beyond the support.

7.1.1.6

Joints in floor *joists* may be butted over supports provided that in the following cases joints shall be lapped or flitched as specified in 7.1.1.7:

(a) In any *joist* to which a *diagonal brace* is attached;

(b) In every third *joist* at a line of support, except where a sheet flooring extends not less than 600 mm on each side of the joint.

7.1.1.7

Joints in floor *joists* (see figure 7.1) shall either:

(a) Be butted and flitched with a piece of timber of the same dimensions as the *joists* and extending not less than 150 mm on each side of the *joist* ends and nailed to both lengths of *joists* from both sides;

(b) Be lapped not less than 150 mm on each side of the centre line of the support and nailed together from both sides; or

(c) Have a nail plate with a fixing *capacity* of 6 kN in tension.

Table 7.1 – Floor joists – SG 8 up to 2 kPa floor loads (see 7.1.1.1)

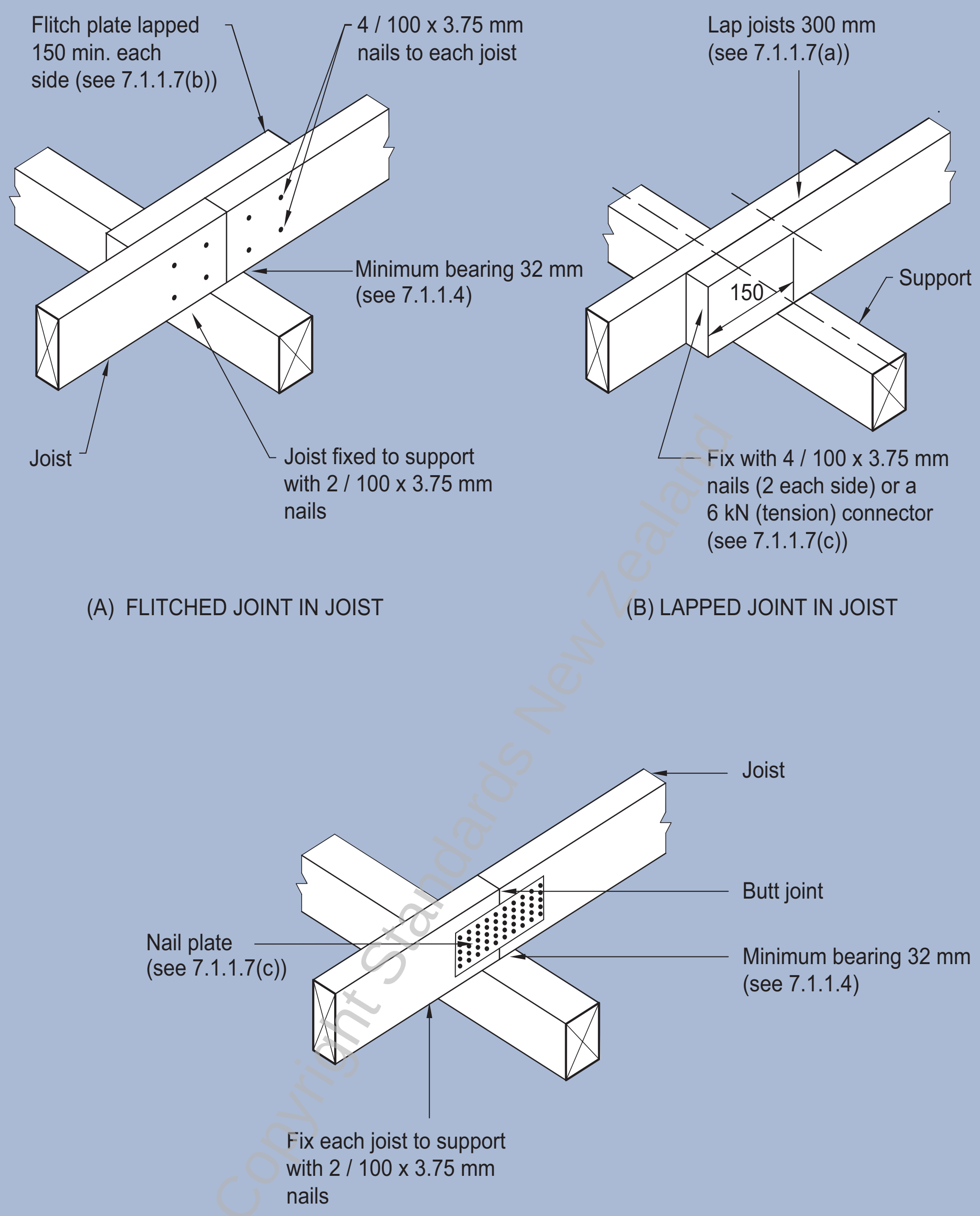
(a) 1.5 kPa floor load SG 8 (dry in service)

Floor joist size	Maximum span* of joists at a maximum spacing (mm) of:		
	400	450	600
(mm x mm)	(m)	(m)	(m)
90 x 45	1.45	1.40	1.25
140 x 35	2.10	2.00	1.80
140 x 45	2.70	2.60	2.00
190 x 45	3.55	3.45	3.15
240 x 45	4.40	4.30	3.90
290 x 45	5.20	5.05	4.60

(b) 2 kPa floor load SG 8 and SG 8 (Wet) (wet in service)

Floor joist size	Maximum span* of joists at a maximum spacing (mm) of:		
	400	450	600
(mm x mm)	(m)	(m)	(m)
90 x 45	1.60	1.50	1.30
140 x 35	2.20	2.05	1.80
140 x 45	2.50	2.35	2.05
190 x 45	3.40	3.20	2.75
240 x 45	4.30	4.05	3.50
290 x 45	5.20	4.90	4.25

* Spans may be increased by 10 % for joists continuous over 2 or more spans.



NOTE –
(1) Joint shall be made over a support (see 7.1.1.5).
(2) See section 4 for durability requirements.

Unless otherwise stated, all dimensions are in mm.

Figure 7.1 – Lapped or butted joints in floor joists (see 7.1.1.7)

7.1.2 Lateral support of floor joists

7.1.2.1

Lines of lateral support to floor *joists* as specified in 7.1.2.2 shall be provided within 300 mm of the following locations:

(a) Ground floor *joists*: Along all subfloor lines of horizontal support (see 5.5);

(b) Other floor *joists*: Along the line of each *wall* that contains a *wall bracing element* in the *storey* below.

7.1.2.2

A line of lateral support to floor *joists* (see figure 7.2) shall consist of:

(a) At the ends of *joists*: A continuous *boundary joist* 25 mm thick and the same depth as the floor *joists*; or

(b) In any location including at *joist* ends: Full depth *blocking* or *strutting* complying with 7.1.2.4 between adjacent floor *joists* at not more than 1.8 m maximum centres provided that:

   (i) There shall be solid *blocking* between the 2 edge pairs of *joists*; and

   (ii) Additional solid *blocking* shall be provided where required by 7.1.4.2.

7.1.2.3

In addition to any lateral support required by 7.1.2.1, floor *joists* having a *span* of over 2.5 m and a depth of 4 or more times their thickness shall be laterally supported by continuous *blocking* or *strutting* complying with 7.1.2.4 at mid-*span* (see figure 7.2).

C7.1.2.4

Squeaks in floor can result from solid blocking that does not fit tightly between the joists. This can be caused by drying/shrinkage of both joists and blocking.

(a) As far as is practicable, joists should be dry before fitting solid blocking or strutting.

7.1.2.4

Full depth *blocking* or *strutting* required by 7.1.2.2(b) or 7.1.2.3 shall be either:

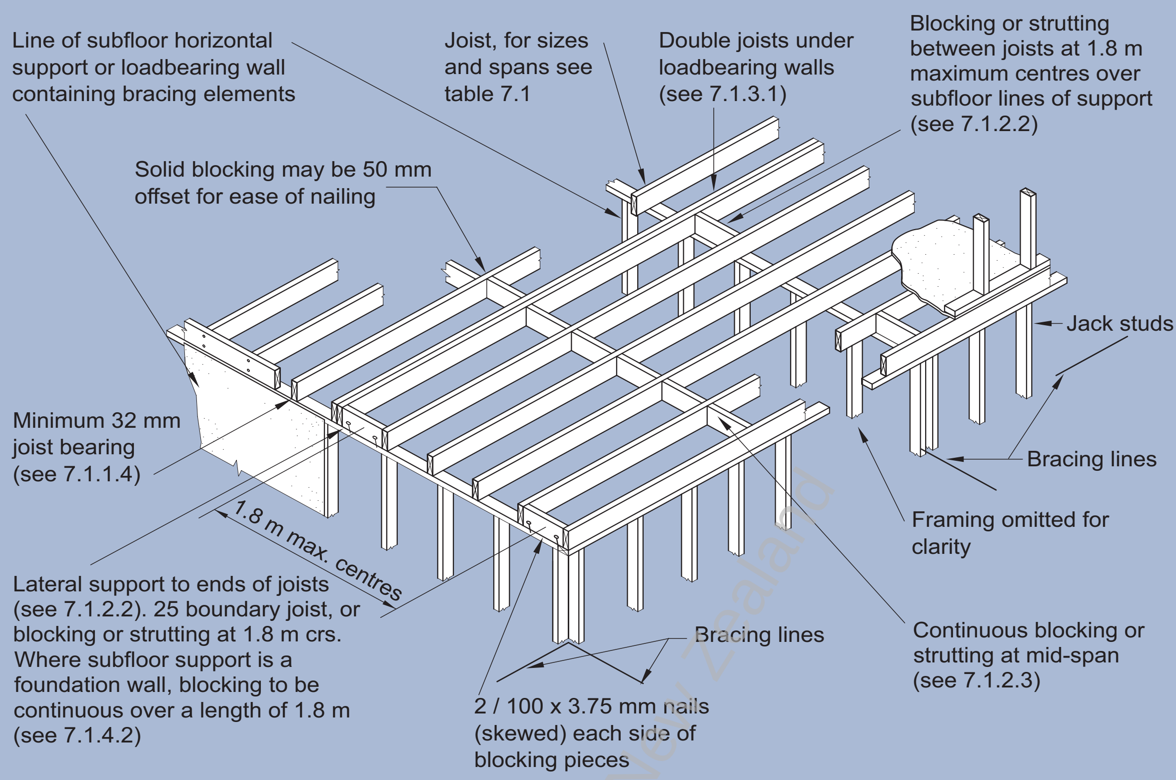
(a) Timber *blocking* 35 mm thick, the same depth as the *joists*, neatly cut between adjacent *joists*; or

(b) *Herringbone strutting* consisting of 2 pieces of 35 mm x 35 mm timber set diagonally in opposite directions, between the top and bottom edges of the *joists*.

7.1.3 Floor joists under walls

7.1.3.1

Where a *loadbearing wall* runs parallel to the line of floor *joists* beneath, it shall be supported by a pair of *joists* (see figure 7.3). Such a pair of *joists* may be separated by solid packing not exceeding 50 mm thick or half the thickness of the *wall* above, whichever is the lesser, at not more than 600 mm centres. If fitted floor *decking* is used, there shall be not less than a 20 mm landing on the *joists* for the *decking*.



NOTE –
(1) Refer to foundation drawings to identify joists adjacent to lines of support which shall have 6 kN fixings to bearer (see 6.7.3.1).
(2) Edge support to be provided for flooring (see 7.2.3.4).
(3) See section 4 for durability requirements.

Unless otherwise stated, all dimensions are in mm.

Figure 7.2 – Floor joists layout criteria (see 7.1.2.2)

7.1.3.2

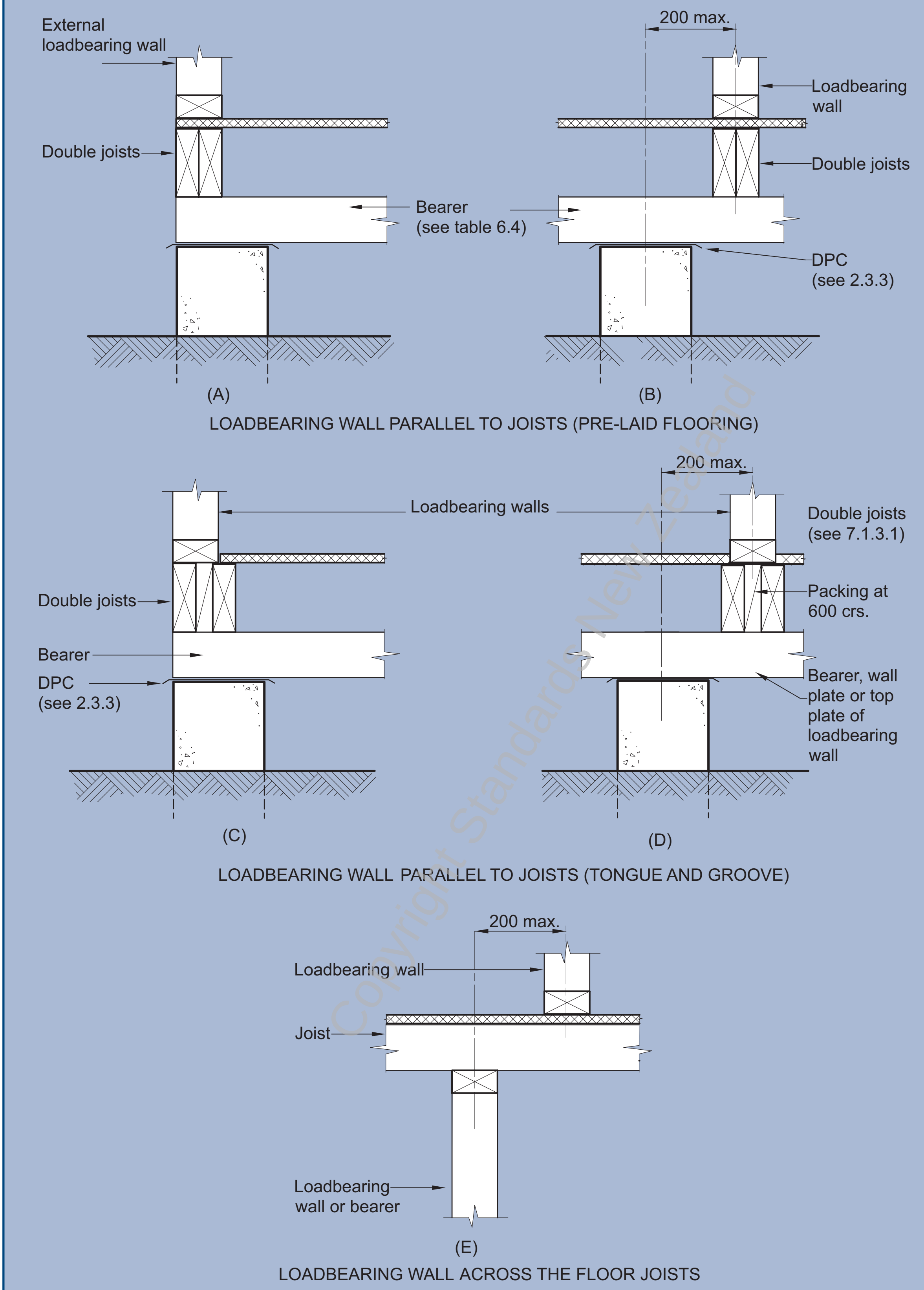
Where such doubled *joists* support a *trimmer stud*, itself supporting a *roof* only, the *trimmer stud* shall be located within 300 mm of the end of the *span* of the doubled floor *joist*. Floor *joists* supporting *trimmer studs* landing outside that limit, or supporting *trimmer studs* which in turn support *floor loads*, shall be subject to *specific engineering design (SED)*.

7.1.3.3

Where a *loadbearing wall* runs at right angles to the line of *joists*, such a *loadbearing wall* shall be located at not more than 200 mm centre-to-centre from a *bearer* or subfloor *loadbearing wall* (see figure 7.3 (E)).

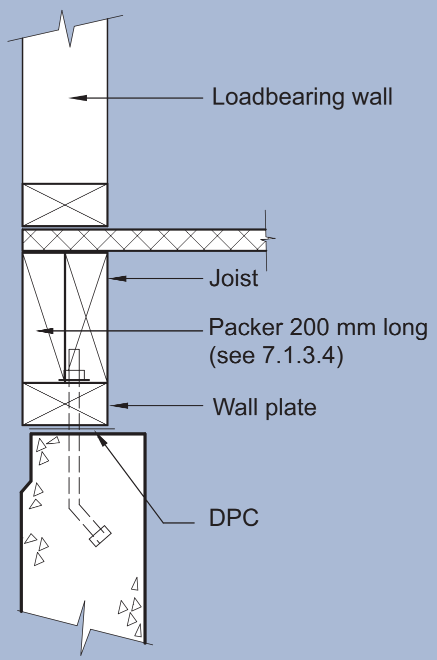
7.1.3.4

Where a *loadbearing wall* is directly over a continuous concrete or concrete masonry *foundation wall*, it may be supported by a 200 mm long packer *spaced* at the same distance as the *studs* in the *loadbearing wall*, provided that the *joist* and packers are supported over the entire *wall* length by the *wall plate* (see figure 7.4).



Unless otherwise stated, all dimensions are in mm.

Figure 7.3 – Support to floor joists under loadbearing walls (see 7.1.3)



NOTE – See section 4 for durability requirements.

Figure 7.4 – Loadbearing wall over foundation (see 7.1.3.4)

7.1.3.5

Where a *non-loadbearing wall*:

(a) Which contains *wall bracing* elements runs parallel to the line of floor *joists* beneath, it shall either:

  (i) Be over a *joist*; or

  (ii) Be supported by solid *blocking* between the *joists* on either side of the *wall* in accordance with 7.1.3.6 and as shown in figure 7.5; or

(b) Does not contain a *wall bracing element* it shall be within 150 mm of a *joist* measured between centre lines.

7.1.3.6

Solid *blocking* shall be 90 mm x 45 mm cut neatly between *joists*, with its top flush with the top of the *joists*, set at each end of the *wall* above, at each side of any door openings, and at not more than 1.2 m centres elsewhere.

7.1.4 Floor joists connected to foundation walls acting as subfloor braces

7.1.4.1

Where floor *joists* run parallel to *foundation walls*, one *joist* shall be directly above the length of *foundation wall* and shall be directly supported for a length of not less than 1.4 m by a *wall plate* or *bearer*, fixed to the *foundation wall* in accordance with 6.11.9.1 (see figure 6.16).

7.1.4.2

Where the floor *joists* run at right angles to the *foundation wall*, then either:

(a) The ends of the *joists* shall be laterally supported by a continuous *boundary joist* in accordance with 7.1.2.2(a); or

(b) The solid *blocking* required by 7.1.2.2(b) shall be provided between each pair of *joists* for a length of 1.8 m along the line of the *foundation wall* and either:

(i) Where the *foundation wall* is at a corner, the 1.8 m length shall be measured from the corner (see figure 7.9); or

(ii) Where the *foundation wall* is not at a corner, the 1.8 m length shall be symmetrically disposed on the *foundation wall*.

7.1.5 Cantilevered floor joists

7.1.5.1

Floor *joists* may project as cantilevers to the distance beyond the face of the support given by table 7.2 provided that cantilevered floor *joists* shall neither support a *balcony decking* having a mass exceeding 40 kg/m^2 nor support a *balcony* balustrade having a mass exceeding 26 kg/m^2. The maximum height of a *wall* supported by cantilevered *joists* shall be 2.4 m.

The cantilevered floor *joists* in table 7.2 or table A7.2 under the heading “2 kPa floor load – Balcony floor and balustrade only” may be wet in service. All other cantilevered *joists* shall be kept dry in service.

C7.1.5.1

Refer to NZS 3602 and section 4 of NZS 3604 for protection required for cantilevered joists exposed to the elements.

The cantilever lengths for the balcony joists have been determined on the basis of the engineering properties of wet timber. For this reason these joists may be exposed to the weather and wetting. The same does not apply to the other joists as these have been determined based on dry properties and accordingly must be kept dry, by closing in or other means, throughout the life of the building.

7.1.5.2

The depth of the *joist* to be used in table 7.2 or table A7.2 shall be the net depth at any notch, step, or hole occurring within two-thirds of the cantilever length from the face of the support.

C7.1.5.2

When a cantilevered floor joist supports a balcony or the like, it is frequently necessary to provide a notch or step in the joist at the external wall for weatherproofing.

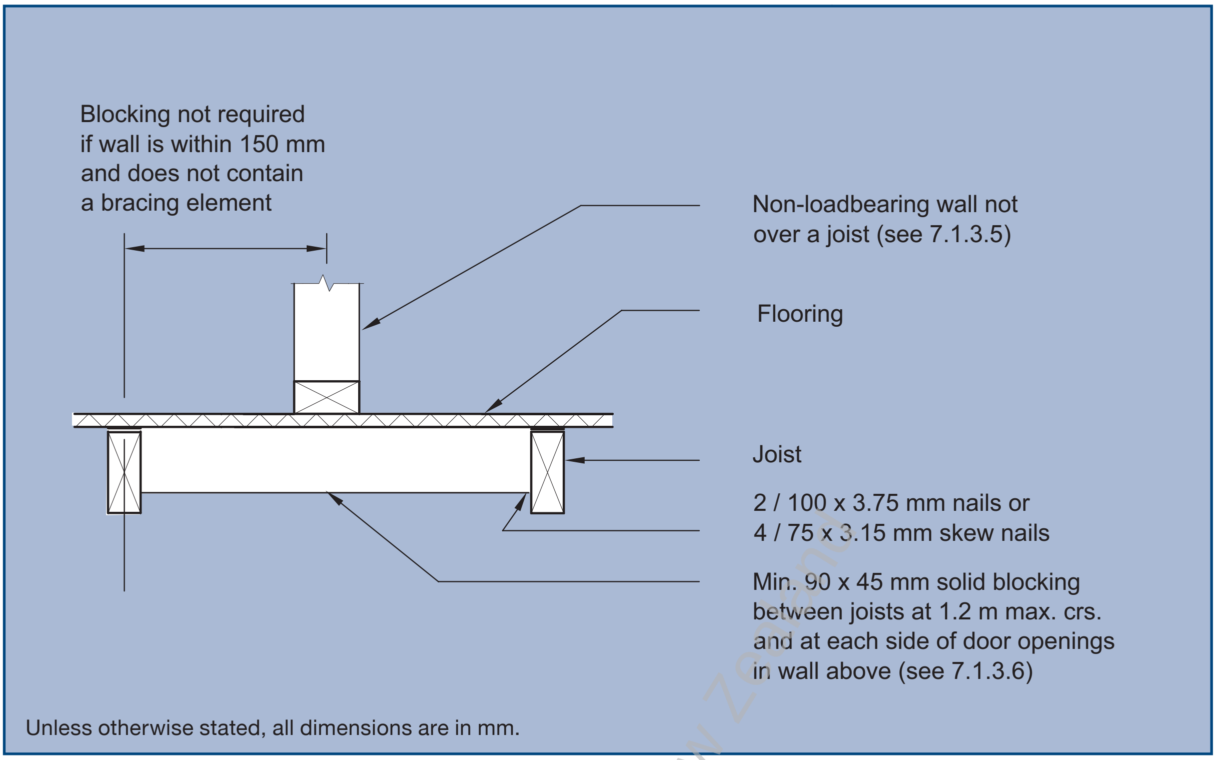


Figure 7.5 – Support to non-loadbearing walls (see 7.1.3.5)

Table 7.2 – Cantilevered floor joists – SG 8 up to 2 kPa floor loads (see 7.1.5)

Joist size	Joist spacing	Maximum cantilever length of joist supporting:						
		Wall, 1.5 kPa floor load						2 kPa floor load
		Light roof of span: (m)			Heavy roof of span: (m)			Balcony* floor and balustrade only
		4.0	8.0	12.0	4.0	8.0	12.0	
(mm x mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
90 x 45**	600 450 400	100 150 150	50 50 100	50 50 50	100 100 100	50 50 50	50 50 50	550 650 700
140 x 45**	600 450 400	300 300 350	150 200 250	100 150 150	250 250 250	150 150 200	100 150 150	900 1100 1150
190 x 45	600 450 400	550 600 600	300 400 450	200 250 300	450 450 500	300 350 350	250 250 250	1300 1500 1600
240 x 45	600 450 400	800 900 900	450 600 700	300 400 450	650 700 750	500 500 550	350 400 450	1650 1900 2050
290 x 45	600 450 400	1150 1200 1250	700 900 1000	450 600 700	950 1000 1050	700 750 750	550 600 600	2000 2350 2500

* Applies to balconies of domestic self-contained dwellings only. Only these joists may be Grade SG 8 (Wet).
** 90 and 140 joist depth is insufficient where cantilevered balustrades are used.

C7.1.5.3

The free ends of cantilevered floor joists of green timber should be propped level until the moisture content is 20 % or less, because green timber cantilevered joists can deflect excessively under their own weight and assume permanent deformations unless propped. For more information refer to NZS 3602.

7.1.5.3

Cantilevered floor *joists* shall either:

(a) Be continuous over the outermost support; or

(b) Be lapped over the outermost support and fixed to the adjacent *joist* as shown in figure 7.6, with the total length of the cantilevered *joist* being not less than 2.25 times the cantilever length.

7.1.6 Trimmers and trimming joists

7.1.6.1

Openings in joisted floors shall be bounded by *trimmer* and *trimming joists* defined in 1.3 (see figure 7.7).

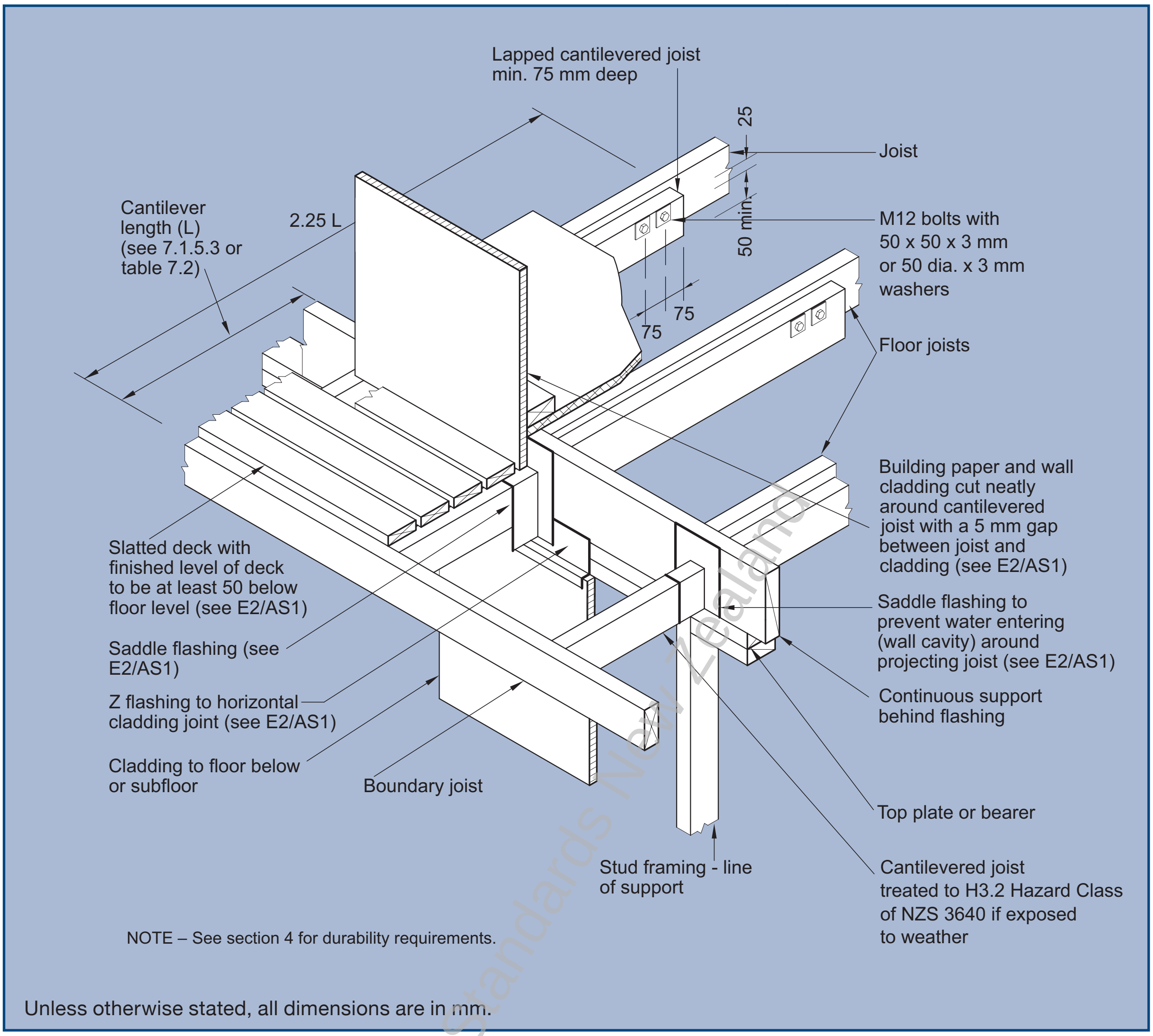


Figure 7.6 – Lapped cantilevered joists (stepped/notched) (see 7.1.5.3)

7.1.6.2

Trimmers shall be the same depth as the *curtailed joists* and for:

(a) *Trimmer spans* not exceeding 1.8 m: 25 mm thicker than the *curtailed joists*;

(b) *Trimmer spans* not exceeding 2.4 m: 50 mm thicker than the *curtailed joists*.

7.1.6.3

Trimming joists shall be the same depth as the *curtailed joists* and for:

(a) *Trimmer spans* not exceeding 1.8 m:

   (i) *Trimming joist spans* not exceeding 3 m: 25 mm thicker than the *curtailed joists*;

   (ii) *Trimming joist spans* exceeding 3 m: 50 mm thicker than the *curtailed joists*;

(b) *Trimmer spans* not exceeding 2.4 m: 50 mm thicker than the *curtailed joists*.

7.1.6.4

Curtailed joists shall be attached to *trimmers* as follows:

(a) Only *curtailed joist spans* not exceeding 3 m: By not fewer than 3 / 100 x 3.75 mm nails through the *trimmer* and extending not less than 50 mm into the ends of the *curtailed joists*; or

(b) By a connector having a *capacity* of:

  (i) *Curtailed joist spans* not exceeding 1.8 m: 2.7 kN;

  (ii) *Curtailed joist spans* not exceeding 3 m: 4.5 kN.

7.1.6.5

Trimmers shall be fixed to *trimming joists* as follows:

(a) By a half housing not less than 25 mm deep and fixed with 3 / 100 x 3.75 mm nails (see figure 7.7); or

(b) By a connector having a *capacity* of:

  (i) *Trimmer spans* not exceeding 1.8 m: 5.3 kN;

  (ii) *Trimmer spans* not exceeding 2.4 m: 7.6 kN.

7.1.7 Holes and notches in floor joists

C7.1.7

Layout of plumbing and drainage should be planned and detailed on the drawings so as to avoid drilling or notching joists.

7.1.7.1

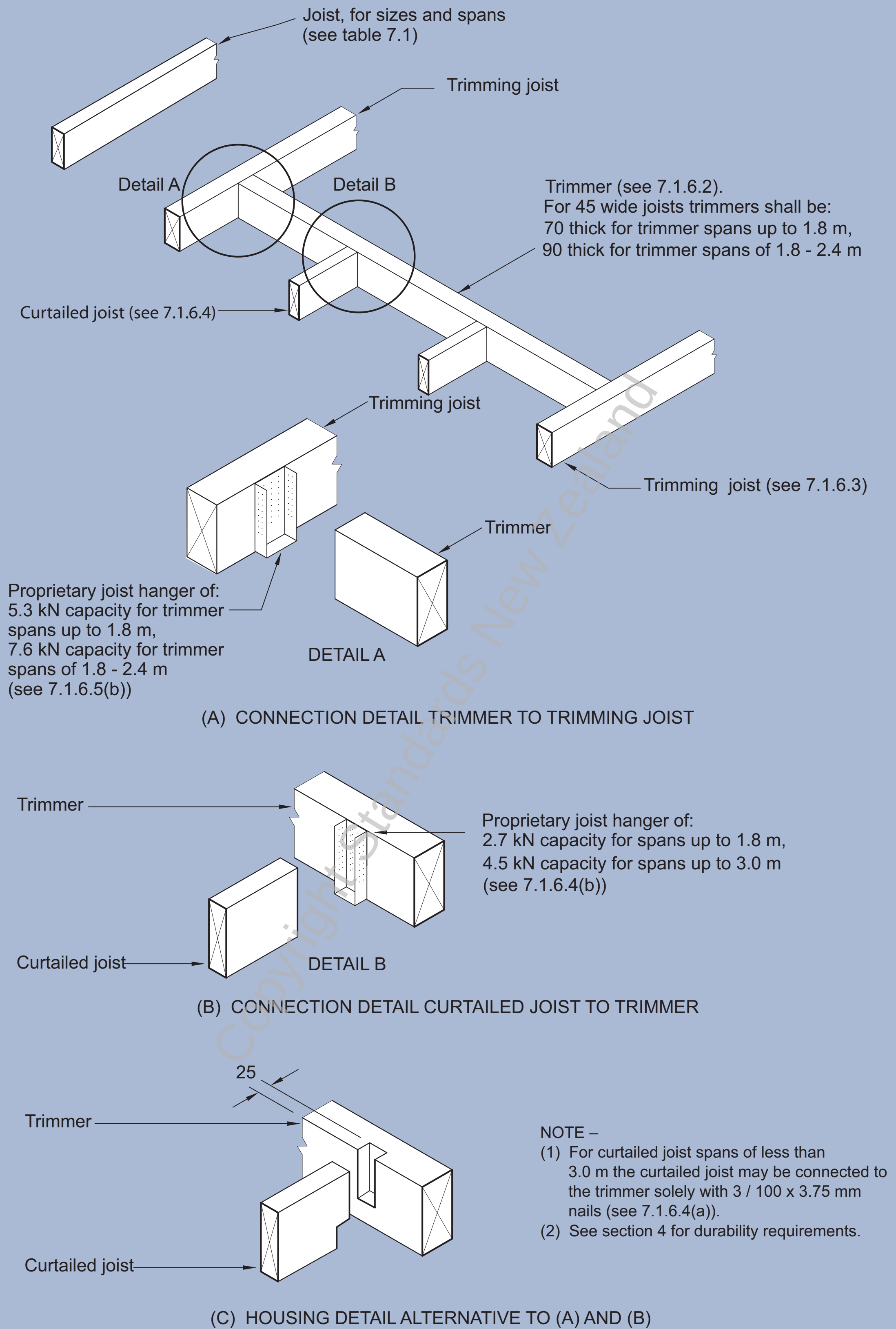
Holes drilled in floor *joists* other than cantilevered *joists* shall be:

(a) Within the middle third of the depth of the *joist*; and

(b) Not more than 3 times the depth of the *joist* from the face of a support (see figure 7.8 (A)).

7.1.7.2

Notches in floor *joists* other than cantilevered *joists* shall be not more than 450 mm from the face of a support; except that notches that do not reduce the effective depth of a *joist* to less than the minimum depth required by table 7.1 for the *joist span* concerned are permitted in any position (see figure 7.8 (B)).



NOTE –
(1) For curtailed joist spans of less than 3.0 m the curtailed joist may be connected to the trimmer solely with 3 / 100 x 3.75 mm nails (see 7.1.6.4(a)).
(2) See section 4 for durability requirements.

Unless otherwise stated, all dimensions are in mm.

Figure 7.7 – Openings in floors (see 7.1.6.1)

7.1.7.3
Holes and notches shall be:

(a) Not more in diameter or depth than one-fifth the depth of the *joist* or 32 mm, whichever is the lesser;

(b) At minimum *spacing* measured along the *joist* between the edges of the holes or notches of not less than the depth of the *joist*.

See figure 7.8 (C).

7.1.7.4
No holes or notches shall be drilled or cut in cantilevered *joists* except as permitted by 7.1.5.2.

7.2 FLOORING

7.2.1 Flooring installation

Sufficient room shall be left around the exterior edge of flooring materials to allow for movement resulting from changes in moisture content. For timber and timber-based products this dimension shall be 6 mm to 10 mm.

7.2.2 Timber strip flooring

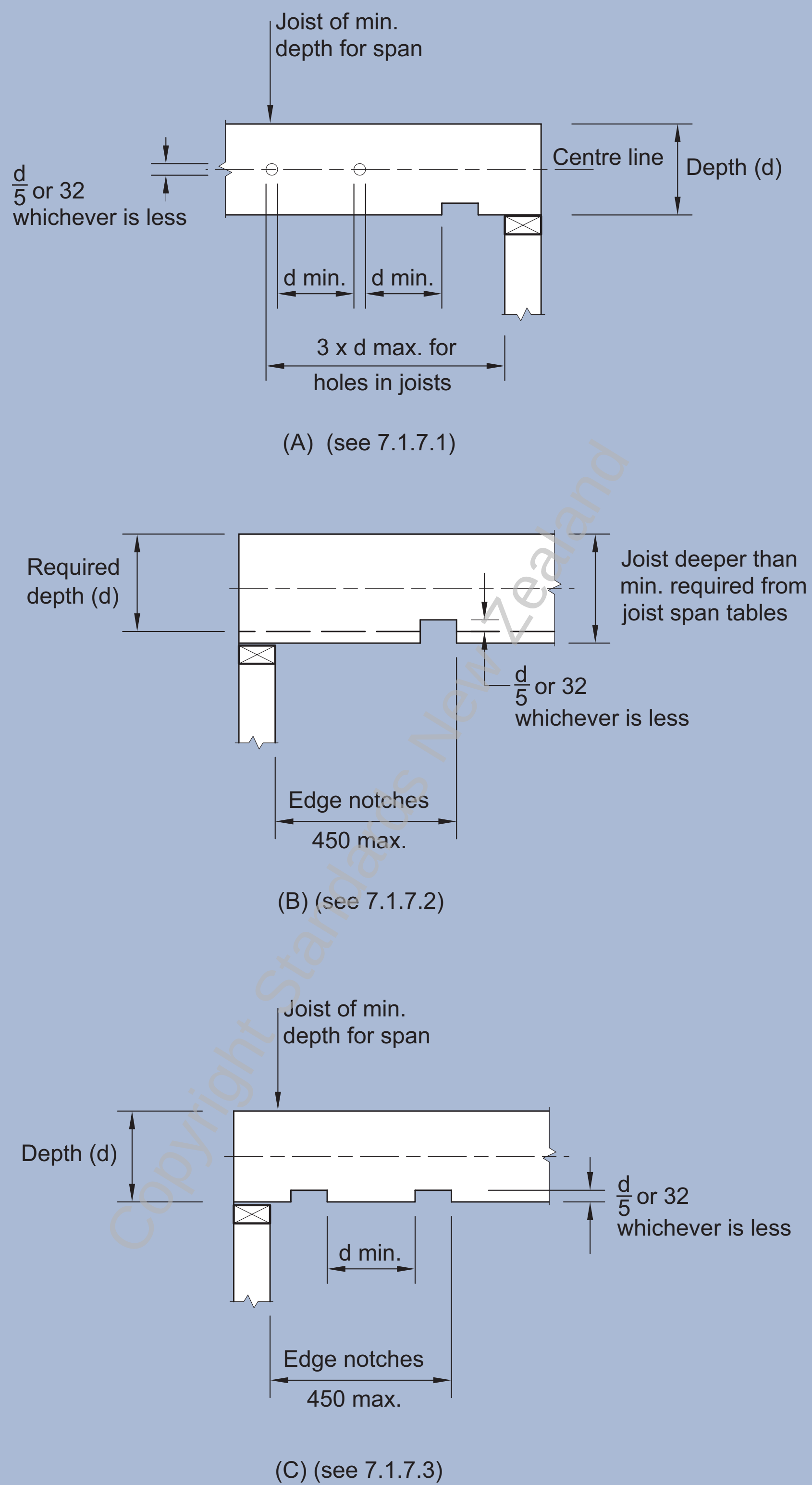
7.2.2.1
The minimum dry dressed thickness of tongued and grooved boards for timber strip flooring for 1.5 kPa and 2 kPa *floor loads* shall be as given by table 7.3 (and table 14.9 for 3 kPa *floor loads*).

7.2.2.2
Floor boards shall be laid in straight parallel lines at right angles to the *joists*, with tongues fitted into grooves and cramped tightly together.

7.2.2.3
Floor boards that do not have matching tongued and grooved ends shall be cut square on ends and butted tightly together at end joints. End joints shall be made over *joists*, and end joints in adjacent boards shall be staggered.

Table 7.3 – Flooring, for up to 2 kPa floor loads (see 7.2.2.1)

Maximum spacing of joists	Minimum dry dressed thickness of tongued and grooved strip flooring of species listed below as:	
	Type A	Type B
(mm)	(mm)	(mm)
400	16	16
450	19	16
600	22	19
Type A timbers:	Radiata pine, matai, rimu, red beech, silver beech, Douglas fir, larch.	
Type B timbers:	Tawa, hard beech, jarrah, karri, blackbutt, tallowwood, New Zealand-grown hardwoods.	



Unless otherwise stated, all dimensions are in mm.

Figure 7.8 – Holes and notches in floor joists other than cantilevered joists (see 7.1.7)

7.2.2.4

Floor boards that have matching tongued and grooved ends shall have tongues fitted into grooves and butted tightly together at end joints. End joints need not be made over *joists* provided that:

(a) Each unjointed length of board shall be supported by two or more *joists*;

(b) In any *span* between *joists* there shall be two or more unjointed boards between end jointed boards.

7.2.2.5

Floor boards shall be fixed to each *joist*. Nails shall be punched to allow for subsequent sanding and stopping. Nails shall be skew driven through tongues profiled for secret nailing. Nails shall be punched to allow full entry of the tongue into the groove.

7.2.3 Wood-based sheet flooring

7.2.3.1

Sheet flooring materials of timber or wood-based products shall comply with 4.3.

7.2.3.2

Sheet flooring material shall to the greatest possible extent be laid in complete sheets.

7.2.3.3

Joints in sheet flooring material shall be made over supports. Timbers 90 mm x 45 mm fixed on edge between *joists*, with their top surfaces set to a common level, shall be provided as necessary for this purpose. See figure 7.9.

7.2.3.4

Each sheet shall be fastened along each edge to *framing* or *blocking* members and shall also be fastened to every intermediate *framing* member. Fastenings shall be not less than 10 mm from sheet edges.

7.2.3.5 Structural plywood flooring

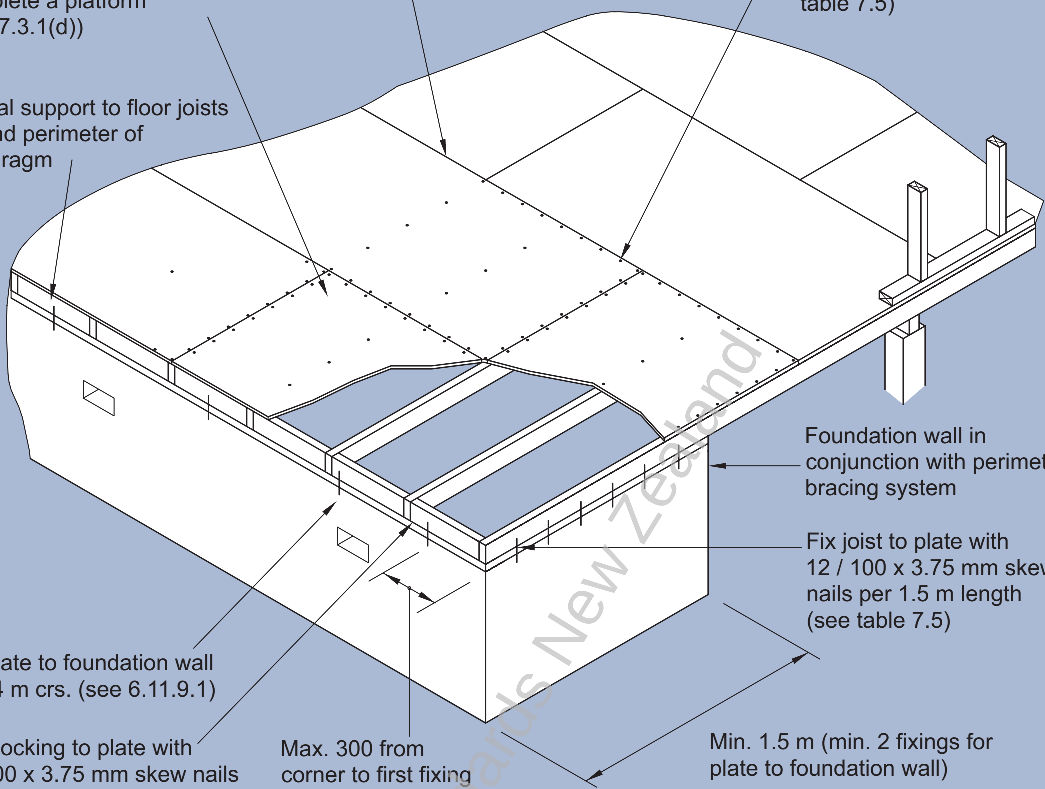
Structural plywood flooring manufactured to AS/NZS 2269 shall be:

(a) Radiata pine plywood CD grade stress levels (F11) of the thickness given in table 7.4 for 1.5 kPa and 2 kPa (and table 14.16 for 3 kPa loads);

(b) Fixed with its face grain running across *joists*.

Table 7.4 – Structural plywood flooring, for up to 2 kPa floor loads
(see 7.2.3.5)

Maximum spacing of joists	Minimum thickness of plywood for floor loads
(mm)	(mm)
400	15
450	15
600	19



NOTE –
(1) Floor diaphragm to cover entire floor area (see 7.3.1(c)).
(2) Diaphragm size (see 7.3.1(b)) for:
(a) Single storey maximum length shall not be greater than 2.5 times the width;
(b) Double storey maximum length shall not be greater than 2.0 times the width.
(3) See section 4 for durability requirements.

Unless otherwise stated, all dimensions are in mm.

Figure 7.9 – Floor diaphragms (see 7.3)

7.3 STRUCTURAL FLOOR DIAPHRAGMS

C7.3.1

A floor diaphragm permits wider spacing of bracing lines below the floor, but has no effect on bracing line (wall) spacing above the floor.

7.3.1

Floor *diaphragms* required to comply with 5.6 shall be constructed in accordance with figure 7.9 and as follows.

Diaphragms shall have a maximum length of 12 m and the following limitations:

(a) The length and width of a *diaphragm* shall be between supporting *bracing lines* at right angles to each other;

(b) Any *diaphragm* or part of a *diaphragm* shall have a length not exceeding 2.5 times its width for single-*storey* buildings, and a length not exceeding 2.0 times its width for two-*storey* buildings;

(c) The flooring shall consist of a sheet material complying with 7.2.3 over the entire area of the *diaphragm*;

(d) The minimum sheet size shall be 2.4 m x 1.2 m except where the building dimensions prevent the use of a complete sheet;

(e) Floor *joists* in a structural floor *diaphragm* shall be laterally supported around the entire perimeter of the *diaphragm* in accordance with 7.1.2.2(a) or as shown in figure 7.9;

(f) The *joist* to *plate*, and *blocking* to *plate* and *blocking* to *stringer* connections shall be as in table 7.5.

7.3.2

Where it is necessary to subdivide a floor into more than one *diaphragm* so as to comply with 7.3.1(a) and (b), one *wall* can be used to support the edges of two *diaphragms*.

7.3.3 Ground-floor diaphragms

The entire perimeter of the ground-floor *diaphragm* for:

(a) Single-*storey* and two-*storey* buildings complying with 5.5.3.2(b) shall be supported by either a continuous *foundation wall*, or an evenly distributed perimeter *bracing* system;

(b) Two-*storey* buildings shall be directly supported by a continuous *foundation wall*, as specified by 5.5.3.2(a).

7.3.4 Upper-floor diaphragms

The entire perimeter of:

(a) An upper floor *diaphragm* shall be located over, and connected to *walls* containing the number of *bracing units* required by 5.6.2.

(b) The first floor *diaphragm* of a three-*storey* building shall be supported by a full *storey* height reinforced concrete masonry *wall* to NZS 4229.

7.4 TIMBER DECKS

7.4.1 General

7.4.1.1

This clause shall be used for *decks* supported from the main part of the building and which are not more than 3.0 m high measured from the lowest *cleared ground level* to the upper surface of the *decking*.

7.4.1.2

Timber *decks* covered by this Standard shall be designed for 2 kPa *floor loads* as follows:

(a) *Decking* shall be as given by 7.4.3;

(b) *Joists* shall be as in table 7.1(b);

(c) *Bearers* shall be as in table 6.4(b);

(d) *Piles* and *footings* shall be as given in section 6;

(e) *Stringers* connected to the building, where used, shall be as in table 6.5 and 6.13 or, if connected to the building's timber *framing* shall be fixed with M12 bolts at *spacings* as in table 6.5 (see section 4 for durability requirements).

7.4.1.3

Where the *deck* or *balcony* is to support a cantilever balustrade, *boundary* edge *joists* screw fixed together shall be provided:

(a) To the end of the *deck joists*;

(b) To the return end *joist* of the *deck*;

(c) To be fixed together by M12 bolts placed 25 mm from the top and bottom of the *joists* at 400 mm centres maximum;

(d) To be fixed to the *deck joists* with 6 kN connections top and bottom encompassing the outer two *boundary edge joists*;

(e) The inner end of *noggings* to be fixed with M12 coach screws;

(f) *Noggings* shall be placed between the outer *deck joists* and edge *joists* at 400 mm centres maximum and the inner *joist* fixed to the *nogging* with 2/M12 x 200 coach screws;

(g) The *spacing* of *posts* shall not exceed the centres as shown in figures 7.10(b), and 7.10(c);

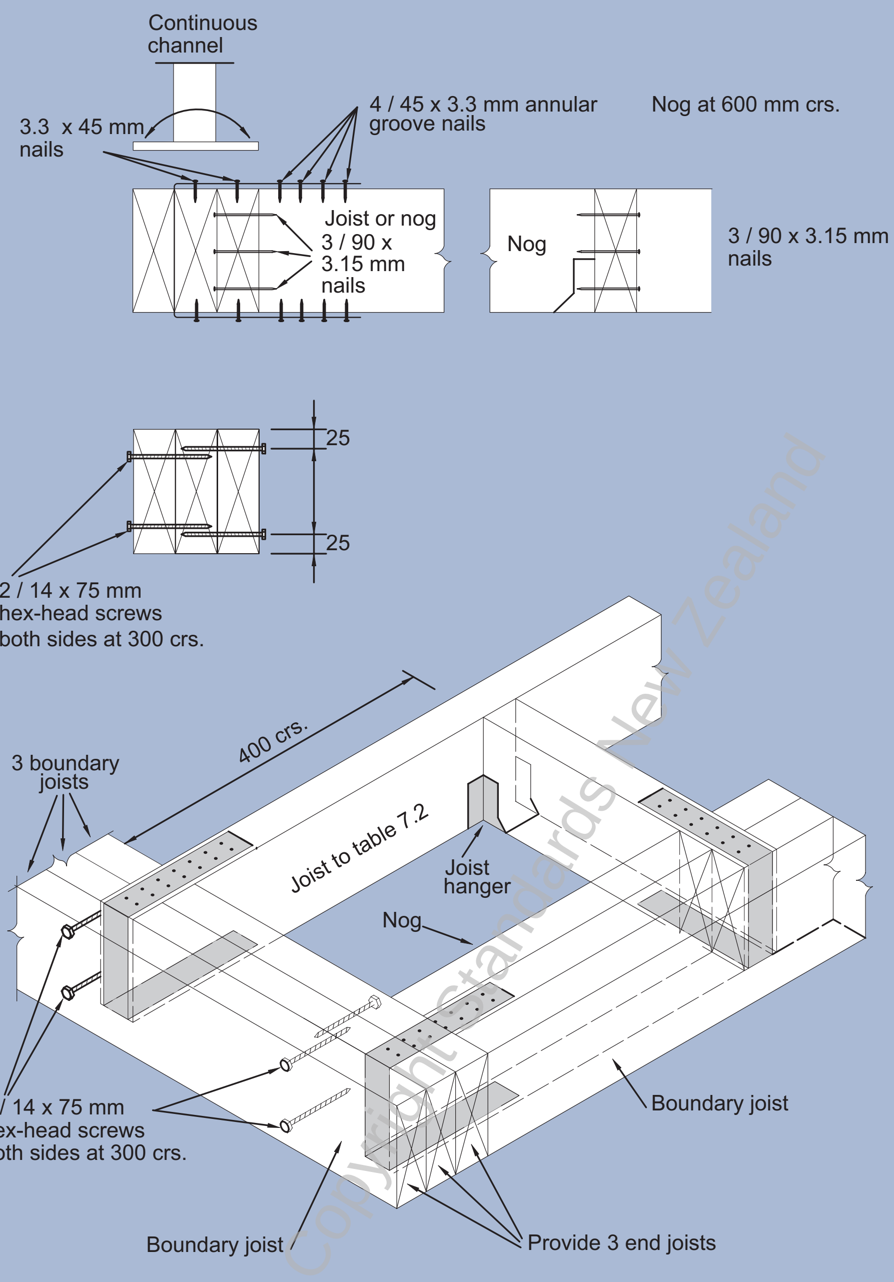
(h) Figure 7.10(a) is for continuous channel cantilever balustrade only;

(i) *Edge*, *boundary*, and *deck joists* shall be 190 x 45 minimum.

C7.4.1.3

Boundary joists supporting cantilevered balustrades are required to resist large torsional loads. Such joists also need to have sufficient width to allow the fixing of baluster base plates.

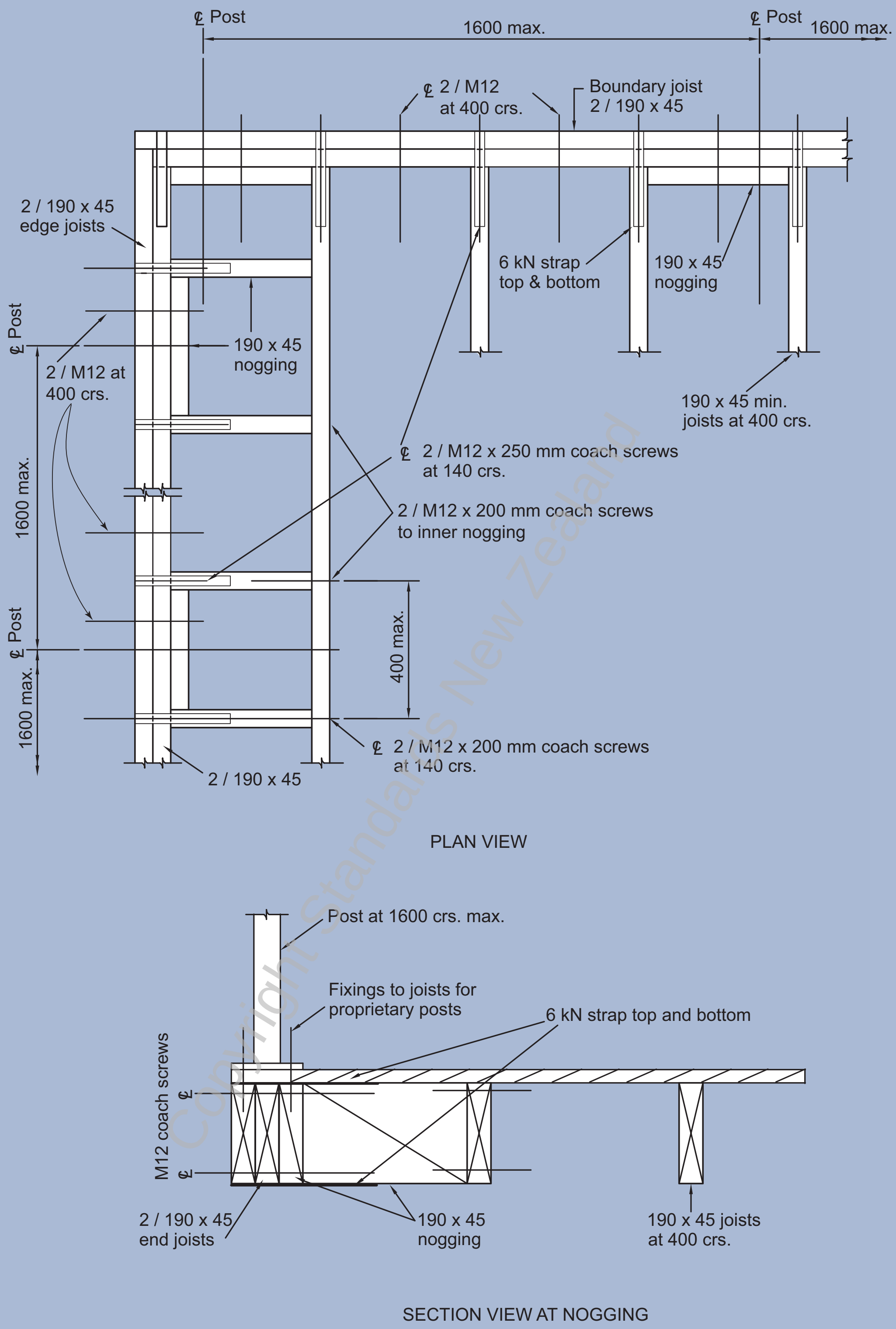
Jack framed timber balustrades require SED.



NOTE –
(1) Applies to balconies of domestic self-contained dwellings only.
(2) See section 4 for durability requirements.

Unless otherwise stated, all dimensions are in mm.

Figure 7.10(a) – Continuous channel support detail for cantilever balustrade (see 7.4.1.3)

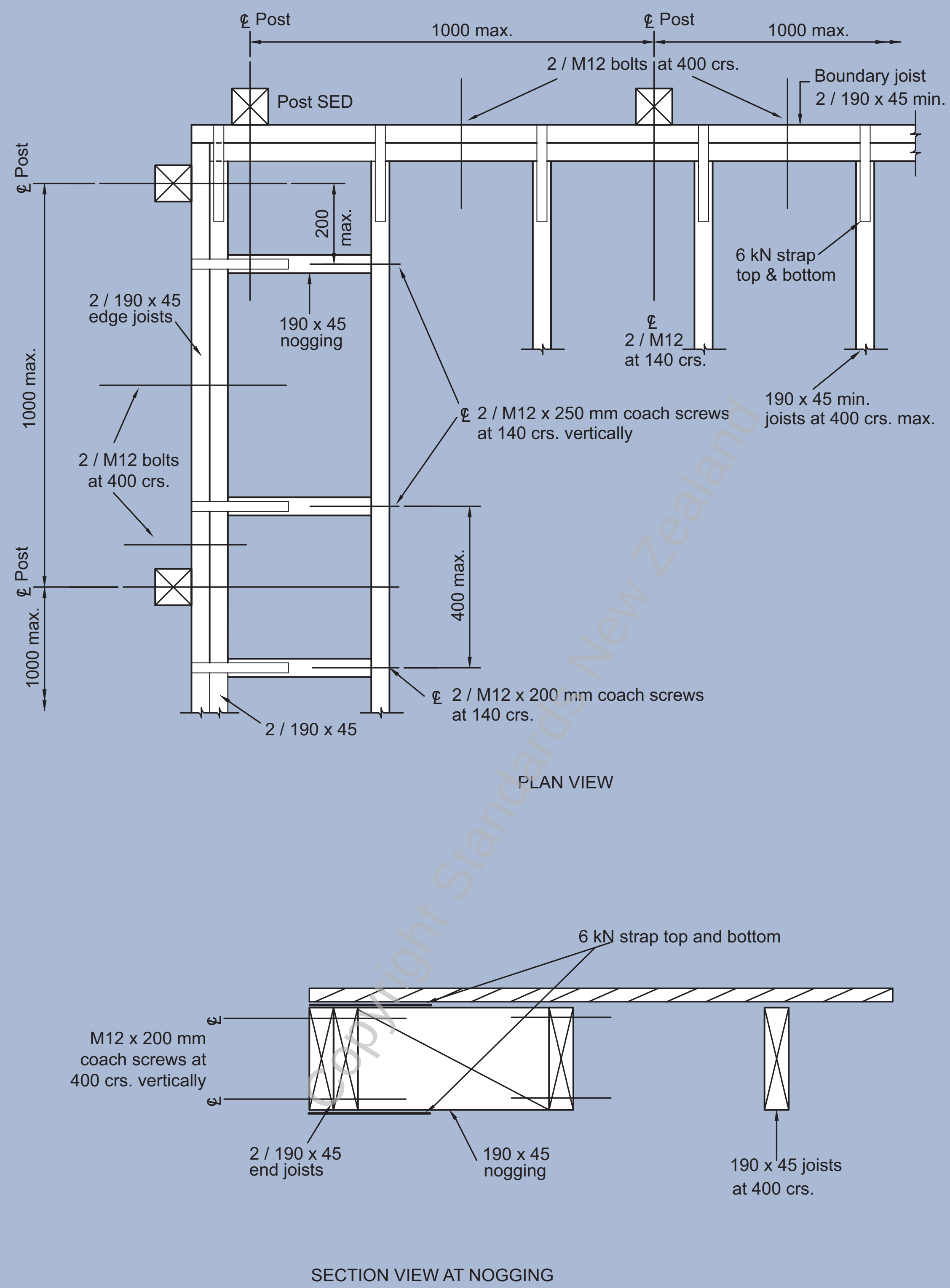


NOTE –

(1) Posts fixed through decking at 1600 crs. max. (SED).
(2) See section 4 for fixing durability.
(3) All bolts to have 50 x 50 washers to head and nut.
(4) ℄ – Centre line.
(5) Applies to balconies of domestic self-contained dwellings only.

Unless otherwise stated, all dimensions are in mm.

Figure 7.10(b) – Top-fixed post support detail for cantilever balustrade (see 7.4.1.3)



NOTE –

(1) See section 4 for fixing durability.
(2) All bolts to have 50 x 50 washers to head and nut.
(3) ℄ – Centre line.
(4) Applies to balconies of domestic self-contained dwellings only.

Unless otherwise stated, all dimensions are in mm.

Figure 7.10(c) – Face-fixed post support detail for cantilever balustrade (see 7.4.1.3)

7.4.2 Bracing

7.4.2.1

Decks with *stringers* and/or *joists* bolted to the building on one or more sides and which project no more than 2 m from the building, do not require subfloor *bracing*.

7.4.2.2

Decks which project more than 2 m from the building shall have *subfloor bracing* provided by anchor and/or *braced piles*, at half the *bracing demand* required by table 5.8 for "light/light/light" *cladding*, for 0° *roof* slope and for "subfloor structures".

7.4.3 Decking

The thickness of the *decking* shall be not less than:

(a) 32 mm for 600 mm *joist* centres; or

(b) 19 mm for 450 mm *joist* centres.

7.4.4 Surface

Deck surfaces that provide the main access to a building shall have a slip resistance not less than 0.4 when wet.

C7.4.4

Uncoated profiled timber has a slip resistance from 0.45 – 0.60 across the direction of travel. Uncoated smooth timber has a slip resistance of 0.20 – 0.35 (i.e. it does not meet the requirements of this clause).

7.5 CONCRETE SLAB-ON-GROUND FLOORS FOR TIMBER BUILDINGS

7.5.1 General

This clause sets down requirements for concrete slab-on-ground floors with a maximum dimension of 24 m either way between *free joints*, or between *free joints* and the slab edge, for an occupancy loading of up to 3 kPa. Slabs exceeding the maximum dimension are outside the scope of this Standard and require *SED* (see C7.5.1 and 7.5.8.5).

C7.5.1

The various spacings for construction and shrinkage control joints are set out in 7.5.8.6. Other useful information can be found in the BRANZ publication "Good practice guide – Concrete floors and basements". Slabs longer than 24 m may be constructed provided they are comprised of sections separated by free joints.

7.5.2 Finished floor levels and foundation edge construction

7.5.2.1

The finished concrete floor level of a slab-on-ground floor shall be a minimum height above the *ground level* as follows:

(a) Where the adjoining ground is protected by permanent paving:

  (i) Masonry veneer exterior *wall* covering: 100 mm where the adjoining ground adjacent to the permanent paving is at least 150 mm below floor level;

  (ii) Any other exterior *wall* covering: 150 mm; or

(b) Where the adjoining ground is not protected by permanent paving:

  (i) Masonry veneer exterior *wall* covering: 150 mm;

  (ii) Any other exterior *wall* covering: 225 mm.

See figure 7.11.

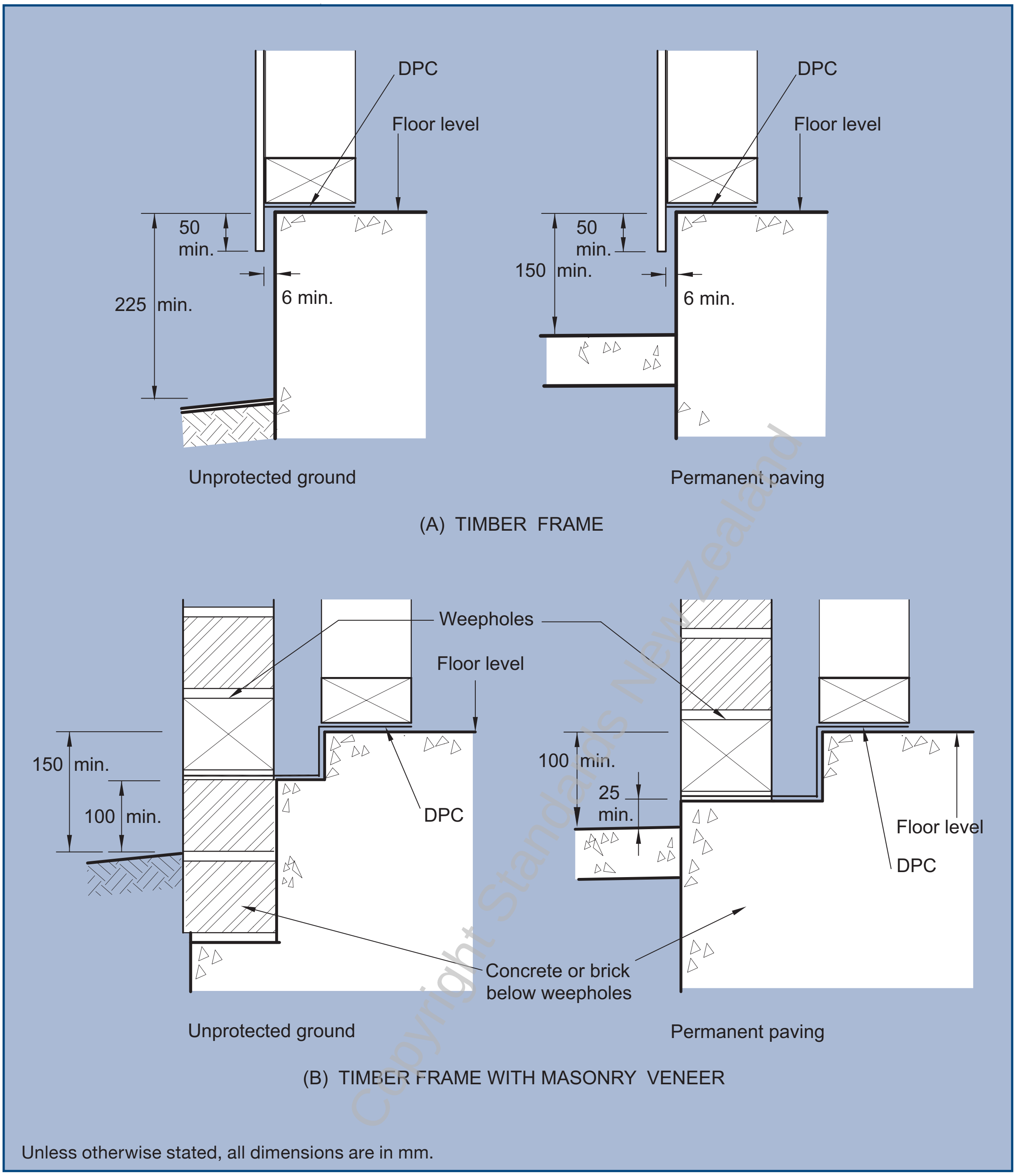


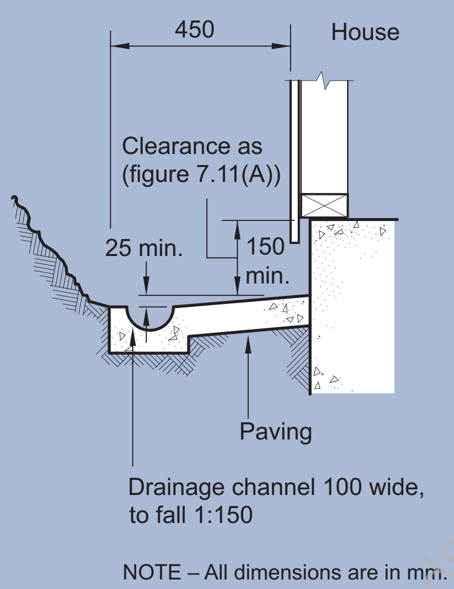
Figure 7.11 – Minimum heights of finished concrete (residential, habitable) slab-on-ground floors above adjoining finished ground level (see 7.5.2.1)

7.5.2.2

The *finished ground level* adjoining the concrete slab-on-ground shall be formed so as to carry water away from the building, at a slope of not less than 1 in 25, for a distance of at least 1 m from the building. Where site conditions do not readily allow such a 1 m wide strip to be formed, then permanent paving shall be laid to the falls and dimensions shown in figure 7.12.

C7.5.2.2

From a practical point of view, to give easier access, widening the drainage channel from 400 mm to 600 mm is recommended.



Unless otherwise stated, all dimensions are in mm.

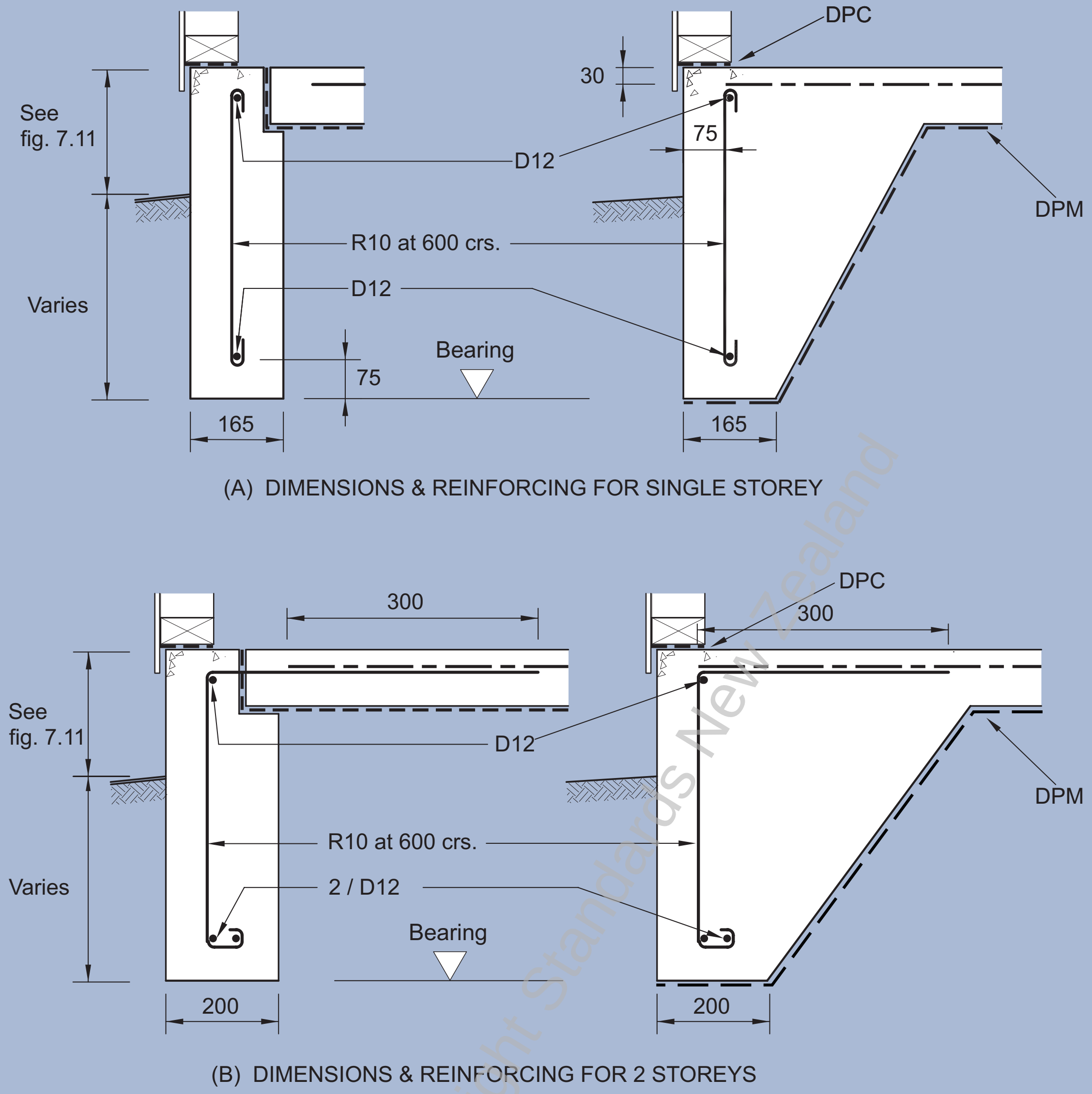
Figure 7.12 – Provision of permanent paving adjoining buildings with concrete slab-on-ground floors (see 7.5.2.2)

7.5.2.3

The combined *foundation* and edge details shall be constructed as shown in figures 7.13 and 7.14 (and figures 7.15 and 7.16 for *foundation* supporting a masonry veneer).

C7.5.2.3

The information contained in the figures is drawn from other sections of this Standard. Dimensions and reinforcement are contained in section 6.



NOTE –

(1) For in-situ concrete foundations for masonry veneer see figure 7.15.

(2) Min. external cover to reinforcement

(a) Against ground 75 mm;

(b) Against formwork 50 mm;

(c) Top cover to mesh 30 mm.

(3) For foundation bearing see 3.4.

Unless otherwise stated, all dimensions are in mm.

Figure 7.13 – Foundation edge details – In-situ concrete (see 7.5.2.3)

7.5.3 Granular base

7.5.3.1

Granular fill material complying with 7.5.3.2 shall be placed and compacted in layers of 150 mm maximum thickness, over the area beneath the proposed ground slab, so that the total thickness of granular base is not less than 75 mm nor more than 600 mm.

Compact each layer until the material is tightly bound together and does not visibly deform under the weight of a pressed adult heel.

SED is required if filling is in excess of 600 mm.

C7.5.3.1

The maximum non-specific design depth of fill up to 600 mm has nothing to do with the compaction of the hardfill. Where fill is in excess of 600 mm, it will be necessary for a geotechnical engineer to investigate the underlying soils to a depth of approximately twice the width of the fill.

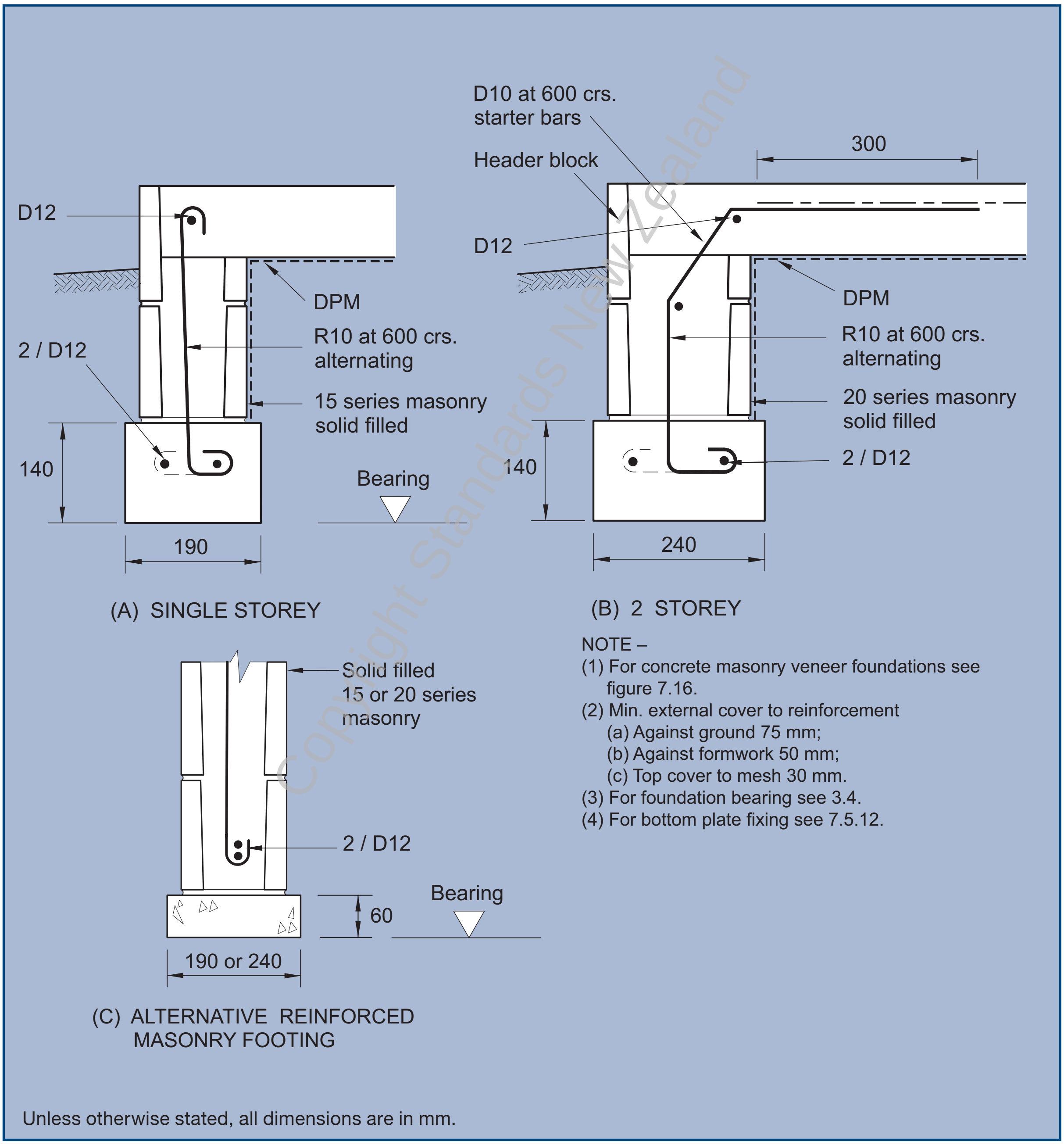


Figure 7.14 – Foundation edge details – Concrete masonry (see 7.5.2.3)

C7.5.3.2

Proper grading of granular fill material is important. Excessively fine material such as sand will cause problems with drainage, capillary action, compaction and settlement and must be avoided.

7.5.3.2

Granular fill material shall be composed of rounded gravel, crushed rock, scoria or approved material.

(a) Not more than 5 % shall pass through a 2.2 mm sieve with the exception of the conditions in 7.5.3.3;

(b) 100 % shall pass either:

  (i) A 19 mm sieve for any fill thickness; or

  (ii) A 37.5 mm sieve for a fill thickness exceeding 100 mm.

7.5.3.3

Where it can be demonstrated that site conditions ensure that capillary water is unlikely to reach the underside of the slab, then the requirements of 7.5.3.2(a) can be waived.

7.5.3.4

The top surface of the granular base shall be a material that will not puncture the *damp-proof membrane* (*DPM*) required in 7.5.4.

7.5.4 Damp-proof membrane

C7.5.4.1

A minimum slab thickness of 50 mm is required to resist vapour pressure and protect the DPM. NZS 3604 also recognizes that "slabs work" without the requirement for an edge vapour barrier up to the face of the external slab edge. In essence, they work because the differential vapour pressure does not exist since there is a free air surface. However, because the edge does get wet from rain and the timber plate covers the slab from the air at that point, a DPC must be used between the plate and the concrete surfaces it covers.

7.5.4.1

Every slab-on-ground floor shall incorporate a continuous *DPM* between the ground and the floor surface (see figures 7.13 and 7.14). The *DPM* shall either be laid:

(a) Beneath the concrete ground slab on a surface suitable to receive the type of *DPM* material being used; or

(b) Over the ground slab and be protected by a concrete slab not less than 50 mm thick.

C7.5.4.2

Various damp-proof membranes are available. Typical examples are polythene sheet, reinforced polyethylene sheet, bituminous sheets, asphalt and rubber emulsions.

7.5.4.2

The *DPM* shall be comprised of one or more of the materials given in 7.5.5, 7.5.6 and 7.5.7 and shall:

(a) Have a water vapour flow resistance not less than 90 MNs/g when tested in accordance with ASTM E96, utilizing standard test conditions at 23 °C;

(b) Be sufficiently durable to resist damage from installation and normal worksite operations;

(c) Be laid on a surface that is unlikely to damage the *DPM* being used; and

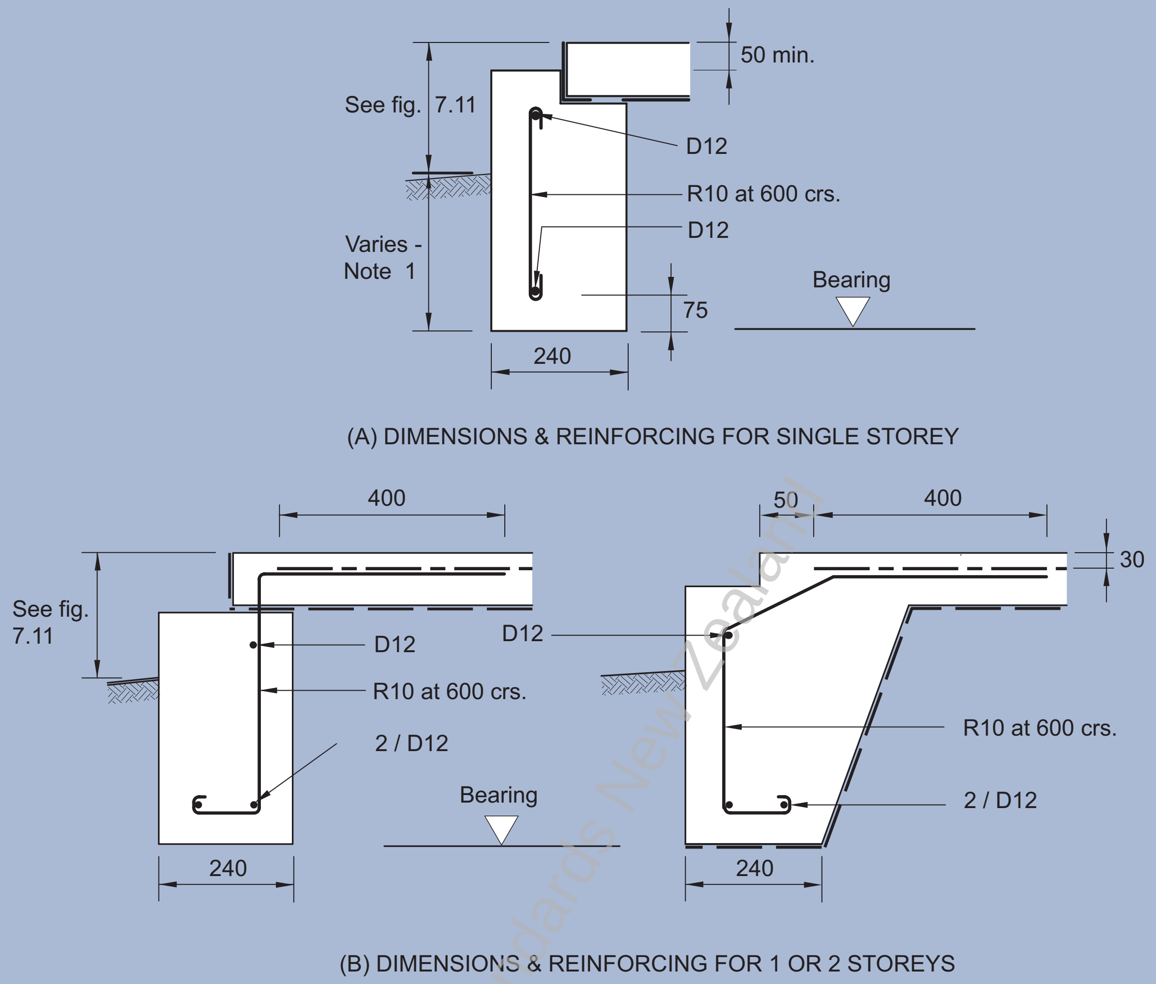
(d) Have penetrations by services, reinforcing or other objects sealed by taping, or by application of wet-applied *DPM* material.

7.5.4.3

The *DPM* shall abut any *damp-proof course* (*DPC*) used to protect timber in accordance with 2.3.3, or the *DPM* may extend to act as a *DPC* provided it is of suitable impervious material.

7.5.4.4

DPM materials shall be repaired or replaced as necessary, immediately before concrete is placed over them.



NOTE –
(1) For in-situ concrete foundations see figure 7.13.
(2) Min. external cover to reinforcement
(a) Against ground 75 mm;
(b) Against formwork 50 mm;
(c) Top cover to mesh 30 mm.
(3) When not cast integrally with, or tied to foundation wall, the slab shall be rebated or set down inside the wall by 50 mm.
(4) For foundation bearing see 3.4.

Unless otherwise stated, all dimensions are in mm.

Figure 7.15 – Masonry veneer foundation edge details – In-situ concrete (see 7.5.2.3)

7.5.5 Bituminous sheet damp-proof membranes

7.5.5.1

Bituminous sheet *DPM* material shall:

(a) Have a hessian or fibreglass core;

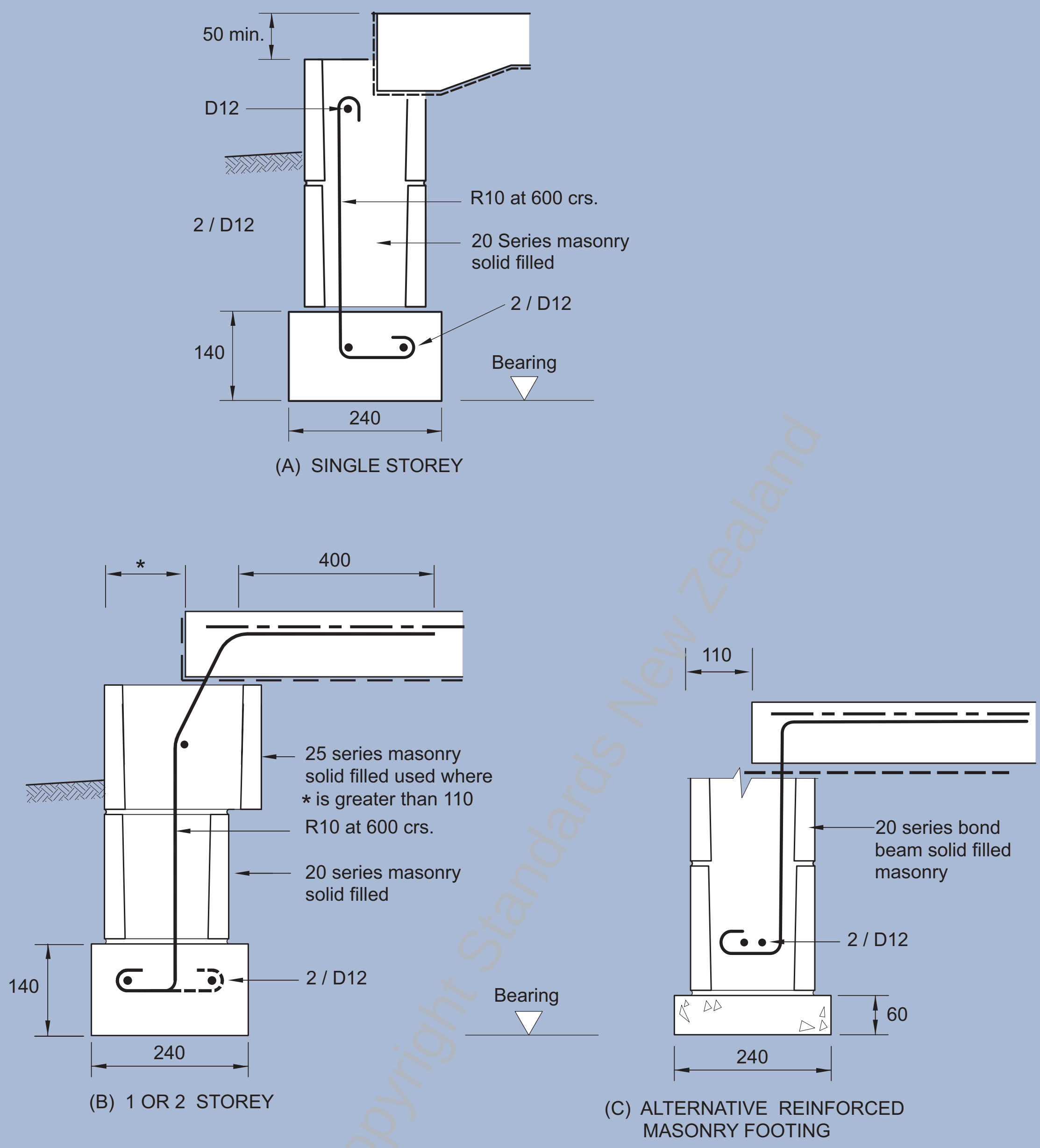
(b) Be not less than 3 mm thick;

(c) Have heat-bonded lap joints not less than 50 mm wide;

(d) Be protected from damage.

C7.5.5.1

Vertical faces cannot be exposed in any situation where the sheet might suffer damage.



NOTE –

(1) For masonry veneer, in-situ concrete foundations, see figure 7.15.

(2) Min. external cover to reinforcement

(a) Against ground 75 mm;

(b) Against formwork 50 mm;

(c) Top cover to mesh 30 mm.

(3) For foundation bearing see 3.4.

(4) For bottom plate fixing see 7.5.12.

(5) When not cast integrally with, or tied to the foundation wall, the slab shall be rebated or set down inside the wall by 50 mm.

Unless otherwise stated, all dimensions are in mm.

Figure 7.16 – Masonry veneer foundation edge details – Concrete masonry (see 7.5.2.3)

7.5.5.2
Bituminous sheet *DPM* material shall be laid over:

(a) A smooth-surfaced blinding layer not less than 10 mm cement sand slurry; or
(b) Heavyweight building paper.

7.5.6 Polyethylene (polythene) sheet damp-proof membranes

7.5.6.1
Polyethylene sheet *DPM* material shall:

(a) Be either:
  (i) A single unprotected layer of polyethylene not less than 0.25 mm thick; or
  (ii) A multi-layer laminate, in which one or more layers of polyethylene having an aggregate thickness of not less than 0.1 mm thick are incorporated with layers of other material that provide adequate protection to the polyethylene;
(b) Have heat-sealed joints not less than 50 mm wide, or lap joints not less than 150 mm wide, sealed with pressure-sensitive plastic tape not less than 50 mm wide (such tape need not be used with self-sealing polyethylene sheets);
(c) Be protected from damage.

C7.5.6
Polyethylene is usually referred to as "polythene" in the New Zealand building industry.

C7.5.6.1
Vertical faces cannot be exposed in any situation where the sheet might suffer damage.

7.5.6.2
Polyethylene sheet vapour barrier material shall be protected where the granular surface is likely to cause intrusions into the vapour barrier by:

(a) Surface blinded with sand to a nominal minimum thickness of 5 mm or a maximum thickness of 25 mm; or a
(b) Heavyweight building paper.

C7.5.6.2
The important issue is that the vapour barrier is not damaged by intrusions from below during the concreting operations.

Thick layers of uncompacted sand are an unsatisfactory support for the slab. A nominal 5 mm to 10 mm thickness of sand to fill gaps in the base course material plus a base-course tolerance allowance of ±15 mm results in a maximum thickness of compacted sand of 25 mm.

7.5.7 Rubber emulsion damp-proof membranes

7.5.7.1
Rubber emulsion *DPM* material shall:

(a) Contain not less than 10 % rubber latex;
(b) Be applied in at least 2 coats at right angles to each other and in accordance with the manufacturer's specifications.

C7.5.7.1
The information supplied by the manufacturer should take account of the shrinkage cracking that will occur in the supporting concrete layer.

7.5.7.2
Rubber emulsion *DPM* material shall be laid on a layer of concrete not less than 50 mm thick.

7.5.8 Concrete slab-on-ground

7.5.8.1
A concrete slab-on-ground slab shall be designed to the following:

(a) When supporting more than one *storey*, the slab shall be reinforced in accordance with 7.5.8.3, 7.5.8.4 and 7.5.8.6.4.
(b) When supporting one *storey* the slab shall be selected from one of the following:
  (i) Reinforced as in (a);
  (ii) Unreinforced in accordance with 7.5.8.6.2;
  (iii) Fibre reinforced in accordance with 7.5.8.6.3.

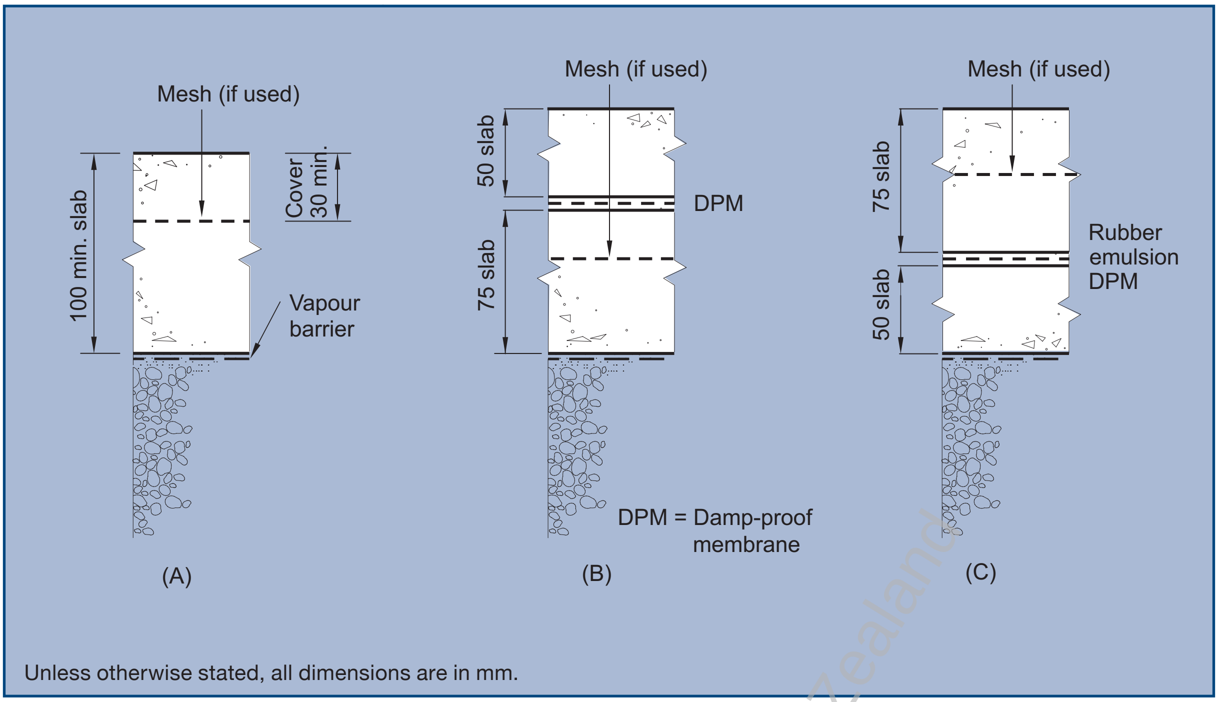


Figure 7.17 – Construction of ground slabs (see 7.5.8.2)

7.5.8.2 Slab thickness

Except as required by 7.5.11 beneath *loadbearing walls*, the minimum thickness of a slab for buildings constructed to this Standard shall be (see figure 7.17):

(a) 100 mm when placed on a bituminous or polyethylene sheet *DPM* laid on a specifically prepared granular base;

(b) 75 mm when:

  (i) Laid on rubber emulsion *DPM* when placed on 50 mm of concrete;

  (ii) Vapour barrier laid over the floor and protected by 50 mm of concrete topping.

C7.5.8.3

665 mesh will comply with this requirement.

Alternative forms of evenly spaced symmetrical mesh may be used providing they meet the mass/m in each direction. Equivalent bar steel may be used with D10 bars at 350 centres, but mesh is preferred.

7.5.8.3

Ground slab reinforcing shall extend to within 75 mm of the outside edge of the slab (including the *foundation wall* when it is cast integrally with the ground slab) and shall consist of a minimum of 2.27 kg/m^2 welded steel mesh for slabs 12 m to 24 m long or 1.29 kg/m^2 welded steel mesh for slabs no longer than 12 m between *free joints* or edges. *Free joints* are joints that have no *reinforcement* passing through the joint that links both sides and no bonding between vertical concrete faces. Bonding shall be prevented with building paper or a bituminous coating. Mesh sheets shall be lapped by 225 mm at sheet joints.

Reinforcing mesh shall comply with AS/NZS 4671.

7.5.8.4

Reinforcing steel shall have a cover of 30 mm minimum from the top surface of the ground slab and shall be placed in such a manner as to avoid damage to the *DPM*.

7.5.8.5 Slab dimensions

Slabs may be of unlimited size provided the requirements of 1.1.2 (l) and 7.5.1 are met.

7.5.8.6 Shrinkage control joints

7.5.8.6.1 General

Shrinkage control joints shall either be formed by saw cutting the slab after it has hardened, or by casting-in a crack inducer into the slab. Crack inducer placement shall not damage the *DPM*.

The inducer or saw cuts shall extend to a quarter of the depth of the slab. Saw cutting shall take place no later than 24 hours after initial set for average ambient temperatures above 20 °C, and 48 hours for average ambient temperatures below 20 °C.

Shrinkage control joints may be cut at an angle as long as the included angle is not less than 60°.

Shrinkage control joints should be positioned where possible below *walls*.

7.5.8.6.2 Unreinforced concrete slabs

Location of shrinkage control joints in unreinforced concrete slabs shall comply with the following criteria:

(a) Panels shall be formed as close as practicable to length to width ratios of between 1.3:1 and 1:1 and shall have a maximum length in any direction of 3 m. Any panels formed which exceed this length shall be reinforced as specified in 7.5.8.3.

(b) The maximum plan dimension of concrete between *construction joints*, or shrinkage control joints is 3 m;

(c) Supplementary steel placed as shown in figure 7.18 but not across shrinkage control joints.

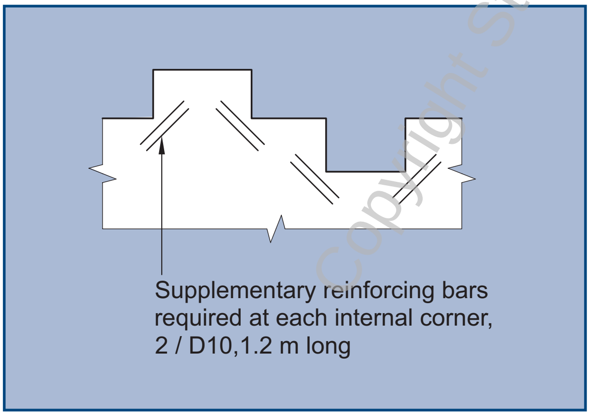


Figure 7.18 – Irregular slab (plan view) (see 7.5.8.6.2)

C7.5.8.5

In the controlled applications set out in this Standard, minor shrinkage cracking is of no structural consequence. However, care should be taken to follow the bay size requirements to minimise the effect of shrinkage cracking in areas where special thin or hard finishes are to be applied, e.g. vinyl sheeting or ceramic/stone tiles.

C7.5.8.6.1

Typically the depth of cut will be 25 mm with a single saw blade width of approximately 5 mm. Special techniques may be used to cut the joints in the concrete's plastic state.

C7.5.8.6.2

The position of special finishes to be laid over the floor should be considered when determining the joint layout.

7.5.8.6.3 Fibre reinforced slabs: polypropylene

Where normal unreinforced concrete slabs are constructed with the addition of polypropylene fibres, the following shall apply:

(a) Minimum fibre dosage rate shall be 0.7 kg/m^3;

(b) The maximum joint *spacing* given in 7.5.8.6.2 can be increased by up to 4.0 m;

(c) Panels shall be formed as close as practicable to length to width ratios of between 1.5:1 and 1:1 and shall have a maximum length in any direction of 4 m. Any panels formed which exceed this length shall be reinforced as specified in 7.5.8.3.

(d) Supplementary steel shall be placed as shown in figure 7.18;

(e) The mixing of fibres and construction of the slab shall be strictly in accordance with the supplier's specifications.

C7.5.8.6.3

Specific design or approved polypropylene producer statements may permit alternative bay sizes, using different types of polypropylene fibre and dosage rates. Steel fibre concrete slabs may be used, but they are the subject of SED.

7.5.8.6.4 Reinforced concrete slabs

Shrinkage control joints in reinforced concrete ground slabs shall comply with the following criteria:

(a) Shrinkage control joints shall be positioned to coincide with major changes of plan. See figure 7.19;

(b) Supplementary steel shall be placed as shown in figure 7.18 but not across shrinkage control joints;

(c) Supplementary shrinkage control joints shall be used such that intermediate bay sizes do not exceed 6 m;

(d) Panels shall be formed as close as practicable to length to width ratios of between 2:1 and 1:1 and shall have a maximum length in any direction of 6 m.

C7.5.8.6.4

The slab reinforcement and control joints provided will not totally eliminate the formation of non-structural shrinkage cracks.

C7.5.8.6.4

(c) It is recommended that intermediate bays do not exceed 6 m for slabs where decorative finishes such as vinyl or ceramic tiles are being used. Where significant areas of exposed concrete, vinyl and ceramic tiles are to be used, SED is recommended which would consider reducing the maximum bay dimension and the preference to produce a bay shape which is approximately square.

7.5.8.7 Concrete strength

Concrete strength shall follow the provisions of 2.6 and 4.5.

C7.5.8.7

Note the minimum strength requirements only relate to buildings covered by this Standard. Special provisions are required for commercial and industrial applications.

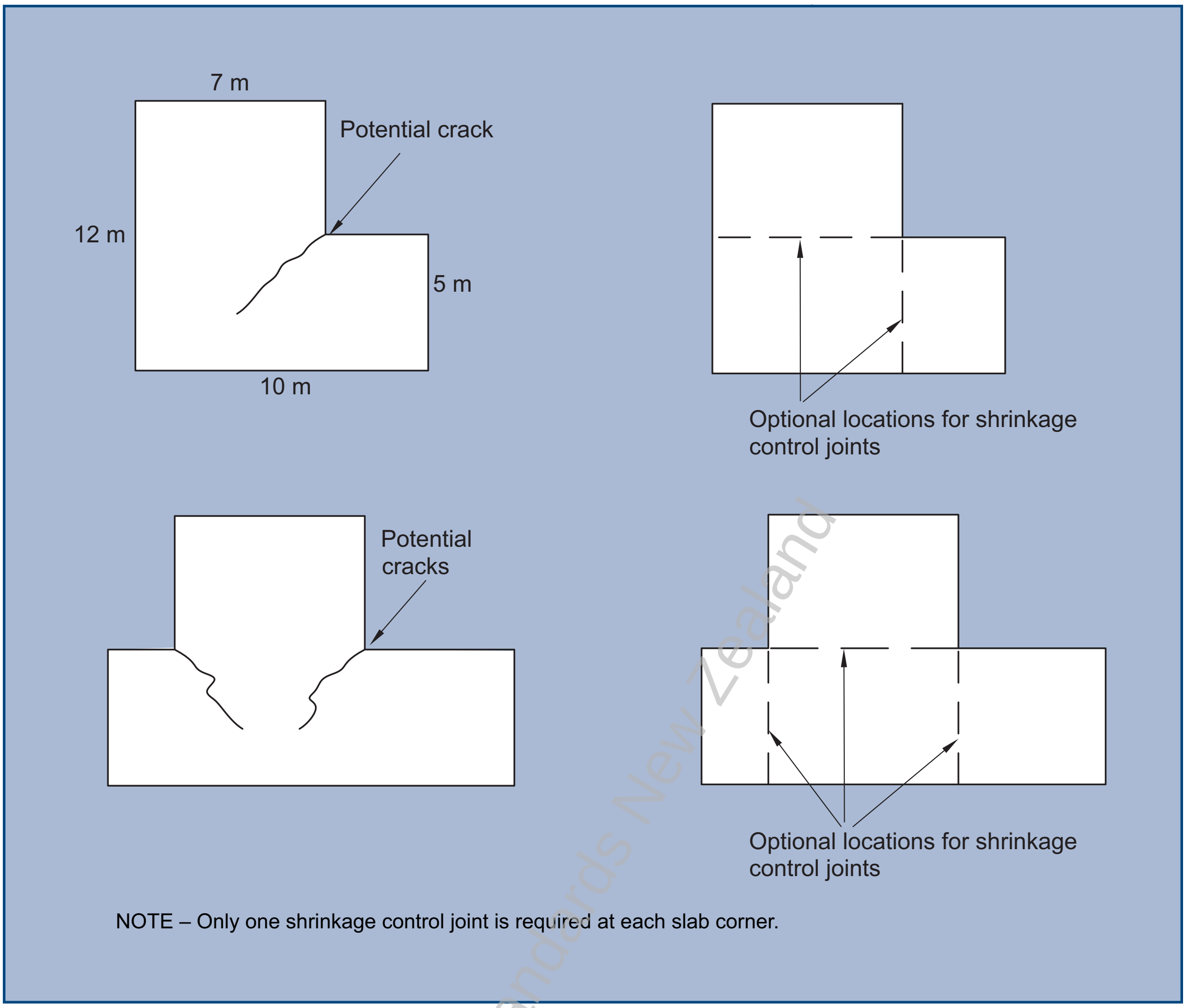


Figure 7.19 – Shrinkage control joints (see 7.5.8.6.4)

7.5.9 Bearing

7.5.9.1

Clause 3.4.2 shall apply to the *foundation walls* but not to the ground slab itself. The depth shall be measured from the *cleared ground level* outside the *foundation wall* and not from the *cleared ground level* beneath the ground slab.

7.5.9.2

Bearing of *footings* on *good ground* shall be as required in 3.1.2. Bearing of the granular fill for the ground slab itself need not be on *good ground* except where the following is encountered at formation level.

(a) Organic topsoil;

(b) Soft or very soft peat;

(c) Loose uncompacted sand;

(d) Fill material without a “Statement of Suitability” as per NZS 4431;

(e) Expansive clay as 3.2.2.

7.5.10 Underfloor thermal insulation

Thermal insulating material may be used provided that there is no reduction of any dimension given by this Standard.

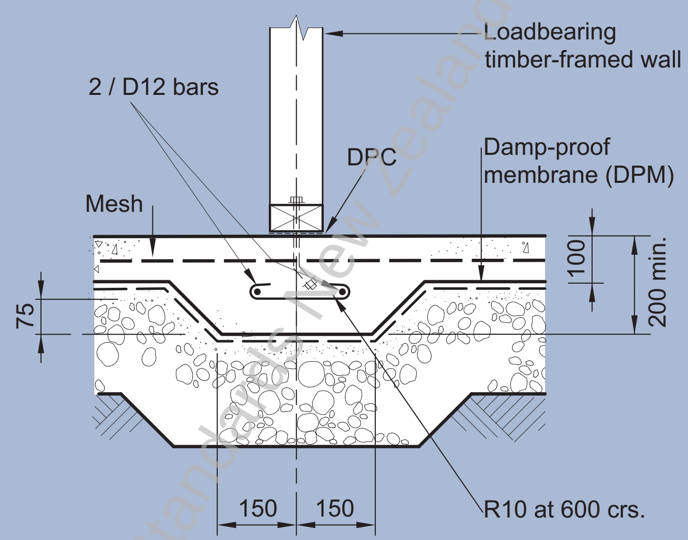
7.5.11 Support of internal loadbearing walls

7.5.11.1

All internal *loadbearing walls* except those of a single-*storey* building supporting only a *roof* shall be supported on a slab thickening complying with 7.5.11.2.

7.5.11.2

A slab thickening shall be 200 mm thick over a minimum width of 300 mm and reinforced with 2/D12 bars as shown in figure 7.20.



Unless otherwise stated, all dimensions are in mm.

Figure 7.20 – Ground slabs beneath internal loadbearing walls (see 7.5.11.2)

7.5.12 Fixing of bottom plates

Bottom plates of *walls* shall be fixed to slab-on-ground floors either by cast-in anchors in accordance with 7.5.12.1 or by proprietary *post* fixed anchors in accordance with 7.5.12.2. Durability of all anchors shall be in accordance with table 4.1 for "ALL ZONES", "All other structural fixings" in a "CLOSED" environment.

Anchors providing end fixings of *bracing elements* shall comply with all the requirements of 7.5.12 as well as their function of resisting *bracing element* uplift.

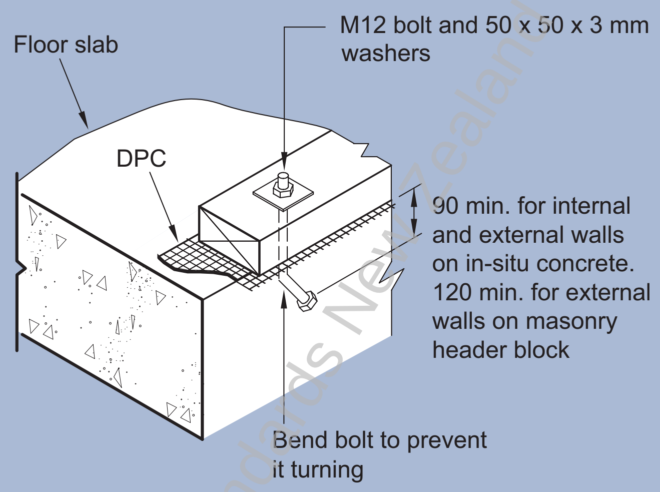
7.5.12.1 Cast-in anchors

Anchors shall be M12 bolts set within 150 mm of each end of the *plate*, *spaced* at a maximum of 1200 mm centres, bent to prevent turning and projecting sufficiently to allow a washer and fully threaded nut above the timber.

(a) For *internal* and *external walls*, where the slab edge is formed with in-situ concrete, anchors shall be set not less than 90 mm into the concrete, maintaining a minimum edge distance of 50 mm.

(b) For *external walls* where the slab edge is formed with masonry header *blocks*, anchors shall be set not less than 120 mm into the concrete, maintaining a minimum edge distance of 50 mm to the outside face of the *blocks*.

See figure 7.21.



Unless otherwise stated, all dimensions are in mm.

Figure 7.21 – Fixing of bottom plates to slabs and cast-in anchors (see 7.5.12.1)

7.5.12.2 Proprietary post fixed anchors

Proprietary anchors shall be within 150 mm of each end of the *plate* and be *spaced* at a maximum of 900 mm centres, or 600 mm centres when used on slab edges formed by masonry header *blocks*.

7.5.12.3

For *external walls*, proprietary anchors shall have a minimum *capacity* when tested in accordance with 2.4.7 as follows:

(a) Horizontal *loads* in the plane of the *wall*.................. 2 kN;

(b) Horizontal *loads* out of the plane of the *wall* .... 3 kN;

(c) Vertical *loads* in axial tension of the fastener .... 7 kN.

7.5.12.4

For *internal walls*, proprietary anchors shall have a minimum *capacity* when tested in accordance with 2.4.7 as follows:

(a) Horizontal *loads* in the plane of the *wall*.................. 2 kN;

(b) Horizontal *loads* out of the plane of the *wall*........... 2 kN.

7.6 NAILING SCHEDULE FOR TIMBER FLOOR FRAMING

Table 7.5 lists the size, number and location of nails to be used in floor *framing*. See 2.4.4 for other requirements for nails.

Table 7.5 – Nailing schedule for hand-driven and power-driven nails (see 7.6)

Joint	Hand-driven nails		Power-driven nails	
	Length (mm) **x diameter** (mm) **and type**	**Number/ Location**	**Length** (mm) **x diameter** (mm) **and type**	**Number/ Location**
Floor framing				
Boundary joist to end of each joist	100 x 3.75	2 (end nailed)	90 x 3.15	2 (end nailed)
Curtailed joist not exceeding 3 m long to trimmer	100 x 3.75	3 (end nailed)	90 x 3.15	5 (end nailed)
Curtailed joist to trimmer when half housed	100 x 3.75	2 (end nailed)	90 x 3.15	3 (end nailed)
Flitched joint in joist	100 x 3.75	4 (each end)	90 x 3.15	6 (each end)
Herringbone strutting to joist	60 x 2.8	2 (skewed)	60 x 2.8	2 (skewed)
Joist to plate on foundation walls	100 x 3.75	12 (skewed) per 1.5 m length	90 x 3.15	18 (skewed) per 1.5 m length
Joist to plate or bearer	100 x 3.75	2 (skewed)	90 x 3.15	3 (skewed)
Lapped joint in joist	100 x 3.75	2 (each side)	90 x 3.15	3 (each side)
Solid blocking between joists to plate bearer or stringer	100 x 3.75	4 (skewed)	90 x 3.15	6 (skewed)
Solid blocking to joist	100 x 3.75 or 75 x 3.15	2 (end nailed) 4 (skewed)	90 x 3.15	2 (end nailed)
Flooring				
Sheet decking (not exceeding 21 mm thick): **(a) Supports at sheet edges** **(b) Intermediate supports**	60 x 3.06 ring shanked galv. or 60 x 2.8	150 mm centres 300 mm centres	60 x 2.8 ring shanked galv.	150 mm centres 300 mm centres
Strip flooring not exceeding 75 mm wide to floor joist	2½ x finished thickness	1	–	1
Strip flooring not exceeding 100 mm wide to floor joist	2½ x finished thickness	2	–	2

NOTE –
(1) Nail lengths and diameters are the minimum required.
(2) See 4.4 for required protective coatings for metal fasteners.

APPENDIX A – SG 6, SG 10 TABLES

(Normative)

Table A7.1 – Floor joists – SG 6 up to 2 kPa floor loads (see 7.1.1.1)

(a) 1.5 kPa floor load (dry in service)			
Floor joist size	**Maximum span* of joists at a maximum spacing** (mm) **of:**		
	400	**450**	**600**
(mm x mm)	(m)	(m)	(m)
90 x 45	1.30	1.25	1.10
140 x 35	1.90	1.80	1.60
140 x 45	2.45	2.35	1.80
190 x 45	3.20	3.10	2.85
240 x 45	3.95	3.90	3.50
290 x 45	4.70	4.55	4.15
(b) 2 kPa floor load (wet in service)			
Floor joist size	**Maximum span* of joists at a maximum spacing** (mm) **of:**		
	400	**450**	**600**
(mm x mm)	(m)	(m)	(m)
90 x 45	1.25	1.20	1.05
140 x 35	1.75	1.65	1.45
140 x 45	2.00	1.85	1.60
190 x 45	2.70	2.55	2.20
240 x 45	3.45	3.25	2.80
290 x 45	4.15	3.90	3.40
* May be increased by 10 % for joists continuous over 2 or more spans.			

Table A7.1 – Floor joists – SG 10 up to 2 kPa floor loads (see 7.1.1.1)

(a) 1.5 kPa floor load (dry in service)			
Floor joist size	**Maximum span* of joists at a maximum spacing** (mm) **of:**		
	400	**450**	**600**
(mm x mm)	(m)	(m)	(m)
90 x 45	1.55	1.50	1.30
140 x 35	2.25	2.15	1.90
140 x 45	2.90	2.80	2.15
190 x 45	3.80	3.70	3.35
240 x 45	4.70	4.60	4.20
290 x 45	5.60	5.40	4.95
(b) 2 kPa floor load (wet in service)			
Floor joist size	**Maximum span* of joists at a maximum spacing** (mm) **of:**		
	400	**450**	**600**
(mm x mm)	(m)	(m)	(m)
90 x 45	1.60	1.50	1.30
140 x 35	2.20	2.05	1.80
140 x 45	2.50	2.35	2.05
190 x 45	3.40	3.20	2.75
240 x 45	4.30	4.05	3.50
290 x 45	5.20	4.90	4.25

* May be increased by 10 % for joists continuous over 2 or more spans.

Table A7.2 – Cantilevered floor joists – SG 6 up to 2 kPa floor loads (see 7.1.5)

Joist size	Joist spacing	Maximum cantilever length of joist supporting:						
		Wall, 1.5 kPa floor load						2 kPa floor load
		Light roof of span: (m)			Heavy roof of span: (m)			Balcony* floor and balustrade only
		4.0	8.0	12.0	4.0	8.0	12.0	
(mm x mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
90 x 45**	600	100	50	50	50	50	50	400
	450	100	50	50	100	50	50	500
	400	100	150	50	100	50	50	550
140 x 45**	600	200	100	100	150	100	100	700
	450	300	150	100	200	150	100	850
	400	300	150	100	250	150	100	900
190 x 45	600	400	200	150	300	200	150	1000
	450	550	300	200	400	300	200	1200
	400	550	350	200	450	300	250	1250
240 x 45	600	650	350	250	500	350	250	1300
	450	800	450	300	650	450	350	1500
	400	850	550	350	700	500	400	1600
290 x 45	600	950	550	350	750	500	400	1600
	450	1150	700	450	950	700	550	1850
	400	1150	800	550	950	700	550	2000

* Applies to balconies of domestic self-contained dwellings only. Only these joists may be wet in service.
** 90 and 140 joist depth is insufficient where cantilevered balustrades are used.

Table A7.2 – Cantilevered floor joists – SG 10 up to 2 kPa floor loads (see 7.1.5)

Joist size	Joist spacing	Maximum cantilever length of joist supporting:						
		Wall, 1.5 kPa floor load						2 kPa floor load
		Light roof of span: (m)			Heavy roof of span: (m)			Balcony* floor and balustrade only
		4.0	8.0	12.0	4.0	8.0	12.0	
(mm x mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
90 x 45**	600 450 400	150 150 150	50 100 100	50 50 50	100 100 100	50 50 50	50 50 50	550 650 700
140 x 45**	600 450 400	300 350 350	200 250 300	100 150 200	250 250 300	150 200 200	150 150 150	900 1100 1150
190 x 45	600 450 400	550 600 650	350 500 500	250 300 350	450 500 500	300 350 350	250 250 300	1300 1500 1600
240 x 45	600 450 400	850 950 1000	600 750 800	400 500 600	700 750 800	500 550 600	400 450 450	1650 1900 2050
290 x 45	600 450 400	1200 1300 1350	850 1050 1100	600 750 850	1000 1050 1100	750 800 850	600 650 650	2000 2350 2500

* Applies to balconies of domestic self-contained dwellings only. Only these joists may be wet in service.
** 90 and 140 joist depth is insufficient where cantilevered balustrades are used.

SECTION 8
WALLS

Table

Figure

8 WALLS

8.1 GENERAL

SG 8 tables are used in this section. For the corresponding SG 6 and SG 10 tables, see the 'A tables' appended to this section.

8.1.1

The *wall* system of each *storey* shall consist of:

(a) A system to resist vertical *loads* and complying with 8.2; combined with

(b) A system to resist horizontal *loads* and complying with 8.3; and

(c) Any other *walls* (such *walls* will be *non-loadbearing*).

C8.1.1

Designers should consider insulation requirements to comply with E3 and H1 when choosing wall members.

8.1.2

Walls designed to this section will support floors that carry 1.5 kPa and 2 kPa loadings (see section 14 for 3 kPa *floor loads*).

8.2 SYSTEMS TO RESIST VERTICAL LOADS

The *wall* system shall be designed to carry vertical *loads* in accordance with 8.4 to 8.8.

8.3 SYSTEMS TO RESIST HORIZONTAL LOADS

8.3.1 General

8.3.1.1

See section 5 for *bracing* design requirements.

8.3.1.2

The *bracing capacity* of *wall bracing elements*, other than those given in 8.3.2, shall be determined from the BRANZ Technical Paper P21. The *wall bracing element* shall duplicate the test in all regards including *framing* size and centres, fixing of *linings* and fixing to the floor.

8.3.1.3 Adjustment of bracing elements for length

Wall bracing elements longer than those tested shall have their *bracing capacity* determined by multiplying the tested *bracing rating* per metre by the length of the element. The end *studs* of the longer *wall* shall be provided with equivalent hold down details to those used in the tested *wall*.

8.3.1.4 Adjustment of bracing elements for height

Adjustment of *bracing capacity* of *walls* of different heights and *walls* with sloping *top plates* shall be obtained by the following method:

(a) For *wall bracing elements* of heights greater than 2.4 m, the *bracing rating* determined by test or from table 8.1 shall be multiplied by:

$$\frac{2.4}{\text{element height in metres}}$$

Elements less than 2.4 m high shall be rated as if they were 2.4 m high.

(b) *Walls* of varying heights, shall have their *bracing capacity* adjusted in accordance with 8.3.1.4(a), using the average height.

Table 8.1 – Ratings of 2.4 m high reinforced concrete or reinforced concrete masonry wall bracing elements (see 8.3.2.1)

If ratio wall length / average wall height is:	Rating in bracing units per metre of wall (BUs/m)
▶ Less than 0.625	0
▶ More than 0.625 but less than 1.5	42
▶ More than 1.5 but less than 3.0	100
▶ More than 3.0 but less than 4.5	200
▶ More than 4.5	300

NOTE –

(1) Bracing units for walls relate to the ratio of wall length to the average wall height.

(2) Walls to be greater than 1.5 m in length.

8.3.2 Reinforced concrete and reinforced concrete masonry

C8.3.2.1

The bracing ratings recognize that the strength contribution of a masonry or concrete wall is limited by the strength of its connections to other structural elements, such as floor or ceiling diaphragms.

Wall bracing elements of reinforced concrete, or reinforced concrete masonry, which are uniformly distributed throughout a building, may be used to contribute to the horizontal bracing of a building, to the ratings permitted in table 8.1.

8.3.2.1

Wall bracing elements of reinforced concrete or reinforced concrete masonry shall have the ratings given in table 8.1.

8.3.2.2

Concrete masonry *bracing elements* shall have a length not less than 1.5 m.

8.3.2.3

The construction of reinforced concrete masonry *walls* shall comply with NZS 4229.

8.3.2.4

Fixing of timber *framing* to concrete or concrete masonry *walls* shall be as required for *foundation walls*.

8.3.2.5

The *bracing* provisions permitted for isolated concrete masonry *brace* elements in this section shall not be used as an alternative to those required in NZS 4229, for reinforced concrete masonry buildings.

8.3.3 Dragon ties

8.3.3.1 General

Dragon ties may be used with a *braced wall* system to permit the construction of spaces up to 7.5 m x 7.5 m, without the need for a ceiling *diaphragm* (see figure 8.1).

8.3.3.2

When diagonal *dragon ties* are used, the distance to the nearest *bracing line* shall be a maximum of 5.0 m from the junction of the *dragon tie* with the *top plate*, in accordance with the following:

(a) The distance from the external corner to the first *bracing line* shall not exceed 7.5 m;

(b) Every *external wall* with a *dragon tie* attached to the *top plate* shall have a *bracing capacity* of at least 100 *bracing units.*

8.3.3.3

Dragon ties shall only be located at external corners and shall be used in pairs, one at each end of the *wall*.

Each dragon tie shall:

(a) Consist of a continuous length of 90 mm x 35 mm timber;

(b) Be connected to the *top plates* of the *external wall* and the adjoining *external wall* at right angles, and to intermediate *roof* and ceiling members;

(c) Be fixed at an angle between 40° and 50° to both *external walls*, not more than 2.5 m from the corner.

8.3.3.4

Dragon ties shall be fixed as follows:

(a) Either directly to the *top plates* or, to *blocking* pieces which are no deeper than 90 mm and are at least 70 mm wide; and

(b) At the *external wall* being considered, the *dragon ties* shall also be fixed within 100 mm of the *top plate* to a *joist*, truss or *rafter*; and

(c) At the adjoining *walls* which are at right angles, the *blocking* piece shall *span* between, and be fixed to, adjacent *joists*, trusses or *rafters* (see figure 8.1).

C8.3.3

Dragon ties help stop walls from spreading.

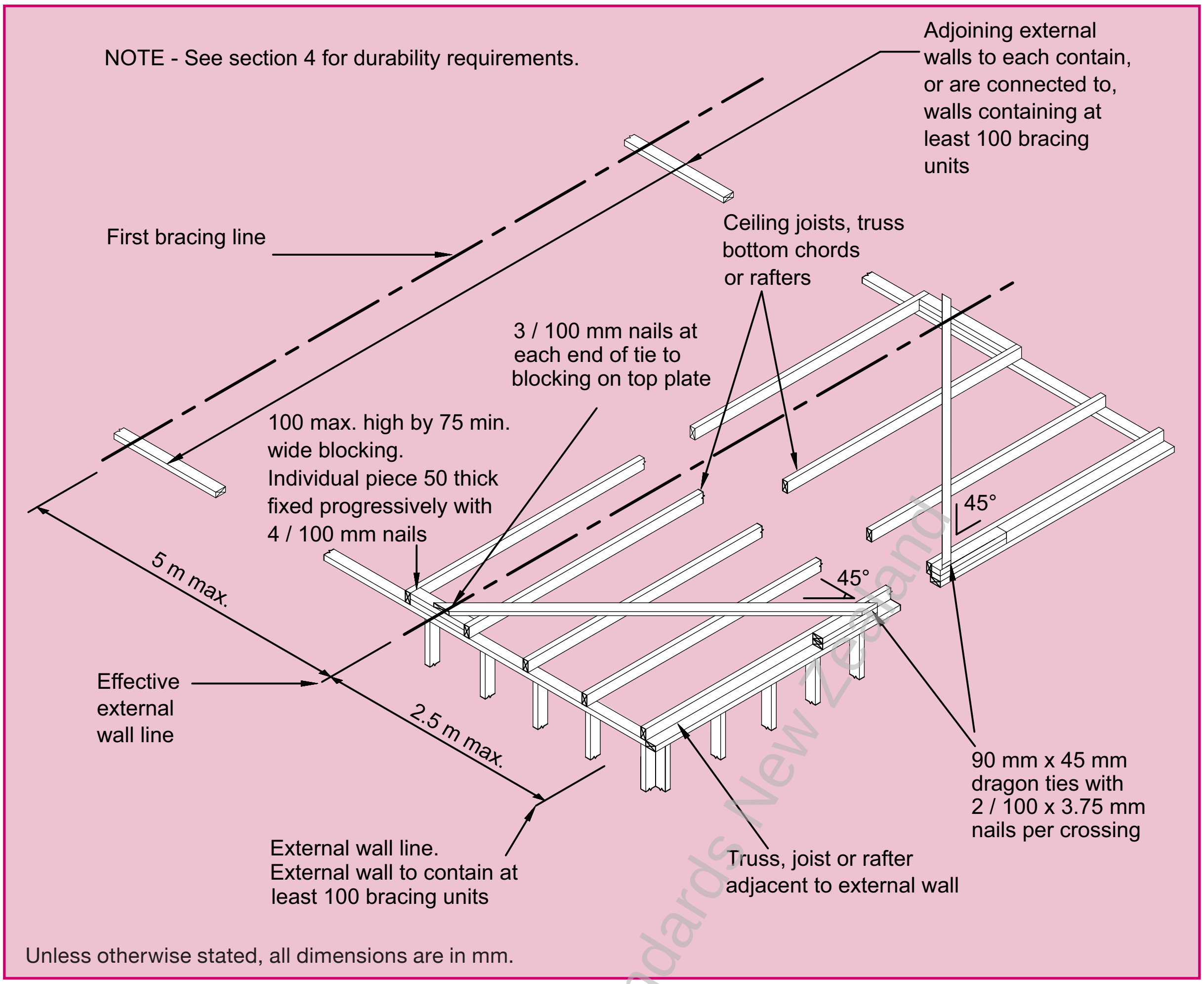


Figure 8.1 – Dragon ties (see 8.3.3.1)

8.4 WALL FRAMING – GENERAL REQUIREMENTS

8.4.1

Wall framing timbers shall be set plumb and square, except as permitted by 8.4.2.

8.4.2

Wall frames may be inclined not more than 20° from the vertical, for the purpose of forming *mansard roofs* only.

8.4.3

The *loaded dimension* shall be determined in accordance with 1.3, for the purpose of determining the dimensions of *wall framing* members.

C8.4.3

The span determined in accordance with figure 1.3 in section 1 relates to the roof mass carried by the walls. It does not correspond to the span and must not be used for determining the sizes of roof members.

8.5 STUDS

8.5.1 General

8.5.1.1

Studs shall be as follows:

(a) *Loadbearing walls*: As given by tables 8.2 and 14.10.

(b) *Non-loadbearing walls*: As given by tables 8.3 and 8.4. See also figure 8.3. Table 8.3 applies only to internal *non-loadbearing walls* and provides for the use of No. 2 Framing. *Gable* end *walls* within 1.2 metres of adjoining rafter or truss shall be regarded as *non-loadbearing walls* and designed in accordance with table 8.4.

C8.5.1.1

Figure 8.3 shows the location of walls as referred to in table 8.2. This Standard does not provide for wall framing supporting vertical loads from heavy wall cladding.

8.5.1.2

Wall framing studs and *trimming studs* may be built-up by nailing two or more pieces together to the required size as follows:

Stud thickness in table		Built-up thickness
Trimming studs	70 mm	2/35 mm
	90 mm	2/45 mm
	105 mm	3/35 mm
	115 mm	2/45 mm + 1/35 mm or 2/35 mm + 1/45 mm
	135 mm	3/45 mm
	140 mm	2/70 mm or 4/35 mm
	180 mm	4/45 mm
	210 mm	4/45 mm + 1/35 mm or 6/35 mm
	270 mm	6/45 mm

NOTE – Built-up members comprised of other combinations of framing members are allowed provided that overall thickness of the original member is matched or exceeded.

Table 8.2 – Studs in loadbearing walls for all wind zones – SG 8 (see 8.5.1.1)

Wind zone	Loaded dimen-sion* of wall (m)	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:		
		300	400	600	300	400	600	300	400	600
		(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(a) Single or top storey – Light and heavy roof										
Extra high	2.0	–	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	4.0	–	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	6.0	–	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
Very high	2.0	–	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70	90 x 45	90 x 70	90 x 90
	4.0	–	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70	90 x 45	90 x 70	90 x 90
	6.0	–	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70	90 x 45	90 x 70	90 x 90
High	2.0	–	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70
	4.0	–	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70
	6.0	–	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70
Medium	2.0	–	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	4.0	–	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	6.0	–	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
Low	2.0	–	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	4.0	–	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	6.0	–	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
Internal walls for all wind zones	2.0	–	70 x 45	70 x 45	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45
	4.0	–	70 x 45	70 x 45	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45
	6.0	–	70 x 45	70 x 45	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45
		3.6			4.2			4.8		
		At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
Extra high	2.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	140 x 90	190 x 90	190 x 90
	4.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	140 x 90	190 x 90	190 x 90
	6.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	140 x 90	190 x 90	190 x 90
Very high	2.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	140 x 90	190 x 45	190 x 90
	4.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	140 x 90	190 x 45	190 x 90
	6.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	140 x 90	190 x 45	190 x 90
High	2.0	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	140 x 90	190 x 90
	4.0	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	140 x 90	190 x 90
	6.0	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	140 x 90	190 x 90
Medium	2.0	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90
	4.0	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90
	6.0	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90
Low	2.0	90 x 35	90 x 70	90 x 70	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90
	4.0	90 x 35	90 x 70	90 x 70	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90
	6.0	90 x 35	90 x 70	90 x 70	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90
Internal walls for all wind zones	2.0	90 x 35	90 x 70	90 x 70	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90
	4.0	90 x 35	90 x 70	90 x 70	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90
	6.0	90 x 35	90 x 70	90 x 70	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90

* For definition of loaded dimension see 1.3.

NOTE –
(1) Determine the loaded dimension of the wall at floor level and the loaded dimension of the wall above at roof level and use the greater value in this table.
(2) 140 x 45 may be substituted for 90 x 90. 90 x 35 may be substituted for 70 x 45.
(3) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.
(4) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table 8.2 – Studs in loadbearing walls for all wind zones – SG 8 (continued) (see 8.5.1.1)

Wind zone	Loaded dimen-sion* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(b) Lower of two storeys or subfloor beneath one storey										
Extra high	2.0	-	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 45
	4.0	-	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 45
	6.0	-	90 x 70	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 45
Very high	2.0	-	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70	90 x 45	90 x 70	90 x 90
	4.0	-	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 45	90 x 70	90 x 90
	6.0	-	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 45	90 x 70	90 x 90
High	2.0	-	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70
	4.0	-	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	6.0	-	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
Medium	2.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	4.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70
	6.0	-	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
Low	2.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	4.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 45
	6.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
Internal walls for all wind zones	2.0	-	70 x 45	90 x 35	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45
	4.0	-	70 x 45	90 x 35	70 x 45	70 x 45	90 x 45	70 x 45	90 x 35	90 x 45
	6.0	-	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45	70 x 45	90 x 35	90 x 70

* For definition of loaded dimension see 1.3.

NOTE –
(1) Determine the loaded dimension of the wall at floor level and the loaded dimension of the wall above at roof level and use the greater value in this table.
(2) 140 x 45 may be substituted for 90 x 90. 90 x 35 may be substituted for 70 x 45.
(3) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.
(4) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table 8.2 – Studs in loadbearing walls for all wind zones – SG 8 (continued) (see 8.5.1.1)

Wind zone	Loaded dimen-sion* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(c) Subfloor beneath two storeys										
Extra high	2.0	90 x 45	90 x 70	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	4.0	90 x 45	90 x 70	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 45
	6.0	90 x 45	90 x 70	90 x 90	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 45
Very high	2.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 45	90 x 70	90 x 90
	4.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	6.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
High	2.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	4.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	6.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
Medium	2.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	4.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
Low	2.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	4.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	6.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
Internal walls for all wind zones	2.0	70 x 45	70 x 45	90 x 35	70 x 45	70 x 45	90 x 45	70 x 45	90 x 35	90 x 70
	4.0	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45	70 x 45	90 x 35	90 x 70
	6.0	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70

* For definition of loaded dimension see 1.3.

NOTE –
(1) Determine the loaded dimension of the wall at floor level and the loaded dimension of the wall above at roof level and use the greater value in this table.
(2) 140 x 45 may be substituted for 90 x 90. 90 x 35 may be substituted for 70 x 45.
(3) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.
(4) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table 8.3 – No. 2 Framing in internal and non-loadbearing walls (see 8.5.1.1)

	Maximum length (height) of stud	Minimum stud size for maximum spacing of studs (mm) of:		
		400	450	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)
Internal non-loadbearing walls in all wind zones	2.4	70 x 45	70 x 45	90 x 35
	2.7	90 x 35	90 x 35	90 x 45
	3.0	90 x 35	90 x 35	90 x 45

Table 8.4 – Studs in non-loadbearing walls for all wind zones – SG 8 (see 8.5.1.1 and figure 8.2)

Wind zone	Maximum length (height) of stud	Stud size for maximum spacing of studs (mm) of:		
		300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)		
Extra high	2.4	90 x 35	90 x 45	90 x 70
	2.7	90 x 45	90 x 70	90 x 90
	3.0	90 x 70	90 x 70	140 x 45
	3.3	90 x 90	140 x 45	140 x 45
	3.6	140 x 45	140 x 45	140 x 70
	3.9	140 x 45	140 x 70	190 x 45
	4.2	140 x 70	140 x 70	190 x 45
	4.8	190 x 45	190 x 70	–
Very high	2.4	90 x 35	90 x 35	90 x 70
	2.7	90 x 35	90 x 45	90 x 70
	3.0	90 x 45	90 x 70	90 x 90
	3.3	90 x 70	90 x 90	140 x 45
	3.6	90 x 90	140 x 45	140 x 45
	3.9	140 x 45	140 x 45	140 x 70
	4.2	140 x 45	140 x 70	190 x 45
	4.8	140 x 70	190 x 45	190 x 70
High	2.4	90 x 35	90 x 35	90 x 45
	2.7	90 x 35	90 x 35	90 x 70
	3.0	90 x 35	90 x 45	90 x 70
	3.3	90 x 70	90 x 70	140 x 45
	3.6	90 x 70	90 x 90	140 x 45
	3.9	90 x 90	140 x 45	140 x 70
	4.2	140 x 45	140 x 45	140 x 70
	4.8	140 x 70	190 x 45	190 x 45
Medium and low	2.4	90 x 35	90 x 35	90 x 35
	2.7	90 x 35	90 x 35	90 x 35
	3.0	90 x 35	90 x 35	90 x 70
	3.3	90 x 35	90 x 45	90 x 70
	3.6	90 x 70	90 x 70	140 x 45
	3.9	90 x 70	90 x 90	140 x 45
	4.2	90 x 90	140 x 45	140 x 70
	4.8	140 x 45	140 x 70	190 x 45
Internal walls for all wind zones	2.4	70 x 45	70 x 45	70 x 45
	2.7	70 x 45	70 x 45	90 x 35
	3.0	70 x 45	90 x 35	90 x 35
	3.3	90 x 35	90 x 35	90 x 70
	3.6	90 x 45	90 x 70	90 x 90
	3.9	90 x 70	90 x 70	140 x 45
	4.2	90 x 70	90 x 90	140 x 45
	4.8	140 x 45	140 x 45	140 x 70

NOTE –
(1) 90 x 35 may be substituted for 70 x 45.
140 x 45 may be substituted for 90 x 90.
(2) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.
(3) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

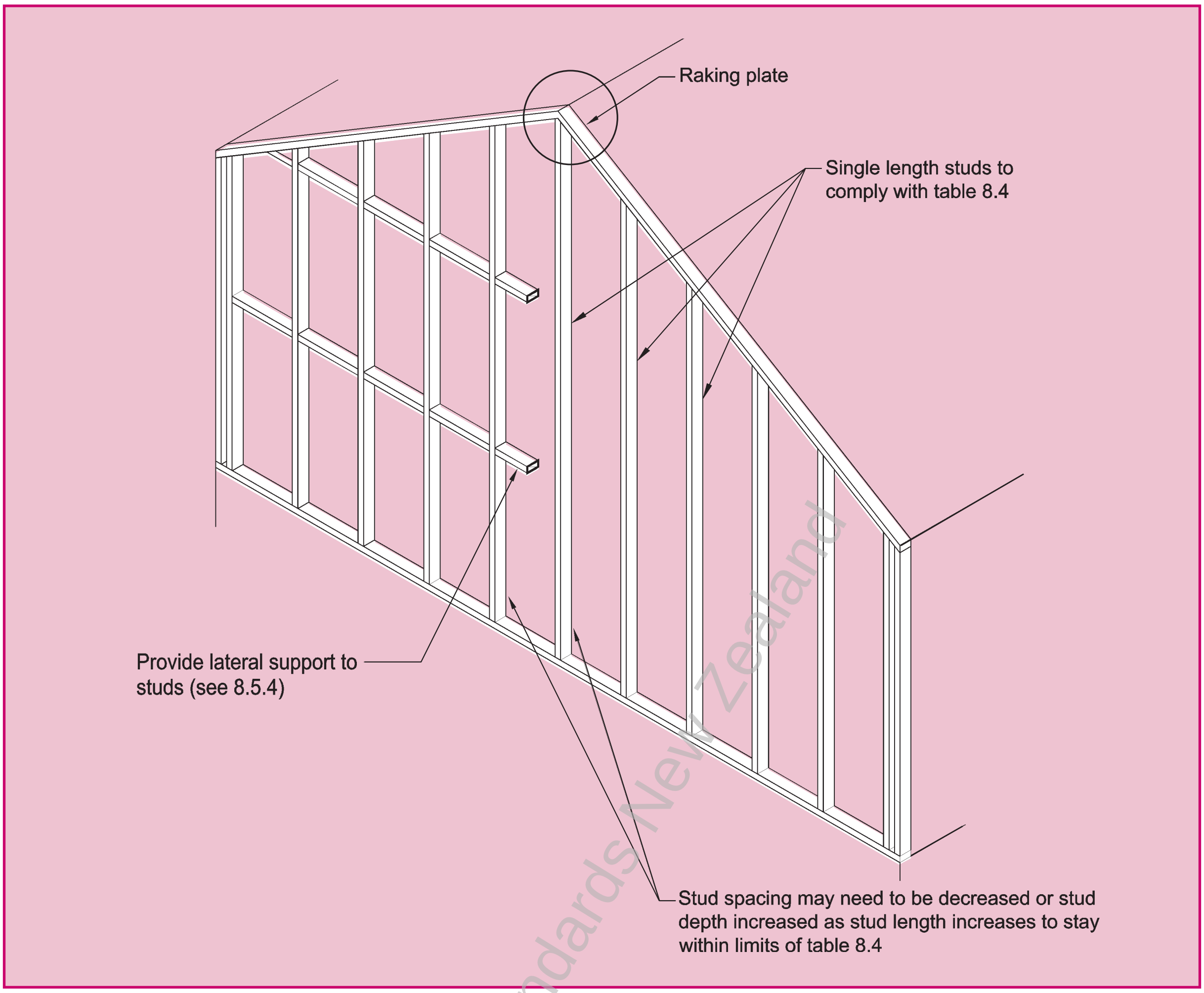


Figure 8.2 – Framing gable end walls to resist wind loads (skillion roofs) (see table 8.4)

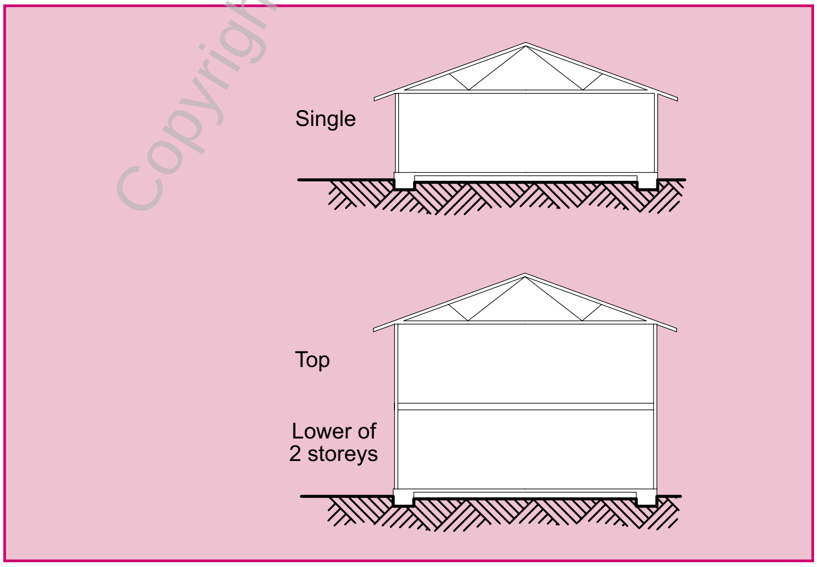


Figure 8.3 – Location of wall framing for the purposes of table 8.2 (see C8.5.1.1)

C8.5.1.3

Internal walls have been designed for, among other things, the effects of varying air pressures within a building (which can impose significant loadings during high winds if doors, windows, and the like are open or break). The design of internal walls ensures a minimum level of strength and stiffness for general serviceability.

8.5.1.3

For *external walls* the wind zone shall be as determined by tables 5.1 and 5.4. The requirements for *internal walls* as given in tables 8.3 and 8.4 can be used for any wind zone.

8.5.1.4

When both floors and *roofs* contribute *load* to a *loadbearing wall* (as in table 8.2(b) and (c)), the *loaded dimension* for the *wall* shall be determined from Note (1) to table 8.2(b) and (c).

8.5.1.5

Wall junctions shall be framed up with not fewer than 2 *studs* blocked and nailed.

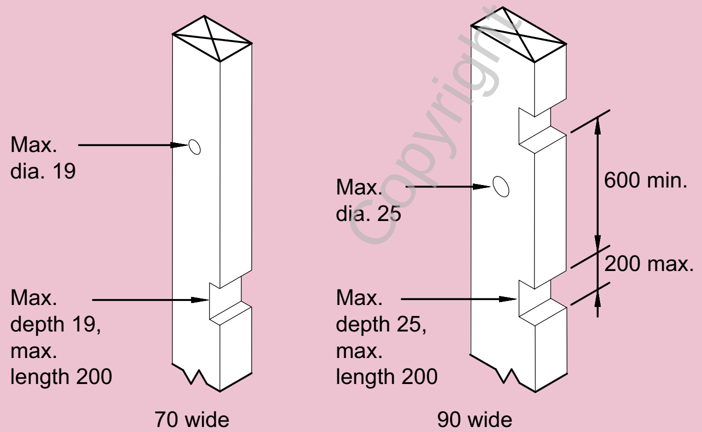
8.5.1.6

Holes in the face and notches in the edge of a *stud* (see figure 8.4) shall:

(a) Be placed anywhere over the face of the *stud* except that:
   (i) In brick veneer *cladding*, holes shall be at least 50 mm clear of the outside face of the *stud* supporting the veneer, to prevent damage from the fixings to services.
   (ii) For limitations on *trimming studs* see 8.5.2.

(b) Be not more in diameter or depth than:
   (i) 70 mm deep *studs*: 19 mm. This may be increased to 22 mm for the purpose of fitting metal *diagonal braces*
   (ii) 90 mm deep *studs*: 25 mm. This may be increased to 35 mm where not more than 3 consecutive *studs* are drilled or notched.

(c) Notches in *studs* to be *spaced* vertically not less than 600 mm apart, irrespective of the edge containing the notch.



NOTE -
(1) For diagonal timber bracing the depth of notches in 70 wide timber may be increased to 22 (see 8.5.1.6).
(2) For 90 wide studs the depth of notches and diameter of holes may be increased to 35 where no more than 3 consecutive studs are drilled or notched (see 8.5.1.6).
(3) Notches in studs to be spaced vertically 600 apart (independent of edge containing the notch).
(4) 100 min. offset between hole and notch.

Unless otherwise stated, all dimensions are in mm.

Figure 8.4 – Checking and boring studs (see 8.5.1.6)

8.5.2 Trimming studs

8.5.2.1

A *trimming stud* shall be provided to each side of any opening as follows (see figure 8.5 and table 8.5).

8.5.2.2

Trimming studs shall have the same width as the *studs* in the *wall* and are subject to 8.5.2.3 with the thickness given by table 8.5.

8.5.2.3

Trimming studs, whether single or double, shall not contain holes, notches, checks, or cuts in the middle third of their length.

8.5.2.4

Where a doubling *stud* which provides support for a *lintel* is shorter by 400 mm or more than the full *stud* height, its thickness shall not be included as contributing to the thickness of *trimming studs* from table 8.5 (see figure 8.5).

8.5.3 Straightening studs

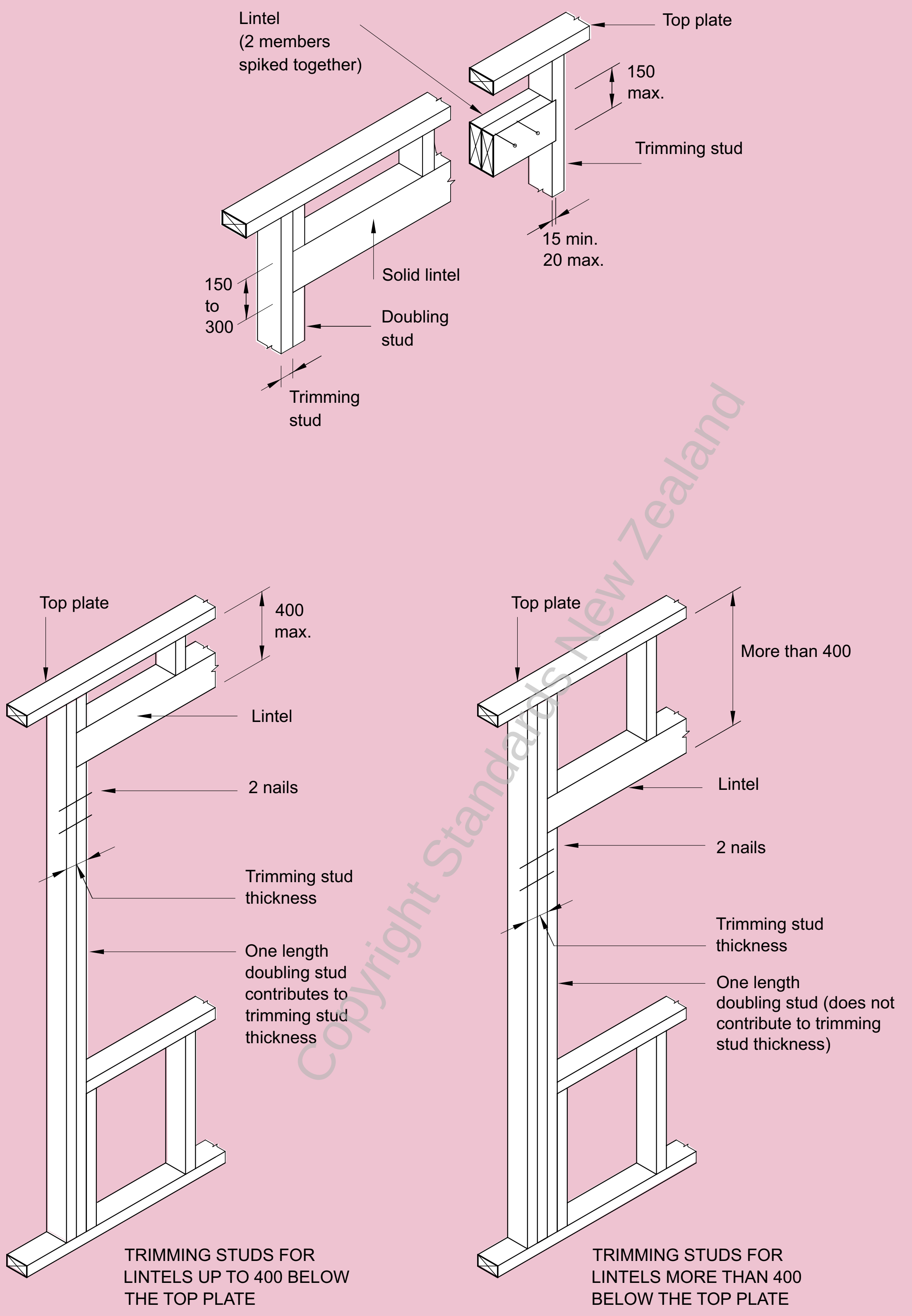
Timber to be used as a *stud* shall not have a crook exceeding the maximum permitted by NZS 3631. Any crook within that limitation, may be corrected or *studs* straightened by cutting from one edge through to not further than the centre line (see figure 8.6) provided that:

(a) There shall not be more than 2 such cuts in any *stud*;

(b) Fishplates the same width as the *stud*, 19 mm thick, and extending not less than 225 mm past each side of the cut shall be nailed to both faces of the *stud*;

(c) Not more than one quarter of the *studs* in any run of *wall* shall be partially cut, and no 2 such cut *studs* shall be adjacent to one another;

(d) No *trimming stud*, whether single or double, shall be partially cut.



Unless otherwise stated, all dimensions are in mm.

Figure 8.5 – Trimming studs and lintels (see 8.5.2.1)

Table 8.5 – Trimming studs (see 8.5.2.1)

Maximum clear width of opening (span of lintel)	Stud thickness required for 600 mm spaced studs	Thickness of trimming studs*
(a) Single storey, top storey or non-loadbearing walls		
(m)	(mm)	(mm)
1.8	35 45 70 90	45 45 90 115
3.0	35 45 70 90	45 70 90 135
3.6	35 45 70 90	70 90 140 180
4.2	35 45 70 90	105 135 210 270
(b) Any other location		
0.9	35 45 70 90	45 70 90 135
1.8	35 45 70 90	70 70 115 135
3.0	35 45 70 90	70 90 140 180

* For brick veneer openings add extra stud for fixing veneer ties.

NOTE – To use this table:

(1) Enter the row corresponding to the lintel span being considered.

(2) From the second column, select the thickness of the studs required for the body of the wall, assuming that they are spaced at 600 mm.

(3) Read the trimming stud thickness from the right side column.

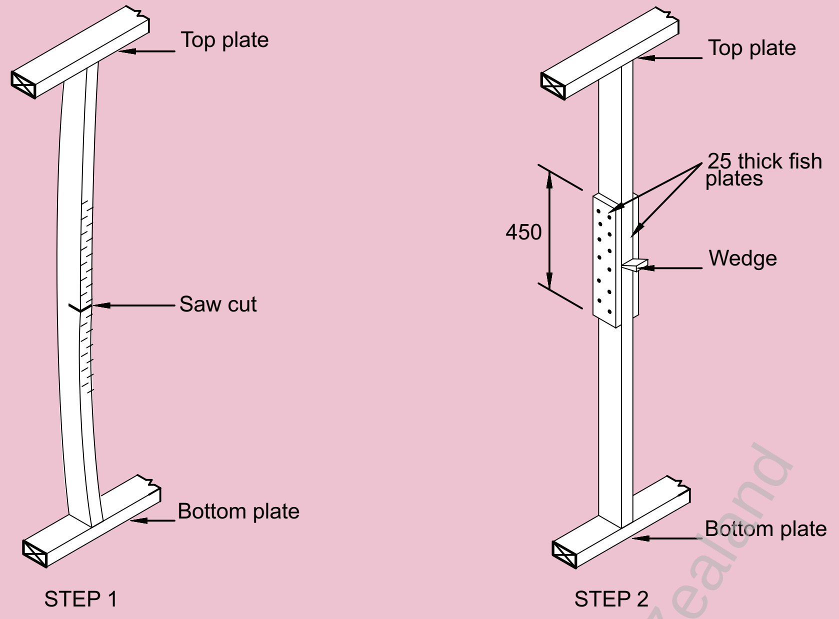


Figure 8.6 – Straightening studs (see 8.5.3)

C8.5.4

Masonry veneer ties, clip fixings, and adhesive fixings are not considered connections of adequate rigidity.

8.5.4 Lateral support of studs

All *studs* shall be laterally supported by either:

(a) Exterior *wall claddings* complying with E2/AS1 or interior *linings* complying with section 12. Such material shall be fixed to the *studs* by direct nailing of *cladding* or *lining* material, provided that building paper or similar material not exceeding 3 mm thick may separate the *lining* or *cladding* material from the *stud*; or

(b) *Dwangs, walings,* or *metal angle walings* in accordance with 8.8.

C8.5.5 Example

Taking an example of 140 x 45 stud at 600 centres, use table 8.6 to calculate as follows.

From the column headed "Original larger stud size" and the row labelled 140 x 45, move across to the column headed "Desired smaller stud size" and headed "90 x 70". The spacing adjustment factor is 0.38. Hence the maximum spacing of the 90 x 70 stud is 0.38 x 600 = 228 mm.

Alternatively, a 90 x 90 (desired smaller stud size) may be used at 0.53 x 600 = 318 mm spacing.

8.5.5 Stud spacing adjustment factor for tall studs of smaller cross section in raking walls

In *walls* of varying height, to achieve uniform *stud* depths, the *stud* sizes and *spacings* determined from tables 8.2, 8.3 and 8.4 shall be adjusted in accordance with table 8.6.

Table 8.6 – Stud spacing adjustment factor for tall studs of smaller cross section in raking walls (see 8.5.5)

Original larger stud size (mm x mm)	**Stud spacing adjustment factor**		
	Desired smaller stud size (mm x mm)		
	90 x 45	90 x 70	90 x 90
90 x 70	0.69	1.00	–
90 x 90	0.50	0.72	1.00
140 x 35	0.34	0.49	0.68
140 x 45	0.27	0.38	0.53
140 x 70	0.18	0.27	0.37
140 x 90	0.13	0.19	0.27

NOTE – Multiply original larger stud size spacing by this factor to obtain the spacing for the desired smaller stud size.

8.6 LINTELS, SILL AND HEAD TRIMMERS

8.6.1 Lintels

8.6.1.1
Lintels shall be provided over all openings in *loadbearing walls* (see figures 8.7 to 8.11).

8.6.1.2
Lintels shall be of the dimensions given by tables 8.9 to 8.13. These tables cover only evenly distributed uniform *loads* at maximum 1200 mm centres, from *wall framing, joists, rafters* and trusses. (See tables 14.11 to 14.14 for 3 kPa *floor load*, tables 15.1 to 15.5 for snow loads, table 16.1 for plywood box beam *lintels* and table 16.2 for glue-laminated timber *lintels*.)

8.6.1.3
Tables for *lintels* have been designed to support *roofs* with a maximum pitch of 45°. For *roofs* of steeper pitches up to 60°, the *loaded dimension* shall be multiplied by the following factors, before using the tables to obtain *lintel* sizes (see table 8.7).

8.6.1.4
For the various *load* cases for *lintels* see table 8.8.

Table 8.7 – Span multipliers for roofs steeper than 45° (see 8.6.1.3)

Roof pitch (degrees)	**Trusses multiplier**	**Single rafters multiplier**
50	1	1.1
55	3	1.2
60	SED	1.4

C8.6.1.2
The size of a lintel, its location and the loads it supports, is determined from table 8.8 and figures 8.7 to 8.11. This will determine which of tables 8.9 to 8.13 to consult. On the relevant table the row containing a loaded dimension greater than the actual loaded dimension is entered, to find a column containing a lintel span greater than the actual lintel span. The minimum lintel size is given at the head of that table column.

C8.6.1.3
Steep pitch trusses subject lintels to large overturning forces when resisting wind loads.

C8.6.1.4
Where concentrated loads occur on a lintel (such as from an upper storey trimming stud supporting a lintel of greater than 1.2 m span, or from a girder truss) then the lintel size must be specifically designed.

It is recommended during construction that all lintels be propped at mid-span, until they dry to their final equilibrium moisture content. This will control any unwanted deflection of green timber as it dries.

Table 8.8 – Reference table for lintel load cases (see 8.6.1.4)

Supporting			Load type				Table no.
Roof	**Walls**	**Floor**	**Roof**	**Snow (kPa)**	**Walls**	**Floor (kPa)**	
✓	–	–	Light	–	–	–	8.9
✓	–	–	Heavy	–	–	–	
✓	✓	–	Light	–	Light	–	8.10
✓	✓	–	Light	–	Medium	–	
✓	✓	–	Heavy	–	Light	–	
✓	✓	–	Heavy	–	Medium	–	
✓	✓	✓	Light	–	Light	1.5 or 2	8.11
✓	✓	✓	Light	–	Medium	1.5 or 2	
✓	✓	✓	Heavy	–	Light	1.5 or 2	
✓	✓	✓	Heavy	–	Medium	1.5 or 2	
–	✓	✓	–	–	Light	1.5 or 2	8.12
–	✓	✓	–	–	Medium	1.5 or 2	
–	–	✓	–	–	–	1.5 or 2	8.13

NOTE – See tables 15.1 to 15.5 for snow loading cases and tables 14.11 to 14.14 for 3 kPa floor loads.

Table 8.9 – Lintel supporting roof only for all wind zones – SG 8 (see figure 8.7)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)									
		90 x 70	**90 x 90**	**140 x 70**	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof	2	1.2	1.4	2.0	2.1	2.7	2.9	3.4	3.6	4.0	4.2
	3	1.1	1.2	1.7	1.9	2.4	2.6	3.0	3.3	3.7	3.9
	4	1.0	1.1	1.5	1.8	2.1	2.4	2.7	3.1	3.2	3.7
	6	0.8	1.0	1.3	1.6	1.8	2.1	2.2	2.7	2.7	3.3
Heavy roof	2	1.0	1.0	1.5	1.6	2.1	2.3	2.6	2.9	3.2	3.5
	3	0.9	0.9	1.4	1.5	1.9	2.0	2.4	2.6	2.9	3.1
	4	0.8	0.9	1.3	1.4	1.7	1.9	2.2	2.4	2.6	2.9
	6	0.7	0.8	1.1	1.2	1.5	1.7	1.9	2.1	2.3	2.6

* Loaded dimension is defined in figure 1.3.

NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

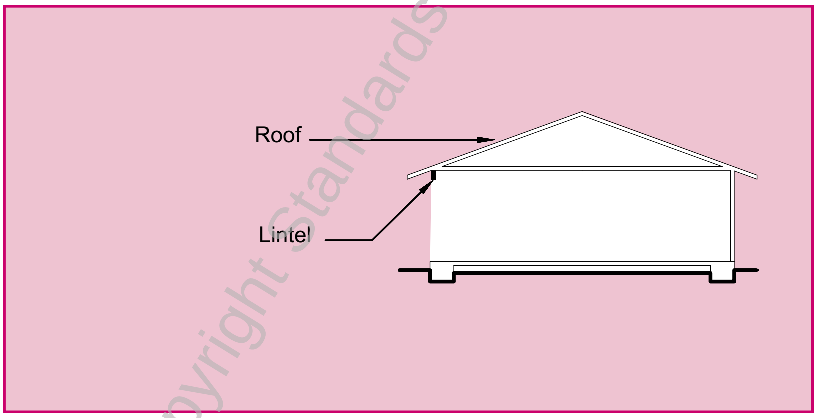


Figure 8.7 – Lintel supporting roof only (see 8.6.1.1 and table 8.9)

Table 8.10 – Lintel supporting roof and wall for all wind zones – SG 8 (see figure 8.8)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)									
		90 x 70	90 x 90	140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light roof Light wall	2	1.0	1.1	1.6	1.8	2.2	2.4	2.8	3.1	3.4	3.7
	3	1.0	1.1	1.5	1.7	2.1	2.3	2.7	2.9	3.2	3.5
	4	0.9	1.0	1.4	1.6	2.0	2.2	2.5	2.7	3.0	3.3
	6	0.8	0.9	1.3	1.4	1.8	2.0	2.3	2.5	2.7	3.0
Light roof Medium wall	2	0.9	1.0	1.5	1.6	2.0	2.2	2.5	2.7	3.1	3.3
	3	0.9	1.0	1.4	1.5	1.9	2.1	2.4	2.6	2.9	3.2
	4	0.7	0.8	1.1	1.2	1.5	1.7	1.9	2.1	2.3	2.6
	6	0.6	0.7	1.0	1.1	1.3	1.5	1.7	1.9	2.0	2.4
Heavy roof Light wall	2	0.9	0.9	1.4	1.5	1.9	2.0	2.4	2.6	2.9	3.1
	3	0.8	0.9	1.3	1.4	1.7	1.9	2.2	2.4	2.7	2.9
	4	0.7	0.8	1.2	1.3	1.6	1.8	2.1	2.2	2.5	2.7
	6	0.6	0.7	1.0	1.2	1.4	1.6	1.8	2.0	2.1	2.4
Heavy roof Medium wall	2	0.8	0.9	1.3	1.4	1.7	1.9	2.2	2.4	2.7	2.9
	3	0.7	0.8	1.2	1.3	1.6	1.8	2.1	2.3	2.5	2.7
	4	0.7	0.8	1.1	1.2	1.5	1.7	1.9	2.1	2.3	2.6
	6	0.6	0.7	1.0	1.1	1.3	1.5	1.7	1.9	2.0	2.4

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall above the lintel at roof level and use this value in the table.

(2) Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

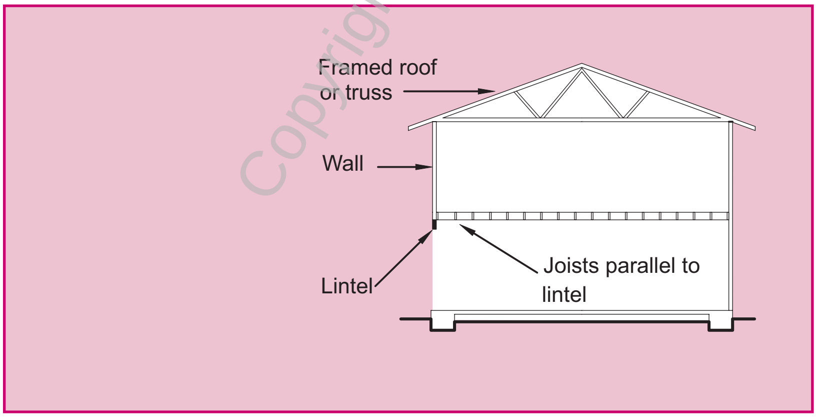


Figure 8.8 – Lintel supporting roof and wall (see 8.6.1.1 and table 8.10)

Table 8.11 – Lintel supporting roof, wall and floor for all wind zones – SG 8 for up to 2 kPa floor loads (see figure 8.9)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)							
		140 x 70	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	2	1.0	1.2	1.4	1.7	1.8	2.1	2.1	2.6
	3	1.0	1.2	1.3	1.6	1.7	2.1	2.1	2.5
	4	0.9	1.1	1.3	1.6	1.6	2.0	2.0	2.4
	6	0.9	1.1	1.2	1.5	1.5	1.9	1.9	2.3
Light roof Medium wall	2	1.0	1.2	1.3	1.6	1.7	2.1	2.1	2.5
	3	0.9	1.1	1.3	1.6	1.6	2.0	2.0	2.4
	4	0.8	1.0	1.1	1.4	1.5	1.8	1.8	2.1
	6	0.8	0.9	1.1	1.3	1.3	1.6	1.6	2.0
Heavy roof Light wall	2	0.9	1.2	1.3	1.6	1.7	2.0	2.0	2.4
	3	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
	4	0.9	1.0	1.2	1.4	1.5	1.8	1.8	2.2
	6	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.0
Heavy roof Medium wall	2	0.9	1.1	1.3	1.5	1.6	1.9	1.9	2.4
	3	0.9	1.1	1.2	1.5	1.5	1.9	1.8	2.2
	4	0.8	1.0	1.1	1.4	1.5	1.8	1.8	2.1
	6	0.8	0.9	1.1	1.3	1.3	1.8	1.6	2.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

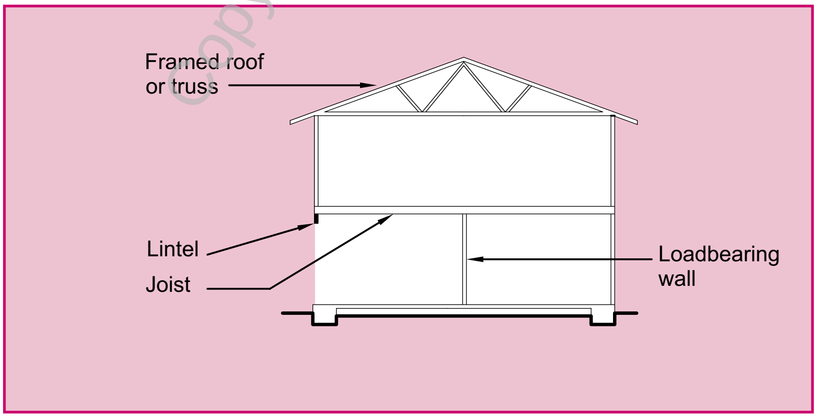


Figure 8.9 – Lintel supporting roof, floor joists and wall (see 8.6.1.1 and table 8.11)

Table 8.12 – Lintel supporting wall and floor for all wind zones – SG 8 for up to 2 kPa floor loads (see figure 8.10)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)							
		140 x 70	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light wall	3.0	1.1	1.4	1.6	1.9	2.0	2.4	2.4	2.9
Medium wall	3.0	1.1	1.4	1.5	1.9	1.9	2.4	2.3	2.8

* For definition of loaded dimension see 1.3.
NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

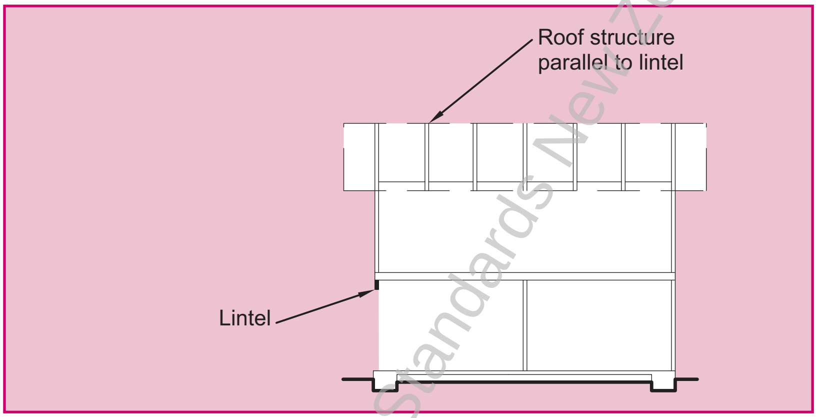


Figure 8.10 – Lintel supporting wall and floor (truss parallel to lintel) (see 8.6.1.1 and table 8.12)

Table 8.13 – Lintel supporting floor only for all wind zones – SG 8 for up to 2 kPa floor loads
(see figure 8.11)

Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m)							
	width x thickness (mm)							
	140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
2.0	1.5	1.8	2.0	2.4	2.6	3.1	3.1	3.7
4.0	1.0	1.3	1.4	1.7	1.8	2.2	2.2	2.7
6.0	0.8	1.0	1.2	1.4	1.5	1.8	1.8	2.2

* For definition of loaded dimension see 1.3.
NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

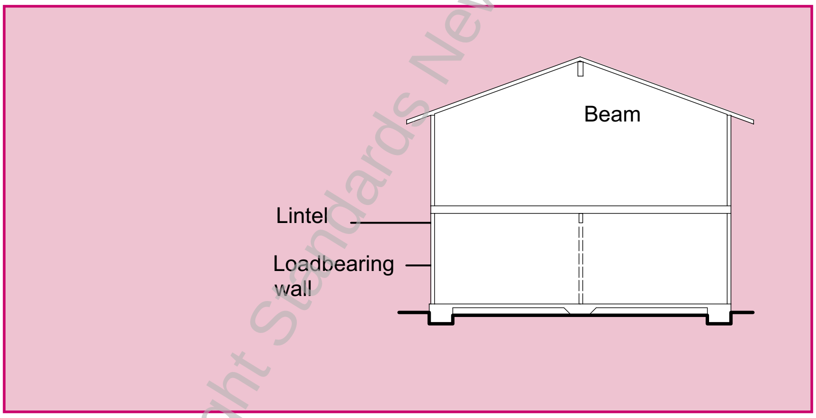


Figure 8.11 – Lintel supporting floor only (see 8.6.1.1 and table 8.13)

8.6.1.5

The thickness of a *lintel* may be made up of 2 or more members, but each member shall be the length of the *lintel*.

8.6.1.6

Lintels shown in figures 8.7 to 8.11 shall be supported at each end for the full thickness of the *lintel* by:

(a) For *lintels* not exceeding 140 mm wide: The *trimming stud* checked not less than 15 mm nor more than 20 mm;

(b) For *lintels* not exceeding 240 mm wide: A 35 mm thick doubling *stud* or *jack stud*;

(c) For *lintels* not exceeding 290 mm wide: A 45 mm thick doubling *stud* or *jack stud*.

8.6.1.7

Lintels supporting *rafters* or trusses of *roofs* shall be secured against uplift where indicated in table 8.14. Where fixing to resist uplift is not required, the fixings in table 8.19 for "Lintel to trimming stud" shall be used.

8.6.1.8

Each *lintel* required by table 8.14 to be secured against uplift shall be fixed at each end to a *trimming stud* which in turn shall be fixed to the floor *framing*. Each fixing to be as shown in figure 8.12, or an alternative fixing of 7.5 kN *capacity* in tension along the line of the *trimming stud*.

8.6.1.9

See section 16 for plywood box beam and glue laminated *lintels* supporting uniformly distributed *roof loads*.

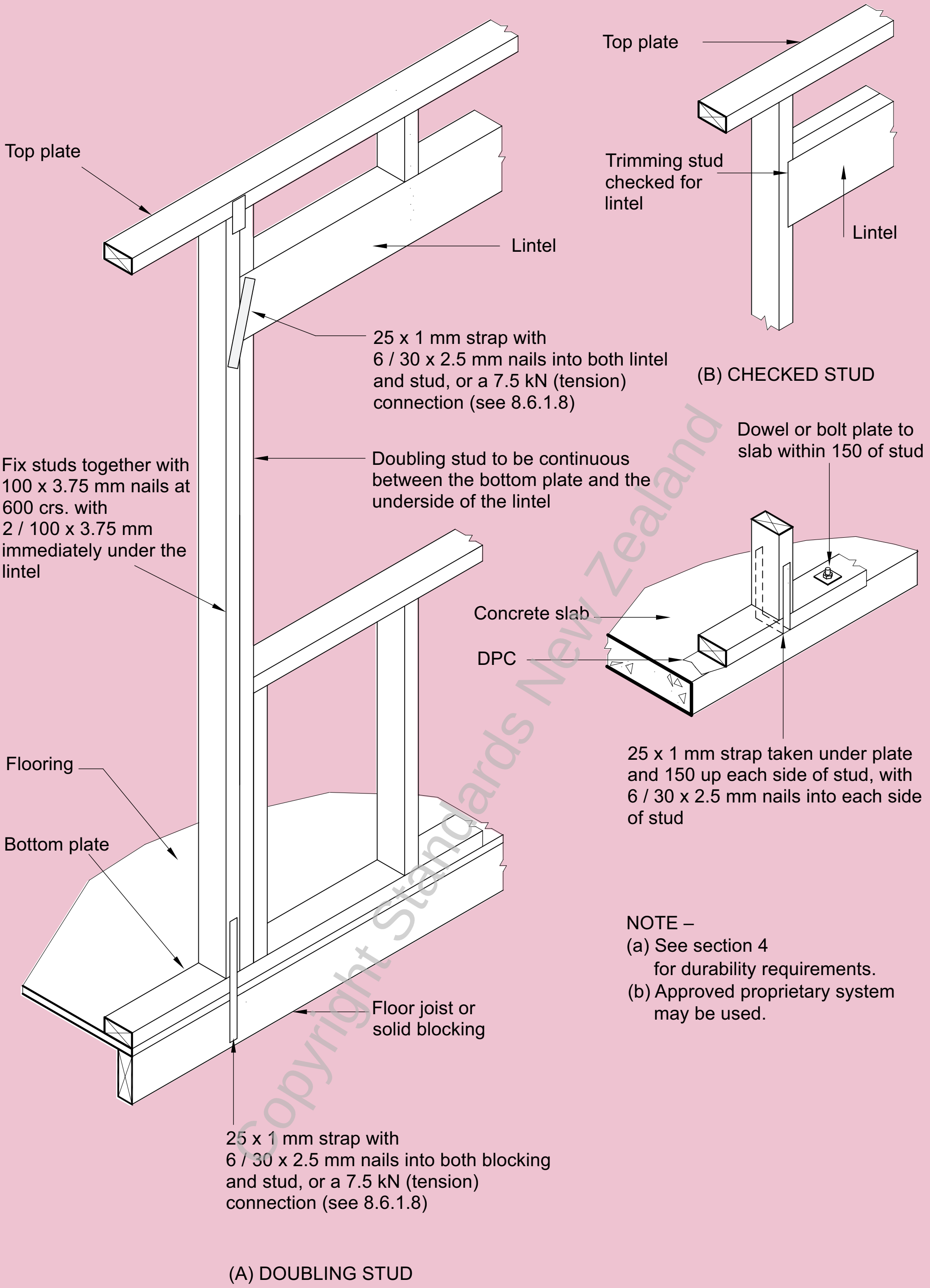
8.6.2 Sill and head trimmers

8.6.2.1

Sill trimmers to openings shall be of the same width as the *studs* and of the thickness given by table 8.15.

8.6.2.2

Where a head *trimmer* to an opening is provided it shall be of the same width as the *studs* and of the thickness given by table 8.15.



Unless otherwise stated, all dimensions are in mm.

Figure 8.12 – Lintel fixing to prevent uplift (see 8.6.1.8 and table 8.14 (a) and (b))

Table 8.14 – Lintel fixing (see 8.6.1.8)

Wind zone	Loaded dimension of lintel (m)	Uplift fixings not required Use fixings from table 8.19	Uplift fixings required See 8.6.1.8 for fixings
		Maximum lintel span for fixings above (m)	
(a) Light roof			
Extra high	2	NA	3.5
	3	NA	2.6
	4	NA	2.0
	6	NA	1.4
Very high	2	NA	4.4
	3	NA	3.2
	4	NA	2.5
	6	NA	1.8
High	2	1.5	5.0
	3	NA	4.3
	4	NA	3.4
	6	NA	2.4
Medium	2	2.4	5.0
	3	1.8	5.0
	4	1.4	5.0
	6	NA	3.7
Low	2	3.6	5.0
	3	2.6	5.0
	4	2.1	5.0
	6	1.4	5.0
(b) Heavy roof			
Extra high	2	NA	4.0
	3	NA	2.9
	4	NA	2.3
	6	NA	1.6
Very high	2	1.3	5.2
	3	NA	3.8
	4	NA	3.0
	6	NA	2.1
High	2	2.1	7.5
	3	1.4	5.5
	4	NA	4.3
	6	NA	3.0
Medium	2	3.5	13.4
	3	2.6	9.8
	4	2.0	7.8
	6	1.4	5.4
Low	2	6.9	*
	3	5.1	*
	4	4.0	*
	6	2.8	10.6

NA Not applicable.
* Table 8.19 fixings are satisfactory.
NOTE – Fixings for lintel spans greater than those shown require specific engineering design.

Table 8.15 – Sill and head trimmers for all wind zones – SG 8
(see 8.6.2.1 and 8.6.2.2)

Maximum clear width of opening	Minimum thickness of sill and header trimmers
(m)	(mm)
2.0	35
2.4	45
3.0	90 (or 2/45 mm)
3.6	135 (or 3/45 mm)
4.2	SED

8.7 PLATES

8.7.1 Top plates

8.7.1.1

Top plates of *loadbearing walls* shall be of the dimensions given in table 8.16 except for any of:

(a) As provided by 8.7.1.2;

(b) Where substituted by a *lintel*;

(c) Where trusses land more than 150 mm away from a *stud* position, see figure 8.13 for *plate* support;

(d) Where low density ceilings are installed and the *bracing lines* are *spaced* between 5.0 m and 6.0 m provide an additional *plate*, see 8.7.4.2.

8.7.1.2

Table 8.16 does not apply where a *roof* or floor *framing* member supported by a *loadbearing wall* lands on the *top plate*, directly over a *stud*. The *top plate* shall in that case be the same width as the *studs* and 35 mm thick.

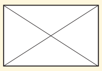
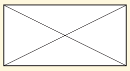
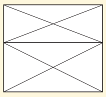
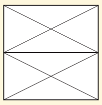
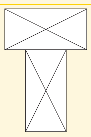
8.7.1.3

Top plates of *non-loadbearing walls* shall be the same width as the *studs* and no less than 35 mm thick.

8.7.1.4

Joints and connections in *top plates* are covered in 8.7.3.

Table 8.16 – Top plates of loadbearing walls – SG 8 (see 8.7.1.1)

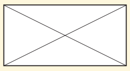
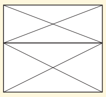
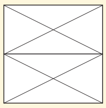
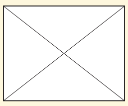
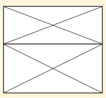
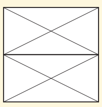
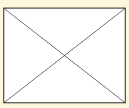
Plate size (mm x mm)		Position of truss or rafter centre line relative to centre line of nearest stud	Maximum spacing of trusses or rafters (mm)	Light roof			Heavy roof		
				Stud spacing (mm)					
				300	400	600	300	400	600
				Maximum loaded dimension* of wall (m)					
(a) Single or top storey (Applies for any spacing of trusses or rafters)									
70 x 45		Anywhere	600 900 1200	6.0 6.0 6.0	6.0 6.0 4.5	5.8 3.7 2.6	6.0 5.0 –	5.4 3.4 –	3.2 1.9 –
		Within 150 mm	600 900 1200	6.0 6.0 6.0	6.0 6.0 5.6	6.0 4.6 3.6	6.0 5.2 –	6.0 4.3 –	4.8 3.0 –
90 x 45		Anywhere	600 900 1200	6.0 6.0 6.0	6.0 6.0 5.9	6.0 4.9 3.5	6.0 6.0 –	6.0 4.5 –	4.2 2.6 –
		Within 150 mm	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 5.8 4.5	6.0 6.0 –	6.0 5.7 –	6.0 4.1 –
90 x 45 plus 90 x 35 (or greater) or 2/90 x 45	**  or 	Anywhere	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 –	6.0 6.0 –	6.0 4.9 –
		Within 150 mm	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 –	6.0 6.0 –	6.0 6.0 –
90 x 45 plus 90 x 45 dwang		Anywhere	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 –	6.0 6.0 –	6.0 6.0 –

* For definition of loaded dimension see 1.3.

** Use of 90 x 35 shall be limited by the requirements of 8.7.4.2.

NOTE – Substitution with built-up members is not allowed (see 5.4.6 and 8.7.4.2).

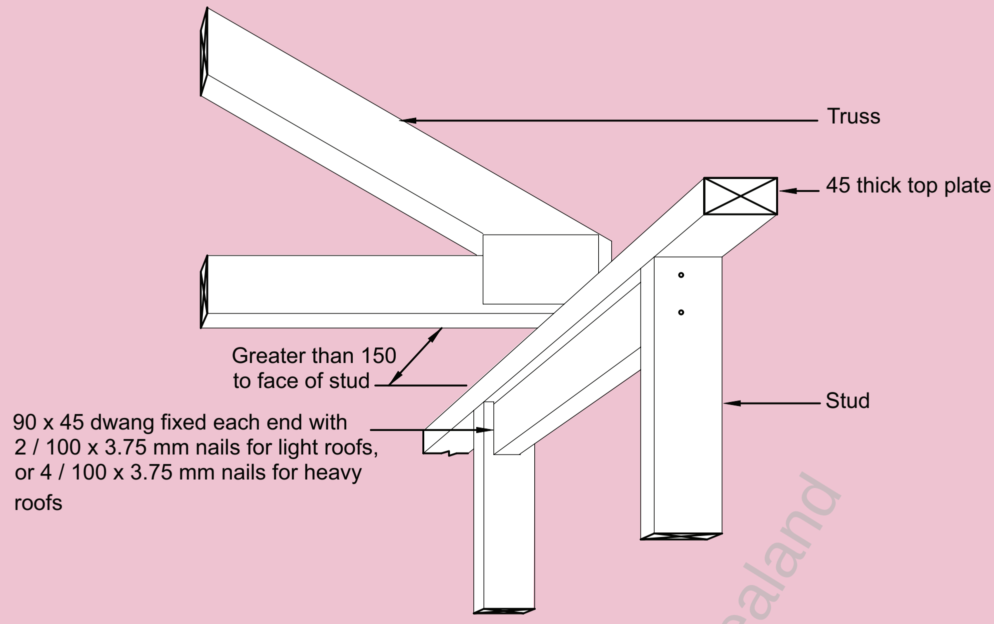
Table 8.16 – Top plates of loadbearing walls – SG 8 (continued) (see 8.7.1.1)

Plate size (mm x mm)		Maximum loaded dimension of wall supporting floor (m)	Maximum spacing of trusses or rafters (mm)	Light roof			Heavy roof		
				Stud spacing (mm)					
				300	400	600	300	400	600
				Maximum loaded dimension* of wall (m)					
(b) Lower of 2 storeys and subfloor stud walls supporting 1 storey									
90 x 45		1.5	400	6.0	6.0	6.0	6.0	6.0	3.6
			450	6.0	6.0	4.8	6.0	6.0	2.7
			600	6.0	6.0	2.0	6.0	4.0	–
		3.0	400	6.0	6.0	1.5	6.0	5.2	–
			450	6.0	6.0	–	6.0	3.9	–
			600	6.0	2.2	–	4.5	–	–
90 x 45 plus 90 x 35 or 2/90 x 45	**  or 	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	4.6
		3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	4.6
			600	6.0	6.0	3.1	6.0	6.0	1.7
90 x 70		1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	6.0
		3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	5.4
(c) Subfloor stud walls supporting 2 storeys									
90 x 45 plus 90 x 35 or 2/90 x 45	**  or 	1.5	400	6.0	6.0	6.0	6.0	6.0	5.4
			450	6.0	6.0	6.0	6.0	6.0	3.9
			600	6.0	6.0	2.0	6.0	6.0	–
		3.0	400	6.0	6.0	–	6.0	6.0	–
			450	6.0	6.0	–	6.0	5.0	–
			600	6.0	–	–	6.0	–	–
90 x 70		1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	4.8
		3.0	400	6.0	6.0	6.0	6.0	6.0	5.3
			450	6.0	6.0	5.5	6.0	6.0	3.2
			600	6.0	6.0	–	5.0	4.1	–

* For definition of loaded dimension see 1.3.

** Use of 90 x 35 shall be limited by the requirements of 8.7.4.2.

NOTE – Substitution with built-up members is not allowed.



Unless otherwise stated, all dimensions are in mm.

Figure 8.13 – Strengthening top plate (see 8.7.1.1 and table 8.16)

8.7.2 Bottom plates

8.7.2.1

Bottom plates shall be of the following dimensions:

(a) *Loadbearing walls*: As given by table 8.17 except as provided by 8.7.2.2 (for *walls* supporting floors with a live *load* of 3 kPa see table 14.15);

(b) *Non-loadbearing walls*: the same width as the *studs* and at least 35 mm thick.

8.7.2.2

The *bottom plate* of a *loadbearing wall* which is continuously supported by either:

(a) A *joist* (including a *boundary joist*);

(b) Solid *blocking*; or

(c) A concrete floor slab;

shall be the same width as the *studs* and at least 35 mm thick. For fixing of *bottom plates* see 7.5.12.

8.7.3 Joints in plates

8.7.3.1

Joints in *top plates* shall be made only over supports being either a *stud* or *blocking*.

Table 8.17 – Bottom plates of loadbearing walls – SG 8 (see 8.7.2.1)

Plate size (mm x mm)	Maximum loaded dimension of wall supporting floor (m)	Maximum spacing of floor joists (m)	Light roof			Heavy roof		
			Stud spacing (mm)					
			300	400	600	300	400	600
			Maximum loaded dimension* of wall supporting roof (m)					
(a) Single or top storey								
70 x 45	NA	400 450 600	6.0 6.0 6.0	6.0 6.0 5.9	6.0 5.9 3.3	3.6 3.0 1.6	6.0 5.3 3.1	3.6 3.0 1.6
70 x 70	NA	400 450 600	6.0 6.0 6.0	6.0 6.0 5.9	6.0 5.9 3.3	3.6 3.0 1.6	6.0 5.3 3.1	3.6 3.0 1.6
90 x 45	NA	400 450 600	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0
90 x 70	NA	400 450 600	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0

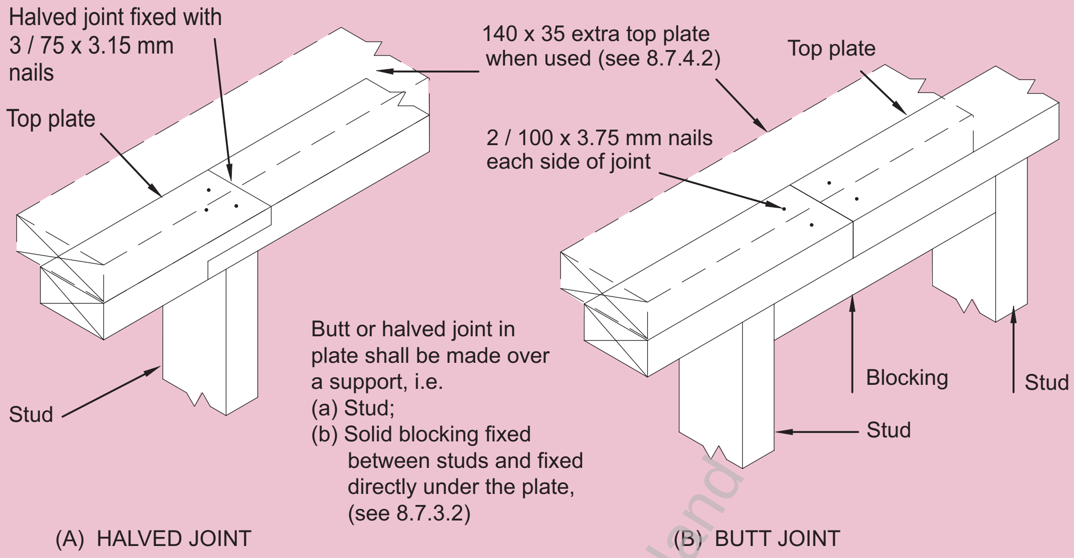
* For definition of loaded dimension see 1.3.

NOTE – Substitution with built-up members is not allowed.

Table 8.17 – Bottom plates of loadbearing walls – SG 8 (continued) (see 8.7.2.1)

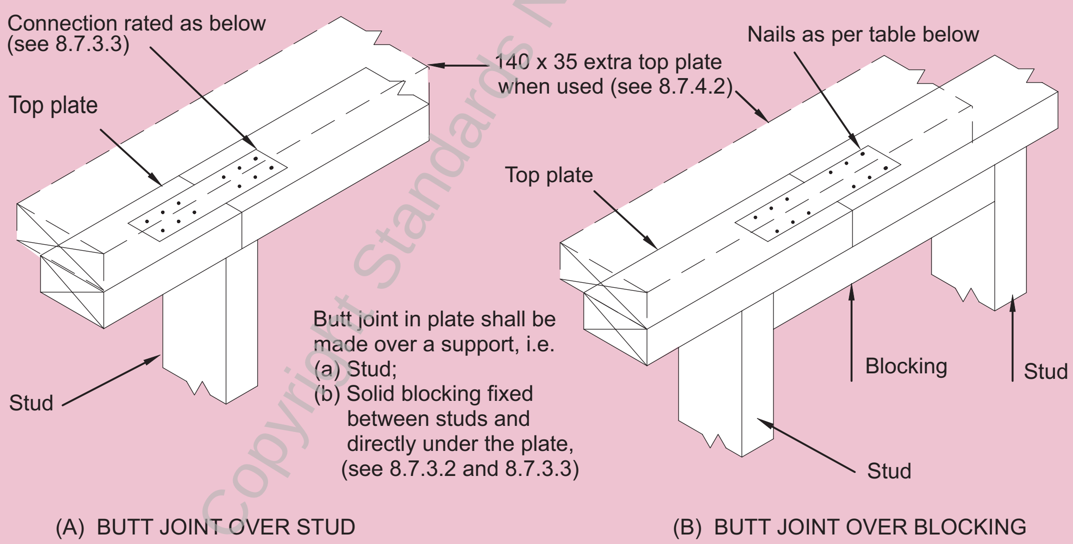
Plate size (mm x mm)	**Maximum loaded dimension of wall supporting floor** (m)	**Maximum spacing of floor joists** (m)	**Light roof**			**Heavy roof**		
			Stud spacing (mm)					
			300	**400**	**600**	**300**	**400**	**600**
			Maximum loaded dimension* of wall supporting roof (m)					
(b) One floor plus roof								
90 x 45	1.5	400	6.0	6.0	3.6	2.0	5.5	2.0
		450	6.0	6.0	2.3	–	4.3	–
		600	6.0	3.2	–	–	1.5	–
	3.0	400	6.0	4.3	–	–	2.5	–
		450	6.0	2.4	–	–	–	–
		600	2.4	–	–	–	–	–
2/90 x 45	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	3.5	6.0	3.5
	3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	5.2	6.0	5.2
		600	6.0	6.0	2.9	–	5.2	–
90 x 70	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	6.0
	3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	5.5	3.2	6.0	3.2
(c) Two floors plus roof								
90 x 45	1.5	400	6.0	3.3	–	5.3	1.8	–
		450	6.0	1.5	–	3.7	–	–
		600	1.5	–	–	–	–	–
	3.0	400	–	–	–	–	–	–
		450	–	–	–	–	–	–
		600	–	–	–	–	–	–
2/90 x 45	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	4.6
		600	6.0	6.0	1.6	6.0	4.5	–
	3.0	400	6.0	6.0	–	6.0	6.0	–
		450	6.0	6.0	–	6.0	5.2	–
		600	6.0	–	–	4.2	–	–
90 x 70	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	4.5	6.0	6.0	2.6
	3.0	400	6.0	6.0	3.8	6.0	6.0	2.2
		450	6.0	6.0	–	6.0	6.0	–
		600	6.0	3.8	–	6.0	2.2	–

* For definition of loaded dimension see 1.3.
NOTE – Substitution with built-up members is not allowed.



Unless otherwise stated, all dimensions are in mm.

Figure 8.14 – Connecting top plates – Walls not containing bracing (see 8.7.3.2)



Capacities of metal plate joints(2)	
Up to 3 kN	3 / 30 x 3.15 mm nails per side
Up to 6 kN	6 / 30 x 3.15 mm nails per side

Capacities of nailed joints(2)	
Up to 3 kN	3 / 100 x 3.75 mm nails per side
Up to 6 kN	6 / 100 x 3.75 mm nails per side

NOTE –
(1) See section 4 for durability requirements.
(2) Not required when extra top plate is used.

Unless otherwise stated, all dimensions are in mm.

Figure 8.15 – Connecting top plates in line – Walls containing bracing (see 8.7.3.3)

8.7.3.2

Joints in the *top plate* of a *wall* that does not contain any *wall bracing elements* (either in line or at *wall* intersections), shall be halved and nailed at the joints, see figure 8.14 (A), or be butted over *blocking* and nailed, see figure 8.14 (B), or be provided with an alternative fixing, having a *capacity* in tension or compression of 3 kN.

8.7.3.3

For single-*storey* buildings the connection in line of the *top plate* of a *wall* that contains one or more *wall bracing elements* shall be jointed according to the *bracing capacity* of the highest-rated individual *wall bracing elements* as follows:

(a) *Bracing capacity* not exceeding 100 *bracing units*: A 3 kN connection as shown in figure 8.15 or by an alternative fixing of 3 kN *capacity* tension and compression along the *plate*;

(b) *Bracing capacity* exceeding 100 *bracing units*: A 6 kN connection as shown in figure 8.15 or by an alternative fixing of 6 kN *capacity* tension and compression along the *plate*.

(c) *Wall top plates* to which ceiling *diaphragms* are attached: A 6 kN connection as shown in figure 8.15 or by an alternative fixing of 6 kN *capacity* in tension and compression along the *plate*.

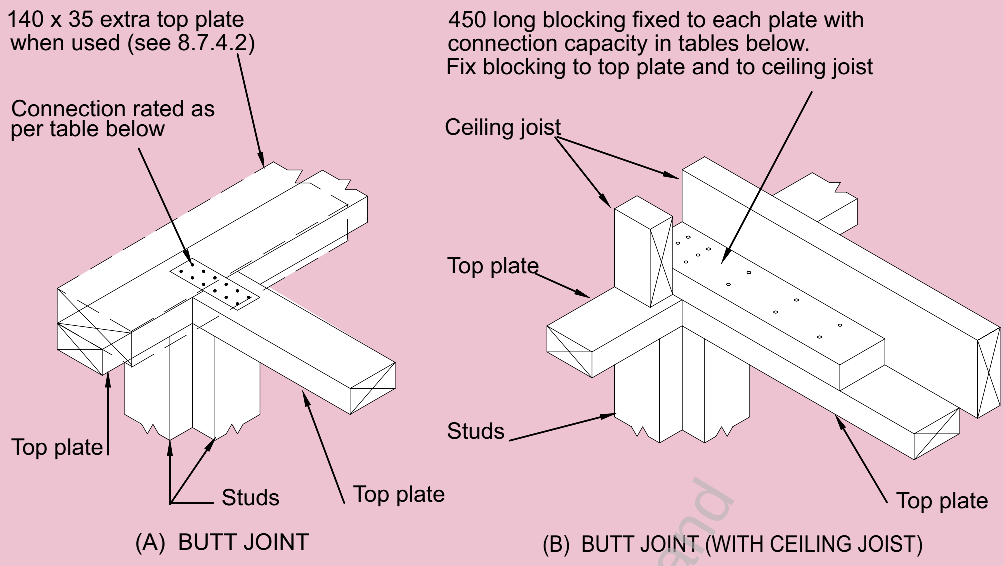
8.7.3.4

Each *wall* that contains one or more *wall bracing elements* shall be connected at the *top plate* level, either directly, or through a *framing* member in the line of the *wall*, to *external walls* at right angles to it. *Top plate* fixing(s) of the *capacity* in tension or compression along the line of the *wall bracing element* are given as follows:

(a) For each *wall* containing *wall bracing elements* with a total *bracing capacity* of not more than 125 *bracing units*: to at least one such *external wall* by a fixing as shown in figure 8.16 of 6 kN *capacity*;

(b) For each *wall* containing *wall bracing elements* with a total *bracing capacity* of not more than 250 *bracing units*: to at least 2 *external walls* by fixings as shown in figure 8.16 each of 6 kN *capacity*;

(c) For each *wall* containing *wall bracing elements* with a total *bracing capacity* of more than 250 *bracing units*: to at least 2 *external walls* by fixings as shown in figure 8.16 each having a rating of not less than 2.4 kN per 100 *bracing units*.



Capacities of metal plate joints	
Up to 3 kN Up to 6 kN	3 / 30 x 3.15 mm nails per side 6 / 30 x 3.15 mm nails per side

Capacities of nailed joints	
Up to 3 kN Up to 6 kN	3 / 100 x 3.75 mm nails per side 6 / 100 x 3.75 mm nails per side

NOTE – See section 4 for durability requirements.

Unless otherwise stated, all dimensions are in mm.

Figure 8.16 – Connecting top plates to external walls at right angles – Walls containing bracing (see 8.7.3.4)

8.7.4 Lateral support of top plates

8.7.4.1

Top plates shall be laterally supported by:

(a) A ceiling with a sheet *lining* material having a density no less than 600 kg/m^3; or

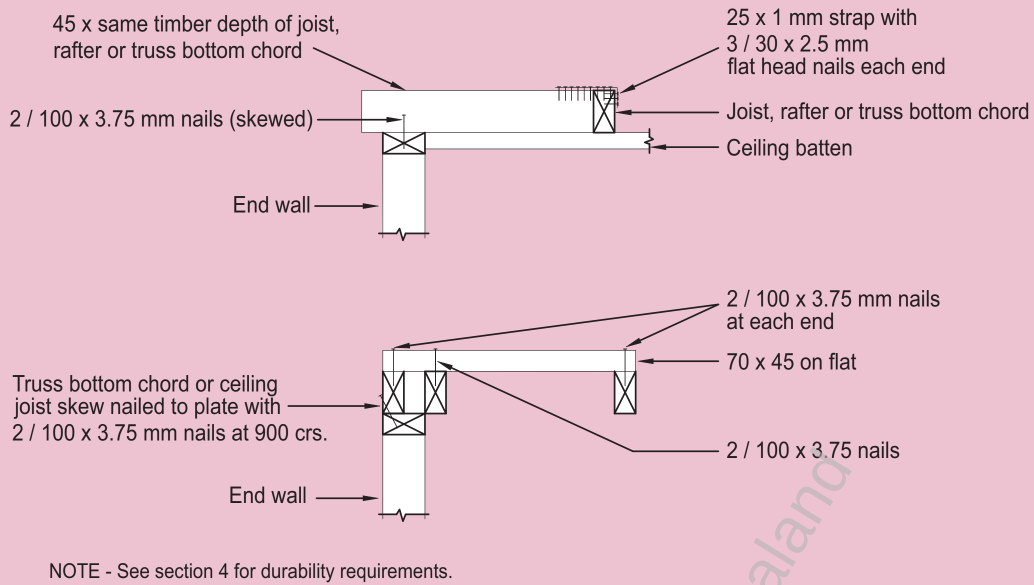
(b) Intersecting *top plates*, *joists*, *rafters*, trusses or *purlins*; or

(c) *Framing* members *spaced* at not greater than 2.5 m; or

(d) 70 x 45 mm connecting members between the *top plate* and a parallel floor or *roof framing member* as shown in figure 8.17.

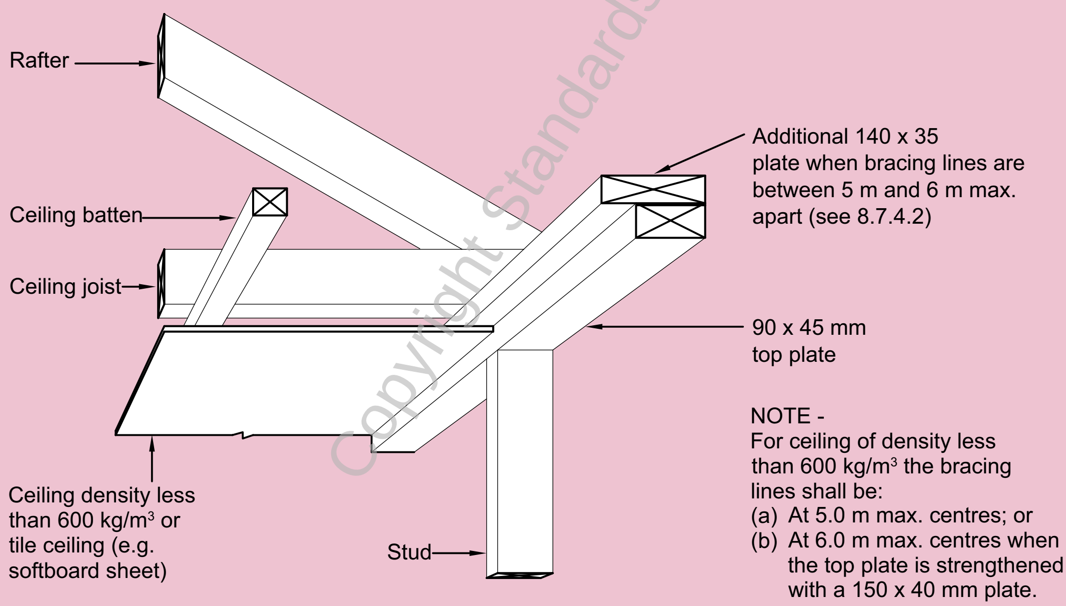
8.7.4.2

When the *top plate* is on the boundary of a ceiling *lining*, having a density less than 600 kg/m^3, and the distance between *bracing lines* at right angles to the *plate* is between 5.0 m and 6.0 m, the 90 x 45 *top plate* shall be strengthened by the addition of a 140 x 35 *plate* of at least the same grade as the *top plate* (see figure 8.18).



Unless otherwise stated, all dimensions are in mm.

Figure 8.17 – Connecting members providing lateral support to top plates (see 8.7.4.1)



Unless otherwise stated, all dimensions are in mm.

Figure 8.18 – Strengthening top plate for low density ceilings (against horizontal forces) (see 8.7.4.2)

8.7.5 Holes and checks in plates

8.7.5.1 Top plates

The sizes of holes or notches shall comply with the dimensions shown in figure 8.19. Where the size of a hole or notch exceeds these dimensions the *plates* shall be strengthened by one of the following methods:

(a) A 70 mm x 45 mm member x 600 mm long nailed to the exterior side of the *plate* with 4/75 x 3.15 nails on each side of the hole or notch;

(b) A 70 mm x 45 mm eaves *runner* connected to all *studs* and no more than 250 mm below the *top plate*; or

(c) A 70 x 45 mm *blocking* fitted between ceiling *joists* or trusses above cut *top plates* and the steel angle shown in figure 8.20.

C8.7.5.1

Strengthening is required against loads vertical to, horizontal to, or along the plate.

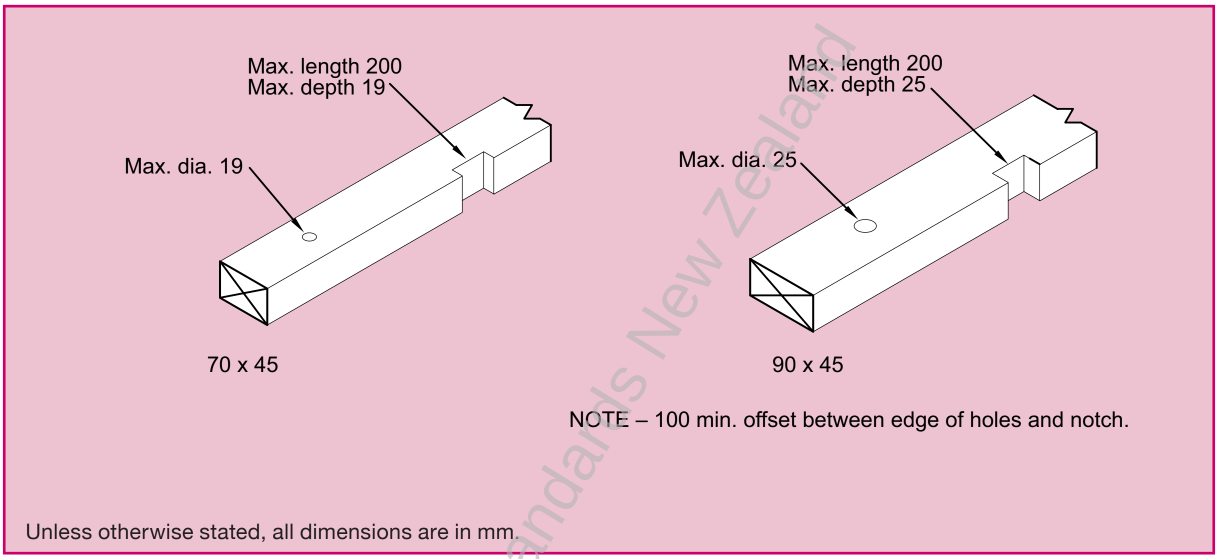


Figure 8.19 – Checking and boring top plates (see 8.7.5.1)

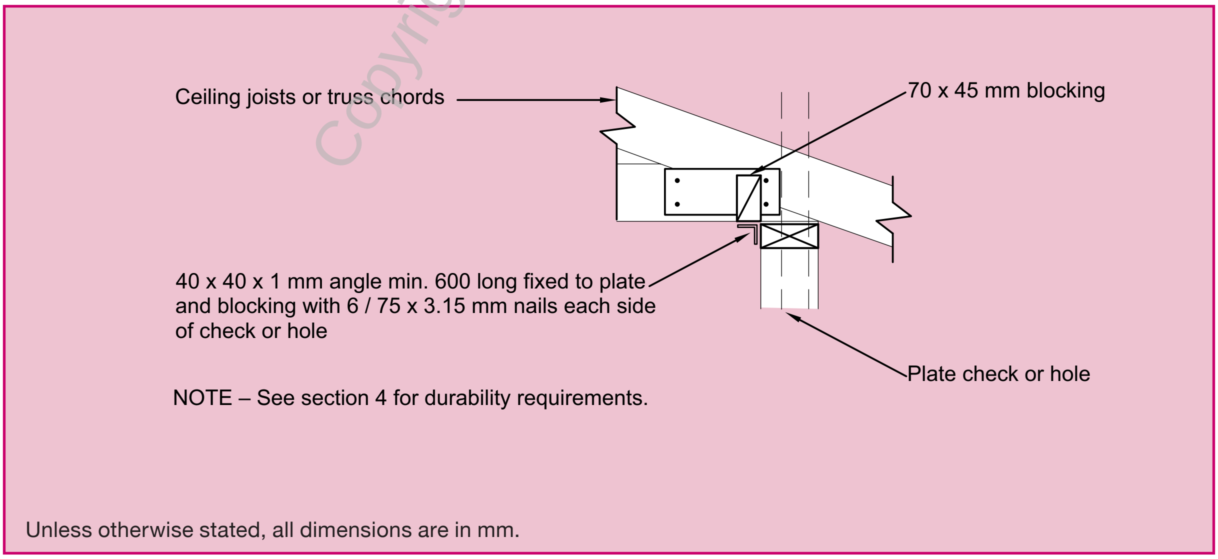


Figure 8.20 – Cut top plate (see 8.7.5.1(c))

8.7.5.2 Bottom plates

Where holes or face notches exceed 50 % of the width of the *bottom plate*, fix the *plate* against sideways movement on each side of the hole or notch, with one 100 mm x 3.75 mm nail.

C8.7.6

Each additional fixing required should be as close as possible to a truss.

8.7.6 Connection of plates to studs

The fixing of *top plates* supporting *roof* members to *wall studs* or *lintels* shall be in accordance with table 8.18 (see figure 8.12).

Table 8.18 – Fixing of top plate of wall to supporting members such as studs and lintels at 600 mm centres (see 8.7.6 and figure 8.12)

Loaded dimension of wall (m)	**Light roof**										**Heavy roof**				
	Roof member spacing (mm)														
	900					**1200**					**900**				
	Wind zone					**Wind zone**					**Wind zone**				
	L	M	H	VH	EH	L	M	H	VH	EH	L	M	H	VH	EH
	Fixing type (see below)														
2.0	A	A	B	B	B	A	A	B	B	B	A	A	A	B	B
3.0	A	B	B	B	B	A	B	B	B	B	A	A	B	B	B
4.0	A	B	B	B	B	A	B	B	B	B	A	A	B	B	B
5.0	B	B	B	B	B	B	B	B	B	B	A	A	B	B	B
6.0	B	B	B	B	B	B	B	B	B	B	A	A	B	B	B

Fixing type	**Fixing to resist uplift**	**Capacity of alternative fixing** (kN)
A	2 / 90 x 3.15 end nails	0.7
B	2 / 90 x 3.15 end nails + 2 wire dogs	4.7

8.8 DWANGS AND WALINGS

8.8.1

Dwangs, *walings*, and *metal angle walings*, where required by 8.5.4, shall be *spaced* at not more than 1350 mm centre-to-centre and shall be of not less than the following dimensions:

(a) *Dwangs*: 45 mm x 45 mm;

(b) *Walings*: 70 mm x 19 mm;

(c) *Metal angle walings*: 22 mm x 22 mm x 1.2 mm angle.

C8.8.1

Dwangs may be staggered either side of a horizontal straight line by a centre-to-centre distance not exceeding 300 mm.

8.8.2

Dwangs for the support of *cladding* or *lining* shall be flush with the face of *studs*.

8.8.3

Walings may be butt jointed on a *stud* anywhere along their length with the fixings required by table 8.19 on both sides of the butt joint.

8.8.4

Walings and *metal angle walings* shall not be checked into opposite sides of the same *stud* within a distance of 150 mm, measured along the *stud*.

8.8.5

Ribbon boards supporting *joists* in balloon *framing* shall be 90 mm x 45 mm on edge, checked 25 mm into *studs* (see figure 8.21).

8.8.6 Nailing schedule

Table 8.19 lists the size, number and location of nails to be used in *wall framing*. See 2.4.4 for other requirements for nails.

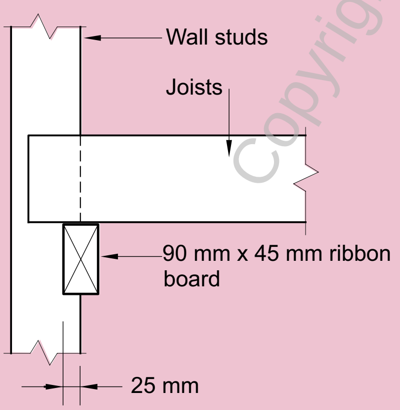


Figure 8.21 – Ribbon boards (see 8.8.5)

Table 8.19 – Nailing schedule for hand-driven and power-driven nails (see 8.8.6)

Joint	Hand-driven nails		Power-driven nails	
	Length (mm) **x diameter** (mm) **and type**	**Number/ Location**	**Length** (mm) **x diameter** (mm) **and type**	**Number/ Location**
Bottom plate to floor framing at: (a) External walls and internal wall bracing elements (b) Internal walls (may be nailed to floor decking) (c) Trimmer not exceeding 4.2 m long	 100 x 3.75 100 x 3.75 100 x 3.75	 2 at 600 mm centres 1 at 600 mm centres 4 (end nailed)	 90 x 3.15 90 x 3.15 90 x 3.15	 3 at 600 mm centres 1 at 600 mm centres 6 (end nailed)
Dwang to stud	75 x 3.15 or 100 x 3.75	2 (skewed) 2 (end nailed)	75 x 3.06 90 x 3.15	2 (skewed) 2 (end nailed)
Fishplate to straightened stud	60 x 2.8	4 each side of cut	60 x 2.8	4 (each side of cut)
Half joint in top plate	75 x 3.15	3	75 x 3.06	4
Lintel to trimming stud	75 x 3.15 or 100 x 3.75	4 (skewed) 2 (end nailed)	90 x 3.15	3 (end nailed)
Ribbon board to stud	100 x 3.75	2	90 x 3.15	3
Sill or header trimmer to trimming stud for: (a) Trimmer not exceeding 2.4 m long (b) Trimmer not exceeding 3.0 m long (c) Trimmers not exceeding 3.6 m long	 100 x 3.75 100 x 3.75 100 x 3.75	 2 (end nailed) 3 (end nailed) 4 (end nailed)	 90 x 3.15 90 x 3.15 90 x 3.15	 3 (end nailed) 5 (end nailed) 6 (end nailed)
Solid plaster batten to stud	60 x 2.8 (galv.)	500 mm centres	60 x 2.8 (galv.)	500 mm centres
Stud to plate	75 x 3.15 or 100 x 3.75	4 (skewed) 2 (end nailed)	75 x 3.06 90 x 3.15	4 (skewed) 3 (end nailed)
Top plate 140 mm x 35 mm to 90 mm x 45 mm and top plate to lintel	100 x 3.75	2 at 500 mm centres	90 x 3.15	3 at 500 mm centres
Trimming studs at openings, blocking and studs at wall intersections	100 x 3.75	600 mm centres	90 x 3.15	600 mm centres
Trimming stud to doubled stud immediately under lintel	100 x 3.75	2	90 x 3.15	2
Waling to stud	60 x 2.8	2	60 x 2.8	2

NOTE –
(1) Nail lengths and diameters are the minimum required.
(2) Refer to 4.4 for required protective coatings for metal fasteners.
(3) For studs up to 2.7 in length, 2 / 90 x 3.15 power-driven nails (end nailed) are sufficient.

APPENDIX A - SG 6 AND SG 10 TABLES

(Normative)

Table A8.2 – Studs in loadbearing walls for all wind zones – SG 6 (see 8.5.1.1)

Wind zone	Loaded dimension* of wall (m)	2.4 – 300	2.4 – 400	2.4 – 600	2.7 – 300	2.7 – 400	2.7 – 600	3.0 – 300	3.0 – 400	3.0 – 600
		Stud sizes for maximum length (height) of: (m)								
		At maximum stud spacing (mm) **of:** (mm x mm) (width x thickness)								
(a) Single or top storey – Light roof and heavy roof										
Extra high	2.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 45	90 x 70	140 x 45	140 x 90
	4.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 45	90 x 70	140 x 45	140 x 90
	6.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 90	90 x 70	140 x 45	140 x 90
Very high	2.0	90 x 35	90 x 70	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 45
	4.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90
	6.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90
High	2.0	90 x 35	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70	90 x 70	90 x 70	140 x 45
	4.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	6.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
Medium	2.0	90 x 35	70 x 45	90 x 45	70 x 45	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	4.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70
Low	2.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	4.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	6.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70
Internal walls for all wind zones	2.0	70 x 45	70 x 45	90 x 35	70 x 45	70 x 45	90 x 45	90 x 35	90 x 35	90 x 70
	4.0	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	6.0	70 x 45	70 x 45	90 x 45	70 x 45	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70

Wind zone	(m)	3.6 – 300	3.6 – 400	3.6 – 600	4.2 – 300	4.2 – 400	4.2 – 600	4.8 – 300	4.8 – 400	4.8 – 600
		At maximum stud spacing (mm) **of:** (mm x mm) (width x thickness)								
Extra high	2.0	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	190 x 90	190 x 90	190 x 90	–
	4.0	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	190 x 90	190 x 90	190 x 90	–
	6.0	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	190 x 90	190 x 90	190 x 90	–
Very high	2.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 90	190 x 45	190 x 90	190 x 90
	4.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 90	190 x 45	190 x 90	190 x 90
	6.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 90	190 x 45	190 x 90	190 x 90
High	2.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	140 x 90	190 x 45	190 x 90
	4.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	140 x 90	190 x 45	190 x 90
	6.0	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45	140 x 90	190 x 45	190 x 90
Medium	2.0	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45
	4.0	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45
	6.0	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45
Low	2.0	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90
	4.0	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90
	6.0	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90
Internal walls for all wind zones	2.0	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90
	4.0	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90
	6.0	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall at floor level and the loaded dimension of the wall above at roof level and use the greater value in this table.

(2) 140 x 45 may be substituted for 90 x 90. 90 x 35 may be substituted for 70 x 45.

(3) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.

(4) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A8.2 – Studs in loadbearing walls for all wind zones – SG 6 (continued) (see 8.5.1.1)

Wind zone	Loaded dimen-sion* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(b) Lower of two storeys or subfloor beneath one storey										
Extra high	2.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 90	90 x 90	140 x 45	140 x 90
	4.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 90	90 x 90	140 x 45	140 x 90
	6.0	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90	90 x 90	140 x 45	140 x 90
Very high	2.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90
	4.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90
	6.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90
High	2.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	4.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	6.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
Medium	2.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	4.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	6.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
Low	2.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70
	4.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
Internal walls for all wind zones	2.0	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70
	4.0	70 x 45	70 x 45	90 x 45	70 x 45	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	70 x 45	90 x 35	90 x 45	70 x 45	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall at floor level and the loaded dimension of the wall above at roof level and use the greater value in this table.

(2) 140 x 45 may be substituted for 90 x 90. 90 x 35 may be substituted for 70 x 45.

(3) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.

(4) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A8.2 – Studs in loadbearing walls for all wind zones – SG 6 (continued) (see 8.5.1.1)

Wind zone	Loaded dimen-sion* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(c) Subfloor beneath two storeys										
Extra high	2.0	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90	90 x 90	140 x 45	140 x 90
	4.0	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90	90 x 90	140 x 45	140 x 90
	6.0	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90	90 x 90	140 x 45	140 x 90
Very high	2.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90
	4.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90
	6.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90
High	2.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	4.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	6.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
Medium	2.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	4.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	6.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
Low	2.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 45	90 x 70
	4.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 45	90 x 70
Internal walls for all wind zones	2.0	70 x 45	90 x 35	90 x 45	70 x 45	90 x 45	90 x 70	90 x 35	90 x 45	90 x 70
	4.0	70 x 45	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	70 x 45	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 45	90 x 70

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall at floor level and the loaded dimension of the wall above at roof level and use the greater value in this table.

(2) 140 x 45 may be substituted for 90 x 90. 90 x 35 may be substituted for 70 x 45.

(3) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.

(4) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A8.2 – Studs in loadbearing walls for all wind zones – SG 10 (see 8.5.1.1)

Wind zone	Loaded dimension* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(a) Single or top storey – Light roof and heavy roof										
Extra high	2.0	-	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	4.0	-	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	6.0	-	90 x 35	90 x 70	90 x 45	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
Very high	2.0	-	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	4.0	-	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	-	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
High	2.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	4.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	6.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
Medium	2.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	4.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	6.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
Low	2.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35
	4.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35
	6.0	-	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35
Internal walls for all wind zones	2.0	-	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	90 x 35
	4.0	-	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	90 x 35
	6.0	-	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	90 x 35
		3.6			4.2			4.8		
		At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
Extra high	2.0	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	140 x 90	190 x 90
	4.0	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	140 x 90	190 x 90
	6.0	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	140 x 90	190 x 90
Very high	2.0	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45
	4.0	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45
	6.0	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90	140 x 90	140 x 90	190 x 45
High	2.0	90 x 70	90 x 70	140 x 45	140 x 45	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90
	4.0	90 x 70	90 x 70	140 x 45	140 x 45	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90
	6.0	90 x 70	90 x 70	140 x 45	140 x 45	140 x 45	140 x 90	140 x 45	140 x 90	140 x 90
Medium	2.0	90 x 35	90 x 45	90 x 70	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90
	4.0	90 x 35	90 x 45	90 x 70	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90
	6.0	90 x 35	90 x 45	90 x 70	90 x 70	90 x 90	140 x 45	140 x 45	140 x 45	140 x 90
Low	2.0	90 x 35	90 x 35	90 x 70	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 45
	4.0	90 x 35	90 x 35	90 x 70	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 45
	6.0	90 x 35	90 x 35	90 x 70	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 45
Internal walls for all wind zones	2.0	90 x 35	90 x 35	90 x 70	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 45
	4.0	90 x 35	90 x 35	90 x 70	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 45
	6.0	90 x 35	90 x 35	90 x 70	90 x 70	90 x 70	140 x 45	90 x 90	140 x 45	140 x 45

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall at floor level and the loaded dimension of the wall above at roof level and use the greater value in this table.

(2) 140 x 45 may be substituted for 90 x 90. 90 x 35 may be substituted for 70 x 45.

(3) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.

(4) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A8.2 – Studs in loadbearing walls for all wind zones – SG 10 (continued) (see 8.5.1.1)

Wind zone	Loaded dimen-sion* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(b) Lower of two storeys or subfloor beneath one storey										
Extra high	2.0 4.0 6.0	- - -	90 x 35 90 x 35 90 x 35	90 x 70 90 x 70 90 x 70	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 90 90 x 90 90 x 90
Very high	2.0 4.0 6.0	- - -	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 45	90 x 70 90 x 70 90 x 70	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70
High	2.0 4.0 6.0	- - -	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 45	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70
Medium	2.0 4.0 6.0	- - -	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45
Low	2.0 4.0 6.0	- - -	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 45
Internal walls for all wind zones	2.0 4.0 6.0	- - -	70 x 45 70 x 45 70 x 45	70 x 45 70 x 45 70 x 45	70 x 45 70 x 45 70 x 45	70 x 45 70 x 45 70 x 45	70 x 45 90 x 35 90 x 35	70 x 45 70 x 45 70 x 45	70 x 45 70 x 45 70 x 45	90 x 45 90 x 45 90 x 45

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall at floor level and the loaded dimension of the wall above at roof level and use the greater value in this table.

(2) 140 x 45 may be substituted for 90 x 90. 90 x 35 may be substituted for 70 x 45.

(3) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.

(4) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A8.2 – Studs in loadbearing walls for all wind zones – SG 10 (continued) (see 8.5.1.1)

Wind zone	Loaded dimension* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:			At maximum stud spacing (mm) of:		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(c) Subfloor beneath two storeys										
Extra high	2.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	4.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	6.0	90 x 35	90 x 45	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
Very high	2.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 45	90 x 90
	4.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 70	90 x 90
	6.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
High	2.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70
	4.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
Medium	2.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	4.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 45
	6.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
Low	2.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	4.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	6.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
Internal walls for all wind zones	2.0	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	90 x 35	70 x 45	70 x 45	90 x 35
	4.0	70 x 45	70 x 45	90 x 35	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45
	6.0	70 x 45	70 x 45	90 x 35	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall at floor level and the loaded dimension of the wall above at roof level and use the greater value in this table.

(2) 140 x 45 may be substituted for 90 x 90. 90 x 35 may be substituted for 70 x 45.

(3) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.

(4) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A8.4 – Studs in non-loadbearing walls for all wind zones – SG 6 (see 8.5.1.1 and figure 8.2)

Wind zone	Maximum length (height) of stud (m)	Stud size for maximum spacing of studs (mm) of:		
		300	400	600
		(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)		
Extra high	2.4	90 x 45	90 x 70	90 x 90
	2.7	90 x 70	90 x 70	140 x 45
	3.0	90 x 70	140 x 45	140 x 70
	3.3	140 x 45	140 x 45	140 x 70
	3.6	140 x 45	140 x 70	190 x 45
	3.9	140 x 70	140 x 70	190 x 70
	4.2	190 x 45	190 x 45	190 x 70
	4.8	190 x 70	190 x 70	–
Very high	2.4	90 x 35	90 x 45	90 x 70
	2.7	90 x 45	90 x 70	90 x 90
	3.0	90 x 70	90 x 90	140 x 45
	3.3	90 x 90	140 x 45	140 x 70
	3.6	140 x 45	140 x 45	140 x 70
	3.9	140 x 45	140 x 70	190 x 45
	4.2	140 x 70	190 x 45	190 x 70
	4.8	190 x 45	190 x 70	–
High	2.4	90 x 35	90 x 35	90 x 70
	2.7	90 x 35	90 x 45	90 x 70
	3.0	90 x 45	90 x 70	90 x 90
	3.3	90 x 70	90 x 90	140 x 45
	3.6	90 x 90	140 x 45	140 x 70
	3.9	140 x 45	140 x 45	140 x 70
	4.2	140 x 45	140 x 70	190 x 45
	4.8	190 x 45	190 x 45	190 x 70
Medium and low	2.4	90 x 35	90 x 35	90 x 45
	2.7	90 x 35	90 x 35	90 x 70
	3.0	90 x 35	90 x 45	90 x 70
	3.3	90 x 45	90 x 70	90 x 90
	3.6	90 x 70	90 x 90	140 x 45
	3.9	90 x 90	140 x 45	140 x 70
	4.2	140 x 45	140 x 45	140 x 70
	4.8	140 x 70	190 x 45	190 x 45
Internal walls for all wind zones	2.4	70 x 45	70 x 45	70 x 45
	2.7	70 x 45	70 x 45	90 x 35
	3.0	90 x 35	90 x 35	90 x 70
	3.3	90 x 35	90 x 45	90 x 70
	3.6	90 x 70	90 x 70	140 x 45
	3.9	90 x 70	90 x 90	140 x 45
	4.2	90 x 90	140 x 45	140 x 70
	4.8	140 x 45	140 x 70	190 x 45

NOTE –

(1) 90 x 35 may be substituted for 70 x 45.

(2) 140 x 45 may be substituted for 90 x 90.

(3) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.

(4) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A8.4 – Studs in non-loadbearing walls for all wind zones – SG 10 (see 8.5.1.1 and figure 8.2)

Wind zone	Maximum length (height) of stud (m)	Stud size for maximum spacing of studs (mm) of:		
		300	400	600
		(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)		
Extra high	2.4	90 x 35	90 x 35	90 x 45
	2.7	90 x 35	90 x 45	90 x 70
	3.0	90 x 45	90 x 70	90 x 90
	3.3	90 x 70	90 x 90	140 x 45
	3.6	90 x 90	140 x 45	140 x 70
	3.9	140 x 45	140 x 45	140 x 70
	4.2	140 x 45	140 x 70	190 x45
	4.8	190 x 45	190 x 45	190 x70
Very high	2.4	90 x 35	90 x 35	90 x 35
	2.7	90 x 35	90 x 35	90 x 45
	3.0	90 x 35	90 x 45	90 x 70
	3.3	90 x 70	90 x 70	140 x 45
	3.6	90 x 70	90 x 90	140 x 45
	3.9	140 x 45	140 x 45	140 x 70
	4.2	140 x 45	140 x 45	140 x 70
	4.8	140 x 70	190 x 45	190 x 70
High	2.4	90 x 35	90 x 35	90 x 35
	2.7	90 x 35	90 x 35	90 x 35
	3.0	90 x 35	90 x 35	90 x 70
	3.3	90 x 45	90 x 70	90 x 90
	3.6	90 x 70	90 x 70	140 x 45
	3.9	90 x 90	140 x 45	140 x 45
	4.2	140 x 45	140 x 45	140 x 70
	4.8	140 x 45	140 x 70	190 x 45
Medium and low	2.4	90 x 35	90 x 35	90 x 35
	2.7	90 x 35	90 x 35	90 x 35
	3.0	90 x 35	90 x 35	90 x 45
	3.3	90 x 35	90 x 45	90 x 70
	3.6	90 x 45	90 x 70	90 x 90
	3.9	90 x 70	90 x 70	140 x 45
	4.2	90 x 70	140 x 45	140 x 45
	4.8	140 x 45	140 x 45	140 x 70
Internal walls for all wind zones	2.4	70 x 45	70 x 45	70 x 45
	2.7	70 x 45	70 x 45	70 x 45
	3.0	70 x 45	70 x 45	90 x 35
	3.3	70 x 45	90 x 35	90 x 45
	3.6	90 x 35	90 x 45	90 x 70
	3.9	90 x 45	90 x 70	90 x 90
	4.2	90 x 70	90 x 90	140 x 45
	4.8	90 x 90	140 x 45	140 x 70

NOTE –
(1) 90 x 35 may be substituted for 70 x 45.
(2) 140 x 45 may be substituted for 90 x 90.
(3) Studs 70 mm and 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 70 mm and 90 mm stud they are replacing.
(4) Studs 70 mm and 90 mm thick may be substituted with built-up members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A8.9 – Lintel supporting roof only for all wind zones – SG 6 (see figure 8.7)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)									
		90 x 70	90 x 90	140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light roof	2	1.1	1.2	1.7	1.9	2.4	2.6	3.0	3.3	3.6	3.9
	3	0.9	1.1	1.5	1.7	2.0	2.4	2.5	3.0	3.1	3.6
	4	0.8	1.0	1.3	1.6	1.8	2.2	2.3	2.7	2.7	3.3
	6	0.7	0.8	1.1	1.3	1.5	1.8	1.9	2.3	2.3	2.8
Heavy roof	2	0.9	0.9	1.4	1.5	1.9	2.0	2.4	2.6	2.9	3.1
	3	0.8	0.8	1.2	1.3	1.7	1.8	2.1	2.3	2.6	2.8
	4	0.7	0.8	1.1	1.2	1.5	1.7	1.9	2.1	2.3	2.6
	6	–	0.7	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3

* Loaded dimension is defined in figure 1.3.

NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A8.9 – Lintel supporting roof only for all wind zones – SG 10 (see figure 8.7)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)									
		90 x 70	90 x 90	140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light roof	2	1.4	1.5	2.2	2.4	3.0	3.3	3.7	4.0	4.3	4.6
	3	1.3	1.4	2.0	2.2	2.7	2.9	3.4	3.7	4.0	4.2
	4	1.2	1.3	1.8	2.0	2.5	2.7	3.2	3.4	3.7	4.0
	6	1.0	1.1	1.5	1.8	2.1	2.4	2.7	3.1	3.3	3.6
Heavy roof	2	1.1	1.2	1.7	1.8	2.3	2.5	2.9	3.2	3.5	3.8
	3	1.0	1.0	1.5	1.7	2.1	2.3	2.6	2.9	3.2	3.5
	4	0.9	1.0	1.4	1.5	1.9	2.1	2.4	2.7	3.0	3.2
	6	0.8	0.9	1.2	1.4	1.7	1.9	2.2	2.4	2.6	2.9

* Loaded dimension is defined in figure 1.3.

NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A8.10 – Lintel supporting roof and wall for all wind zones – SG 6 (see figure 8.8)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)									
		90 x 70	**90 x 90**	**140 x 70**	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	2	0.9	1.0	1.5	1.6	2.0	2.2	2.6	2.8	3.1	3.4
	3	0.9	0.9	1.4	1.5	1.9	2.1	2.4	2.6	2.9	3.2
	4	0.8	0.9	1.3	1.4	1.8	1.9	2.3	2.5	2.7	3.0
	6	0.7	0.8	1.1	1.3	1.5	1.8	1.9	2.3	2.3	2.7
Light roof Medium wall	2	0.8	0.9	1.3	1.4	1.8	2.0	2.3	2.5	2.8	3.0
	3	0.8	0.9	1.2	1.4	1.7	1.9	2.2	2.4	2.6	2.9
	4	0.6	0.7	0.9	1.1	1.3	1.5	1.6	1.9	2.0	2.3
	6	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.1
Heavy roof Light wall	2	0.8	0.8	1.2	1.3	1.7	1.8	2.2	2.3	2.6	2.8
	3	0.7	0.8	1.1	1.2	1.5	1.7	1.9	2.2	2.3	2.6
	4	0.6	0.7	1.0	1.2	1.4	1.6	1.7	2.0	2.1	2.5
	6	0.5	0.6	0.8	1.0	1.2	1.4	1.5	1.8	1.8	2.2
Heavy roof Medium wall	2	0.7	0.8	1.1	1.2	1.5	1.7	1.9	2.2	2.4	2.6
	3	0.6	0.7	1.0	1.2	1.4	1.6	1.8	2.0	2.1	2.5
	4	0.6	0.7	0.9	1.1	1.3	1.5	1.6	1.9	2.0	2.3
	6	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.1

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall above the lintel at roof level and use this value in the table.

(2) Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A8.10 – Lintel supporting roof and wall for all wind zones – SG 10 (see figure 8.8)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)									
		90 x 70	**90 x 90**	**140 x 70**	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	2	1.2	1.3	1.8	2.0	2.5	2.7	3.2	3.5	3.8	4.0
	3	1.1	1.2	1.7	1.9	2.3	2.5	3.0	3.2	3.6	3.8
	4	1.0	1.1	1.6	1.8	2.2	2.4	2.8	3.1	3.4	3.7
	6	0.9	1.0	1.5	1.6	2.0	2.2	2.6	2.8	3.1	3.4
Light roof Medium wall	2	1.0	1.1	1.6	1.8	2.2	2.4	2.8	3.1	3.4	3.7
	3	1.0	1.1	1.5	1.7	2.1	2.3	2.7	2.9	3.3	3.5
	4	0.8	0.9	1.3	1.4	1.7	1.9	2.2	2.4	2.6	2.9
	6	0.7	0.8	1.1	1.2	1.6	1.7	2.0	2.2	2.4	2.6
Heavy roof Light wall	2	1.0	1.1	1.5	1.7	2.1	2.3	2.7	2.9	3.2	3.5
	3	0.9	1.0	1.4	1.5	1.9	2.1	2.5	2.7	3.0	3.2
	4	0.8	0.9	1.3	1.4	1.8	2.0	2.3	2.5	2.8	3.0
	6	0.7	0.8	1.2	1.3	1.6	1.8	2.1	2.3	2.5	2.7
Heavy roof Medium wall	2	0.9	1.0	1.4	1.5	1.9	2.1	2.5	2.7	3.0	3.3
	3	0.8	0.9	1.3	1.4	1.8	2.0	2.3	2.5	2.8	3.1
	4	0.8	0.9	1.3	1.4	1.7	1.9	2.2	2.4	2.6	2.9
	6	0.7	0.8	1.1	1.2	1.6	1.7	2.0	2.2	2.4	2.6

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall above the lintel at roof level and use this value in the table.

(2) Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A8.11 – Lintel supporting roof, wall and floor for all wind zones – SG 6 for up to 2 kPa floor loads (see figure 8.9)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)							
		140 x 70	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	2	0.8	1.0	1.2	1.4	1.5	1.8	1.8	2.2
	3	0.8	1.0	1.1	1.4	1.4	1.7	1.7	2.1
	4	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.0
	6	0.7	0.9	1.0	1.2	1.3	1.6	1.6	1.9
Light roof Medium wall	2	0.8	1.0	1.1	1.4	1.4	1.7	1.7	2.1
	3	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.0
	4	0.7	0.8	1.0	1.2	1.2	1.5	1.5	1.8
	6	0.6	0.8	0.9	1.1	1.1	1.4	1.4	1.7
Heavy roof Light wall	2	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.1
	3	0.7	0.9	1.0	1.3	1.3	1.6	1.6	2.0
	4	0.7	0.9	1.0	1.2	1.3	1.5	1.5	1.9
	6	0.7	0.8	0.9	1.1	1.2	1.4	1.4	1.7
Heavy roof Medium wall	2	0.8	0.9	1.1	1.3	1.3	1.6	1.6	2.0
	3	0.7	0.9	1.0	1.2	1.3	1.6	1.6	1.9
	4	0.7	0.8	1.0	1.2	1.2	1.5	1.5	1.8
	6	0.6	0.8	0.9	1.1	1.1	1.4	1.4	1.7

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A8.11 – Lintel supporting roof, wall and floor for all wind zones – SG 10 for up to 2 kPa floor loads (see figure 8.9)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)							
		140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light roof Light wall	2	1.2	1.4	1.7	2.0	2.1	2.5	2.6	3.0
	3	1.2	1.4	1.6	1.9	2.0	2.4	2.5	3.0
	4	1.1	1.4	1.5	1.9	2.0	2.4	2.4	2.9
	6	1.1	1.3	1.4	1.8	1.8	2.2	2.2	2.7
Light roof Medium wall	2	1.2	1.4	1.6	1.9	2.0	2.4	2.5	2.9
	3	1.1	1.3	1.5	1.8	2.0	2.3	2.4	2.8
	4	1.0	1.2	1.4	1.6	1.7	2.1	2.1	2.5
	6	0.9	1.1	1.3	1.5	1.6	1.9	1.9	2.4
Heavy roof Light wall	2	1.1	1.3	1.6	1.8	2.0	2.3	2.4	2.8
	3	1.1	1.3	1.5	1.7	1.9	2.2	2.3	2.7
	4	1.0	1.2	1.4	1.7	1.8	2.1	2.2	2.6
	6	0.9	1.1	1.3	1.6	1.7	2.0	2.0	2.4
Heavy roof Medium wall	2	1.1	1.3	1.5	1.8	1.9	2.2	2.3	2.7
	3	1.0	1.2	1.4	1.7	1.8	2.1	2.2	2.6
	4	1.0	1.2	1.4	1.6	1.7	2.1	2.1	2.5
	6	0.9	1.1	1.3	1.5	1.6	1.9	1.9	2.4

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A8.12 – Lintel supporting wall and floor for all wind zones – SG 6 for up to 2 kPa floor loads (see figure 8.10)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m)							
		width x thickness (mm)							
		140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light wall	3	1.0	1.2	1.3	1.6	1.7	2.0	2.0	2.5
Medium wall	3	1.0	1.2	1.3	1.6	1.6	2.0	2.0	2.4

* For definition of loaded dimension see 1.3.
NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A8.12 – Lintel supporting wall and floor for all wind zones – SG 10 for up to 2 kPa floor loads (see figure 8.10)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m)							
		width x thickness (mm)							
		140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light wall	3	1.4	1.6	1.9	2.2	2.4	2.7	2.9	3.3
Medium wall	3	1.4	1.5	1.8	2.1	2.3	2.6	2.8	3.2

* For definition of loaded dimension see 1.3.
NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A8.13 – Lintel supporting floor only for all wind zones – SG 6 for up to 2 kPa floor loads (see figure 8.11)

Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)							
	140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
2.0	1.2	1.5	1.7	2.1	2.2	2.6	2.6	3.2
4.0	0.9	1.1	1.2	1.5	1.5	1.9	1.8	2.2
6.0	0.7	0.9	1.0	1.2	1.2	1.5	1.5	1.8

* For definition of loaded dimension see 1.3.
NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A8.13 – Lintel supporting floor only for all wind zones – SG 10 for up to 2 kPa floor loads (see figure 8.11)

Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)							
	140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
2.0	1.8	2.0	2.4	2.7	3.1	3.4	3.7	4.0
4.0	1.2	1.5	1.7	2.1	2.2	2.6	2.6	3.2
6.0	1.0	1.2	1.4	1.7	1.8	2.1	2.1	2.6

* For definition of loaded dimension see 1.3.
NOTE – Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

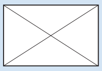
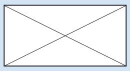
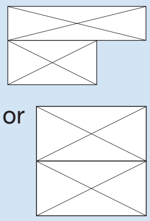
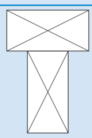
Table A8.15 – Sill and head trimmers for all wind zones – SG 6
(see 8.6.2.1 and 8.6.2.2)

Maximum clear width of opening	Minimum thickness of sill and header trimmers
(m)	(mm)
2.0	35
2.4	70
3.0	135 (or 3/45 mm)
3.6	SED
4.2	SED

Table A8.15 – Sill and head trimmers for all wind zones – SG 10
(see 8.6.2.1 and 8.6.2.2)

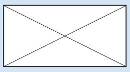
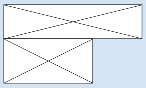
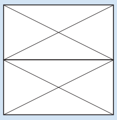
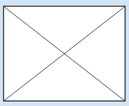
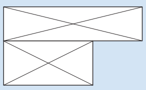
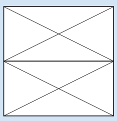
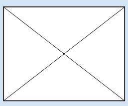
Maximum clear width of opening	Minimum thickness of sill and header trimmers
(m)	(mm)
2.0	35
2.4	45
3.0	70
3.6	135 (or 3/45 mm)
4.2	SED

Table A8.16 – Top plates of loadbearing walls – SG 6 (see 8.7.1.1)

Plate size (mm x mm)		Position of truss or rafter centre line relative to centre line of nearest stud	Maximum spacing of trusses or rafters (mm)	Light roof			Heavy roof		
				Stud spacing (mm)					
				300	400	600	300	400	600
				Maximum loaded dimension* of wall (m)					
(a) Single or top storey (Applies for any spacing of trusses or rafters)									
70 x 45		Anywhere	600 900 1200	6.0 6.0 4.5	6.0 4.2 3.0	4.0 2.4 1.7	5.4 3.4 –	3.7 2.2 –	2.1 – –
		Within 150 mm	600 900 1200	6.0 6.0 5.0	6.0 5.3 3.8	5.1 3.6 2.7	6.0 3.8 –	4.6 2.9 –	3.3 2.0 –
90 x 45		Anywhere	600 900 1200	6.0 6.0 6.0	6.0 5.6 4.1	5.3 3.3 2.3	6.0 4.6 –	4.9 3.0 –	2.8 1.7 –
		Within 150 mm	600 900 1200	6.0 6.0 6.0	6.0 6.0 5.1	6.0 4.5 3.5	6.0 5.1 –	6.0 3.9 –	4.4 2.7 –
90 x 45 plus 140 x 35 or 2/90 x 45	** 	Anywhere	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 4.4	6.0 6.0 –	6.0 5.6 –	5.2 3.3 –
		Within 150 mm	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 4.9	6.0 6.0 –	6.0 6.0 –	6.0 5.0 –
90 x 45 plus 90 x 45 dwang		Anywhere	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 –	6.0 6.0 –	6.0 6.0 –

* For definition of loaded dimension see 1.3.
** Use of 90 x 35 shall be limited by the requirements of 8.7.4.2.
NOTE – Substitution with built-up members is not allowed.

Table A8.16 – Top plates of loadbearing walls – SG 6 (continued) (see 8.7.1.1)

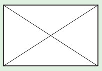
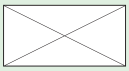
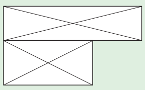
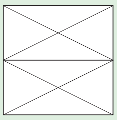
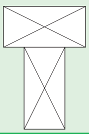
Plate size (mm x mm)		**Maximum loaded dimension of wall supporting floor** (m)	**Maximum spacing of floor joists** (mm)	**Light roof**			**Heavy roof**		
				Stud spacing (mm)					
				300	**400**	**600**	**300**	**400**	**600**
				Maximum loaded dimension* **of wall above supporting roof** (m)					
(b) Lower of 2 storeys and subfloor stud walls supporting 1 storey									
90 x 45		1.5	400 450 600	6.0 6.0 6.0	6.0 6.0 3.1	2.6 1.6 –	6.0 6.0 4.1	4.6 3.6 1.7	– – –
		3.0	400 450 600	6.0 6.0 2.3	3.2 1.6 –	– – –	5.4 4.0 –	1.7 – –	– – –
90 x 45 plus 140 x 35 or 2/90 x 45	**  or 	1.5	400 450 600	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 3.7	6.0 6.0 6.0	6.0 6.0 5.7	5.2 4.1 2.1
		3.0	400 450 600	6.0 6.0 6.0	6.0 6.0 4.9	4.1 2.4 –	6.0 6.0 6.0	6.0 6.0 2.8	2.3 – –
90 x 70		1.5	400 450 600	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 4.8
		3.0	400 450 600	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 3.4	6.0 6.0 6.0	6.0 6.0 6.0	6.0 4.8 1.9
(c) Subfloor stud walls supporting 2 storeys									
90 x 45 plus 140 x 35 or 2/90 x 45	**  or 	1.5	400 450 600	6.0 6.0 6.0	6.0 6.0 3.9	3.0 – –	6.0 6.0 6.0	6.0 5.5 2.2	1.7 – –
		3.0	400 450	6.0 6.0 –	2.6 – –	– – –	6.0 5.2 –	– – –	– – –
90 x 70		1.5	400 450 600	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 2.4	6.0 6.0 6.0	6.0 6.0 6.0	5.7 4.2 –
		3.0	400 450 600	6.0 6.0 6.0	6.0 6.0 1.5	– – –	6.0 6.0 5.0	6.0 5.4 –	– – –

* For definition of loaded dimension see 1.3.

** Use of 90 x 35 shall be limited by the requirements of 8.7.4.2.

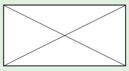
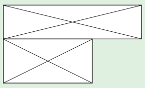
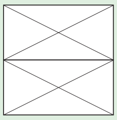
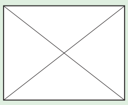
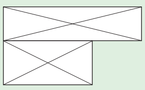
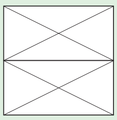
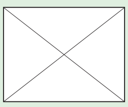
NOTE – Substitution with built-up members is not allowed.

Table A8.16 – Top plates of loadbearing walls – SG 10 (see 8.7.1.1)

Plate size (mm x mm)		Position of truss or rafter centre line relative to centre line of nearest stud	Maximum spacing of trusses or rafters (mm)	Light roof			Heavy roof		
				Stud spacing (mm)					
				300	400	600	300	400	600
				Maximum loaded dimension* of wall (m)					
(a) Single or top storey (Applies for any spacing of trusses or rafters)									
70 x 45		Anywhere	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 5.5 4.0	6.0 5.2 –	6.0 4.9 –	4.8 3.0 –
		Within 150 mm	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 4.8	6.0 5.2 –	6.0 4.9 –	6.0 4.6 –
90 x 45		Anywhere	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 5.3	6.0 6.0 –	6.0 6.0 –	6.0 4.0 –
		Within 150 mm	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 –	6.0 6.0 –	6.0 6.0 –
90 x 45 plus 140 x 35 or 2/90 x 45	**  or 	Anywhere	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 –	6.0 6.0 –	6.0 6.0 –
		Within 150 mm	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 –	6.0 6.0 –	6.0 6.0 –
90 x 45 plus 90 x 45 dwang		Anywhere	600 900 1200	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 6.0	6.0 6.0 –	6.0 6.0 –	6.0 6.0 –

* For definition of loaded dimension see 1.3.
** Use of 90 x 35 shall be limited by the requirements of 8.7.4.2.
NOTE – Substitution with built-up members is not allowed.

Table A8.16 – Top plates of loadbearing walls – SG 10 (continued) (see 8.7.1.1)

Plate size (mm x mm)		**Maximum loaded dimension of wall supporting floor** (m)	**Maximum spacing of floor joists** (mm)	**Light roof**			**Heavy roof**		
				Stud spacing (mm)					
				300	**400**	**600**	**300**	**400**	**600**
				Maximum loaded dimension* of wall above supporting roof (m)					
(b) Lower of 2 storeys and subfloor stud walls supporting 1 storey									
90 x 45		1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	5.7
			600	6.0	6.0	5.5	6.0	6.0	3.2
		3.0	400	6.0	6.0	6.0	6.0	6.0	4.0
			450	6.0	6.0	4.9	6.0	6.0	2.8
			600	6.0	6.0	–	4.8	4.2	–
90 x 45 plus 140 x 35 or 2/90 x 45	**  or 	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	6.0
		3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	5.4
90 x 70		1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	6.0
		3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	6.0
(c) Subfloor stud walls supporting 2 storeys									
90 x 45 plus 140 x 35 or 2/90 x 45	**  or 	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	4.8
		3.0	400	6.0	6.0	6.0	6.0	6.0	5.2
			450	6.0	6.0	5.4	6.0	6.0	3.2
			600	6.0	6.0	–	6.0	6.0	–
90 x 70		1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	6.0
		3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	5.6	5.0	4.1	3.3

* For definition of loaded dimension see 1.3.
** Use of 90 x 35 shall be limited by the requirements of 8.7.4.2.
NOTE – Substitution with built-up members is not allowed.

Table A8.17 – Bottom plates of loadbearing walls – SG 6 (see 8.7.2.1)

Plate size (mm x mm)	Maximum loaded dimension of wall supporting floor (m)	Maximum spacing of floor joists (m)	Light roof			Heavy roof		
			Stud spacing (mm)					
			300	400	600	300	400	600
			Maximum loaded dimension* of wall supporting roof (m)					
(a) Single or top storey								
70 x 45	NA	400	6.0	6.0	6.0	4.4	5.8	4.0
		450	2.1	6.0	6.0	3.8	5.0	3.4
		600	1.7	5.8	3.9	1.9	3.0	1.9
70 x 70	NA	400	–	6.0	6.0	4.4	5.8	4.0
		450	2.1	6.0	6.0	3.8	5.0	3.4
		600	1.7	5.8	3.9	1.9	3.0	1.9
90 x 45	NA	400	–	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	6.0
90 x 70	NA	400	4.4	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	6.0
(b) One floor plus roof								
90 x 45	1.5	400	6.0	4.3	–	5.0	2.5	–
		450	6.0	3.0	–	3.9	1.7	–
		600	3.0	–	–	1.5	–	–
	3.0	400	3.5	–	–	2.0	–	–
		450	1.8	–	–	–	–	–
		600	–	–	–	–	–	–
2/90 x 45	1.5	400	6.0	6.0	6.0	6.0	6.0	5.7
		450	6.0	6.0	6.0	6.0	6.0	4.5
		600	6.0	6.0	3.1	6.0	4.3	1.5
	3.0	400	6.0	6.0	4.6	6.0	6.0	2.7
		450	6.0	6.0	2.7	6.0	6.0	1.5
		600	6.0	4.4	–	5.1	2.2	–
90 x 70	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	5.7
		600	6.0	6.0	5.2	6.0	6.0	3.1
	3.0	400	6.0	6.0	6.0	6.0	6.0	4.0
		450	6.0	6.0	4.7	6.0	6.0	2.7
		600	6.0	6.0	–	6.0	4.0	–
(c) Two floors plus roof								
90 x 45	1.5	400	2.5	–	–	–	–	–
		450	–	–	–	–	–	–
		600	–	–	–	–	–	–
	3.0	400	–	–	–	–	–	–
		450	–	–	–	–	–	–
		600	–	–	–	–	–	–
2/90 x 45	1.5	400	6.0	6.0	3.6	6.0	6.0	2.0
		450	6.0	6.0	1.7	6.0	5.5	–
		600	6.0	3.1	–	4.3	1.5	–
	3.0	400	6.0	2.4	–	6.0	–	–
		450	6.0	–	–	4.2	–	–
		600	–	–	–	–	–	–
90 x 70	1.5	400	6.0	6.0	5.8	6.0	6.0	3.4
		450	6.0	6.0	3.7	6.0	6.0	2.1
		600	6.0	5.8	–	6.0	3.4	–
	3.0	400	6.0	5.7	–	6.0	3.4	–
		450	6.0	2.6	–	6.0	–	–
		600	2.6	–	–	–	–	–

* For definition of loaded dimension see 1.3.
NOTE – Substitution with built-up members is not allowed.

Table A8.17 – Bottom plates of loadbearing walls – SG 10 (see 8.7.2.1)

Plate size (mm x mm)	Maximum loaded dimension of wall supporting floor (m)	Maximum spacing of floor joists (m)	Light roof			Heavy roof		
			Stud spacing (mm)					
			300	400	600	300	400	600
			Maximum loaded dimension* of wall supporting roof (m)					
(a) Single or top storey								
70 x 45	NA	400	6.0	6.0	6.0	6.0	6.0	5.8
		450	6.0	6.0	6.0	6.0	6.0	5.0
		600	6.0	6.0	5.3	6.0	4.8	2.7
70 x 70	NA	400	6.0	6.0	6.0	6.0	6.0	5.8
		450	6.0	6.0	6.0	6.0	6.0	5.0
		600	6.0	6.0	5.3	6.0	4.8	2.7
90 x 45	NA	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	6.0
90 x 70	NA	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	6.0
(b) One floor plus roof								
90 x 45	1.5	400	6.0	6.0	6.0	6.0	6.0	5.0
		450	6.0	6.0	6.0	6.0	6.0	3.9
		600	6.0	6.0	2.5	6.0	3.8	–
	3.0	400	6.0	6.0	3.5	6.0	6.0	2.0
		450	6.0	6.0	1.8	6.0	5.3	–
		600	6.0	3.5	–	4.4	1.7	–
2/90 x 45	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	6.0
	3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	4.4
90 x 70	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	6.0
	3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	6.0
(c) Two floors above								
90 x 45	1.5	400	6.0	6.0	2.5	6.0	6.0	–
		450	6.0	6.0	–	6.0	4.6	–
		600	6.0	2.2	–	3.6	–	–
	3.0	400	6.0	–	–	5.2	–	–
		450	5.1	–	–	3.0	–	–
		600	–	–	–	–	–	–
2/90 x 45	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	3.6
	3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	4.2
		600	6.0	6.0	–	6.0	4.8	–
90 x 70	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	6.0
	3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	2.6	6.0	6.0	–

* For definition of loaded dimension see 1.3.
NOTE – Substitution with built-up members is not allowed.

SECTION 9

POSTS

Table

Figure

9 POSTS

This section is to provide support for *roofs*.

9.1 GENERAL

Isolated 100 mm x 100 mm *posts* not exceeding 3 m long may be used to support beams which directly support *rafters* or *bearers*. The verandah beam sizes shall be obtained from table 10.8.

9.2 UPLIFT – CONCRETE VOLUME AT BASE

9.2.1

Where a *roof* is supported by *posts* and is open to wind exposure on one, two adjacent or three sides, the *posts* shall be secured against uplift. Secure each *post* against uplift by concrete *footings* complying with 9.2.2.

C9.2.1

This clause gives guidance on support for verandahs or decks.

9.2.2

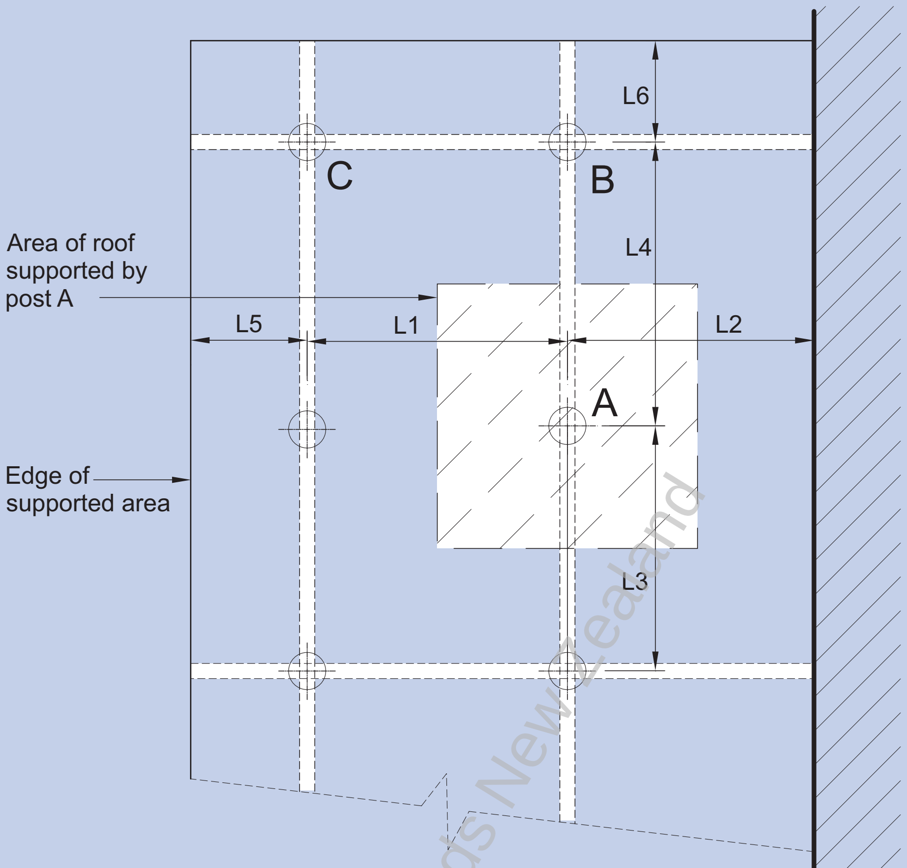
The area of the *roof* supported by the *post* shall be determined from figure 9.1 and the volume of the concrete *footing* required to resist uplift shall be as given in table 9.1.

9.3 CONNECTIONS

Each end of each *post* shall be provided with connections as given by table 9.2 and either figures 9.2, 9.3, 9.4 or by alternative proprietary connections of an equal or greater *capacity*.

Table 9.1 – Post concrete footings to resist uplift (see 9.2.2)

Roof type	Wind zone	Volume of footing concrete (m^3) for area of roof supported						
		1 m^2	2 m^2	4 m^2	6 m^2	8 m^2	10 m^2	12 m^2
Light	Extra high	0.09	0.16	0.32	0.49	0.61	0.79	1.00
	Very high	0.07	0.13	0.26	0.40	0.50	0.65	0.80
	High	0.05	0.10	0.20	0.30	0.40	0.50	0.60
	Medium	0.03	0.05	0.10	0.15	0.20	0.25	0.30
	Low	0.02	0.03	0.07	0.10	0.15	0.15	0.20
Heavy	Extra high	0.05	0.09	0.16	0.25	0.32	0.39	0.49
	Very high	0.04	0.07	0.13	0.20	0.26	0.32	0.40
	High	0.03	0.05	0.10	0.15	0.20	0.25	0.30
	Medium and Low	No securement for uplift required						



Interior post A, supported area = $\frac{L1 + L2}{2} \times \frac{L3 + L4}{2}$

Edge post B, supported area = $\frac{L1 + L2}{2} \times \left(\frac{L4}{2} + L6\right)$

Edge post C, supported area = $\left(\frac{L1}{2} + L5\right) \times \left(\frac{L4}{2} + L6\right)$

Figure 9.1 – Area of roof supported by post (see 9.2.2)

Table 9.2 – Connections to posts and beams to resist uplift (see 9.3)

Roof type	Wind zone	Capacity of post and beam connections (kN) for area of roof supported						
		1 m^2	2 m^2	4 m^2	6 m^2	8 m^2	10 m^2	12 m^2
Light	Extra high	2.5	4.9	9.6	14.4	19.2	24.0	28.8
	Very high	2.0	4.0	7.9	11.9	15.8	19.8	23.8
	High	1.5	2.9	5.9	8.8	11.8	14.7	17.7
	Medium	1.0	1.9	3.8	5.8	7.7	9.6	11.5
	Low	0.7	1.3	2.6	3.9	5.2	6.5	7.8
Heavy	Extra high	2.0	3.9	7.9	11.8	15.8	19.7	23.5
	Very high	1.6	3.2	6.5	9.7	13.0	16.2	19.4
	High	1.1	2.2	4.4	6.7	8.9	11.1	13.3
	Medium and Low	No securement for uplift required						

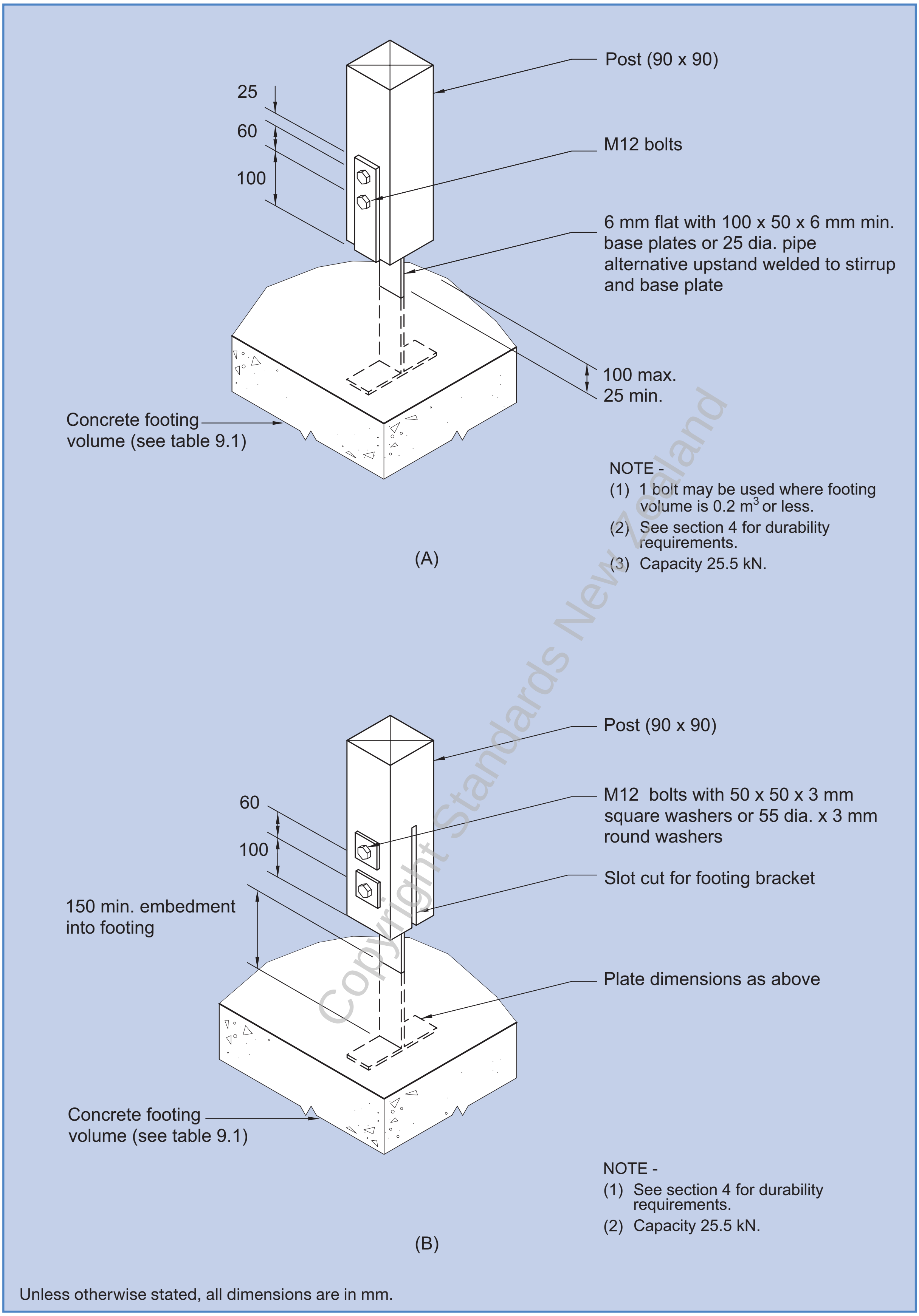


Figure 9.2 – Post/footing connections (see 9.3)

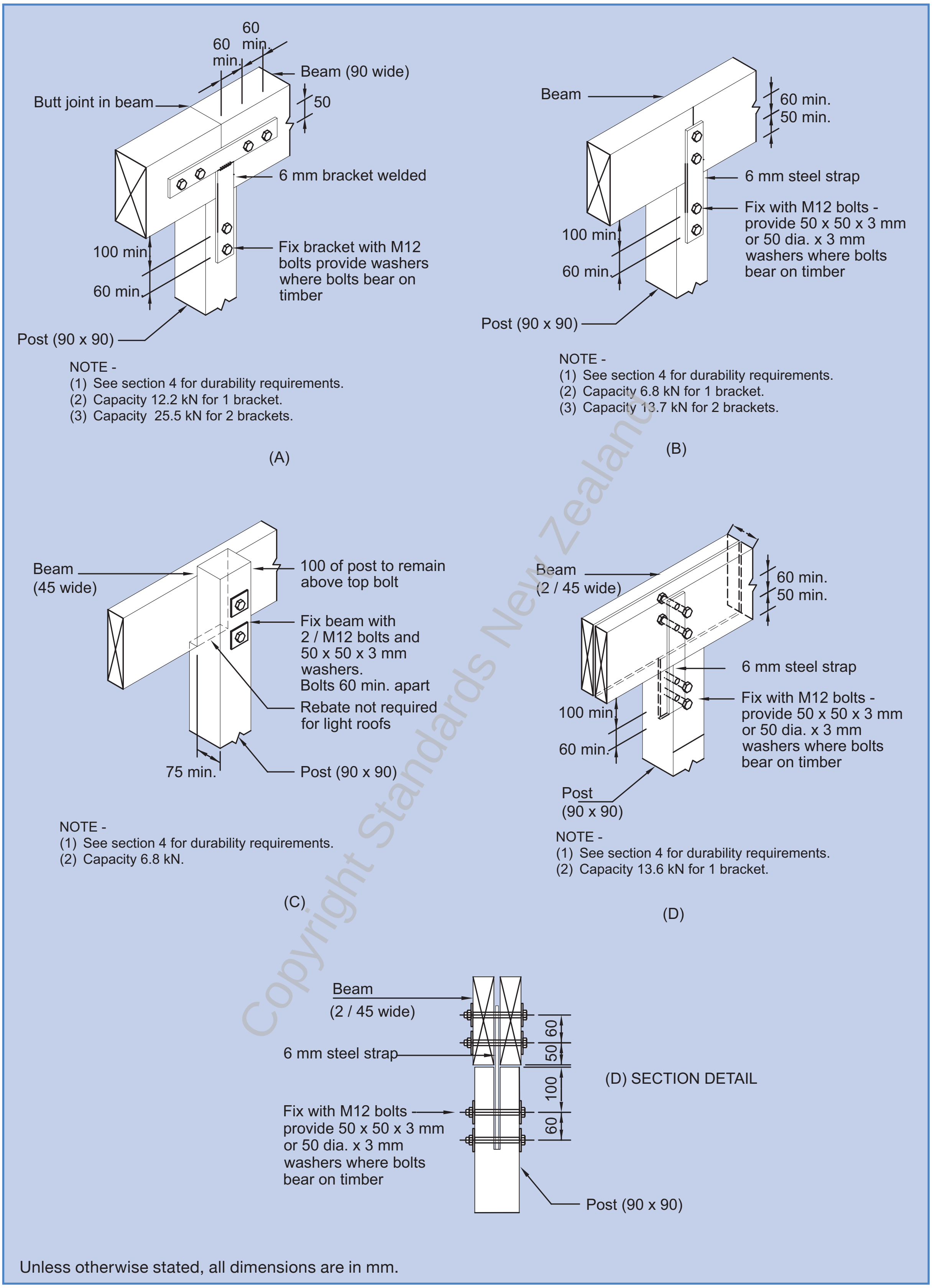
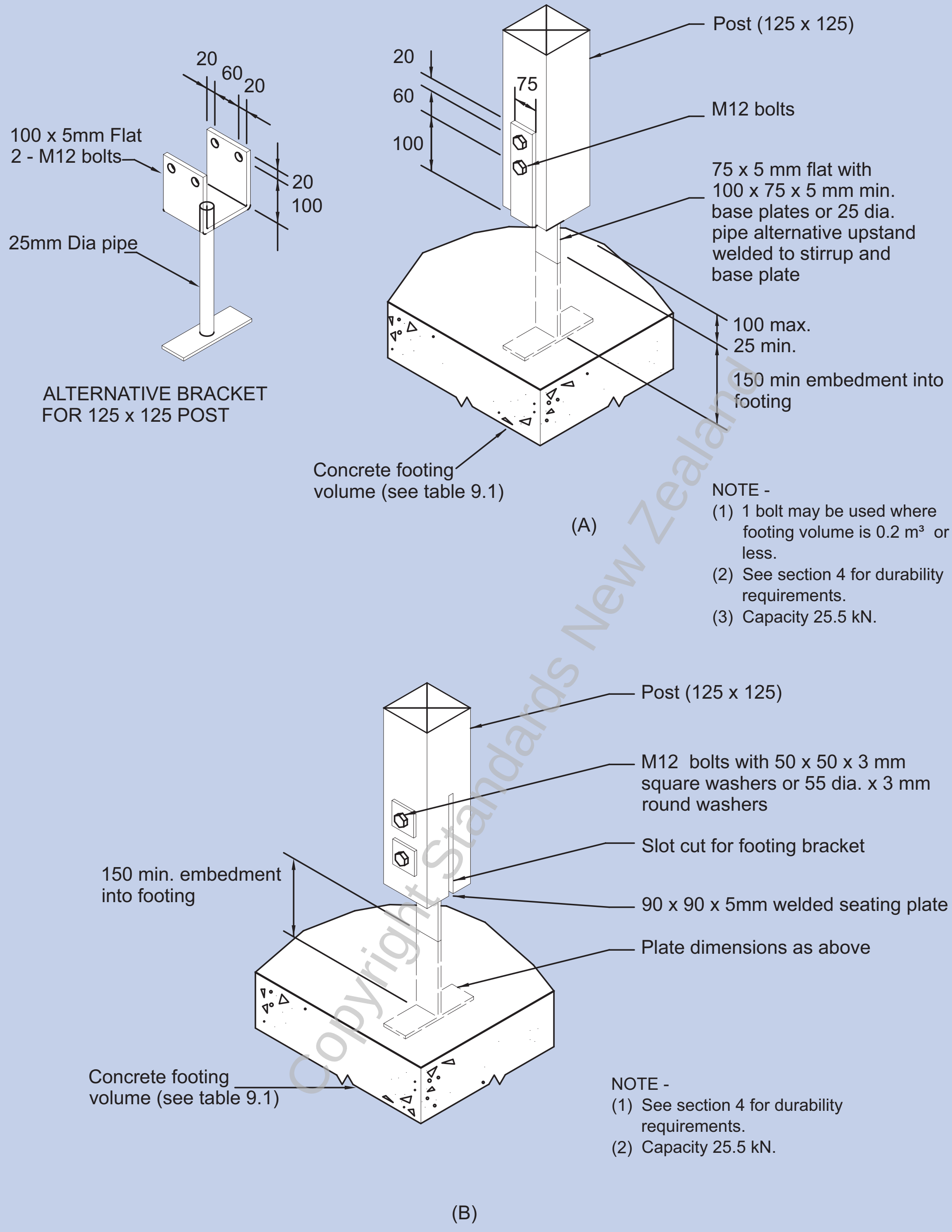


Figure 9.3 – Beam/post connections (see 9.3)



Unless otherwise stated, all dimensions are in mm.

Figure 9.4 – Alternative post/footing connections (see 9.3)

SECTION 10

ROOF FRAMING

Table

Figure

10 ROOF FRAMING

10.1 GENERAL

SG 8 tables are used in this section. For the corresponding SG 6 and SG 10 tables, see the 'A tables' appended to this section.

10.1.1 Scope

The scope of this section is as follows:

(a) This section includes *trussed roofs, framed roofs* and their *bracing* requirements;

(b) This section does not include design for *snow loads* which can be found in section 15;

(c) This section does not include any *flat roof* with access for fire escape, *roof* garden, light storage, or general pedestrian traffic, and any *flat roof* where people can be expected to congregate on occasions, irrespective of the ease of access. These shall be assessed as a floor with a 2 kPa *floor load* for the purposes of this Standard;

(d) For minimum pitch and weathertightness refer to E2/AS1.

10.1.2 Roof system

The *roof* system shall consist of:

(a) A system to resist vertical *loads* complying with 10.1.3; combined with

(b) A system to resist horizontal *loads* complying with 10.1.4.

10.1.3 Vertical loads

The system to resist vertical *loads* shall consist of a combination of:

(a) *Roof framing* members complying with 10.2.1; and

(b) *Roof trusses* complying with 10.2.2.

10.1.4 Horizontal loads

For both *trussed* and *framed roofs*, the system to resist horizontal *loads* shall consist of *roof bracing* complying with 10.3 and 10.4 (see table 10.16).

10.1.5 Concrete or concrete masonry walls in roof spaces

10.1.5.1

Where a concrete or concrete masonry *wall* extends above or to the underside of *roof cladding*, *roof framing* shall be supported on 90 mm x 45 mm *stringers* or *bearers*, fixed to the side of the *wall*, with M12 bolts at not more than 1.4 m centres. Alternative fixings to the M12 bolt shall comply with 2.4.7.

10.1.5.2

Where the *wall* is required to provide a fire separation, the anchorages for these bolts shall not extend through the *wall*, or reduce the fire integrity rating of the *wall*.

10.2 SYSTEMS TO RESIST VERTICAL LOADS

10.2.1 Framed roofs

10.2.1.1 Scope

The scope of this clause is as follows:

(a) Clause 10.2.1 is written specifically for *couple-close roofs* (see figures 10.1 and 10.3), but the requirements for individual *roof framing* members apply equally to *framed roofs* of other types; for example, mono-pitch *skillion* and exposed *rafter roofs*.

(b) This clause does not include "cathedral ceiling" type *roofs* (see figure 10.3);

(c) The *rafter spacing* shall not exceed 1200 mm for *light roofs*, and 900 mm for *heavy roofs*.

10.2.1.2 Joints in roof framing members

10.2.1.2.1

Joints in all *roof framing* members, other than *ridge boards* shall be made only over supports.

C10.2.1.2.1

All roof framing members should, as far as possible, be in continuous lengths.

10.2.1.2.2

Joints shall not be made at a support beyond which a *framing* member is cantilevered.

10.2.1.2.3

Joints in *hip rafters* and *ridge boards* shall be made by a connector of 3 kN *capacity* in tension or compression along the line of the members. This may be achieved by butting and flitching with timber 19 mm thick extending not less than 225 mm on each side on the joint (see figure 10.2).

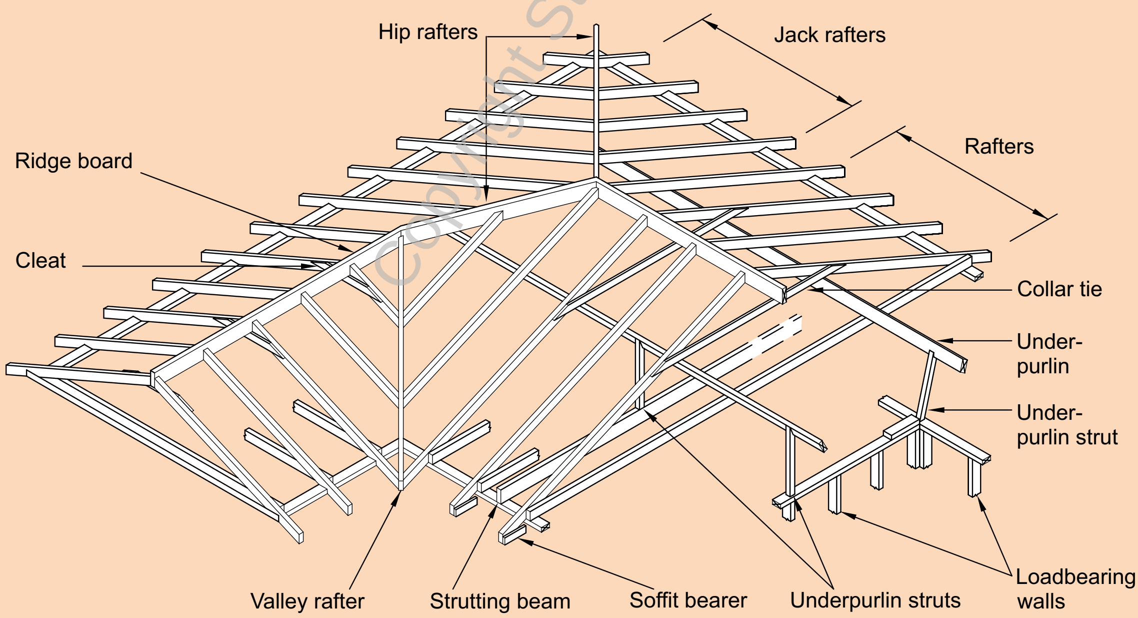


Figure 10.1 – Roof framing members, couple-close roof (see 10.2.1.1)

10.2.1.3 Rafters

10.2.1.3.1

Rafters (including hip and *valley rafters*) shall *span* between any two of the following:

(a) *Ridge board;*

(b) *Underpurlin*;

(c) *Top plate*;

(d) *Lintel, ridge beam,* verandah beam or *stringer*;

(e) Another *rafter*.

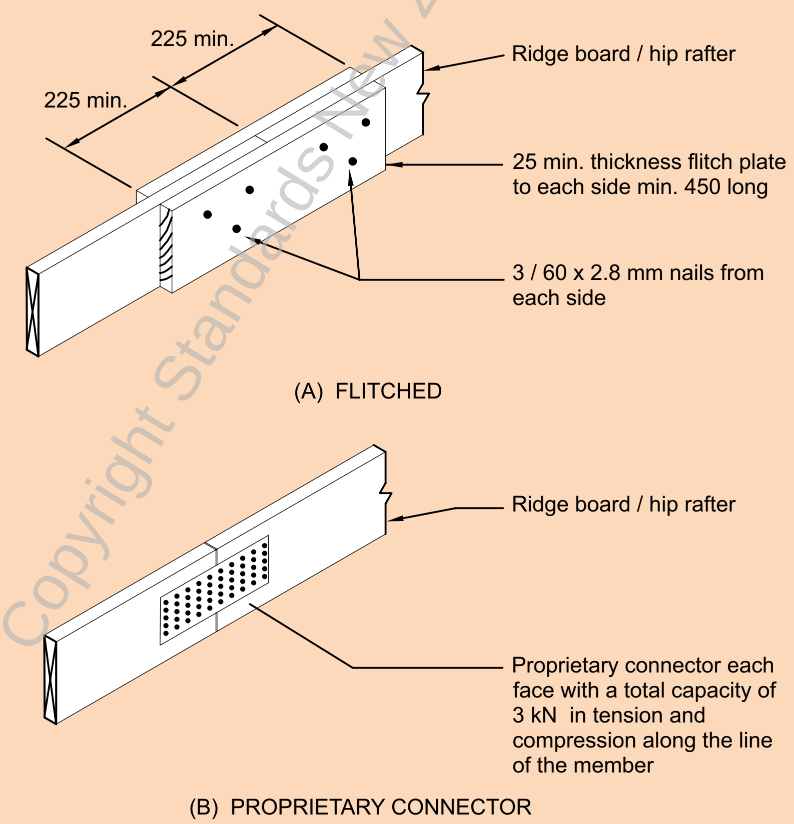
See figure 10.3 for definition of *rafter spans*.

10.2.1.3.2

Rafter and *valley rafter* dimensions and fixing types shall be as given by table 10.1 (see tables 15.6 and A15.6 for *snow loads*). *Couple-close roofs* shall have ceiling *joists* fixed to each *rafter*.

C10.2.1.3.2

Designers should consider insulation requirements to comply with H1 and E3 when choosing roof members.



Unless otherwise stated, all dimensions are in mm.

Figure 10.2 – Jointing hip rafters and ridge boards (see 10.2.1.2.3)

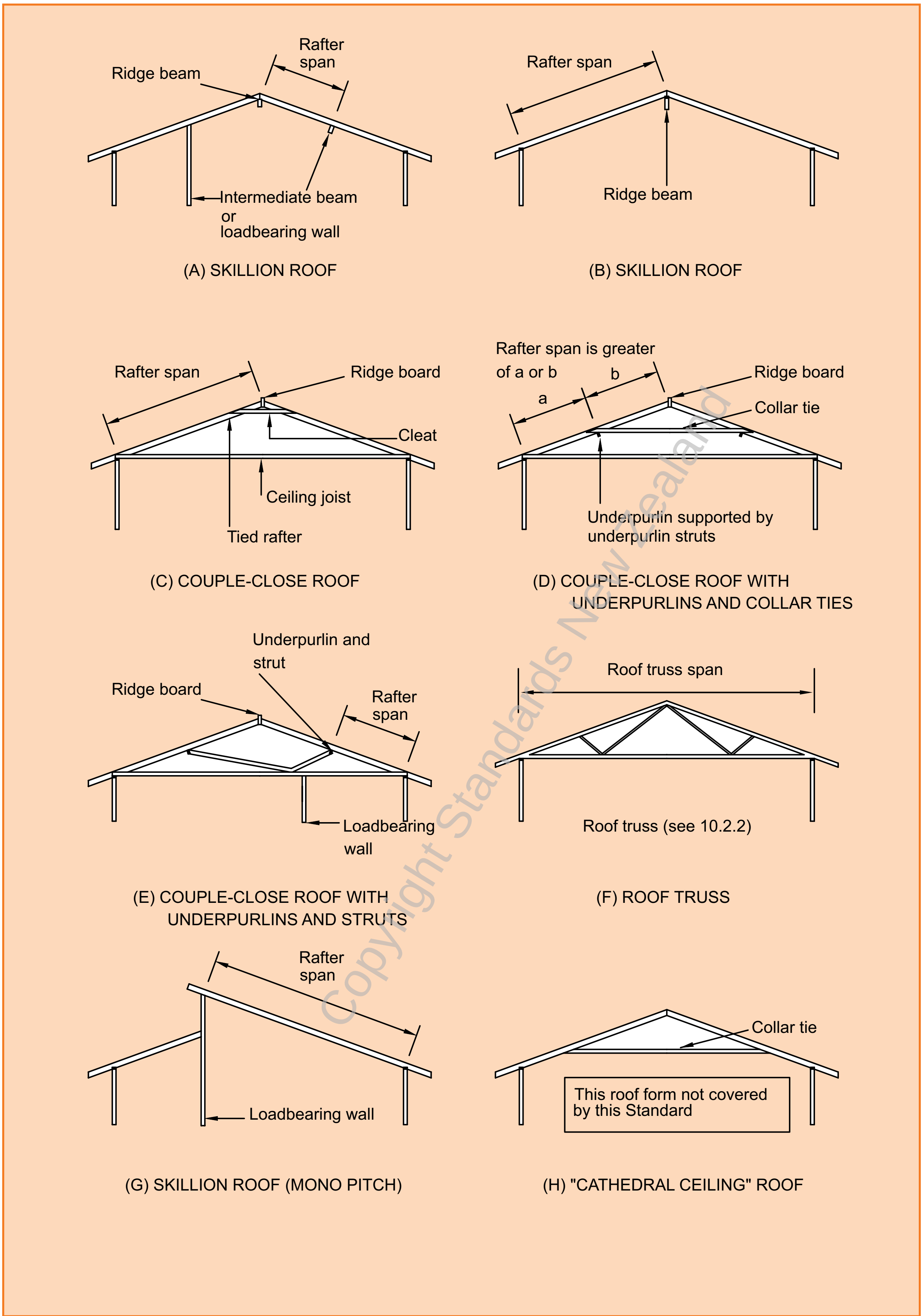


Figure 10.3 – Rafter spans (see 10.2.1.3.1)

Table 10.1 – Rafters for all wind zones – SG 8 (see 10.2.1.3.2)

Rafter size (width x thickness)	Rafter spacing (mm)							
	480		600		900		1200 (see Note (4))	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(a) Ordinary rafters for light and heavy roofs								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	1.3	E	1.3	E	1.2	E	1.3	E
140 x 45	2.7	E	2.5	E	2.2	E	2.2	E
190 x 45	3.5	E	3.3	E	2.8	E	2.5	E
240 x 45	3.8	E	3.5	E	3.1	E	2.8	E
290 x 45	4.1	E	3.8	E	3.3	E	3.0	E
140 x 70	3.2	E	2.9	E	2.6	E	2.8	E
190 x 70	4.3	E	4.0	E	3.5	E	3.7	E
240 x 70	5.4	E	5.1	E	4.4	E	4.3	F
290 x 70	6.4	E	5.9	E	5.1	E	4.6	F
140 x 90	3.4	E	3.2	E	2.8	E	3.0	E
190 x 90	4.7	E	4.3	E	3.8	E	4.1	F
240 x 90	5.9	E	5.5	E	4.8	F	5.1	F
290 x 90	7.2	E	6.7	E	5.8	F	5.9	F

The table gives maximum spans for Extra high wind zone.
In other wind zones, span lengths shall be multiplied by the following factors:

Low and Medium:	**1.3**	**High and Very high:**	**1.1**

Fixing type	Description	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

NOTE –

(1) Rafter spans may be increased by 10 % for rafters continuous over 2 or more spans that have not been birdsmouth jointed at intermediate supports.

(2) Fixing types at intermediate supports for rafters running continuously over those supports shall have double the capacity of the fixing types given in this table.

(3) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(4) Rafter spacing of 1200 mm does not include heavy roofs.

Table 10.1 – Rafters for all wind zones – SG 8 (continued) (see 10.2.1.3.2)

Rafter size (width x thickness)	**Maximum span of valley rafters and their fixing types for all wind zones** (m)			
	Light roof		**Heavy roof**	
	Rafter span	**Fixing**	**Rafter span**	**Fixing**
(b) Valley rafters for light and heavy roofs				
(mm x mm)	(m)	type	(m)	type
90 x 45	1.6	E	1.4	E
140 x 45	2.3	E	2.0	E
190 x 45	2.9	E	2.6	E
240 x 45	3.4	E	3.1	E
290 x 45	3.8	E	3.6	E
90 x 70	1.8	E	1.6	E
140 x 70	2.5	E	2.3	E
190 x 70	3.2	E	2.9	E
240 x 70	3.8	E	3.4	E
290 x 70	4.4	E	4.0	E

Fixing type	**Fixing to resist uplift**	**Alternative fixing capacity** (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7

NOTE –
(1) Proprietary fixings that have the required fixing capacity indicated in tables may be used.
(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

10.2.1.3.3
Hip rafters that support *jack rafters*, which are horizontally restrained by ceiling *joists* and ceiling *framing*, shall be 19 mm thick and 50 mm deeper than the members that they support.

10.2.1.3.4
Hip rafters that project 600 mm or more, measured along the *rafter* beyond their supports, so as to form overhanging eaves shall either be:

(a) Of the same thickness as the *rafters* they support; or

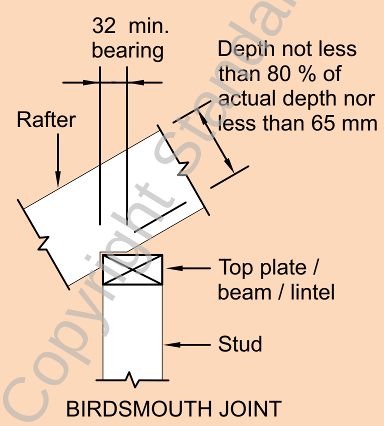
(b) *Flitched* on both sides with timber 25 mm thick (see figure 10.2), extending not less than 450 mm along the *rafter* in both directions from the birdsmouth (see figure 10.4 for birdsmouth joint details). Each *flitch* shall be nailed to each *rafter* end with 6 evenly-*spaced* 60 x 2.8 nails.

10.2.1.3.5
Each *rafter* other than a hip or *valley rafter* shall run at right angles to its associated ridge or eaves line.

10.2.1.3.6
Rafters shall be seated to *top plates, lintels*, and beams as shown in figures 10.4 and 10.5 and according to the following criteria:

(a) The bearing width shall not be less than 32 mm;

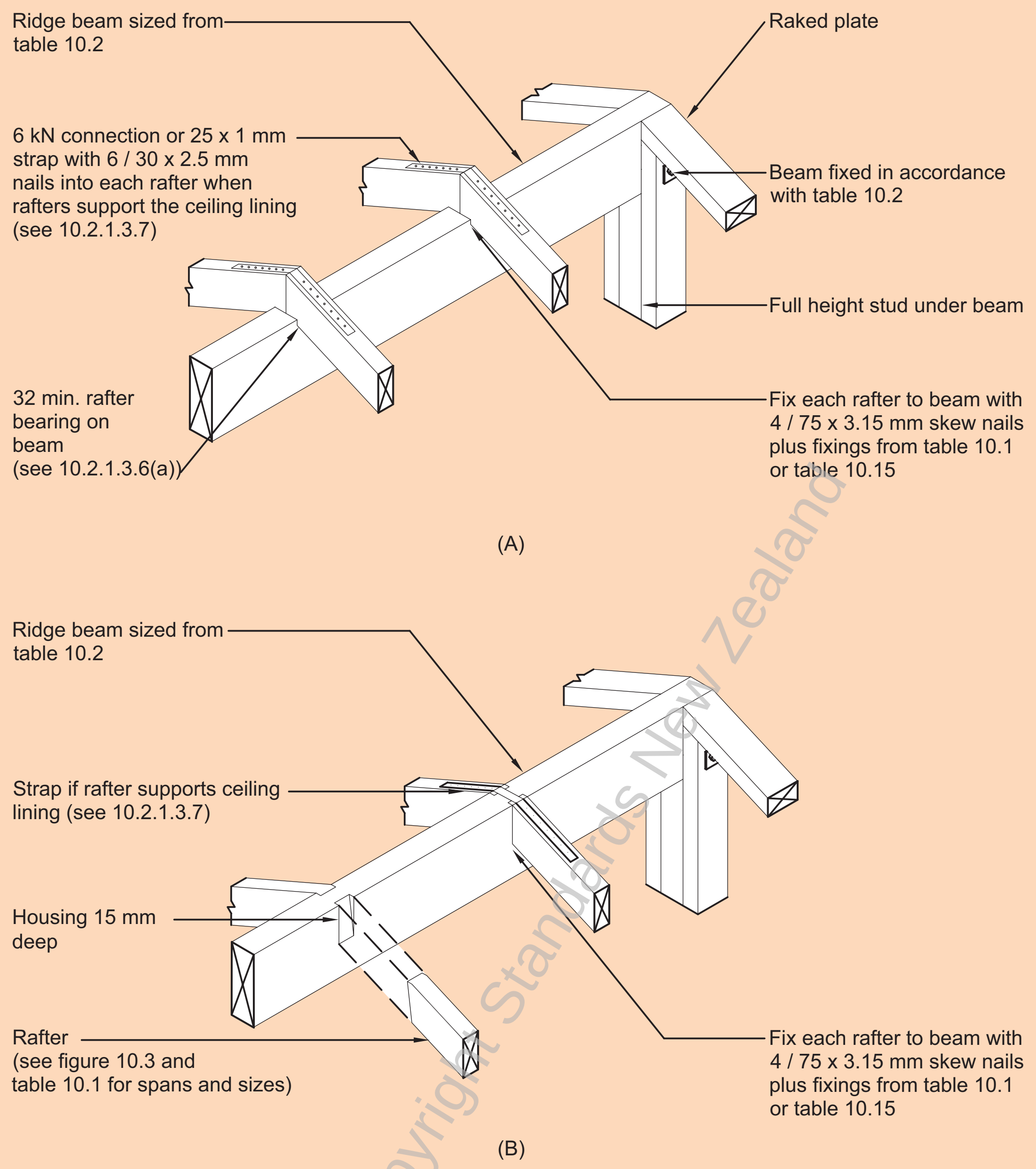
(b) The net depth of the *rafter* at the notch or birdsmouth shall not be less than 80 % of the actual depth of the *rafter*, nor less than 65 mm.



NOTE – See section 4 for durability requirements.

Unless otherwise stated, all dimensions are in mm.

Figure 10.4 – Seating of rafters (see 10.2.1.3.6)



NOTE –
(1) Ridge beams shall be used where the roof does not have cleats or underpurlins (not couple-close) or ceiling joists.
(2) See section 4 for durability requirements.

Unless otherwise stated, all dimensions are in mm.

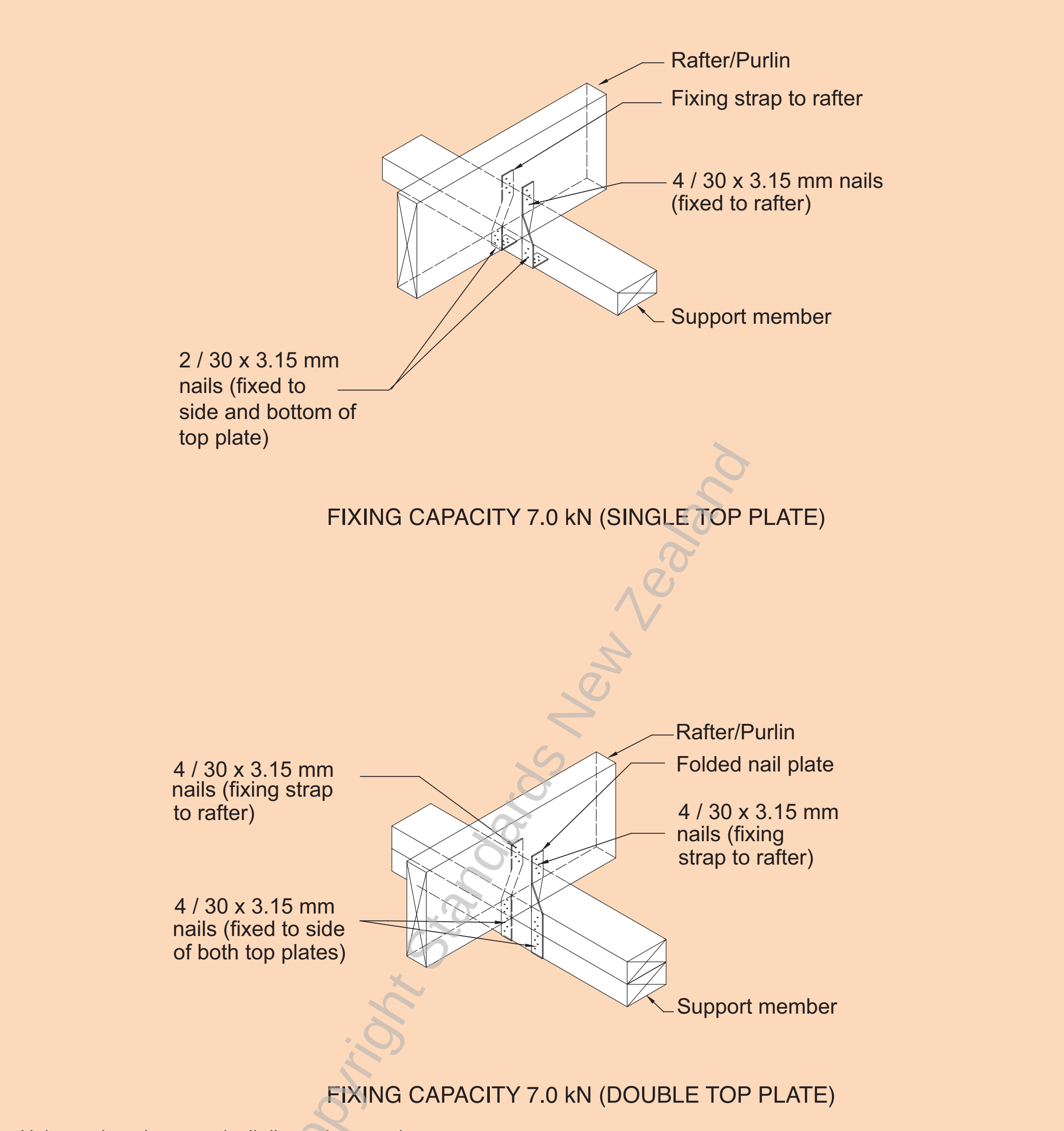
Figure 10.5 – Rafter to ridge beam connections (see 10.2.1.3.6)

10.2.1.3.7

Rafters shall be fixed as follows:

(a) To *top plates*: See figure 10.6;

(b) To corresponding *rafters*: As shown in figures 10.5 or 10.7.



Unless otherwise stated, all dimensions are in mm.

Figure 10.6 – Rafter to top plate connections

10.2.1.4 Ridge boards

10.2.1.4.1

Ridge boards in *couple-close roofs* shall be a minimum of 19 mm thick and provide full bearing for the whole depth of the *rafters* (see figure 10.15).

10.2.1.4.2

Any length of *ridge board* that supports one or more *jack rafters* shall itself be supported by *struts* at no more than the following centres depending on the timber grade of the *ridge board*: 1.4 m for SG 6; 1.6 m for SG 8; and 1.8 m for SG 10. Such *struts* shall comply with the requirements for *underpurlin struts* given by 10.2.1.10.

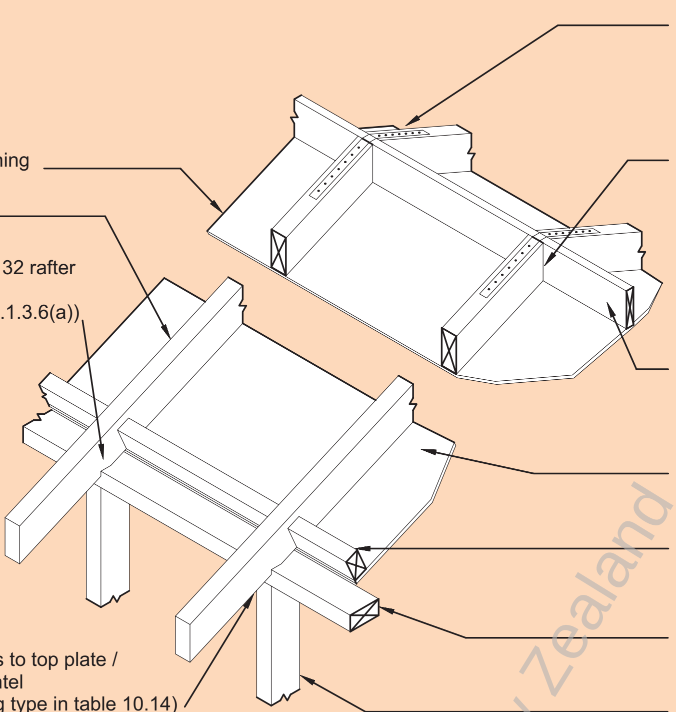


Figure 10.7 – Fixing rafters – Skillion roof (see 10.2.1.3.7)

10.2.1.4.3

Ridge boards may project as a cantilever to a distance beyond the face of its support not exceeding one quarter of its *span*.

10.2.1.5 Ridge beams

10.2.1.5.1

Ridge beams may be used to support the upper ends of paired *rafters* whose lower ends are not tied with ceiling *joists* or other *framing*. *Collar ties* do not provide this tie.

10.2.1.5.2

The *ridge beam* sizes shall be determined from table 10.2. The *ridge beam* shall be secured to the *wall* with a fixing type determined from table 10.2. The fixing shall be as required by table 10.2 and shown by figure 10.8. The built-up *studs* shown in figure 10.8 shall be provided with base connections as required by table 10.2 and the *wall* base connection details of figure 8.12.

10.2.1.6 Ceiling joists

10.2.1.6.1

Ceiling *joists* shall be of the dimensions given by table 10.3.

10.2.1.6.2

Ceiling *joists* shall have their bottom surfaces set to a common level to support the ceiling *lining* and shall be laid in straight lines on edge.

10.2.1.6.3

Ceiling *joists* shall have a minimum landing on their supports, other than *ceiling runners*, of 32 mm.

10.2.1.6.4

Ceiling *joists* shall not be supported by *roof* or ceiling *framing* members other than *ceiling runners* complying with 10.2.1.7.

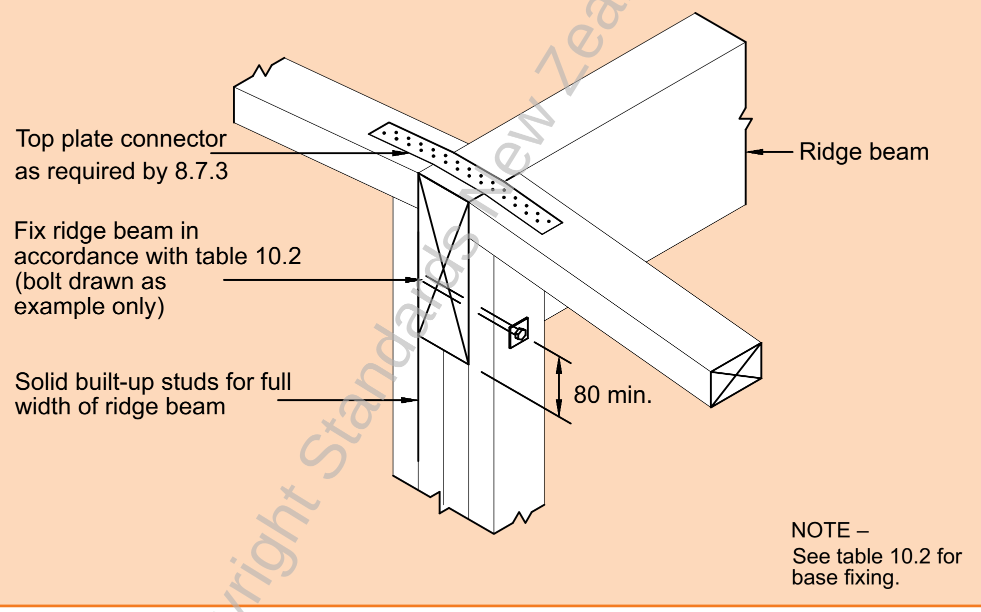


Figure 10.8 – Example of fixing ridge beam to wall (see 10.2.1.5.2)

Table 10.2 – Ridge beams for all wind zones – SG 8 (see 10.2.1.5.2)

Ridge beam size	Loaded dimension of ridge beam (m)							
	1.8		2.7		3.6		4.2	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(mm x mm)	(m)	type	(m)	type	(m)	type	(m)	type
(a) Light roof								
240 x 45	2.3	H	1.9	H	1.7	H	1.6	H
290 x 45	2.4	H	2.1	H	1.9	H	1.8	I
190 x 70	2.7	H	2.4	H	2.1	I	1.9	I
240 x 70	4.3	I	3.8	I	3.4	I	3.2	I
290 x 70	4.8	I	4.1	I	3.7	I	3.5	J
190 x 90	3.7	H	3.2	I	2.9	I	2.8	I
240 x 90	4.7	I	4.1	I	3.7	I	3.5	J
290 x 90	5.7	I	5.0	I	4.5	J	4.3	J
(b) Heavy roof								
240 x 45	2.3	G	1.9	H	1.6	H	1.5	H
290 x 45	2.5	H	2.2	H	1.9	H	1.7	H
190 x 70	2.3	G	2.0	H	1.7	H	1.6	H
240 x 70	3.6	H	3.2	I	2.9	I	2.7	I
290 x 70	4.4	H	3.8	I	3.5	I	3.3	I
190 x 90	3.1	H	2.7	H	2.5	I	2.3	I
240 x 90	4.0	H	3.5	I	3.1	I	3.0	I
290 x 90	4.8	I	4.2	I	3.8	I	3.6	I

Fixing type	Fixing to resist uplift		Alternative fixing capacity (kN)
	Base connection for built-up studs	Ridge beam to built-up studs	
G	6 / 90 x 3.15 skew nails into bottom plate	10 / 90 x 3.15 nails (5 each side)	4.7
H	25 x 1 strap with 12 nails to stud	1 / M12 bolt	8.5
I	2 / 25 x 1 straps with 6 nails to stud and plate. 24 nails total	2 / M12 bolts	16.0
J	3 / 25 x 1 straps with 12 nails to stud and plate. 36 nails total	2 / M16 bolts	24.0

NOTE –
(1) Fix plate to joist with 1 / M12 x 150 coach screw.
(2) Fix plate to joist with 2 / M12 x 150 coach screws.
(3) Strap nails to be 30 x 2.5 mm.

Table 10.3 – Ceiling joists – SG 8 (see 10.2.1.6.1)

Ceiling joist size	Maximum span* of ceiling joists at a maximum spacing (mm) of:		
	480	600	900
(mm x mm)	(m)	(m)	(m)
90 x 35	1.9	1.8	1.8
90 x 45	2.4	2.3	2.0
140 x 35	3.5	3.3	2.8
140 x 45	3.8	3.6	3.1
190 x 45	4.9	4.6	4.0

*May be increased by 10 % for joists continuous over 2 or more spans.
NOTE – This table is applicable to all wind zones.

10.2.1.6.5
As shown in figure 10.9, *joints* in ceiling *joists* shall be made over supports and shall either:

(a) Be lapped not less than 300 mm; or

(b) Be butted and flitched with timber of the same dimensions as the *joists* and extending not less than 225 mm on each side of the joint.

10.2.1.7 Ceiling runners

10.2.1.7.1
Ceiling runners shall be of the dimensions given by table 10.4.

10.2.1.7.2
Ceiling runners shall be laid in straight lines on edge.

10.2.1.7.3
Ceiling runners shall have a minimum landing of 65 mm on a packer, which is directly supported by the *top plate* of a *loadbearing wall*, provided that either:

(a) The *ceiling runner* shall land directly over a *stud*; or

(b) The packer shall *span* between the *studs* on each side of the *ceiling runner*.

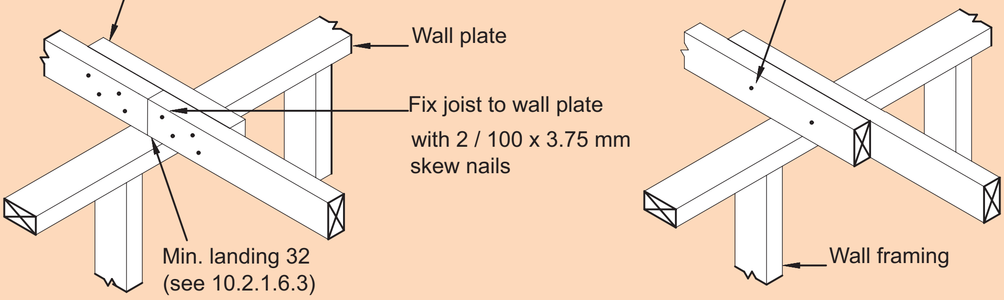


Figure 10.9 – Joints in ceiling joists (see 10.2.1.6.5)

Table 10.4 – Ceiling runners – SG 8 (see 10.2.1.7.1)

Ceiling runner size (width x thickness)	**Maximum span of ceiling runners at a maximum spacing** (m) **of:**		
	1.8	**2.4**	**3.0**
(mm x mm)	(m)	(m)	(m)
140 x 45	2.1	1.9	1.8
190 x 45	2.9	2.7	2.5
240 x 45	3.7	3.3	3.0
290 x 45	4.2	3.7	3.3
290 x 90	5.7	5.2	4.8

NOTE – Members up to 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

10.2.1.7.4

The ends of *ceiling runners* may be chamfered, but the depth of the *ceiling runner* at its support shall remain at least 50 %.

10.2.1.7.5

Ceiling runners shall be restrained from twisting at each end with *framing* or packing timbers.

10.2.1.7.6

Ceiling joists may be fixed to *ceiling runners* by hangers which alternate on opposite sides of the *ceiling runner*, or be skew nailed to the *ceiling runner* (see figure 10.10).

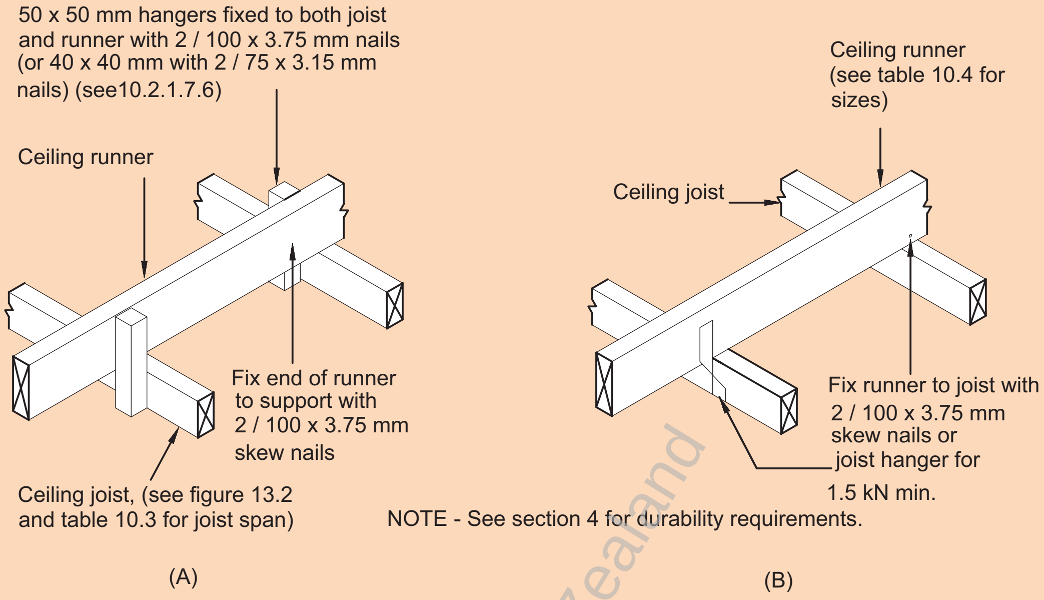


Figure 10.10 – Ceiling runners (see 10.2.1.7.6)

10.2.1.8 Valley boards

Each *valley board* shall be:

(a) 19 mm thick and wide enough to support the valley gutter;

(b) Fixed to each supporting member.

10.2.1.9 Underpurlins

10.2.1.9.1

The sizes of *underpurlins* and the fixings to their supports shall be as given in table 10.5 (and table 15.7 for *snow loads* greater than 1.5 kPa).

10.2.1.9.2

An *underpurlin* may project as a cantilever to a distance beyond the face of its support, not exceeding one quarter of its *span*.

C10.2.1.9.2

Cantilevered ends of underpurlins will generally occur at hips and valleys, where the underpurlin should be mitred and fixed to the hip or valley rafter.

Table 10.5 – Underpurlins for all wind zones – SG 8 (see 10.2.1.9.1, and figures 10.11 and 10.12)

Underpurlin size	Maximum span of underpurlin for loaded dimension* of: (m)					
	1.5		2.1		2.7	
	Span	Fixing	Span	Fixing	Span	Fixing
(a) Light roof						
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	1.1	L	1.0	L	0.9	L
140 x 45	1.8	L	1.5	L	1.4	L
190 x 45	2.2	L	1.9	L	1.7	M
240 x 45	2.4	L	2.1	M	1.9	M
290 x 45	2.6	L	2.3	M	2.1	SED
90 x 70	1.3	L	1.2	L	1.1	L
140 x 70	2.1	L	1.9	L	1.7	M
190 x 70	2.9	M	2.6	M	2.4	SED
240 x 70	4.6	SED	4.1	SED	3.8	SED
290 x 70	5.1	SED	4.5	SED	4.1	SED
190 x 90	4.0	SED	3.5	SED	3.2	SED
240 x 90	5.0	SED	4.5	SED	4.1	SED
290 x 90	6.1	SED	5.4	SED	5.0	SED

Fixing type	Underpurlin to strut fixing to resist uplift (see figures 10.11 and 10.12)	Alternative fixing capacity (kN)
L	2 / M12 Bolts	9.8
M	2 / M16 Bolts	13.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Span may be increased by 10 % for underpurlins continuous over 2 or more spans.

(2) Fixing types for continuous spans shall have double the capacity to that listed in the table.

(3) For the full range of underpurlin fixing types and capacities see table 10.15.

(4) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table 10.5 – Underpurlins for all wind zones – SG 8 (continued) (see 10.2.1.9.1, and figures 10.11 and 10.12)

Underpurlin size	**Maximum span of underpurlin for loaded dimension* of:** (m)					
	1.5		**2.1**		**2.7**	
	Span	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**
(b) Heavy roof						
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	1.0	L	0.8	L	0.7	L
140 x 45	1.5	L	1.3	L	1.1	L
190 x 45	2.1	L	1.7	L	1.5	L
240 x 45	2.5	L	2.1	L	1.9	M
290 x 45	2.7	L	2.4	M	2.2	M
90 x 70	1.1	L	1.0	L	0.9	L
140 x 70	1.8	L	1.6	L	1.4	L
190 x 70	2.4	L	2.2	L	2.0	M
240 x 70	3.9	M	3.5	SED	3.2	SED
290 x 70	4.7	SED	4.2	SED	3.8	SED
190 x 90	3.3	M	3.0	M	2.7	SED
240 x 90	4.2	M	3.8	SED	3.5	SED
290 x 90	5.1	SED	4.6	SED	4.2	SED

Fixing type	**Underpurlin to strut fixing to resist uplift** (see figures 10.11 and 10.12)	**Alternative fixing capacity** (kN)
L	2 / M12 Bolts	9.8
M	2 / M16 Bolts	13.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Span may be increased by 10 % for underpurlins continuous over 2 or more spans.

(2) Fixing types for continuous spans shall have double the capacity to that listed in the table.

(3) For the full range of underpurlin fixing types and capacities see table 10.15.

(4) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

10.2.1.9.3

The *underpurlin spacing* shall be the distance between the *underpurlin* and the adjacent *rafter* support, measured along the *rafter*.

10.2.1.10 Underpurlin struts

10.2.1.10.1

Underpurlin struts provided to support *underpurlins* shall be either:

(a) Isolated *struts*
Positioned at any angle between the vertical and at a right angle to the plane of the *roof* (see figure 10.11); or

(b) As pairs
Fixed to a common member and supporting 2 *underpurlins*. This common member shall be located at more than a quarter of the distance between the *underpurlins*, measured from either side of the building and within 300 mm centre-to-centre of a *loadbearing wall* (see figure 10.12 (A)).

10.2.1.10.2

The maximum length of *underpurlins struts* shall be selected from table 10.6.

Table 10.6 – Underpurlin struts (see 10.2.1.10.2)

Underpurlin struts			
Member size (mm)	**Timber grade** **Maximum length** (m)		
	SG 6	**SG 8**	**SG 10**
90 x 45	1.45	1.60	1.70
90 x 70	3.15	3.45	3.65

NOTE – Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

10.2.1.10.3

Underpurlin struts shall be directly supported by one of the following:

(a) The *top plate* of a *loadbearing wall*, provided that either:

  (i) The *underpurlin strut* shall land directly over a *stud* or

  (ii) The *top plate* shall be doubled between the *studs* on each side of the *underpurlin strut*;

(b) A *lintel* complying with 8.6;

(c) A *strutting beam* complying with 10.2.1.11;

(d) A 90 mm x 45 mm timber *plate* laid on its flat on top of ceiling *joists* and within 300 mm of a *loadbearing wall*. The timber shall be fixed to at least 2 *joists* each side of the *underpurlin strut*.

10.2.1.10.4

Underpurlin struts shall be fixed to *underpurlins, strutting beams, top plates,* and *lintels* as shown in figures 10.11 and 10.12 together with those additional fixings listed in table 10.5 depending on the weight of the *roof* and wind speed to which the building is subjected.

10.2.1.11 Strutting beams

10.2.1.11.1

Strutting beams shall be of the dimensions given by table 10.7 and figure 10.13.

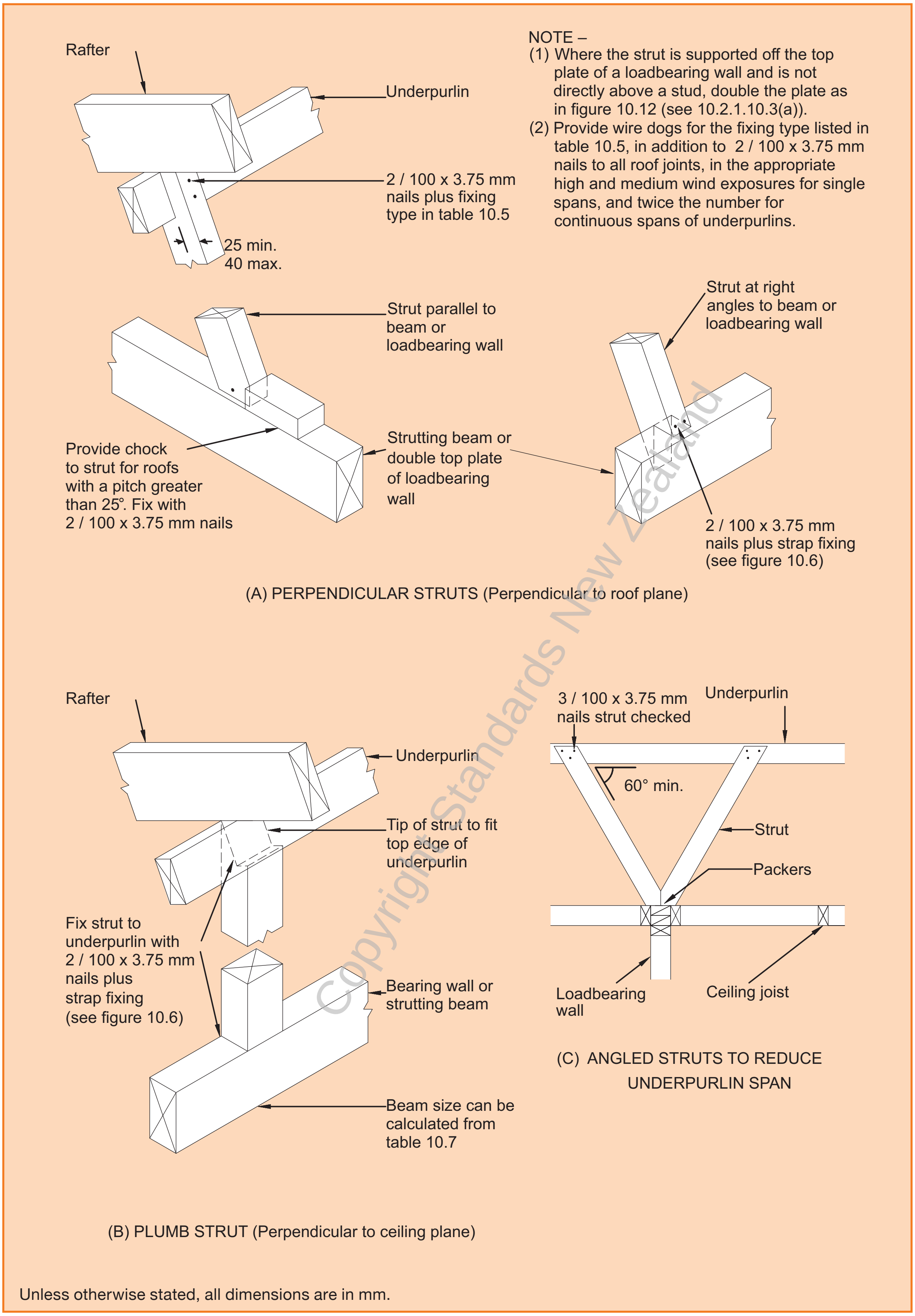
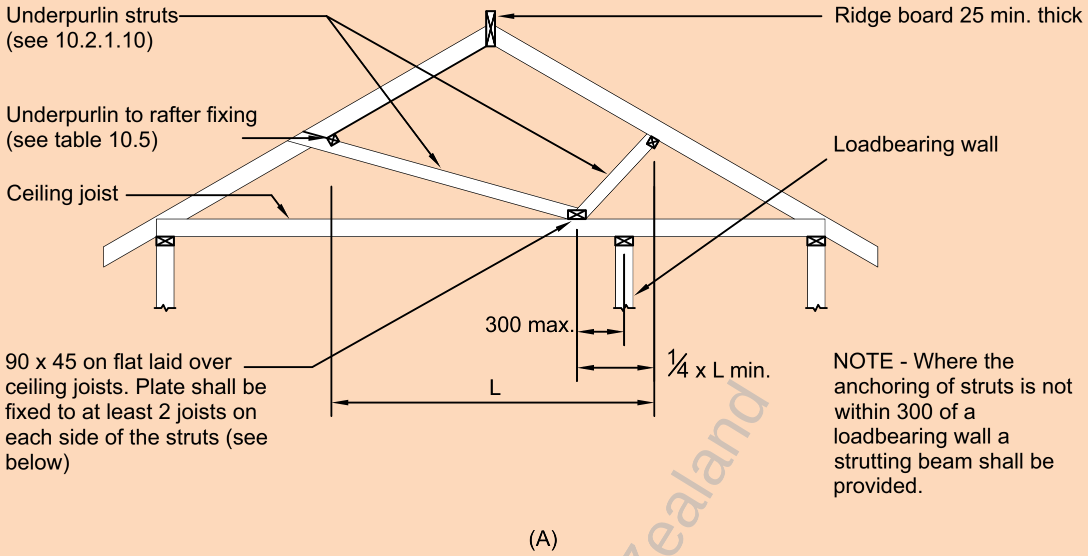
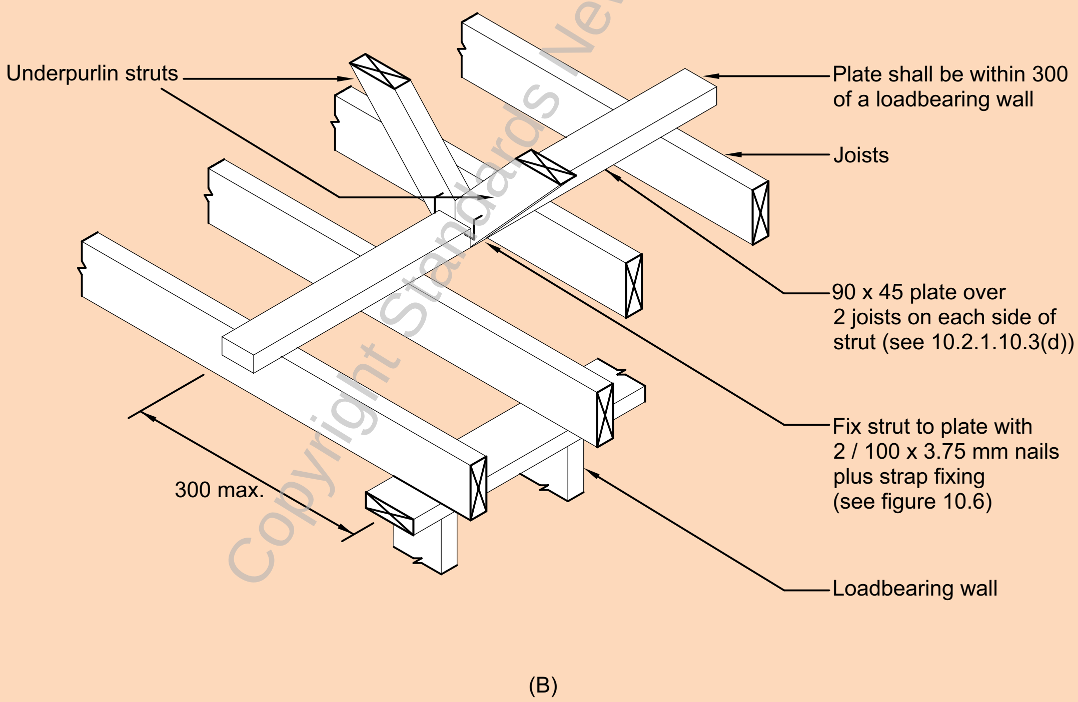


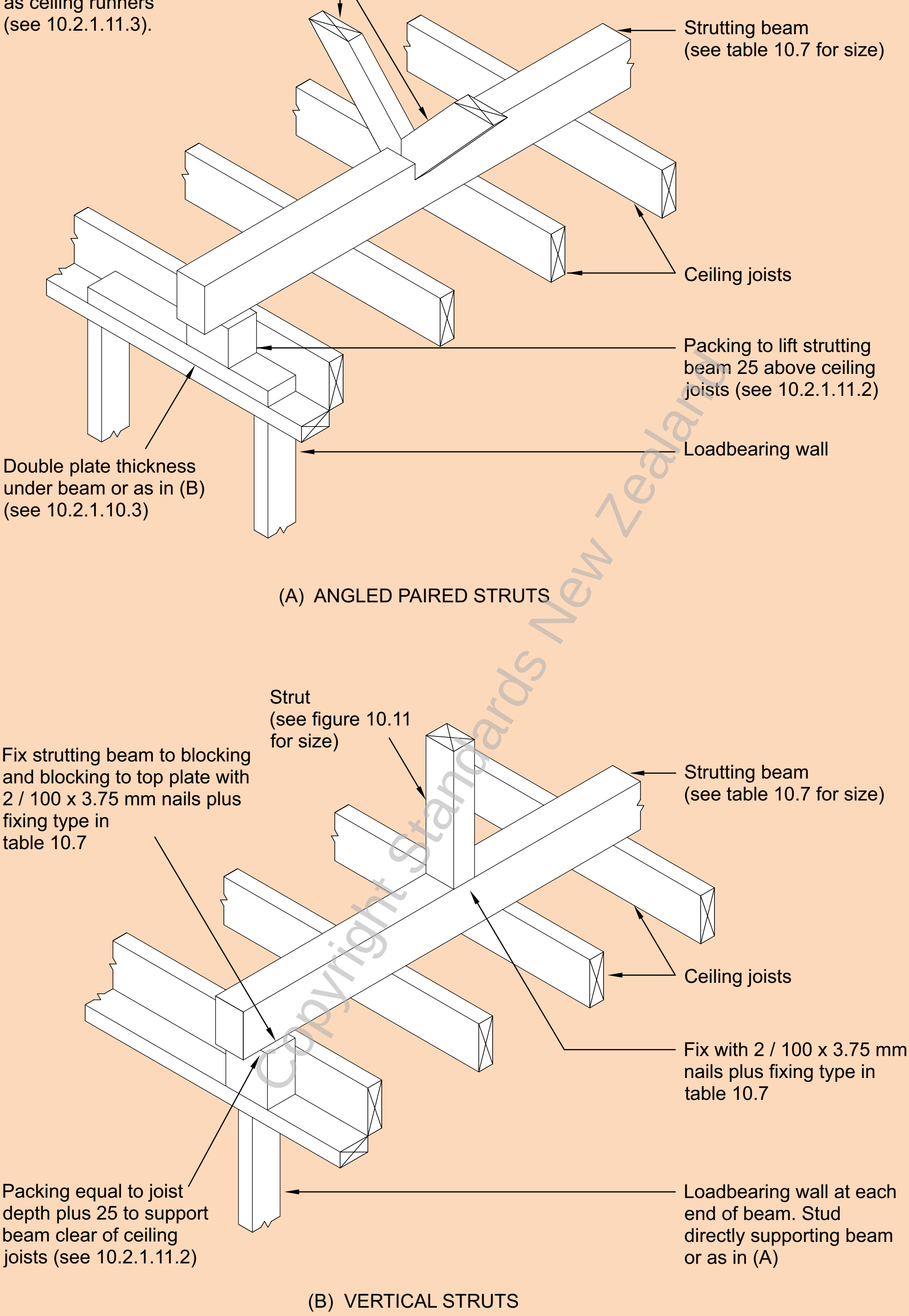
Figure 10.11 – Underpurlin struts – Single (see 10.2.1.10.1(a))





Unless otherwise stated, all dimensions are in mm.

Figure 10.12 – Underpurlin struts – Paired (see 10.2.1.10.1(b))



Unless otherwise stated, all dimensions are in mm.

Figure 10.13 – Strutting beams (see 10.2.1.11.1)

Table 10.7 – Maximum span and fixing types for strutting beams for all wind zones – SG 8 (see 10.2.1.11)

Strutting beam size	Maximum loaded dimension* of underpurlin	Maximum span of strutting beam, for strut spacing of: (m)					
		1.2		1.5		1.8	
		Span	Fixing	Span	Fixing	Span	Fixing
(mm x mm)	(m)	(m)	(type)	(m)	(type)	(m)	(type)
(a) Light roof							
140 x 90	1.5 2.1 2.7	2.5 2.1 1.7	F F F	2.2 1.7 –	F F –	2.0 – –	F – –
190 x 90	1.5 2.1 2.7	4.0 3.3 2.9	SED SED SED	3.5 3.0 2.5	SED SED SED	3.2 2.6 2.0	SED SED SED
(b) Heavy roof							
140 x 90	1.5 2.1 2.7	2.1 1.8 1.5	E E F	1.9 1.5 –	E F –	1.7 – –	F – –
190 x 90	1.5 2.1 2.7	3.4 2.8 2.5	F SED SED	3.0 2.5 2.2	F SED SED	2.7 2.3 1.8	SED SED SED

Fixing type	Strutting beam fixing to resist uplift (see figure 10.13)	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Fixing types for continuous spans shall have double the capacity to that listed in the table. For the full range of fixing types and capacities see table 10.15.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

10.2.1.11.2

Strutting beams shall have a clearance of not less than 25 mm above the ceiling *lining* or *framing*.

10.2.1.11.3

Strutting beams shall not be used as *ceiling runners*.

10.2.1.11.4

The ends of *strutting beams* may be chamfered provided that the depth of the *strutting beam* at its support shall not be reduced by more than 50 %.

10.2.1.11.5

Strutting beams shall have a minimum landing of 65 mm on a packer directly supported by one of the following:

(a) The *top plate* of a *loadbearing wall*, provided that either:

 (i) The *strutting beam* shall land directly over a *stud*; or

 (ii) The *top plate* shall be doubled between the *studs* on each side of the *strutting beam.*

(b) A *lintel* complying with 8.6.

C10.2.1.12

Verandah beams are subject to high uplift wind forces from below and above the rafters. Lightweight roofs are affected by higher uplift forces than are heavy roofs.

10.2.1.12 Verandah beams

Verandah beams shall be of the dimensions given in table 10.8 (and table 15.8 for *snow loads*) in all wind zones.

10.2.1.13 Collar ties and cleats

C10.2.1.13.1

Collar ties provide horizontal restraint to the horizontal reaction of underpurlin struts supporting underpurlins. A collar tie cannot be used without a ceiling joist connection to the base of the rafters, unless on its own, or as a roof structure member. Rafters, collar ties, and all connections should be specifically designed to resist loads and deflections.

10.2.1.13.1

In *couple-close roofs* steeper than 10° to the horizontal (1 in 6), pairs of *rafters* shall be connected by the following (see figures 10.14 and 10.15):

(a) Where *underpurlins* are used: *Collar ties* complying with 10.2.1.13.2;

(b) Where *underpurlins* are not used: *Cleats* complying with 10.2.1.13.3.

Table 10.8 – Verandah beams for all wind zones – SG 8 (see 10.2.1.12)

Beam size (width x thickness)	Loaded dimension of verandah beam (m)							
	0.9		1.4		1.8		2.1	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(mm x mm)	(m)	type	(m)	type	(m)	type	(m)	type
(a) Light roof								
140 x 45	1.8	N	1.6	N	1.5	N	1.4	N
190 x 45	2.1	N	2.0	N	1.8	O	1.8	O
240 x 45	2.4	N	2.2	O	2.1	O	2.0	O
290 x 45	2.5	O	2.3	O	2.2	O	2.1	O
140 x 70	2.1	N	1.9	N	1.8	O	1.8	O
190 x 70	2.8	O	2.6	O	2.5	O	2.4	P
220 x 70	3.3	O	3.0	P	2.9	P	2.7	P
240 x 70	3.5	O	3.2	P	3.0	P	2.9	P
290 x 70	3.9	P	3.6	P	3.4	P	3.3	P
140 x 90	2.2	N	2.1	O	2.0	O	1.9	O
190 x 90	3.1	O	2.8	O	2.7	P	2.6	P
240 x 90	3.9	P	3.6	P	3.4	P	3.3	P
290 x 90	5.9	P	5.5	P	5.2	Q	5.1	Q
(b) Heavy roof								
140 x 45	1.5	N	1.4	N	1.3	N	1.2	N
190 x 45	2.1	N	1.9	N	1.7	N	1.7	N
240 x 45	2.3	N	2.1	N	2.0	O	1.9	O
290 x 45	2.5	N	2.3	N	2.1	O	2.1	O
140 x 70	1.8	N	1.7	N	1.6	N	1.5	N
190 x 70	2.4	N	2.3	N	2.1	O	2.1	O
220 x 70	2.8	N	2.6	O	2.5	O	2.4	O
240 x 70	3.1	O	2.9	O	2.7	O	2.6	P
290 x 70	3.8	O	3.5	P	3.3	P	3.1	P
140 x 90	1.9	N	1.8	N	1.7	N	1.7	N
190 x 90	2.7	N	2.5	O	2.3	O	2.3	O
240 x 90	3.4	O	3.1	O	3.0	P	2.9	P
290 x 90	5.2	P	4.8	P	4.6	P	4.4	P

Fixing type	Fixing to resist uplift	Alternative fixing capacity (kN)
N	6 / 100 x 4.0 nails hand-driven	4.7
O	2 / M12 bolts (see figure 9.3 (C))	6.8
P	2 / HDG ‘flat’ straps (see figure 9.3 (B))	13.7
Q	2 / HDG ‘tee’ straps (see figure 9.3 (A))	25.5

NOTE –

(1) This table includes provision for the rafters cantilevering a maximum of 750 mm beyond the verandah beam to support a soffit.

(2) Fixing type for continuous spans shall have a double capacity to that listed in the table.

(3) Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

10.2.1.13.2

Collar ties (see figure 10.14) shall:

(a) Be at 1.8 m centres or every third pair of *rafters*, whichever is the closer;

(b) Be fixed to the sides of the *rafters* immediately above each *underpurlin*; and

(c) Consist of 140 mm x 19 mm or 90 mm x 45 mm timber.

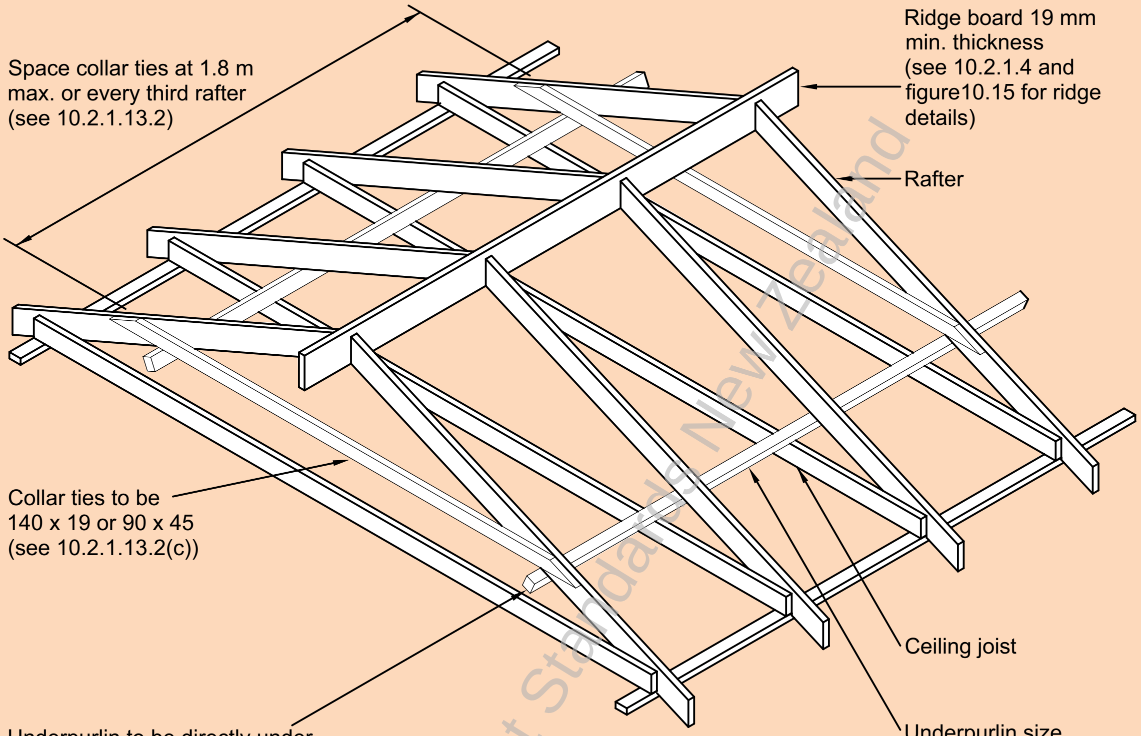


Figure 10.14 – Collar ties and underpurlins – Roof pitches greater than 10° (see 10.2.1.13.1 and 10.2.1.13.2)

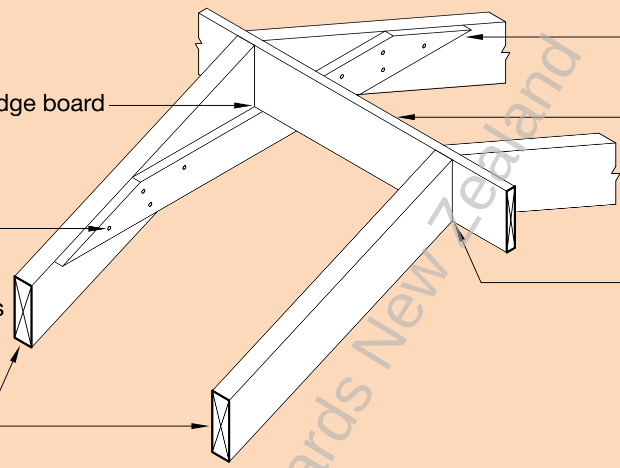
10.2.1.13.3

Cleats (see figure 10.15) shall:

(a) Be at 1.8 m centres or every third pair of *rafters*, whichever is the closer;

(b) Be fixed to the sides of the *rafters* immediately beneath the *ridge board*; and

(c) Consist of 90 mm x 19 mm timber.



Unless otherwise stated, all dimensions are in mm.

Figure 10.15 – Fixing cleats (see 10.2.1.13.1 and 10.2.1.13.3)

C10.2.1.14.1

The eaves of truss roofs are covered by the design requirements of 10.2.2.

10.2.1.14 Eaves

10.2.1.14.1

A *rafter* may extend as a cantilever beyond its supporting *top plate* for a distance not exceeding 40 % of its maximum permitted *span*, or 750 mm measured horizontally from the face of the support, whichever is the lesser. Where 90 mm x 45 mm *rafters* are supported by *eaves bearers* (boxed) they may extend to 750 mm.

10.2.1.14.2

Where the eaves are boxed, the *eaves bearers* shall be attached to the ends of *rafters* or trusses and to *studs or ribbon boards*, and shall be at not more than 1200 mm centres.

10.2.1.14.3

Eaves bearers shall consist of:

(a) Not exceeding 600 mm long: 45 mm x 35 mm timber;

(b) Not exceeding 750 mm long: 70 mm x 35 mm timber on edge.

10.2.1.15 Gable verges

10.2.1.15.1

Gable verges shall be framed by either:

(a) *Purlins* extending as cantilevers beyond their end supports as shown in figure 10.16 for a distance not exceeding that given by 10.2.1.15.2; or

(b) Outriggers complying with 10.2.1.15.3 and as shown in figure 10.16.

10.2.1.15.2

Purlins with a back *span* over at least 3 *rafters* may extend as cantilevers beyond their end supports for a distance not exceeding:

(a) Laid on their flat:
 (i) Light and *heavy roofs* at no more than 900 mm *spacing*
 (ii) 70 mm x 45 mm *purlins*: 300 mm
 (iii) 90 mm x 45 mm *purlins*: 450 mm

(b) Laid on their edge, light and *heavy roofs*, in accordance with table 10.8(a).

10.2.1.15.3

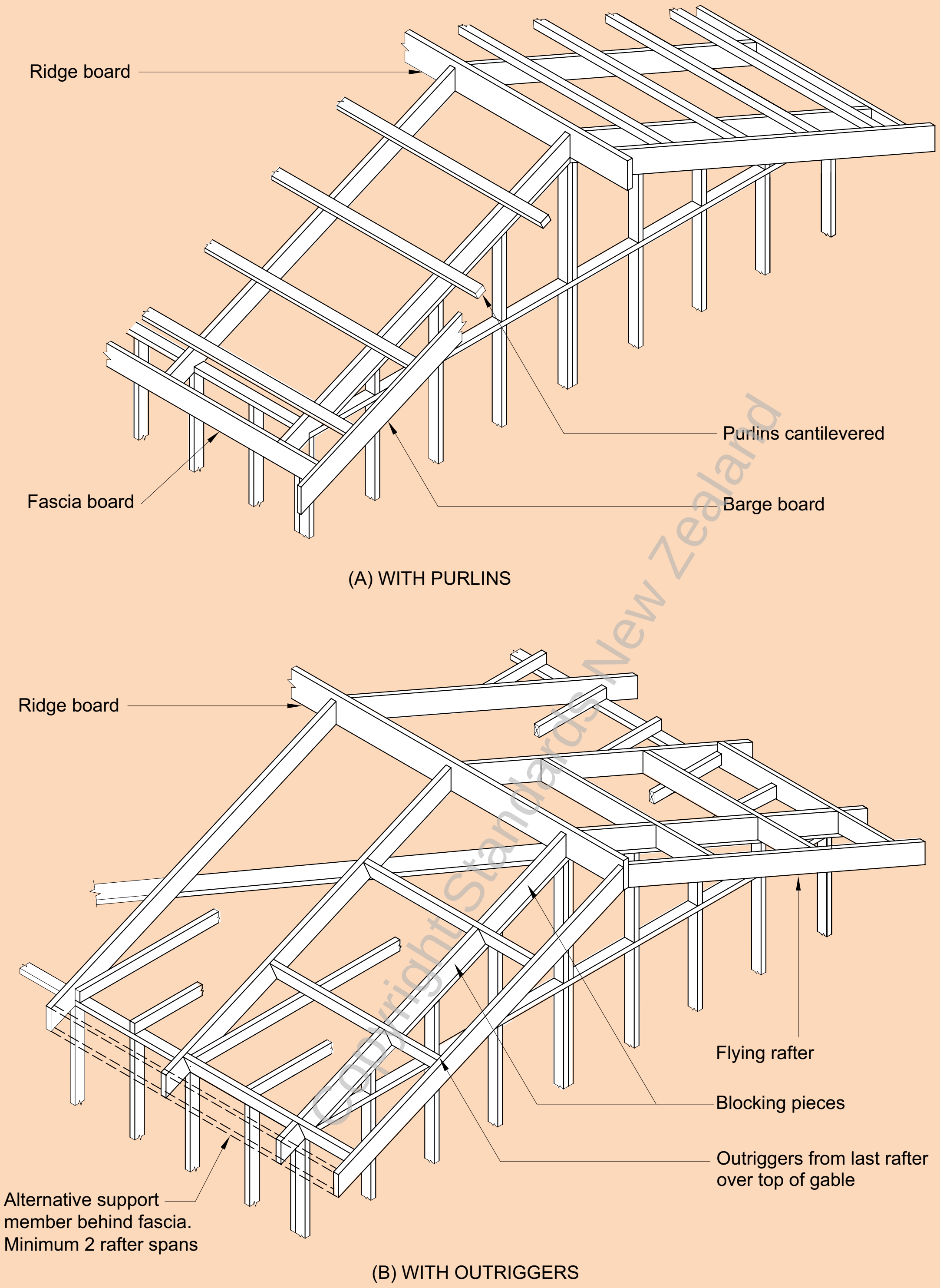
Outrigger, fly *rafter* size, orientation and *spacing* shall be according to table 10.9 (see figure 10.16(a)), and:

(a) Have *blocking* pieces of the same size as the outriggers fitted and fixed between the outriggers along the line of the end support. *Purlins* shall be fixed to the *blocking* pieces and to the fly *rafter* (see figure 10.17);

(b) Be fixed to *wall framing* with fixings determined from table 10.10 or table 10.11 as appropriate if the outriggers are *purlins*.

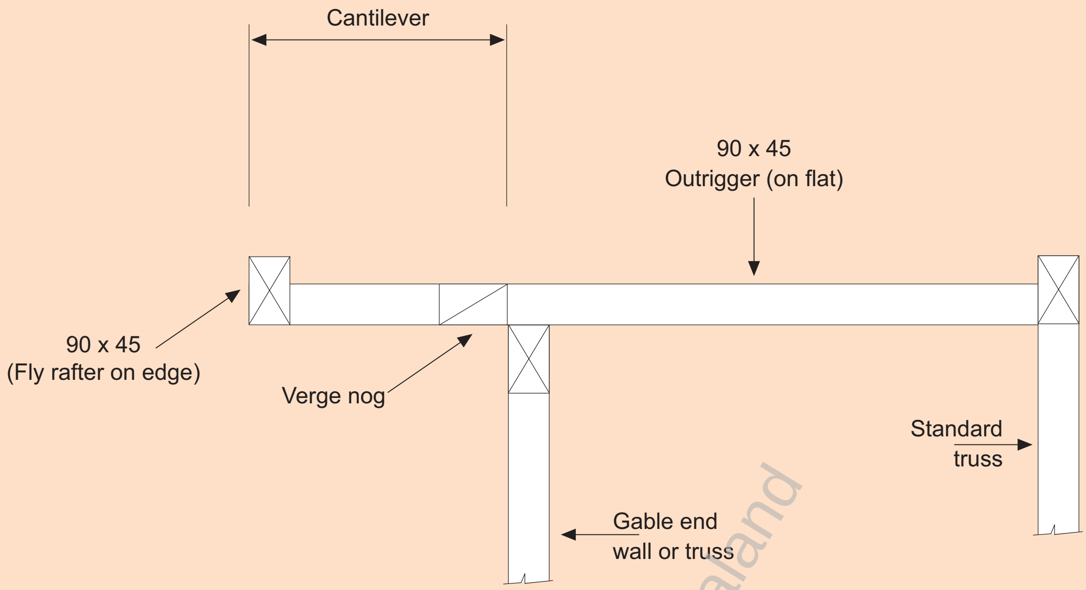
Table 10.9 – Outriggers – SG 8 (see 10.2.1.15.3)

Outrigger size and orientation (mm)	**Maximum outrigger spacing for a maximum cantilever of:** (mm)		**Boundary / Fly rafter size** (mm)
	600	**750**	
70 x 45	900	600	70 x 45 (on edge)
90 x 45	1200	900	90 x 45 (on edge)
45 x 90	600	400	90 x 45 (on edge)
NOTE – All joints fixed using a minimum of 2 / 90 x 3.15 mm nails.			



Unless otherwise stated, all dimensions are in mm.

Figure 10.16 – Gable verge framing (see 10.2.1.15)



NOTE – Typical detail showing fly rafter and outrigger orientations.
Sizes and orientation to be taken from table 10.9.

Unless otherwise stated, all dimensions are in mm.

Figure 10.16(a) – Fly rafter/outrigger orientation

10.2.1.16 Purlins and tile battens

10.2.1.16.1

The size of *purlins* shall be taken from table 10.10 (on their flat) or table 10.11 (on their edge) using *spacing* to suit the spanning capability of the *cladding*.

Purlins on their flat may be substituted for the following sizes on their edge:

On flat	On edge
70 x 45	70 x 45
90 x 45	70 x 45

C10.2.1.16.1

Spacings should not be greater than those recommended by the manufacturer of the roof cladding.

Table 10.10 – Purlins on their flat in all wind zones – SG 8 (see 10.2.1.16.1)

Purlin size	Max. span	Maximum spacing and fixing in the following wind zones									
		Low		Medium		High		Very high		Extra high	
		Spacing	Fixing	Spacing	Fixing	Spacing	Fixing	Spacing	Fixing	Spacing	Fixing
	(mm)	(mm)	(type)	(mm)	(type)	(mm)	(type)	(mm)	(type)	(mm)	(type)
70 x 45	900	900	S	900	T	900	T	900	T	900	U
70 x 45	900	1200	T	1200	T	1200	T	1050	U	900	U
70 x 45	900	1800	T	1800	U	1400	U	1050	U	900	U
70 x 45	1200	1200	T	1150	T	800	T	600	T	500	T
70 x 45	1200	1300	T	1150	T	800	T	600	T	500	T
90 x 45	1200	1700	T	1450	U	1000	U	750	U	650	U

Fixing type	Description	Alternative fixing capacity (kN)
S	2 / 90 x 3.15 gun nails	0.8
T	1 / 10g self-drilling screw, 80 mm long	2.4
U	1 / 14g self-drilling type 17 screw, 100 mm long	5.5

NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

Table 10.11 – Purlins on their edge in all wind zones – SG 8 (see 10.2.1.16.1)

Purlin size (depth x thickness)	Purlin spacing (mm)							
	600		900		1200		1800	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
140 x 45	2.6	E	2.2	E	2.0	F	1.7	E
190 x 45	3.5	E	3.1	F	2.8	F	2.4	F
240 x 45	4.4	F	3.9	F	3.5	F	3.0	SED
290 x 45	5.4	E	4.7	F	4.1	SED	3.4	SED

Fixing type	Description	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

10.2.1.16.2

Purlins on their flat and *tile battens* shall be laid directly over *rafters*, trusses or dummy *rafters* and parallel to the associated ridge or eaves line (see figures 10.18 and 10.19 and table 10.10). *Purlins* on their edge shall be laid over, and fixed to *top plates* of *walls* (see table 10.11).

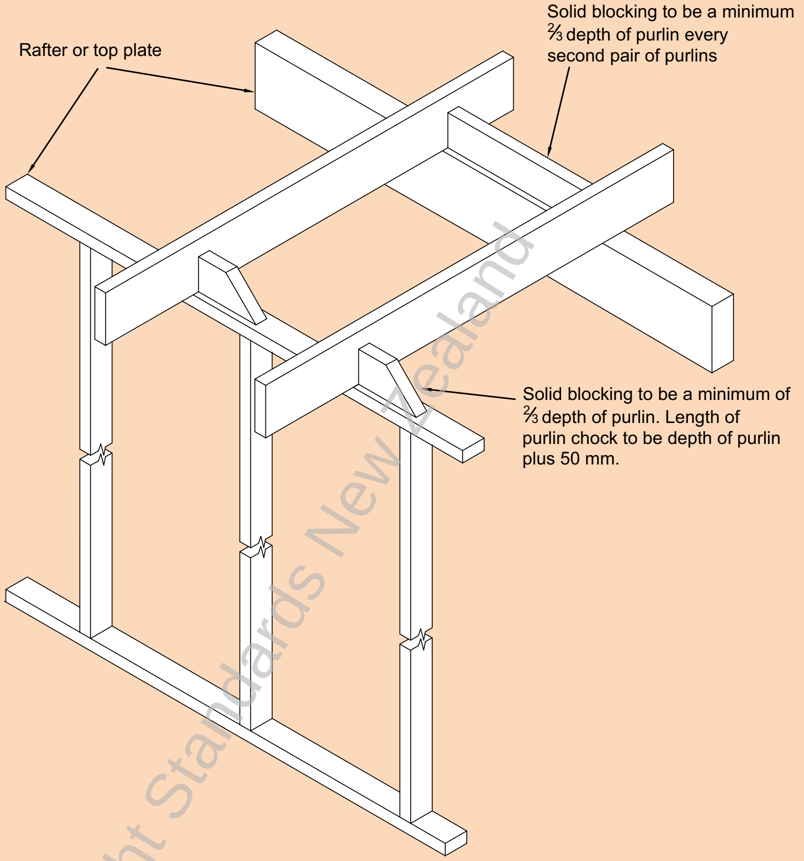


Figure 10.17 – Solid blocking for purlins (see 10.2.1.16.6.1)

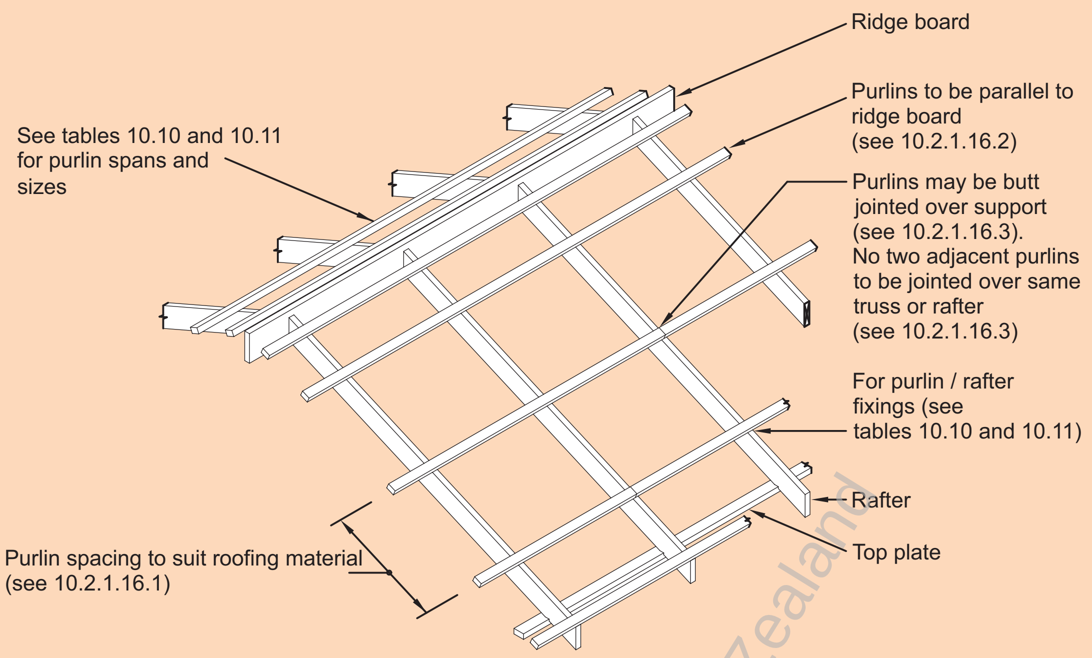
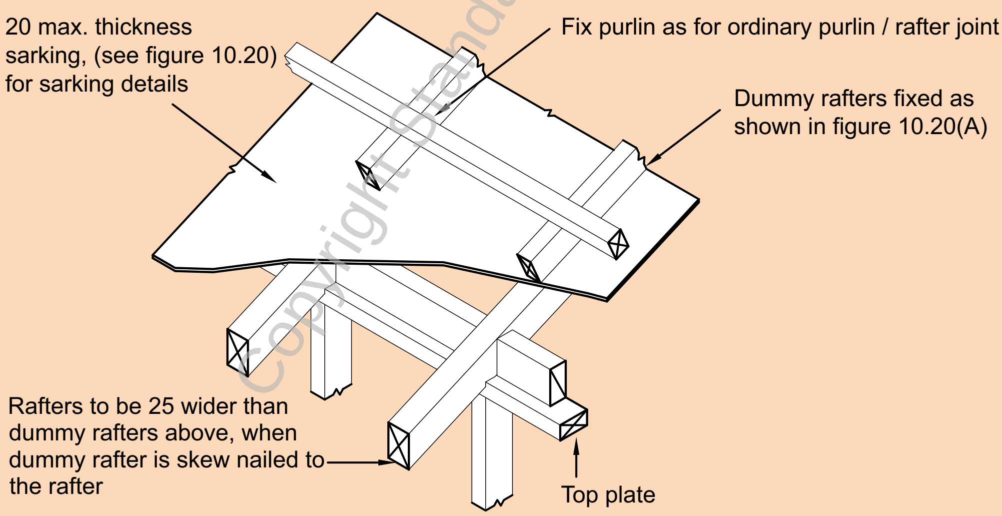


Figure 10.18 – Purlins fixed directly to rafters (see 10.2.1.16.2)



Unless otherwise stated, all dimensions are in mm.

Figure 10.19 – Fixing purlins and dummy rafters to skillion roofs (see 10.2.1.16.2 and 10.2.1.17.2)

10.2.1.16.3

Purlins on their flat and *tile battens* shall be continuous over at least two *spans*, and may be butt jointed over supports provided that no two adjacent *purlins* or *tile battens* shall be jointed over the same truss or *rafter*. *Purlins* on their edge may be single *spans*.

C10.2.1.16.3

The strength of purlins is increased by being a continuous length over as many spans as possible.

10.2.1.16.4

Purlins may extend as cantilevers to form a *gable* verge as provided by 10.2.1.15.1.

10.2.1.16.5

Purlins and *tile battens* shall be fixed in accordance with the following:

(a) Fixed to *rafters*, trusses or *top plates* in accordance with table 10.10 and table 10.11;

(b) Where *purlins* on their flat and tile *battens* are laid directly over sheet *sarking* or ceiling sheet *lining material* of maximum 20 mm thickness, the *purlin* or *tile batten* shall be fixed as shown in figure 10.20(B). Alternative fixings with required uplift *capacity* determined in accordance with 2.4.7 may be used.

10.2.1.16.6

Purlins on their edge shall be laterally supported by *blocking* in accordance with 10.2.1.16.6.1, located in accordance with 10.2.1.16.6.2. See figure 10.17.

10.2.1.16.6.1

Lateral support shall be provided by *blocking* in accordance with figure 10.17. Fixing to *purlin* shall be by 2 / 100 x 3.75 FH or 2 / 90 x 3.15 gun nails at each end (see figure 10.17).

10.2.1.16.6.2

Blocking shall be located at each line of support, and at mid-*span* of the *purlin* where its *span* exceeds 2.5 m.

10.2.1.16.7 Tile battens

Tile battens shall be selected for strength on site as follows:

Battens shall be selected so as to be free from visual defects, or alternatively be able to resist a load of 100 kg gradually applied at mid-*span* without failure. The test *span* shall be the same as the spacing of the *rafters* where the *batten* is to be used.

The size and fixing of *tile battens* shall be taken from table 10.12.

C10.2.1.16.7

The test represents the weight of a roof worker, and may be conducted between any two suitable supports at ground level.

Table 10.12 – Tile battens for all wind zones (see 10.2.1.16.7)

Tile batten size	Max. span	Maximum spacing and fixing in the following wind zones									
		Low		Medium		High		Very high		Extra high	
		Spacing	Fixing	Spacing	Fixing	Spacing	Fixing	Spacing	Fixing	Spacing	Fixing
(mm)		(mm)		(mm)		(mm)		(mm)		(mm)	
Light roof cladding											
50 x 40	900	370	R	370	R	370	S	370	S	370	T
50 x 50	1200	370	R	370	S	370	T	370	T	370	T
Heavy roof cladding											
50 x 25	480	370	R	370	R	370	R	370	R	370	R
50 x 40	600	370	R	370	R	370	R	370	R	370	R
50 x 50	900	370	R	370	R	370	R	370	R	370	R

Fixing type	Description	Alternative fixing capacity (kN)
R	1 / 90 x 3.15 gun nail	0.55
S	2 / 90 x 3.15 gun nails	0.8
T	1 / 10g self-drilling screw, 80 mm long	2.4

10.2.1.17 Dummy rafters

10.2.1.17.1

Dummy *rafters* may be laid over sheet *sarking* or ceiling *lining* material which is a maximum of 20 mm thick (see figure 10.20).

10.2.1.17.2

Purlin to dummy *rafter* and dummy *rafter* to *rafter* fixings shall be as given by table 10.13 and figures 10.19 and 10.20.

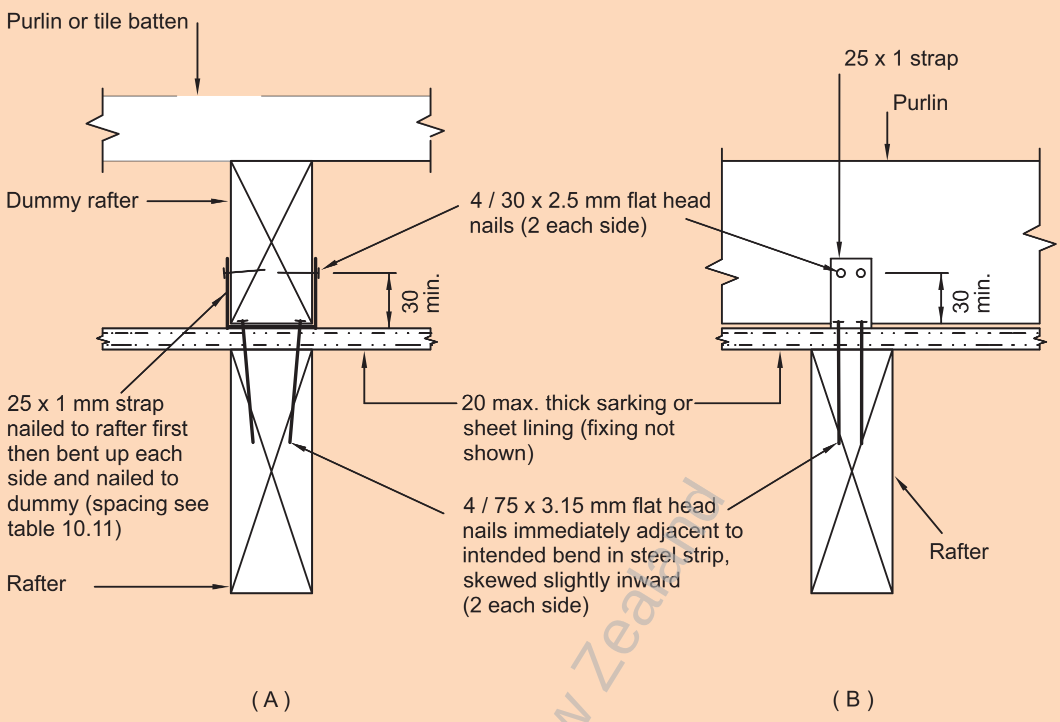


Figure 10.20 – Fixing purlins and dummy rafters to sarked roofs (see 10.2.1.17.1)

Table 10.13 – Spacing of fixings for dummy rafters for sarked roofs (see 10.2.1.17.2)

Rafter spacing	Fixing type	Fixing spacings for wind zone (mm)				
(mm)	Wind zone	Low	Medium	High	Very high	Extra high
600	25 x 1 mm steel strap	1600	1200	800	650	500
900	25 x 1 mm steel strap	1000	800	600	400	300
1200	25 x 1 mm steel strap	650	500	400	300	–

10.2.2 Roof trusses

This clause applies to timber nailed-plated *roof* trusses.

C10.2.2

This does not preclude the use of other types of timber roof trusses, however the design of these is outside the scope of NZS 3604.

10.2.2.1 Design and fabrication

Roof trusses shall be *SED* in accordance with B1/VM1 and manufactured by an accredited fabricator. The truss design and construction is outside the scope of this Standard.

C10.2.2.1

An accredited fabricator is a company accredited by a nail-plate manufacturer to fabricate roof trusses using nail-plates and construction specifications supplied by that same nail-plate manufacturer.

An accredited fabricator is also licensed to use certified specific design software, supplied by the nail-plate manufacturer.

Roof truss designs may be prepared by the nail-plate manufacturer or by other parties accredited by the nail-plate manufacturer, however, such designs should be manufactured by an accredited fabricator as per the requirements of this clause.

10.2.2.2 Maximum dimensions and spacings

Roof trusses shall comply with the following:

(a) The *support span* of a *roof* truss as given by figure 1.3 (A) shall not exceed 12 m;

(b) The eaves overhang shall not exceed 750 mm measured horizontally from the face of the support;

(c) Truss *spacing* shall not exceed 900 mm for *heavy roofs* or 1200 mm for *light roofs*;

(d) The loadbearing reaction of a *roof* truss, including girder trusses determined in accordance with AS/NZS 1170, shall not exceed 16 kN in a downwards or upwards direction; and

(e) Should *snow load* exceed 2 kPa on the ground as per section 15, *SED* is required.

C10.2.2.2

The loadbearing reaction for a roof truss is the worst case (most conservative) combination of actions (loads) for both upwards and downwards direction as set out in AS/NZS 1170.0.

10.2.2.3 Drawings and specifications

Roof truss layouts and fabricator statements shall be provided for all *roof* truss systems. These shall be location/site specific showing issue date and shall contain information relating to the specific design as well as all necessary information to install the trusses in accordance with their specific design and shall specifically include:

(a) A producer statement (design) issued by a chartered professional engineer verifying the design software;

(b) A design statement issued by an accredited fabricator including the following information:

- (i) Identification that the timber grades used, as a minimum, are as specified in NZS 3603 or AS/NZS 4357;
- (ii) The truss job/design reference name or number;
- (iii) The permanent actions (dead *loads*) i.e. *cladding* and ceiling materials;
- (iv) The imposed actions (live *loads*) i.e. *floor loads*;
- (v) The wind action;
- (vi) The snow action. The *snow load* at *ground level*;
- (vii) The *roof* pitch;
- (viii) The truss eaves overhang;
- (ix) A list of trusses showing individual truss labels, *spans* and maximum *spacing*;
- (x) A layout drawing showing truss labels and locating dimensions;
- (xi) Identification of supporting structures i.e. *loadbearing walls*;
- (xii) Nomination and location of truss to truss and truss to supporting structure fixings;
- (xiii) Lateral support requirements, if any, for individual truss member stability;

C10.2.2.3

Other than the manufacturing statement, the information in 10.2.2.3 is required as part of the design process and should be sought from an accredited roof truss fabricator prior to completion of the design of the supporting structure.

The manufacturing statement, design statement and producer statement (design) are linked documents that are intended to reference each other providing evidence of the process path between design and manufacture.

(xiv) Notification and location of any loadbearing reactions outside the scope of 10.2.2.2(d);

(c) A manufacturing statement issued by the fabricator identifying that the trusses have been manufactured in accordance with the design statement and truss layout.

10.2.2.4 Handling, transport, and erection

Handling, transport, and installation procedures for *roof* trusses shall protect the trusses from damage.

10.2.2.5 Truss identification

A selection of trusses in a job lot manufactured by a fabricator shall carry identification labels or markings fitted during manufacture. Identification shall be evident on the bottom chords of main *rafter* or girder trusses on a minimum of six trusses in a job lot, or on every truss where there are less than six trusses in the job lot. Identification text shall be a minimum of 10 mm high and shall include:

(a) The fabricator name;

(b) The nail-plate manufacturer name;

(c) The truss job/design reference name or number.

10.2.2.6 Anchorage

The fixing for a *roof* truss at its support shall be as given by the truss fabricator but not less than that required in tables 10.14 and 10.15 and figure 10.21.

10.2.2.7 Roof truss bracing

Roof truss *bracing* shall be in accordance with 10.3.

C10.2.2.4

Any truss that has been damaged should be removed from the site, or advice on repairs sought from the person or firm responsible for the specific design of the truss. This applies both to accidental damage, including over-stressing of connections, and to deliberate actions such as cutting a truss member to facilitate erection. Roof trusses should be installed in accordance with the drawings and specifications so as to be plumb and properly aligned at the required spacings.

C10.2.2.5

There needs to be traceability such that a truss job lot can be identified on site and then linked back to the fabricator and the supporting documentation.

C10.2.2.6

Table 10.14 provides fixings for roof trusses at their supports for simple truss layouts only. It does not provide fixings for girder trusses, hip trusses or complex truss roof systems. The load paths and fixings for these are to form part of the overall truss systems design. Alternative fixings can be selected provided they meet the minimum capacity requirements of table 10.15.

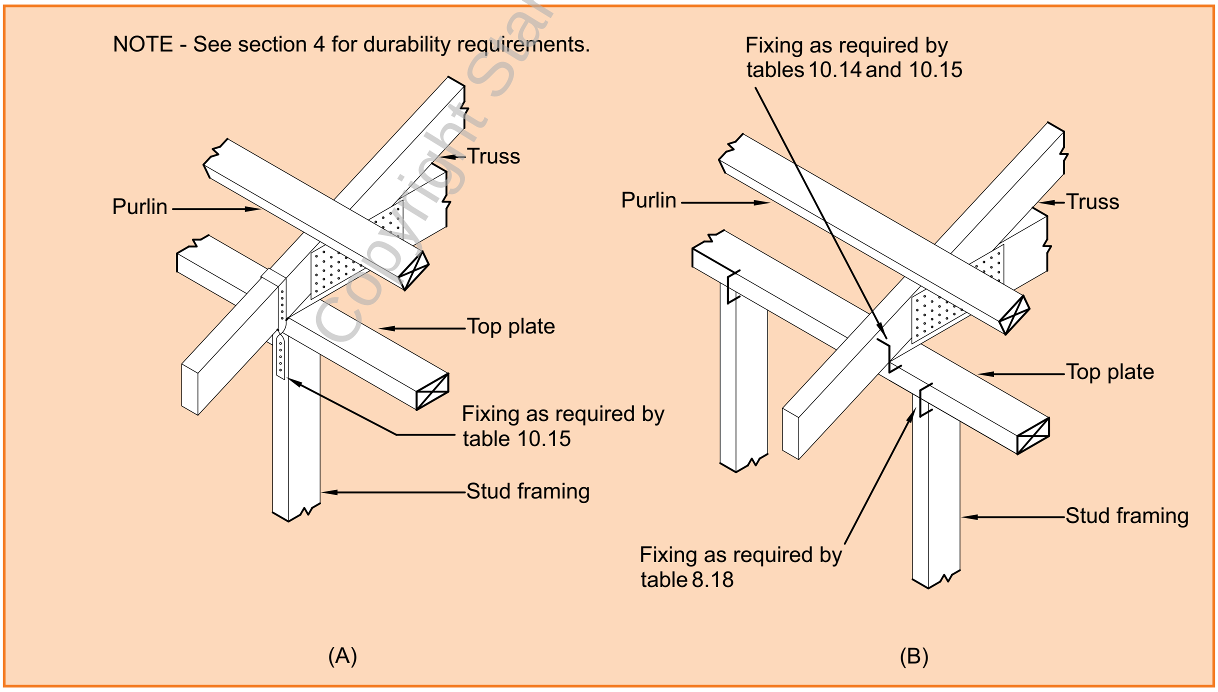


Figure 10.21 – Truss/top plate connections (see 10.2.2.6)

Table 10.14 – Fixing types of roof trusses at supports for all wind zones (see 10.2.2.6)

Truss spacing (mm)	Fixing type														
	Light roofs										Heavy roofs				
	900					1200					900				
Wind zone	**L**	**M**	**H**	**VH**	**EH**	**L**	**M**	**H**	**VH**	**EH**	**L**	**M**	**H**	**VH**	**EH**
Loaded dimension of support (m)															
3.0	E	E	E	E	F	E	E	E	F	F	E	E	E	E	E
3.5	E	E	E	F	F	E	E	E	F	SED	E	E	E	E	E
4.0	E	E	E	F	F	E	E	F	SED	SED	E	E	E	E	F
4.5	E	E	E	F	SED	E	E	F	SED	SED	E	E	E	E	F
5.0	E	E	E	F	SED	E	E	F	SED	SED	E	E	E	E	F
5.5	E	E	F	F	SED	E	E	F	SED	SED	E	E	E	F	F
6.0	E	E	F	SED	SED	E	E	SED	SED	SED	E	E	E	F	SED

Fixing type	Fixing to resist uplift	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

Table 10.15 – Key to fixing types and capacity for rafters, roof trusses, underpurlins, ridge beams and strutting beams (see 10.2.2.6)

Fixing type	Fixing to resist uplift	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0
G	10 / 90 x 3.15 nails (5 each side)	4.7
H	1 / M12 bolt	8.5
I	2 / M12 bolts	16.0
J	2 / M16 bolts	24.0
K	6 / 90 x 3.15 nails	3.0
L	2 / M12 bolts	9.8
M	2 / M16 bolts	13.0

10.3 SYSTEMS TO RESIST HORIZONTAL LOADS

Table 10.16 summarizes the requirements of 10.3.

Table 10.16 – Summary of roof bracing systems (see 10.1.4)

Roof type	Roof plane diagonal brace	Roof space diagonal braces	Hip or valley rafters	Sarking or ceiling directly fixed to rafters or top chord of trusses
Light	One per 50 m^2			Continuous
Heavy	One per 25 m^2			Continuous

NOTE –
(1) Roofs with hip and valley rafters shall have at least 3 hips or valleys connected to the ridge and top plates (see 10.3).
(2) Additional hip and valley rafters shall be counted as roof plane braces.

10.3.1 General

Roof bracing for both truss and framed *roofs* shall be provided in accordance with this clause, provided that *roof* plane *braces* and *roof* space *braces* may be omitted where there is:

(a) *Sarking* complying with 10.4.4; or

(b) A structural ceiling *diaphragm* complying with 13.5 and directly attached to the *rafters*.

Small *roof* planes of less than 6 m^2, such as dormers or porches, do not require *bracing*.

10.3.2 Light pitched roofs

Light *pitched roofs* shall be *braced* by one *brace* complying with 10.4 for each 50 m^2, or part thereof, of plan area including overhangs, with a minimum of 2 *braces* for each ridge line.

10.3.3 Heavy pitched roofs

Heavy *pitched roofs* shall be *braced* by one *brace* complying with 10.4 for each 25 m^2, or part thereof, of plan area including overhangs, with a minimum of 2 *braces* for each ridge line.

10.3.4 Monopitch roofs

Unless the *wall* is *braced* full height, monopitch *roofs* where the ceiling is not directly attached to the *rafters* shall be considered to be a *pitched roof* and shall comply with 10.3.2, or 10.3.3. The highest support shall be considered to be a ridge line.

10.3.5 Flat roofs

No specific provisions are required for *flat roofs* less than 5°, see 10.1.1(d).

10.4 ROOF BRACING DETAIL

10.4.1 General

Roof bracing as required by 10.3 shall consist of either *roof* plane *braces* in accordance with 10.4.2, *roof* space *braces* in accordance with 10.4.3, or *sarking* in accordance with 10.4.4. Combinations of these *brace* types are permissible, as long as the total required number of *braces* is provided.

10.4.2 Roof plane diagonal braces – Timber

See figure 10.22 for timber *roof* plane diagonal *bracing* details.

10.4.2.1 Distribution

Braces shall intersect each end of the ridge line and any additional *braces* shall, as far as practicable, be evenly distributed along the ridge and run alternately in opposing directions.

10.4.2.2 Braces

Each *roof* plane *brace* shall consist of one of:

(a) A continuous length of 90 mm x 19 mm timber at 45° to the ridge line, in the plane of the *roof* and continuous from the ridge to the supporting *wall*;

(b) A diagonally opposing pair of continuous steel strips each having a *capacity* of 4.0 kN in tension, fixed to each top chord or *rafter* that is intersected, and to the *top plate*; or

(c) A hip or *valley rafter* in accordance with 10.2.1.3.2, and 10.2.1.3.3.

C10.4.2.2

(c) Blocking between trusses or joists may be necessary at the intersection with the top plate (see figure 10.22).

10.4.2.3 Fixings

Fixings to each *roof framing* member, except at the bottom end, shall be as per table 10.15.

Fixings at the bottom end shall be one of (as appropriate):

(a) 4 / 75 x 3.15 nails to the last *rafter*/truss crossed, plus 4 / 75 x 3.15 nails to *blocking* between *rafters*/trusses, as shown in figure 10.22;

(b) The strip shall be wrapped around the *top plate*, and to the *ridge board* if present, and fixed with 5 / 75 x 3.15 nails to the *top plate*; or

(c) A hip or *valley rafter* in accordance with 10.2.1.3.

10.4.3 Roof space diagonal braces

See figure 10.23 for *roof* space *diagonal bracing* requirements.

10.4.3.1

Roof space *diagonal braces* shall as far as possible be evenly distributed over the length of the *roof* and run alternately in opposite directions.

10.4.3.2 Braces

Each *roof* space *diagonal brace* shall:

(a) Run not steeper than 45° to the horizontal from top chord level to bottom chord level or from *ridge board* or *rafter* level to ceiling *joist* level as appropriate;

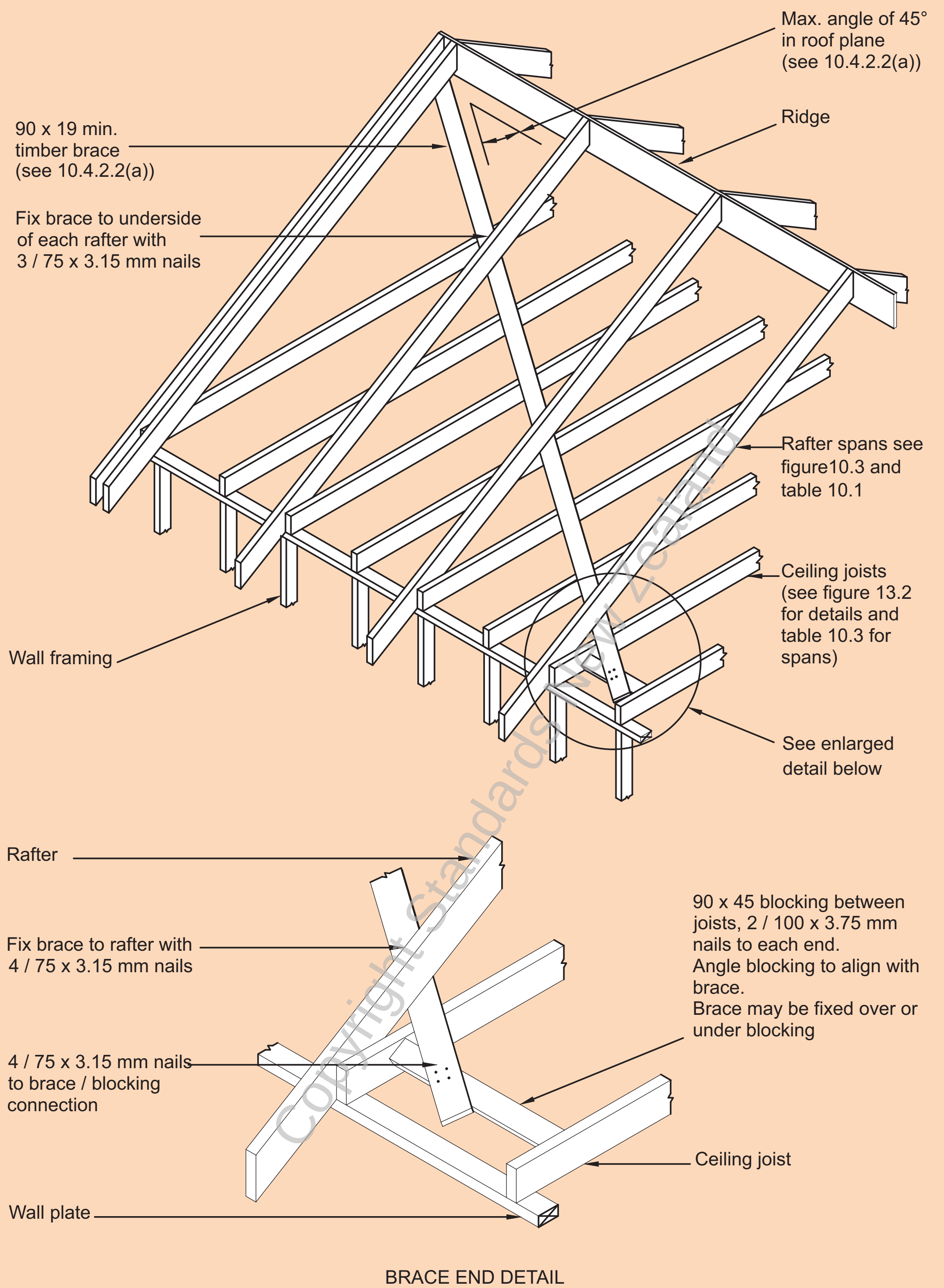
(b) Consist of 90 mm x 45 mm continuous members as required in table 10.17. Where two members are required they shall be *spaced* 45 mm apart and nailed together through the *spacing* pieces at centres not exceeding 1 m.

Table 10.17 – Roof space diagonal braces

Roof space diagonal braces	
Member size (mm)	**Timber grade**
	SG 8
	Maximum length (m)
90 x 45	1.85
2 / 90 x 45 spaced	4.80

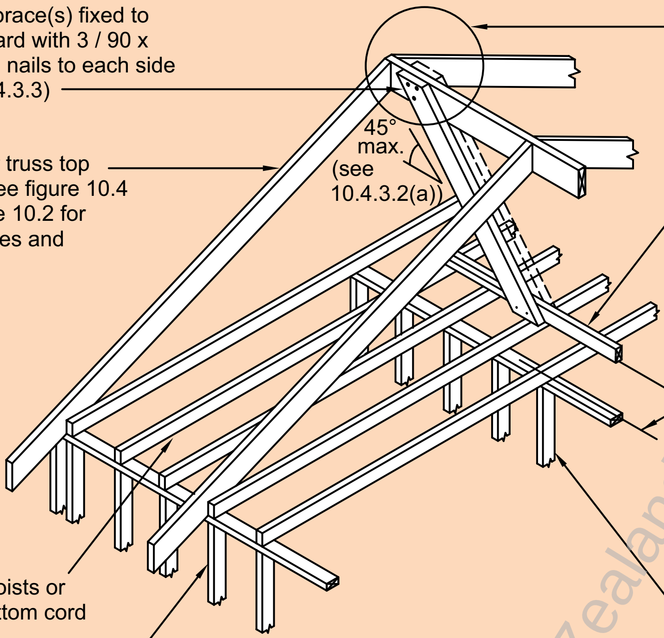
10.4.3.3 Top fixings

The top end of each *roof* space *diagonal brace* shall be fixed to the *ridge board* or to a 90 mm x 45 mm *blocking* piece fixed between adjacent top *chords* or *rafters*.

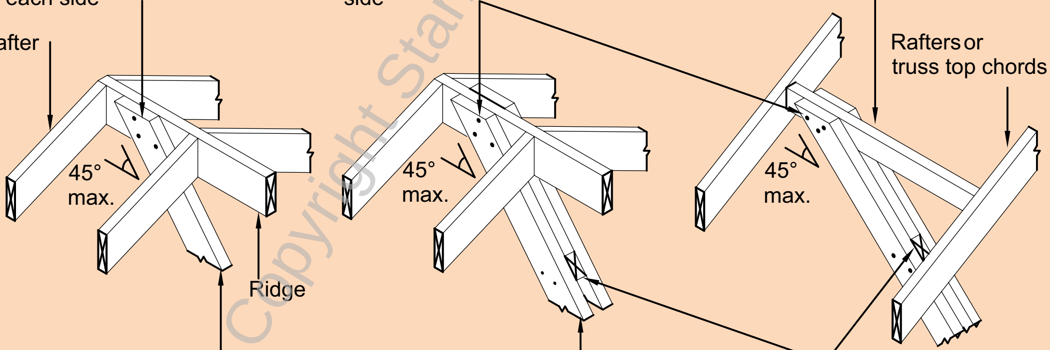


Unless otherwise stated, all dimensions are in mm.

Figure 10.22 – Roof plane diagonal brace – Timber (see 10.4.2)



NOTE –
(1) Roof space diagonal braces shall, as far as possible, be evenly distributed over the length of the roof.
(2) Braces shall be installed in alternately opposite directions where more than 1 brace is required (see 10.4.3.1).



(A) LESS THAN 2 m LONG (see 10.4.3.2(b))

(B) GREATER THAN 2 m LONG (see 10.4.3.2(b))

(C) WHERE BRACE IS NOT DIRECTLY UNDER THE RIDGE (see 10.4.3.3)

Unless otherwise stated, all dimensions are in mm.

Figure 10.23 – Roof space diagonal brace – Alternative fixings (see 10.4.3)

10.4.3.4 Bottom fixings

The bottom end of each *roof* space *diagonal brace* shall be fixed to a 70 mm x 45 mm *brace runner* which shall:

(a) Either be laid over a ceiling *diaphragm* complying with 13.5 or run parallel to and within 300 mm measured centre-to-centre of a *wall* containing a *wall bracing element*;

(b) Be fixed to not less than 2 bottom chords or ceiling *joists* on each side of the *diagonal brace*.

10.4.4 Sarking

10.4.4.1 Hit and miss sarking

Hit and miss *sarking* shall consist of boards of 140 x 19 mm size, inclined at between 40° and 50° to the ridge line. *Spacing* shall be not more than a board width apart. Boards shall be fixed to each *rafter* with 2 / 75 x 3.15 nails. Boards shall be joined only over *rafter* members or top chords.

10.4.4.2 Sheet sarking

Sheet *sarking* shall:

(a) Be one of:

(i) Plywood not less than 6 mm thick three-ply;

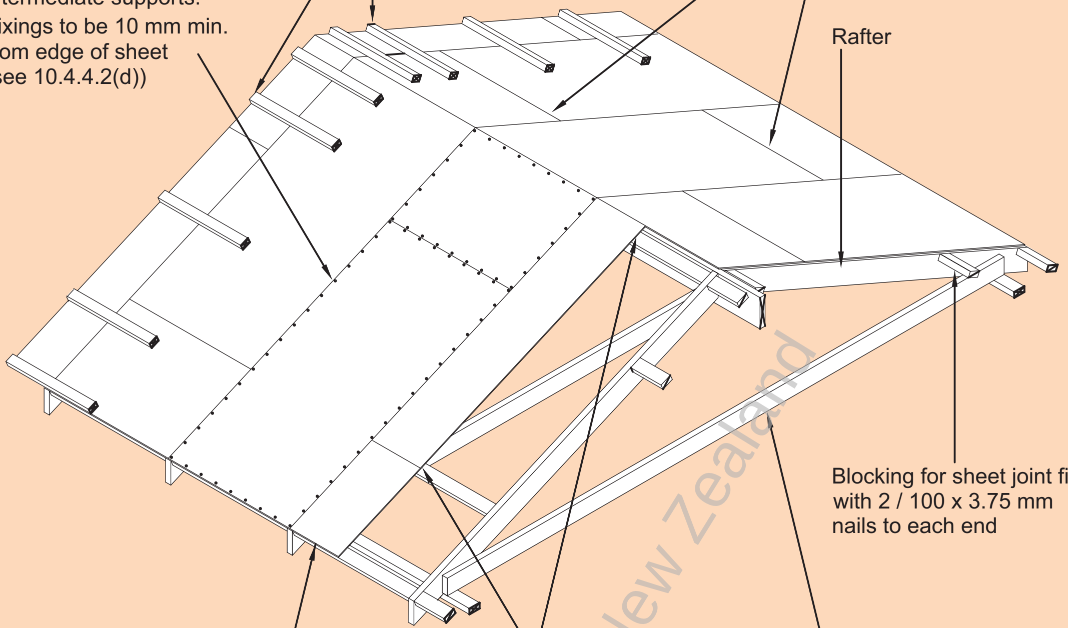
(ii) Any other wood-based product of not less than 4.5 mm thick having a density not less than 880 kg/m^3; or

(iii) Any other wood-based product of not less than 6 mm thick having a density not less than 600 kg/m^3;

(b) Cover the entire *roof* surface (see figure 10.24);

(c) Be fixed directly to *rafters* or truss top chords; and

(d) Have fixings of not less than 10 mm from sheet edges.



NOTE -
(1) Sheet sarking shall comprise (see 10.4.4.2(a)):
(a) 3 ply plywood not less than 6 mm thick; or
(b) 4.5 mm min. wood-based product with a density not less than 880 kg/m^3 ; or
(c) 6 mm min. wood-based product with a density not less than 600 kg/m^3.
(2) Sheet sarking may substitute for roof plane braces.

Unless otherwise stated, all dimensions are in mm.

Figure 10.24 – Sheet sarked roof (see 10.4.4.2(b))

10.5 NAILING SCHEDULE FOR ROOFS

10.5.1

Table 10.18 lists the size, number and location of nails to be used in *roof framing*. See 2.4 and 4.4.3 for other requirements for nails.

10.5.2

Rafter to *ridge beam* connections shall be as detailed in figure 10.5.

Table 10.18 – Nailing schedule for hand-driven and power-driven nails (see 10.5.1)

Joint	Hand-driven nails		Power-driven nails	
	Length (mm) **x diameter** (mm) **and type**	**Number/ Location**	**Length** (mm) **x diameter** (mm) **and type**	**Number/ Location**
Roof framing				
Rafter or jack rafter to ridge board or top plate (except skillion roofs) (see 10.2.1.3.7)	See table 10.1	See table 10.1	See table 10.1	See table 10.1
Truss to top plate of external wall	See tables 10.14 and 10.15	See tables 10.14 and 10.15	See tables 10.14 and 10.15	See tables 10.14 and 10.15
Truss to top plate of internal wall	100 x 3.75	2	90 x 3.15	2
Ceiling batten to parallel top plate of internal wall bracing element	75 x 3.15	2 at 400 mm centres	90 x 3.15	2 at 400 mm centres
Collar tie or cleat to rafter	75 x 3.15	4	75 x 3.06	4
Flitches to ridge board and roof members for each side on both joints	60 x 2.8	3	60 x 2.8	3
Hip rafter to top plate	See table 10.1	See table 10.1	See table 10.1	See table 10.1
Underpurlin strut to underpurlin or top plate or strutting beam	100 x 3.75 together with fixing types as set out in table 10.5	2	90 x 3.15 together with fixing types as set out in table 10.5	3
Strutting beam to top plate	See table 10.7	See table 10.7	See table 10.7	See table 10.7
Roof braces at each connection to a framing member:				
(a) 90 mm x 19 mm brace	75 x 3.15	3	75 x 3.15	3
(b) 70 mm x 45 mm brace runner	100 x 3.75	2	90 x 3.15	3
(c) 90 mm x 45 mm brace	100 x 3.75	3	90 x 3.15	5
(d) Steel strip brace				
(i) At ends	60 x 3.15	3	–	–
(ii) Other cases	60 x 3.15	2	–	–
(iii) To ends of braces	–	–	–	–

NOTE –
(1) Nail lengths and diameters are the minimum required.
(2) Refer to 4.4 for required protective coatings for metal fasteners.
(3) Proprietary fixings with the required fixing capacity indicated in the tables may be used.

Table 10.18 – Nailing schedule for hand-driven and power-driven nails (continued) (see 10.5.1)

Joint	Hand-driven nails		Power-driven nails	
	Length (mm) **x diameter** (mm) **and type**	**Number/ Location**	**Length** (mm) **x diameter** (mm) **and type**	**Number/ Location**
Roof framing (continued)				
Blocking between rafters, joists or truss chords, 90 mm x 45 mm	100 x 3.75	2 (end nailed)	90 x 3.15	2 (end nailed)
Outrigger to gable top plate (as for equivalent purlins)	See table 10.10 and table 10.11	See table 10.10 and table 10.11	See table 10.10 and table 10.11	See table 10.10 and table 10.11
Outrigger to rafter	100 x 3.75 or 75 x 3.15	2 (end nailed) 4 (skewed)	90 x 3.15	3 (end nailed)
Flying rafter to outrigger	100 x 3.75	2	90 x 3.15	3
Outrigger blocking to top plate	100 x 3.75	4 (skewed)	90 x 3.15	4 (skewed)
Purlin or batten directly to rafter or top chord	See table 10.10 and table 10.11	See table 10.10 and table 10.11	See table 10.10 and table 10.11	See table 10.10 and table 10.11
Roof sarking				
Board sarking to rafters or top chords: (a) Boards not exceeding 75 mm wide (b) Boards exceeding 75 mm wide	2½ x finished thickness	1 2	– –	– –
Sheet material for sheet sarking to: (a) Rafters or top chords at sheet edges (b) Intermediate supports	30 x 2.5 FH	150 mm centres 300 mm centres	– –	– –
Purlins or battens through sarking to rafter or top chord	See table 10.15	See table 10.15	See table 10.15	See table 10.15

NOTE –
(1) Nail lengths and diameters are the minimum required.
(2) Refer to 4.4 for required protective coatings for metal fasteners.
(3) Proprietary fixings with the required fixing capacity indicated in the tables may be used.

APPENDIX A – SG 6 AND SG 10 TABLES

(Normative)

Table A10.1 – Rafters for all wind zones – SG 6 (see 10.2.1.3.2)

Rafter size (width x thickness)	**Rafter spacing** (mm)							
	480		**600**		**900**		**1200** (see Note (4))	
	Span	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**
(a) Ordinary rafters for light and heavy roofs								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	1.0	E	0.9	E	0.9	E	0.9	E
140 x 45	2.1	E	2.0	E	1.8	E	1.9	E
190 x 45	3.1	E	2.9	E	2.5	E	2.2	E
240 x 45	3.4	E	3.2	E	2.7	E	2.5	E
290 x 45	3.6	E	3.4	E	2.9	E	2.7	E
140 x 70	2.9	E	2.6	E	2.3	E	2.5	E
190 x 70	3.9	E	3.6	E	3.1	E	3.2	E
240 x 70	4.9	E	4.6	E	4.0	E	3.7	E
290 x 70	5.7	E	5.2	E	4.5	E	4.1	F
140 x 90	3.1	E	2.9	E	2.5	E	2.7	E
190 x 90	4.2	E	3.9	E	3.4	E	3.7	E
240 x 90	5.4	E	5.0	E	4.3	E	4.6	F
290 x 90	6.5	E	6.0	E	5.3	F	5.2	F

The table gives maximum spans for Extra high wind zone.
In other wind zones, span lengths shall be multiplied by the following factors:

Low and Medium:	**1.3**	**High and Very high:**	**1.1**

Fixing type	**Description**	**Alternative fixing capacity** (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

NOTE –
(1) Rafter spans may be increased by 10 % for rafters continuous over 2 or more spans that have not been birds mouthed at intermediate supports.
(2) Fixing types at intermediate supports for rafters running continuously over those supports shall have double the capacity of the fixing types given in this table.
(3) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.
(4) Rafter spacing of 1200 mm does not include heavy roofs.

Table A10.1 – Rafters for all wind zones – SG 6 (continued) (see 10.2.1.3.2)

Rafter size (width x thickness)	**Maximum span of valley rafters and their fixing types for all wind zones** (m)			
	Light roof		**Heavy roof**	
	Rafter span	**Fixing**	**Rafter span**	**Fixing**
(b) Valley rafters for light and heavy roofs				
(mm x mm)	(m)	type	(m)	type
90 x 45	1.5	E	1.3	E
140 x 45	2.1	E	1.9	E
190 x 45	2.6	E	2.4	E
240 x 45	3.0	E	2.9	E
290 x 45	3.4	E	3.3	E
90 x 70	1.7	E	1.5	E
140 x 70	2.4	E	2.1	E
190 x 70	3.0	E	2.7	E
240 x 70	3.5	E	3.2	E
290 x 70	4.0	E	3.7	E

Fixing type	**Fixing to resist uplift**	**Alternative fixing capacity** (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7

NOTE –
(1) Proprietary fixings that have the required fixing capacity indicated in tables may be used.
(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.1 – Rafters for all wind zones – SG 10 (see 10.2.1.3.2)

Rafter size (width x thickness)	**Rafter spacing** (mm)							
	480		**600**		**900**		**1200** (see Note (4))	
	Span	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**
(a) Ordinary rafters for light and heavy roofs								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	1.8	E	1.7	E	1.5	E	1.7	E
140 x 45	3.0	E	2.8	E	2.5	E	2.5	E
190 x 45	4.0	E	3.7	E	3.2	E	2.9	E
240 x 45	4.3	E	4.0	E	3.5	E	3.2	E
290 x 45	4.6	E	4.3	E	3.7	E	3.4	E
140 x 70	3.5	E	3.3	E	2.9	E	3.1	E
190 x 70	4.8	E	4.5	E	3.9	E	4.2	F
240 x 70	6.1	E	5.6	E	4.9	E	4.9	F
290 x 70	7.2	E	6.7	E	5.8	F	5.2	F
140 x 90	3.8	E	3.6	E	3.1	E	3.4	E
190 x 90	5.2	E	4.9	E	4.2	E	4.6	F
240 x 90	6.6	E	6.1	E	5.4	F	5.6	F
290 x 90	7.9	E	7.4	E	6.5	F	6.4	SED

The table gives maximum spans for Extra high wind zone.
In other wind zones, span lengths shall be multiplied by the following factors:

Low and Medium:	**1.3**	**High and Very high:**	**1.1**

Fixing type	**Description**	**Alternative fixing capacity** (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

NOTE –
(1) Rafter spans may be increased by 10 % for rafters continuous over 2 or more spans that have not been birds-mouthed at intermediate supports.
(2) Fixing types at intermediate supports for rafters running continuously over those supports shall have double the capacity of the fixing types given in this table.
(3) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.
(4) Rafter spacing of 1200 mm does not include heavy roofs.

Table A10.1 – Rafters for all wind zones – SG 10 (continued) (see 10.2.1.3.2)

Rafter size (width x thickness)	**Maximum span of valley rafters and their fixing types for all wind zones** (m)			
	Light roof		**Heavy roof**	
	Rafter span	**Fixing**	**Rafter span**	**Fixing**
(b) Valley rafters for light and heavy roofs				
(mm x mm)	(m)	type	(m)	type
90 x 45	1.8	E	1.6	E
140 x 45	2.5	E	2.2	E
190 x 45	3.1	E	2.8	E
240 x 45	3.7	E	3.3	E
290 x 45	4.3	E	3.9	E
90 x 70	2.0	E	1.8	E
140 x 70	2.8	E	2.5	E
190 x 70	3.5	E	3.1	E
240 x 70	4.2	E	3.7	E
290 x 70	4.8	E	4.3	E

Fixing type	**Fixing to resist uplift**	**Alternative fixing capacity** (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7

NOTE –
(1) Proprietary fixings that have the required fixing capacity indicated in tables may be used.
(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.2 – Ridge beams for all wind zones – SG 6 (see 10.2.1.5.2)

Ridge beam size	Loaded dimension of ridge beam (m)							
	1.8		2.7		3.6		4.2	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(mm x mm)	(m)	type	(m)	type	(m)	type	(m)	type
(a) Light roof								
240 x 45	2.0	G	1.7	H	1.5	H	1.4	H
290 x 45	2.1	G	1.9	H	1.7	H	1.6	H
190 x 70	2.4	H	2.0	H	1.7	H	1.6	H
240 x 70	3.9	H	3.3	I	2.9	I	2.7	I
290 x 70	4.2	I	3.7	I	3.3	I	3.1	I
190 x 90	3.4	H	2.9	I	2.7	I	2.5	I
240 x 90	4.3	I	3.7	I	3.4	I	3.2	I
290 x 90	5.2	I	4.5	I	4.0	J	3.8	J
(b) Heavy roof								
240 x 45	1.9	G	1.6	G	1.4	H	1.3	H
290 x 45	2.2	G	1.8	H	1.6	H	1.5	H
190 x 70	2.0	G	1.7	H	1.4	H	1.3	H
240 x 70	3.3	H	2.9	H	2.6	I	2.4	I
290 x 70	4.0	H	3.5	I	3.1	I	2.9	I
190 x 90	2.8	H	2.5	H	2.2	H	2.1	I
240 x 90	3.6	H	3.1	I	2.8	I	2.7	I
290 x 90	4.3	H	3.8	I	3.4	I	3.3	I

Fixing type	Fixing to resist uplift		Alternative fixing capacity (kN)
	Base connection for built-up studs	Ridge beam to built-up studs	
G	6 / 90 x 3.15 skew nails into bottom plate	10 / 90 x 3.15 nails (5 each side)	4.7
H	25 x 1 strap with 12 nails to stud	1 / M12 bolt	8.5
I	2 / 25 x 1 straps with 6 nails to stud and plate. 24 nails total	2 / M12 bolts	16.0
J	3 / 25 x 1 straps with 12 nails to stud and plate. 36 nails total	2 / M16 bolts	24.0

NOTE –
(1) Fix plate to joist with 1 / M12 x 150 coach screw.
(2) Fix plate to joist with 2 / M12 x 150 coach screws.
(3) Strap nails to be 30 x 2.5 mm.

Table A10.2 – Ridge beams for all wind zones – SG 10 (see 10.2.1.5.2)

Ridge beam size	Loaded dimension of ridge beam (m)							
	1.8		2.7		3.6		4.2	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(mm x mm)	(m)	type	(m)	type	(m)	type	(m)	type
(a) Light roof								
240 x 45	2.6	H	2.2	H	2.0	I	1.9	I
290 x 45	2.7	H	2.4	H	2.1	I	2.0	I
190 x 70	3.0	H	2.6	H	2.4	I	2.3	I
240 x 70	4.8	I	4.2	I	3.8	J	3.6	J
290 x 70	5.4	I	4.7	I	4.2	J	4.0	J
190 x 90	4.2	I	3.6	I	3.3	I	3.1	I
240 x 90	5.3	I	4.6	I	4.2	J	4.0	J
290 x 90	6.4	I	5.6	J	5.0	J	4.8	J
(b) Heavy roof								
240 x 45	2.7	H	2.2	H	1.9	H	1.8	H
290 x 45	2.9	H	2.5	H	2.2	H	2.1	I
190 x 70	2.5	H	2.2	H	2.0	H	1.9	H
240 x 70	4.1	H	3.5	I	3.2	I	3.1	I
290 x 70	4.9	I	4.3	I	3.9	I	3.7	I
190 x 90	3.5	H	3.0	H	2.8	I	2.6	I
240 x 90	4.4	H	3.9	I	3.5	I	3.3	I
290 x 90	5.4	I	4.7	I	4.2	I	4.0	J

Fixing type	Fixing to resist uplift		Alternative fixing capacity (kN)
	Base connection for built-up studs	Ridge beam to built-up studs	
H	25 x 1 strap with 12 nails to stud	1 / M12 bolt	8.5
I	2 / 25 x 1 straps with 6 nails to stud and plate. 24 nails total	2 / M12 bolts	16.0
J	3 / 25 x 1 straps with 12 nails to stud and plate. 36 nails total	2 / M16 bolts	24.0

NOTE –
(1) Fix plate to joist with 1 / M12 x 150 coach screw.
(2) Fix plate to joist with 2 / M12 x 150 coach screws.
(3) Strap nails to be 30 x 2.5 mm.

Table A10.3 – Ceiling joists – SG 6 (see 10.2.1.6.1)

Ceiling joist size	Maximum span* of ceiling joists at a maximum spacing (mm) of:		
	480	600	900
(mm x mm)	(m)	(m)	(m)
90 x 35	1.4	1.3	1.3
90 x 45	1.7	1.7	1.6
140 x 35	3.1	3.0	2.5
140 x 45	3.5	3.2	2.8
190 x 45	4.5	4.2	3.6

* May be increased by 10 % for joists continuous over 2 or more spans.
NOTE – This table is applicable to all wind zones.

Table A10.3 – Ceiling joists – SG 10 (see 10.2.1.6.1)

Ceiling joist size	Maximum span* of ceiling joists at a maximum spacing (mm) of:		
	480	600	900
(mm x mm)	(m)	(m)	(m)
90 x 35	2.4	2.2	2.0
90 x 45	2.6	2.4	2.1
140 x 35	3.8	3.5	3.1
140 x 45	4.1	3.8	3.3
190 x 45	5.3	4.9	4.3

* May be increased by 10 % for joists continuous over 2 or more spans.
NOTE – This table is applicable to all wind zones.

Table A10.4 – Ceiling runners – SG 6 (see 10.2.1.7.1)

Ceiling runner size (width x thickness)	**Maximum span of ceiling runners at a maximum spacing** (m) **of:**		
	1.8	**2.4**	**3.0**
(mm x mm)	(m)	(m)	(m)
140 x 45	1.9	1.8	1.6
190 x 45	2.6	2.4	2.1
240 x 45	3.3	2.8	2.5
290 x 45	3.6	3.1	2.8
290 x 90	5.1	4.7	4.3

NOTE – Members up to 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.4 – Ceiling runners – SG 10 (see 10.2.1.7.1)

Ceiling runner size (width x thickness)	**Maximum span of ceiling runners at a maximum spacing** (m) **of:**		
	1.8	**2.4**	**3.0**
(mm x mm)	(m)	(m)	(m)
140 x 45	2.4	2.2	2.0
190 x 45	3.3	3.0	2.8
240 x 45	4.1	3.8	3.5
290 x 45	5.0	4.4	3.9
290 x 90	6.3	5.8	5.3

NOTE – Members up to 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.5 – Underpurlins for all wind zones – SG 6 (see 10.2.1.9.1, and figures 10.11 and 10.12)

Underpurlin size	Maximum span of underpurlin for loaded dimension* of: (m)					
	1.5		2.1		2.7	
	Span	Fixing	Span	Fixing	Span	Fixing
(a) Light roof						
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	1.0	L	0.8	L	0.7	L
140 x 45	1.5	L	1.3	L	1.2	L
190 x 45	1.9	L	1.7	L	1.5	L
240 x 45	2.1	L	1.9	L	1.7	M
290 x 45	2.3	L	2.0	M	1.9	M
90 x 70	1.2	L	1.1	L	0.9	L
140 x 70	1.9	L	1.7	L	1.5	L
190 x 70	2.6	L	2.3	M	2.0	M
240 x 70	4.2	SED	3.7	SED	3.3	SED
290 x 70	4.5	SED	4.0	SED	3.7	SED
190 x 90	3.6	M	3.2	SED	2.9	SED
240 x 90	4.5	SED	4.0	SED	3.7	SED
290 x 90	5.5	SED	4.9	SED	4.5	SED

Fixing type	Underpurlin to strut fixing to resist uplift (see figures 10.11 and 10.12)	Alternative fixing capacity (kN)
L	2 / M12 Bolts	9.8
M	2 / M16 Bolts	13.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Span may be increased by 10 % for underpurlins continuous over 2 or more spans.

(2) Fixing types for continuous spans shall have double the capacity to that listed in the table.

(3) For the full range of underpurlin fixing types and capacities see table 10.15.

(4) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.5 – Underpurlins for all wind zones – SG 6 (continued) (see 10.2.1.9.1, and figures 10.11 and 10.12)

Underpurlin size	Maximum span of underpurlin for loaded dimension* of: (m)					
	1.5		2.1		2.7	
	Span	Fixing	Span	Fixing	Span	Fixing
(b) Heavy roof						
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	0.8	K	0.7	L	0.6	L
140 x 45	1.3	L	1.1	L	1.0	L
190 x 45	1.7	L	1.5	L	1.3	L
240 x 45	2.1	L	1.8	L	1.6	L
290 x 45	2.4	L	2.1	L	1.8	M
90 x 70	1.0	L	0.9	L	0.8	L
140 x 70	1.6	L	1.4	L	1.2	L
190 x 70	2.2	L	1.9	L	1.7	L
240 x 70	3.5	M	3.1	SED	2.9	SED
290 x 70	4.2	SED	3.8	SED	3.5	SED
190 x 90	3.0	L	2.7	M	2.5	SED
240 x 90	3.8	M	3.4	SED	3.1	SED
290 x 90	4.6	SED	4.1	SED	3.8	SED

Fixing type	Underpurlin to strut fixing to resist uplift (see figures 10.11 and 10.12)	Alternative fixing capacity (kN)
K	6 / 90 x 3.15 nails	3.0
L	2 / M12 Bolts	9.8
M	2 / M16 Bolts	13.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Span may be increased by 10 % for underpurlins continuous over 2 or more spans.

(2) Fixing types for continuous spans shall have double the capacity to that listed in the table.

(3) For the full range of underpurlin fixing types and capacities see table 10.15.

(4) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.5 – Underpurlins for all wind zones – SG 10 (see 10.2.1.9.1, and figures 10.11 and 10.12)

Underpurlin size	Maximum span of underpurlin for loaded dimension* of: (m)					
	1.5		2.1		2.7	
	Span	Fixing	Span	Fixing	Span	Fixing
(a) Light roof						
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	1.3	L	1.1	L	1.0	L
140 x 45	2.0	L	1.8	L	1.6	M
190 x 45	2.5	L	2.2	M	2.0	M
240 x 45	2.7	L	2.4	M	2.2	SED
290 x 45	2.9	M	2.6	M	2.4	SED
90 x 70	1.5	L	1.3	L	1.2	L
140 x 70	2.4	L	2.1	M	1.9	M
190 x 70	3.2	M	2.9	SED	2.6	SED
240 x 70	5.1	SED	4.6	SED	4.2	SED
290 x 70	5.8	SED	5.1	SED	4.7	SED
190 x 90	4.4	SED	3.9	SED	3.6	SED
240 x 90	5.6	SED	5.0	SED	4.6	SED
290 x 90	6.8	SED	6.0	SED	5.6	SED

Fixing type	Underpurlin to strut fixing to resist uplift (see figures 10.11 and 10.12)	Alternative fixing capacity (kN)
L	2 / M12 Bolts	9.8
M	2 / M16 Bolts	13.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Span may be increased by 10 % for underpurlins continuous over 2 or more spans.

(2) Fixing types for continuous spans shall have double the capacity to that listed in the table.

(3) For the full range of underpurlin fixing types and capacities see table 10.15.

(4) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.5 – Underpurlins for all wind zones – SG 10 (continued) (see 10.2.1.9.1, and figures 10.11 and 10.12)

Underpurlin size	Maximum span of underpurlin for loaded dimension* of: (m)					
	1.5		2.1		2.7	
	Span	Fixing	Span	Fixing	Span	Fixing
(b) Heavy roof						
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	1.1	L	1.0	L	0.9	L
140 x 45	1.7	L	1.5	L	1.4	L
190 x 45	2.3	L	2.1	L	1.8	M
240 x 45	2.9	L	2.5	M	2.2	M
290 x 45	3.1	L	2.7	M	2.5	SED
90 x 70	1.3	L	1.1	L	1.0	L
140 x 70	2.0	L	1.8	L	1.6	L
190 x 70	2.7	L	2.4	M	2.2	M
240 x 70	4.3	SED	3.9	SED	3.5	SED
290 x 70	5.2	SED	4.7	SED	4.3	SED
190 x 90	3.7	M	3.3	SED	3.0	SED
240 x 90	4.7	SED	4.2	SED	3.9	SED
290 x 90	5.7	SED	5.1	SED	4.7	SED

Fixing type	Underpurlin to strut fixing to resist uplift (see figures 10.11 and 10.12)	Alternative fixing capacity (kN)
L	2 / M12 Bolts	9.8
M	2 / M16 Bolts	13.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Span may be increased by 10 % for underpurlins continuous over 2 or more spans.

(2) Fixing types for continuous spans shall have double the capacity to that listed in the table.

(3) For the full range of underpurlin fixing types and capacities see table 10.15.

(4) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.7 – Maximum span and fixing types for strutting beams for all wind zones – SG 6 (see 10.2.1.11)

Strutting beam size	Maximum loaded dimension* of underpurlin	Maximum span of strutting beam, for strut spacing of: (m)					
		1.2		1.5		1.8	
		Span	Fixing	Span	Fixing	Span	Fixing
(mm x mm)	(m)	(m)	(type)	(m)	(type)	(m)	(type)
(a) Light roof							
140 x 90	1.5 2.1 2.7	2.1 1.5 -	E F -	1.7 - -	F - -	- - -	- - -
190 x 90	1.5 2.1 2.7	3.4 2.8 2.2	SED SED SED	3.0 2.3 1.7	SED SED SED	2.6 1.9 -	SED SED -
(b) Heavy roof							
140 x 90	1.5 2.1 2.7	1.7 - -	E - -	1.5 - -	E - -	- - -	- - -
190 x 90	1.5 2.1 2.7	2.9 2.4 1.9	F F F	2.6 2.0 1.5	F F F	2.3 1.7 -	F F -

Fixing type	Strutting beam fixing to resist uplift (see figure 10.13)	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Fixing types for continuous spans shall have double the capacity to that listed in the table. For the full range of fixing types and capacities see table 10.15

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.7 – Maximum span and fixing types for strutting beams for all wind zones – SG 10
(see 10.2.1.11)

Strutting beam size	Maximum loaded dimension* of underpurlin	Maximum span of strutting beam, for strut spacing of: (m)					
		1.2		1.5		1.8	
		Span	Fixing	Span	Fixing	Span	Fixing
(mm x mm)	(m)	(m)	(type)	(m)	(type)	(m)	(type)
(a) Light roof							
140 x 90	1.5 2.1 2.7	2.9 2.5 2.2	F SED SED	2.6 2.2 1.9	SED SED SED	2.4 2.0 1.6	SED SED SED
190 x 90	1.5 2.1 2.7	4.7 3.9 3.5	SED SED SED	4.2 3.5 3.1	SED SED SED	3.8 3.2 2.8	SED SED SED
(b) Heavy roof							
140 x 90	1.5 2.1 2.7	2.5 2.1 1.8	E F F	2.2 1.9 1.6	F F F	2.0 1.7 –	F F –
190 x 90	1.5 2.1 2.7	4.0 3.3 2.9	SED SED SED	3.5 3.0 2.6	SED SED SED	3.2 2.7 2.4	SED SED SED

Fixing type	Strutting beam fixing to resist uplift (see figure 10.13)	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Fixing types for continuous spans shall have double the capacity to that listed in the table. For the full range of fixing types and capacities see table 10.15.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.8 – Verandah beams for all wind zones – SG 6 (see 10.2.1.12)

Beam size (width x thickness)	Loaded dimension of verandah beam (m)							
	0.9		1.4		1.8		2.1	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(mm x mm)	(m)	type	(m)	type	(m)	type	(m)	type
(a) Light roof								
140 x 45	1.5	N	1.4	N	1.3	N	1.2	N
190 x 45	1.9	N	1.7	N	1.6	N	1.5	N
240 x 45	2.1	N	1.9	N	1.8	O	1.7	O
290 x 45	2.2	N	2.1	O	2.0	O	1.9	O
140 x 70	1.9	N	1.7	N	1.6	N	1.5	N
190 x 70	2.5	O	2.3	O	2.2	O	2.1	O
220 x 70	2.9	O	2.6	O	2.5	O	2.3	P
240 x 70	3.1	O	2.8	O	2.6	P	2.5	P
290 x 70	3.4	O	3.2	P	3.0	P	2.8	P
140 x 90	2.0	N	1.9	N	1.8	O	1.7	O
190 x 90	2.8	O	2.6	O	2.4	O	2.4	P
240 x 90	3.5	O	3.3	P	3.1	P	3.0	P
290 x 90	5.4	P	5.0	P	4.7	P	4.6	Q
(b) Heavy roof								
140 x 45	1.3	N	1.2	N	1.1	N	1.0	N
190 x 45	1.8	N	1.6	N	1.5	N	1.4	N
240 x 45	2.0	N	1.9	N	1.8	N	1.7	N
290 x 45	2.2	N	2.0	N	1.9	N	1.8	O
140 x 70	1.6	N	1.5	N	1.4	N	1.3	N
190 x 70	2.2	N	2.0	N	1.9	N	1.8	O
220 x 70	2.6	N	2.4	O	2.2	O	2.1	O
240 x 70	2.8	N	2.6	O	2.4	O	2.3	O
290 x 70	3.3	O	3.1	O	2.9	O	2.7	P
140 x 90	1.8	N	1.6	N	1.5	N	1.5	N
190 x 90	2.4	N	2.2	N	2.1	O	2.0	O
240 x 90	3.0	O	2.8	O	2.7	O	2.6	O
290 x 90	4.7	P	4.3	P	4.1	P	4.0	P

Fixing type	Fixing to resist uplift	Alternative fixing capacity (kN)
N	6 / 100 x 4.0 nails hand-driven	4.7
O	2 / M12 bolts (see figure 9.3 (C))	6.8
P	2 / HDG 'flat' straps (see figure 9.3 (B))	13.7
Q	2 / HDG 'tee' straps (see figure 9.3 (A))	25.5

NOTE –

(1) This table includes provision for the rafters cantilevering a maximum of 750 mm beyond the verandah beam to support a soffit.

(2) Fixing type for continuous spans shall have a double capacity to that listed in the table.

(3) Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.8 – Verandah beams for all wind zones – SG 10 (see 10.2.1.12)

Beam size (width x thickness)	Loaded dimension of verandah beam (m)							
	0.9		1.4		1.8		2.1	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(mm x mm)	(m)	type	(m)	type	(m)	type	(m)	type
(a) Light roof								
140 x 45	2.0	N	1.8	N	1.7	O	1.7	O
190 x 45	2.4	N	2.2	O	2.1	O	2.0	O
240 x 45	2.7	O	2.5	O	2.3	O	2.3	P
290 x 45	2.9	O	2.7	O	2.5	P	2.4	P
140 x 70	2.3	N	2.1	O	2.0	O	2.0	O
190 x 70	3.1	O	2.9	P	2.8	P	2.7	P
220 x 70	3.7	P	3.4	P	3.2	P	3.1	P
240 x 70	4.0	P	3.7	P	3.5	P	3.4	P
290 x 70	4.4	P	4.1	P	3.9	P	3.7	P
140 x 90	2.5	O	2.3	O	2.2	O	2.1	O
190 x 90	3.4	O	3.2	P	3.0	P	2.9	P
240 x 90	4.3	P	4.0	P	3.8	P	3.7	P
290 x 90	6.6	P	6.2	Q	5.9	Q	5.6	Q
(b) Heavy roof								
140 x 45	1.7	N	1.6	N	1.5	N	1.5	N
190 x 45	2.4	N	2.2	N	2.0	O	2.0	O
240 x 45	2.6	N	2.4	O	2.3	O	2.2	O
290 x 45	2.8	N	2.6	O	2.4	O	2.4	O
140 x 70	2.0	N	1.9	N	1.8	N	1.7	N
190 x 70	2.7	N	2.5	O	2.4	O	2.3	O
220 x 70	3.2	O	2.9	O	2.8	O	2.7	P
240 x 70	3.5	O	3.2	O	3.1	P	2.9	P
290 x 70	4.2	O	3.9	P	3.7	P	3.6	P
140 x 90	2.2	N	2.0	N	1.9	N	1.8	O
190 x 90	3.0	O	2.8	O	2.6	O	2.5	O
240 x 90	3.8	O	3.5	P	3.3	P	3.2	P
290 x 90	5.8	P	5.4	P	5.1	P	4.9	P

Fixing type	Fixing to resist uplift	Alternative fixing capacity (kN)
N	6 / 100 x 4.0 nails hand-driven	4.7
O	2 / M12 bolts (see figure 9.3 (C))	6.8
P	2 / HDG 'flat' straps (see figure 9.3 (B))	13.7
Q	2 / HDG 'tee' straps (see figure 9.3 (A))	25.5

NOTE –

(1) This table includes provision for the rafters cantilevering a maximum of 750 mm beyond the verandah beam to support a soffit.

(2) Fixing type for continuous spans shall have a double capacity to that listed in the table.

(3) Members 70 mm and 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A10.10 – Purlins on their flat in all wind zones – SG 6 (see 10.2.1.16.1)

Purlin size	Max. span	Maximum spacing and fixing in the following wind zones									
		Low		Medium		High		Very high		Extra high	
		Spacing	Fixing	Spacing	Fixing	Spacing	Fixing	Spacing	Fixing	Spacing	Fixing
	(mm)	(mm)	(type)	(mm)	(type)	(mm)	(type)	(mm)	(type)	(mm)	(type)
70 x 45	900	900	S	900	T	900	T	750	T	600	T
70 x 45	900	1200	T	1200	T	1000	T	750	T	600	T
70 x 45	900	1700	T	1450	T	1000	T	750	T	600	T
70 x 45	1200	-	-	-	-	-	-	-	-	-	-
70 x 45	1200	-	-	-	-	-	-	-	-	-	-
90 x 45	1200	1200	T	1050	T	700	T	550	T	450	T

Fixing type	Description	Alternative fixing capacity (kN)
S	2 / 90 x 3.15 gun nails	0.8
T	1 / 10g self-drilling screw, 80 mm long	2.4

NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

Table A10.10 – Purlins on their flat in all wind zones – SG 10 (see 10.2.1.16.1)

Purlin size	Max. span	Maximum spacing and fixing in the following wind zones									
		Low		Medium		High		Very high		Extra high	
		Spacing	Fixing	Spacing	Fixing	Spacing	Fixing	Spacing	Fixing	Spacing	Fixing
	(mm)	(mm)	(type)	(mm)	(type)	(mm)	(type)	(mm)	(type)	(mm)	(type)
70 x 45	900	900	S	900	T	900	T	900	T	900	U
70 x 45	900	1200	T	1200	T	1200	T	1200	U	1200	U
70 x 45	900	1800	T	1800	U	1800	U	1550	U	1250	U
70 x 45	1200	1200	T	1200	T	1150	U	850	U	700	U
70 x 45	1200	1400	T	1400	U	1150	U	850	U	700	U
90 x 45	1200	1800	T	1800	U	1450	U	1100	U	900	U

Fixing type	Description	Alternative fixing capacity (kN)
S	2 / 90 x 3.15 gun nails	0.8
T	1 / 10g self-drilling screw, 80 mm long	2.4
U	1 / 14g self-drilling type 17 screw, 100 mm long	5.5

NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

Table A10.11 – Purlins on their edge in all wind zones – SG 6 (see 10.2.1.16.6)

Purlin size (depth x thickness)	**Purlin spacing** (mm)							
	600		**900**		**1200**		**1800**	
	Span	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
140 x 45	2.3	E	2.0	E	1.8	E	1.4	F
190 x 45	3.2	E	2.8	F	2.4	E	2.0	F
240 x 45	4.0	E	3.5	E	3.1	F	2.5	F
290 x 45	4.9	E	4.0	F	3.5	F	2.8	SED

Fixing type	**Description**	**Alternative fixing capacity** (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

Table A10.11 – Purlins on their edge in all wind zones – SG 10 (see 10.2.1.16.6)

Purlin size (depth x thickness)	**Purlin spacing** (mm)							
	600		**900**		**1200**		**1800**	
	Span	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
140 x 45	2.8	E	2.4	E	2.2	F	1.9	F
190 x 45	3.8	E	3.3	E	3.0	F	2.6	F
240 x 45	4.8	E	4.2	F	3.8	F	3.3	SED
290 x 45	5.8	F	5.0	F	4.6	SED	4.0	SED

Fixing type	**Description**	**Alternative fixing capacity** (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

SECTION 11

BUILDING ENVELOPE – ROOF AND WALL CLADDINGS

11 BUILDING ENVELOPE – ROOF AND WALL CLADDINGS

Previously NZS 3604:1999 covered *roof* and *wall claddings*, underlays and *sheathing*, exterior joinery, stucco and masonry veneer *claddings* and windows. This information is now contained in E2/AS1 and NZS 4229.

11.1 WEATHERTIGHTNESS

The durability of "closed" timber *framing* outlined in NZS 3604 requires the effective installation of *roof* and *wall claddings* (including windows and doors) and interior *linings* for prevention of moisture ingress.

C11.1

Designers must consider specific requirements for claddings in conjunction with the requirements for timber framing and concrete foundation. Claddings selected from E2/AS1, will affect specific structural details such as wall and roof framing spacing and sizes, foundation details, bracing, and set-outs.

E2/AS1 is an Acceptable Solution and E2/VM1 is a Verification (test) Method for roof and wall cladding systems, including windows and doors, on timber-framed buildings constructed to NZS 3604.

When using E2/AS1 for cladding it is important that the building wind zone (Low, Medium, High, Very high, or Extra high) used is the same as that determined by section 5 of this Standard for the framing and bracing requirements of the building.

The weathertightness details in E2/AS1 are intended for habitable buildings. E2/AS1 solutions may therefore be in excess of requirements for uninhabited buildings such as outbuildings and stand-alone garages.

SECTION 12

INTERIOR LININGS

12 INTERIOR LININGS

12.1 GENERAL

Interior *linings* are not a general requirement of this Standard. However, when selected *linings* are used as part of a *wall bracing* or ceiling *diaphragm* system, they shall comply with sections 4, 5 and 8 or section 13 respectively. The interior *lining* on each side of a *wall* shall weigh less than 12.0 kg/m^2.

C12.1

Linings may also provide in part for other NZBC provisions, such as fire safety, acoustic separation, interior moisture and hygienic surfaces; but these and other such uses are outside the scope of this Standard.

SECTION 13

CEILINGS

Table

Figure

13 CEILINGS

13.1 CEILING LININGS

Ceiling *linings* are not a general requirement of this Standard; however, certain *linings* may be utilized to provide *bracing* strength. Such *linings* shall be designed as ceiling *diaphragms* in accordance with 13.5. Other ceilings, where provided, shall be supported from *framing* timbers as described in this section. Ceiling material shall be less than 17.5 kg/m^2.

13.2 CEILING LINING SUPPORTS

13.2.1 Truss roofs

The *framing* timbers required for the support of ceiling *linings* under trussed *roofs* shall be any one, or any combination of the following:

(a) Bottom chords of trusses;

(b) 70 mm x 45 mm solid *dwanging* on edge, as shown in figure 13.1 or on the flat, at not more than 900 mm centres and spanning between bottom chords;

(c) *Ceiling battens* attached to the underside of bottom chords shall be of Merchantable grade or better, in accordance with NZS 3631, and be of dimensions set out in table 13.1 (see figure 13.1).

C13.2.1

Ceiling battens and solid dwanging can serve not only to support ceiling linings but also to provide lateral support to bottom chords, against buckling in compression, as a result of wind uplift forces on the roof.

Battens 70 mm x 35 mm in size are quite often used at 600 mm centres to allow for greater tolerance to fix ceiling linings.

13.2.2 Framed roofs and floors

The *framing* timbers required for the support of ceiling *linings* under framed *roofs* or floors shall be any one, or any combination of the following (see figure 13.1):

(a) Ceiling *joists* complying with 10.2.1.6 or floor *joists* complying with 7.1;

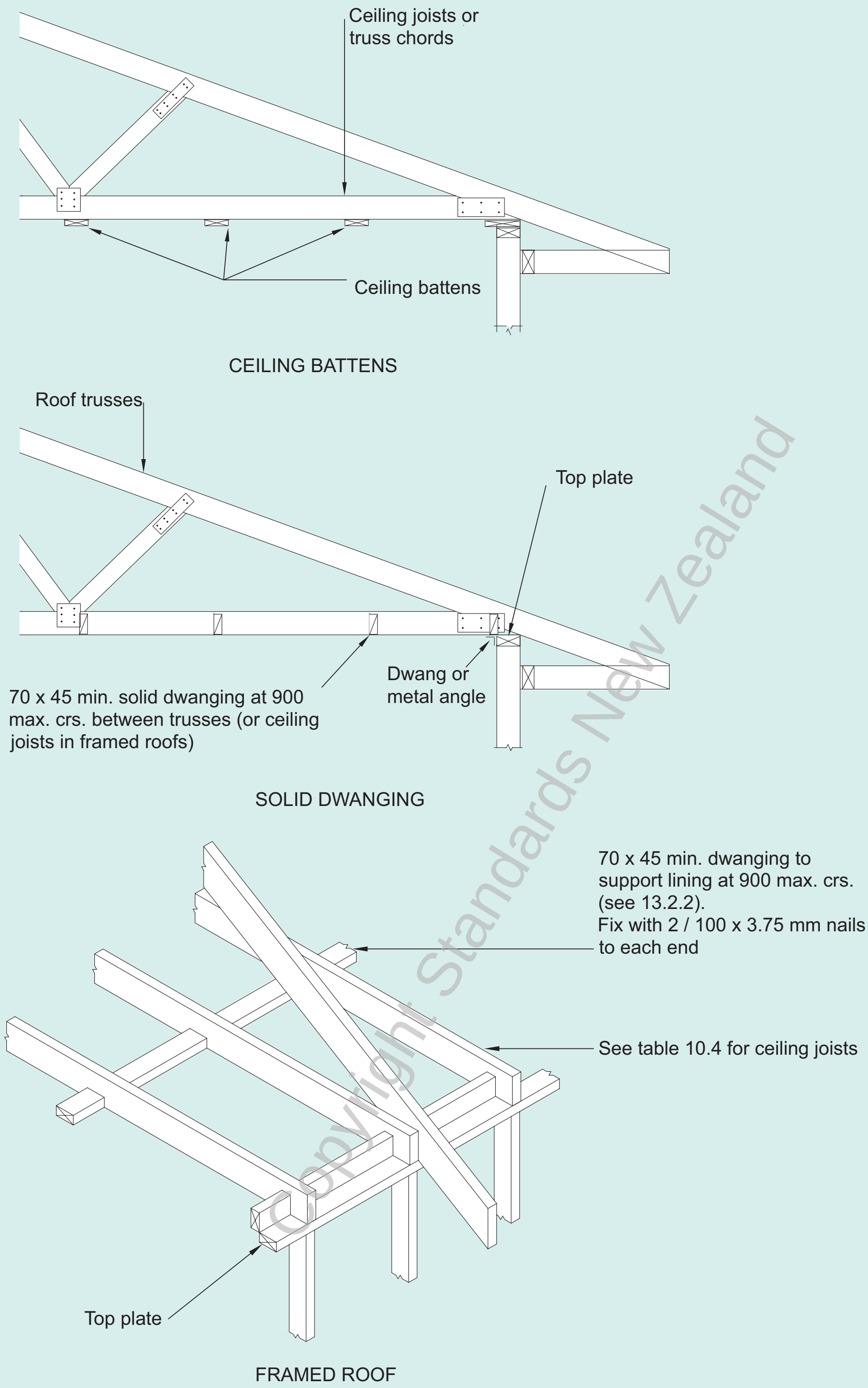
(b) *Rafters* complying with 10.2.1.3;

(c) 70 mm x 45 mm solid *dwanging* on edge or on the flat (as shown in figure 13.1) at not more than 900 mm centres and spanning between ceiling *joists*, floor *joists* or *rafters*;

(d) *Ceiling battens* having the dimension given by table 13.1 attached to the underside of *rafters*, floor *joists* or ceiling *joists* shall be of Merchantable grade or better, in accordance with NZS 3631, and be of the dimensions set out in table 13.1.

Table 13.1 – Ceiling battens (see 13.2.1 and 13.2.2)

Maximum spacing of ceiling battens	Size of ceiling battens for a maximum span (mm) of:		
	600	900	1200
(mm)	(mm x mm)	(mm x mm)	(mm x mm)
400	45 x 19	70 x 35	70 x 35
600	70 x 19	70 x 35	70 x 35



Unless otherwise stated, all dimensions are in mm.

Figure 13.1 – Ceiling lining supports (see 13.2.1 and 13.2.2)

13.3 OPENINGS IN CEILINGS

13.3.1

Where access to a ceiling space is required through the ceiling, a clear opening not less than 600 mm x 500 mm shall be provided, giving easy unobstructed access of at least 600 mm in height between the top of the ceiling *joists* and other *roof* members (see figure 13.2).

13.3.2

Openings in ceilings shall be bounded by *trimmers* and *trimming joists*.

13.3.3

Trimmers shall be the same depth as the curtailed ceiling *joists* and their thickness (see figure 13.2 and table 13.2) shall be:

(a) For *trimmer spans* up to 1.2 m, the same thickness as the *curtailed joists*;

(b) For *trimmer spans* over 1.2 m and up to 2.4 m, 25 mm thicker than the *curtailed joists*;

(c) For *trimmer spans* over 2.4 m and up to 3 m, 50 mm thicker than the *curtailed joists*.

13.3.4

Trimming joists shall be the same depth as the curtailed ceiling *joists* and their thickness (see figure 13.2 and table 13.2) shall be:

(a) For *trimmer spans* up to 1.2 m:

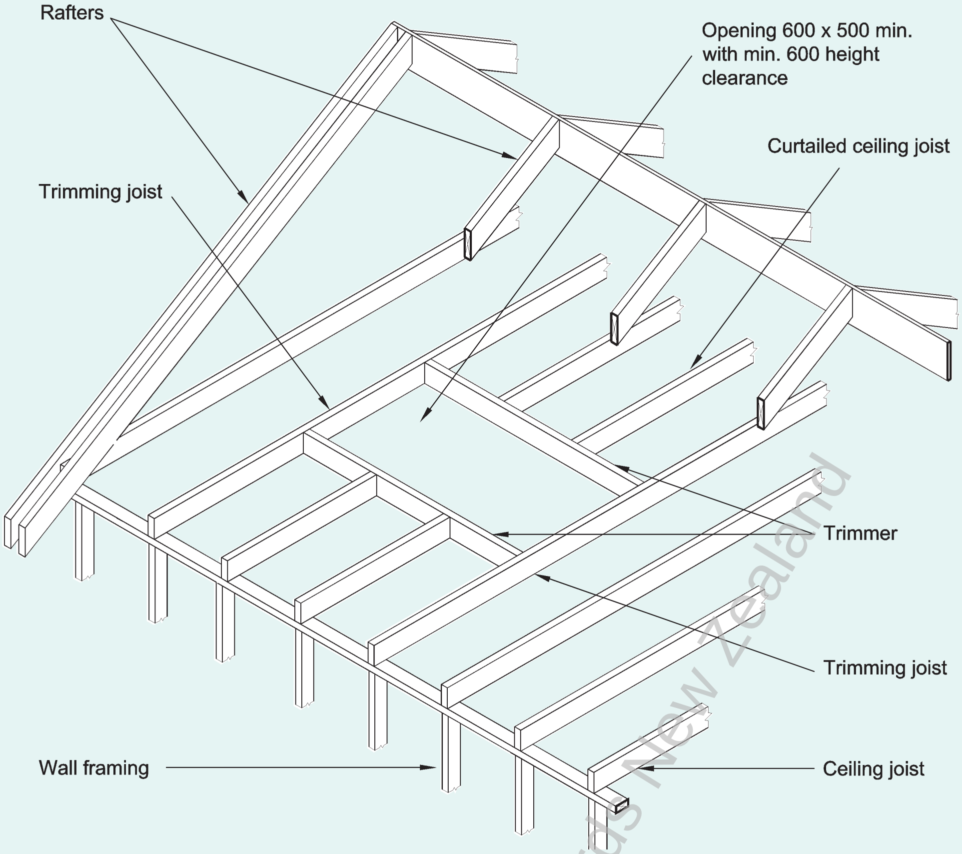
  (i) For *trimming joist spans* up to 3 m, the same thickness as the *curtailed joists*;

  (ii) For *trimming joist spans* over 3 m, 25 mm thicker than the *curtailed joists*;

(b) For *trimmer spans* up to 3 m, 50 mm thicker than the *curtailed joists*.

Table 13.2 – Thickness of trimmers and trimming joists (see 13.3.3 and 13.3.4)

Trimmer and trimming joist thicknesses	Trimmer span (m)		
	Up to 1.2	Over 1.2 up to 2.4	Over 2.4 up to 3.0
Trimmer thickness	t	t + 25 mm	t + 50 mm
Trimming joist thickness			
Trimming joist span up to 3.0 m	t	t + 50 mm	t + 50 mm
Trimming joist span over 3.0 m	t + 25 mm	t + 50 mm	t + 50 mm
t = thickness of curtailed joist (mm)			



Unless otherwise stated, all dimensions are in mm.

Figure 13.2 – Openings in ceilings (see 13.3.1)

13.4 WATER TANKS IN THE ROOF SPACE

13.4.1

Water tanks (supply tanks or hot water cylinders) in the *roof* space shall not exceed 300 litres in *capacity*. Tanks shall be supported on a base and located as shown in figure 13.3.

13.4.2

Lateral restraint of the tanks needs to be considered but is outside the scope of this Standard.

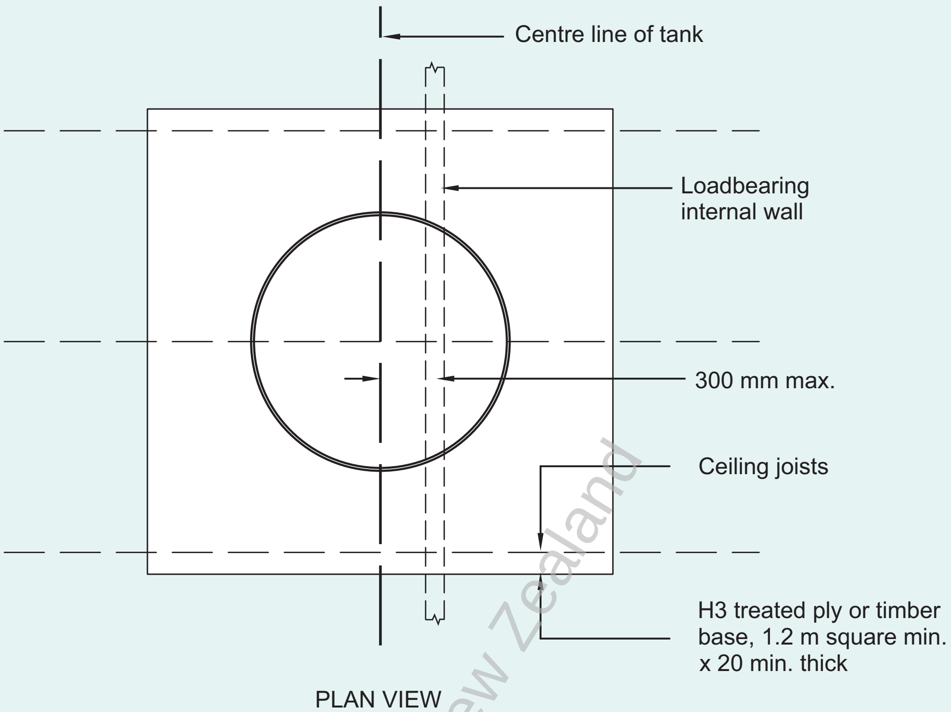


Figure 13.3 – Support of water tanks in the roof space (see 13.4.1)

13.5 STRUCTURAL CEILING DIAPHRAGMS

13.5.1

Ceiling *diaphragms* required to comply with 5.6.1(b) shall be constructed as follows:

(a) The length (L) of the *diaphragm* shall not exceed twice its width (W), both length and width being measured between supporting *bracing elements*;

(b) The basic shape of a ceiling *diaphragm* shall be rectangular. Protrusions are permitted but cut-outs are not (see figure 13.3(a));

(c) The ceiling *lining* shall consist of a sheet material complying with 13.5.2 over the entire area of the *diaphragm* (see figure 13.4);

(d) Complete sheets with a minimum size of 1800 x 900 mm shall be used except where building dimensions prevent their use;

(e) Each sheet shall be fastened as shown in figure 13.4;

(f) Fastenings shall be not less than 10 mm from sheet edges.

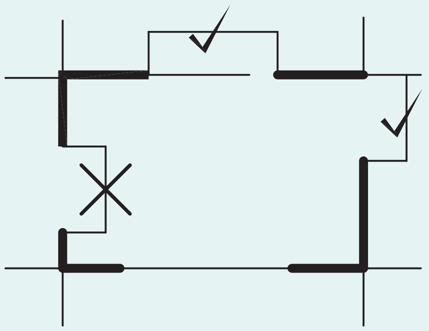


Figure 13.3(a) – Ceiling diaphragm protrusions and cut-outs (see 13.5.1(b))

C13.5.2

Clause 13.5.2 refers to the slope (if any) of the ceiling, not of the roof. Sloping ceilings are often at the same slope as the roof above.

13.5.2

Ceiling *lining* material for ceiling *diaphragms* shall be:

(a) For *diaphragms* not steeper than 15° to the horizontal and not exceeding 7.5 m long under *light* or *heavy roofs:* a gypsum-based sheet material not less than 10 mm thick having a density of not less than 600 kg/m^3 or any material permitted by 13.5.2(b);

(b) For *diaphragms* not steeper than 25° to the horizontal and not exceeding 12 m long under *light* or *heavy roofs*:

- (i) Plywood not less than 6 mm thick three-ply;
- (ii) Any other wood-or fibre-cement based product not less than 4.5 mm thick having a density of not less than 880 kg/m^2 (e.g. hardboard); or
- (iii) Any other wood-or fibre-cement based product not less than 6 mm thick having a density of not less than 600 kg/m^3 (e.g. particleboard).

(c) For *diaphragms* not steeper than 45° to the horizontal and not exceeding 7.5 m long under *light* or *heavy roofs*: as for (b) above.

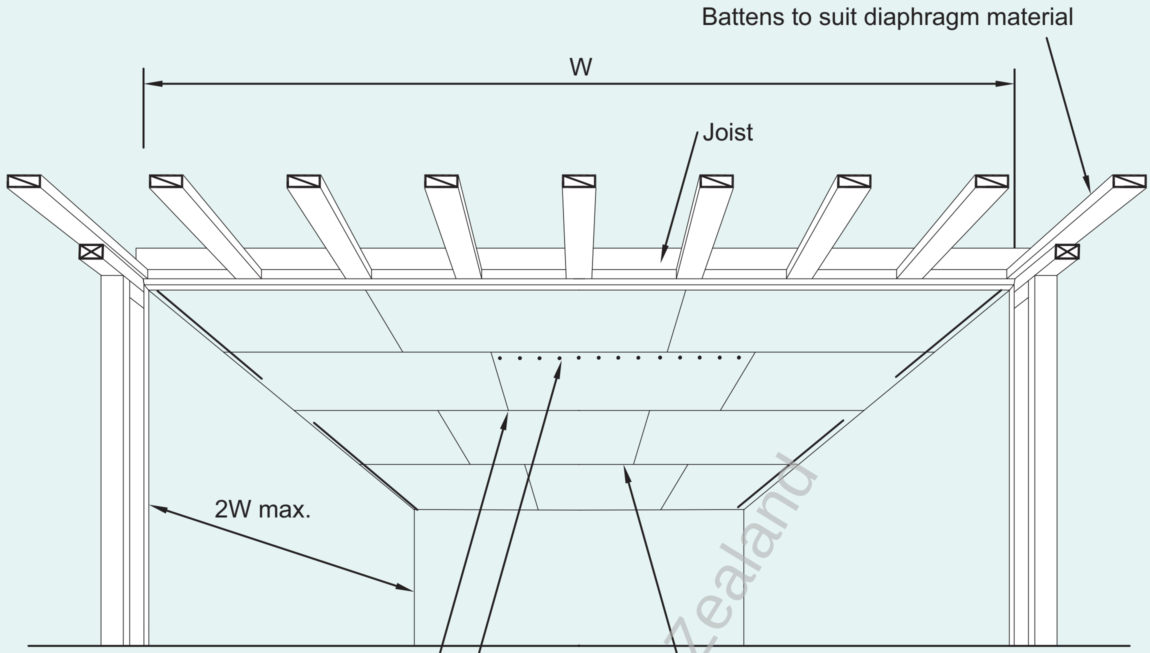


Figure 13.4 – Ceiling diaphragms (see 13.5.1)

13.6 NAILING SCHEDULE FOR CEILINGS

Table 13.3 lists the size, number and location of nails to be used in ceilings. See 2.4 and 4.4.3 for other requirements for nails.

Table 13.3 – Nailing schedule for hand-driven and power-driven nails (see 13.6)

Joint	Hand-driven nails		Power-driven nails	
	Length (mm) **x diameter** (mm) **and type**	**Number/ Location**	**Length** (mm) **x diameter** (mm) **and type**	**Number/ Location**
Ceiling framing				
Ceiling batten to top plate	75 x 3.15	1	75 x 3.06	1
Ceiling joist to top plate	100 x 3.75	2 (skewed)	90 x 3.15	3 (skewed)
Ceiling joist to rafter	100 x 3.75	3	90 x 3.15	4
Lapped joint in joist	100 x 3.75	2 (each side)	90 x 3.15	4 (each side)
Flitched joint in joist	100 x 3.75	4 (each end)	90 x 3.15	6 (each end)
Ceiling runner to top plate packer	100 x 3.75	2 (skewed)	90 x 3.15	2 (skewed)
Ceiling runner to ceiling joist	100 x 3.75	2 (skewed)	90 x 3.15	4 (skewed)
Hanger to runner or joist	100 x 3.75	2	90 x 3.15	3
Ceiling batten to joist, rafter or truss: (a) 45 mm x 19 mm	60 x 2.8 or	1	60 x 2.8	1
	57 x 11.1 x 1.8 staple	1	–	–
(b) 70 mm x 35 mm	75 x 3.15	2	75 x 3.06	2
Dragon tie to top plate or blocking piece: 90 mm x 35 mm	100 x 3.75	3	90 x 3.15	5
Dragon tie to joist, truss, or rafter: 90 mm x 35 mm	100 x 3.75	2	90 x 3.15	2
Blocking piece to top plate truss, joist or rafter	100 x 3.75	4	90 x 3.15	6

NOTE –
(1) Nail lengths and diameters are the minimum required.
(2) Refer to 4.4 for required protective coatings for metal fasteners.

SECTION 14

REQUIREMENTS FOR 3 kPa FLOOR LOADS

14 REQUIREMENTS FOR 3 kPa FLOOR LOADS

14.1 GENERAL

NZS 3604 as modified by tables 14.1 to 14.16 shall be used for the design of buildings with 3 kPa *floor loadings*. This section details the increased requirements for the design of structural components (*framing*, subfloor, flooring and fixings) and the increased earthquake *bracing demand*.

NOTE – SG 8 tables are used in this section. For the corresponding SG 6 and SG 10 tables, see the 'A tables' appended to this section.

C14.1

This section does not cover garages with timber floors where wheel loads are 9 kN and exceed the maximum concentrated load in 1.1.2(e).

14.2 CONCRETE SLAB-ON-GROUND

Concrete slab-on-ground where required to carry more than 3 kPa loading shall be the subject of *specific engineering design*.

C14.2

For the design of floors carrying such loads it becomes necessary to consider the subgrade properties of strength and deflection as well as the thickness of base material which may result in thicker granular bases or concrete slabs.

Table 14.1 – Bracing demand for various cladding combinations for single-storey buildings on subfloor framing for 3 kPa floor loads, soil type D/E and earthquake zone 3 (see 5.3.1)

Roof cladding	Single-storey cladding	Subfloor cladding	Roof pitch degrees	Subfloor	Single-storey walls
				Bracing demand in BUs/m² of floor area	
Light roof	Light	Light and Medium	0-25 25-45 45-60	17 17 18	11 12 13
		Heavy	0-25 25-45 45-60	19 19 20	12 12 14
	Medium	Medium	0-25 25-45 45-60	19 20 21	13 13 15
		Heavy	0-25 25-45 45-60	21 22 23	13 14 16
	Heavy	Heavy	0-25 25-45 45-60	29 29 30	18 19 20
Heavy roof	Light	Light and Medium	0-25 25-45 45-60	21 23 26	16 18 22
		Heavy	0-25 25-45 45-60	23 25 28	17 19 23
	Medium	Medium and Heavy	0-25 25-45 45-60	23 25 28	18 20 23
	Heavy	Heavy	0-25 25-45 45-60	33 35 38	23 26 29

Multiplication factors		EQ zone			
Soil class		1	2	3	4
A and B	Rock	0.3	0.5	0.6	0.9
C	Shallow	0.4	0.6	0.7	1.1
D and E	Deep to very soft	0.5	0.8	1.0	1.5

NOTE – See 5.3.4 for additional bracing demand.

Table 14.2 – Bracing demand for various cladding combinations for two-storey buildings on subfloor framing, 3 kPa floor loads (see 5.3.1)

Roof cladding	Upper storey cladding	Lower storey cladding	Subfloor cladding	Roof pitch degrees	Subfloor	Lower storey walls	Upper storey walls
					Bracing demand in BUs/m² of floor area		
Light roof	Light	Light	Light to Heavy	0-25 25-45 45-60	26 27 28	23 24 25	11 12 14
		Medium	Medium and Heavy	0-25 25-45 45-60	29 30 31	25 26 27	12 13 14
		Heavy	Heavy	0-25 25-45 45-60	37 38 39	33 33 35	13 14 15
	Medium	Medium	Medium and Heavy	0-25 25-45 45-60	33 33 34	29 29 31	13 14 16
		Heavy	Heavy	0-25 25-45 45-60	41 42 43	36 37 38	14 15 17
	Heavy	Heavy	Heavy	0-25 25-45 45-60	51 52 53	45 46 47	19 20 21
Heavy roof	Light	Light	Light to Heavy	0-25 25-45 45-60	30 32 35	27 29 33	17 19 23
		Medium	Medium and Heavy	0-25 25-45 45-60	33 35 38	30 32 35	18 20 24
		Heavy	Heavy	0-25 25-45 45-60	42 43 47	37 39 43	19 21 26
	Medium	Medium and Heavy	Medium and Heavy	0-25 25-45 45-60	37 39 42	33 35 39	19 21 25
	Heavy	Heavy	Heavy	0-25 25-45 45-60	55 57 60	50 52 55	25 27 32

Multiplication factors		EQ zone			
Soil class		1	2	3	4
A and B	Rock	0.3	0.5	0.6	0.9
C	Shallow	0.4	0.6	0.7	1.1
D and E	Deep to very soft	0.5	0.8	1.0	1.5

NOTE – See 5.3.4 for additional bracing demand.

Table 14.3 – Bracing demand for various cladding combinations for single-storey and two-storey buildings on concrete slab-on-ground, 3 kPa floor loads (see 5.3.1)

Roof cladding	Single or upper storey cladding	Lower storey cladding	Roof pitch degrees	Single storey walls	Lower storey walls	Upper storey walls
				Bracing demand in BUs/m² of floor area		
Light roof	Light	Light	0-25 25-45 45-60	6 6 7	17 17 18	9 10 11
		Medium	0-25 25-45 45-60	N/A N/A N/A	19 19 20	9 10 11
		Heavy	0-25 25-45 45-60	N/A N/A N/A	24 25 26	10 11 12
	Medium	Medium	0-25 25-45 45-60	6 7 8	21 22 23	11 11 13
		Heavy	0-25 25-45 45-60	N/A N/A N/A	27 27 28	11 12 14
	Heavy	Heavy	0-25 25-45 45-60	9 9 11	34 35 36	15 16 17
Heavy roof	Light	Light	0-25 25-45 45-60	10 11 15	21 23 26	14 16 19
		Medium	0-25 25-45 45-60	N/A N/A N/A	23 25 28	14 16 20
		Heavy	0-25 25-45 45-60	N/A N/A N/A	28 30 33	15 17 21
	Medium	Medium and Heavy	0-25 25-45 45-60	11 12 16	25 27 30	15 17 21
	Heavy	Heavy	0-25 25-45 45-60	13 15 18	38 40 43	20 23 26

Multiplication factors		EQ zone			
Soil class		1	2	3	4
A and B	Rock	0.3	0.5	0.6	0.9
C	Shallow	0.4	0.6	0.7	1.1
D and E	Deep to very soft	0.5	0.8	1.0	1.5

NOTE – See 5.3.4 for additional bracing demand.

Table 14.4 – Bearers, 3 kPa floor loads – SG 8 (see 6.12.2.1)

Maximum span of bearer continuous over 2 or more spans (m)	**Loaded dimension* of bearer** (m)	**Bearer size (width x thickness)** (mm x mm)
1.30	1.0 1.9 2.5 3.6	90 x 90 140 x 70 140 x 90 190 x 70
1.65	1.2 1.5 2.2	140 x 70 140 x 90 190 x 70
2.00	1.0 1.5	140 x 90 190 x 70

* For definition of loaded dimension see 1.3.

NOTE – Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table 14.5 – Subfloor jack studs, 3 kPa floor loads – SG 8 (see 6.10.2.1)

Maximum span of bearers (m)	**Jack stud** (mm x mm)	**Maximum jack stud height for loaded dimension* of the bearer of:** (m)		
		2.0	**3.5**	**5.0**
Supporting 1 storey				
1.30	90 x 70 90 x 90	2.0 3.0	1.9 2.8	1.7 2.6
1.65	90 x 70 90 x 90	1.8 2.7	1.6 2.4	1.5 2.3
2.00	90 x 70 90 x 90	1.6 2.4	1.5 2.2	1.3 2.0
Supporting 2 storeys				
1.30	90 x 70 90 x 90	1.7 2.6	1.5 2.3	1.3 2.0
1.65	90 x 70 90 x 90	1.5 2.3	1.3 2.0	1.1 1.7
2.00	90 x 70 90 x 90	1.3 2.0	1.1 1.8	0.6 1.5
Supporting 3 storeys				
1.30	90 x 70 90 x 90	1.5 2.3	1.3 1.9	1.0 1.7
1.65	90 x 70 90 x 90	1.3 2.0	0.9 1.7	– 1.3
2.00	90 x 70 90 x 90	1.1 1.8	– 1.4	– –

* For definition of loaded dimension see 1.3.
NOTE – Substitution with built-up members is not allowed.

Table 14.6 – Square pile footings for 3 kPa floor loads (see 6.4.5.4)

Maximum spans* of:		**Minimum plan dimensions of square footing for pile supporting:**		
Bearers (m)	**Joists** (m)	**Floor only** (mm x mm)	**Floor and walls of: 1 storey** (mm x mm)	**Floor and walls of: 2 storeys** (mm x mm)
1.30	2.0	225 x 225†	300 x 300†	375 x 375
	3.5	300 x 300†	400 x 400	500 x 500
	5.0	325 x 325†	450 x 450	575 x 575
	6.0	350 x 350	500 x 500	625 x 625
1.65	2.0	250 x 250†	350 x 350	425 x 425
	3.5	325 x 325†	425 x 425	575 x 575
	5.0	375 x 375	500 x 500	650 x 650
2.0	2.0	275 x 275†	375 x 375	475 x 475
	3.5	375 x 375	475 x 475	625 x 625

* Span is the average of the bearer or joist spans on either side of the pile under consideration.
† 350 mm x 350 mm for anchor piles.

Table 14.7 – Spacing of M12 bolts supporting stringers for 3 kPa floor loads (see 6.13.1)

Maximum span of floor joists (m)	**Maximum spacing of bolts** (m)	**Stringer nominal size** (mm)
2	1.25	140 x 45
3	0.9	140 x 45
4	0.7	140 x 45
5	0.5	140 x 45
6	0.5	140 x 45

Table 14.8 – Floor joists for 3 kPa floor loads – SG 8 (see 7.1.1.1)

Floor joist size	**Maximum span* of joists at a maximum spacing of:** (mm)		
	400	**450**	**600**
(mm x mm)	(m)	(m)	(m)
90 x 45	1.45	1.35	1.20
140 x 35	2.00	1.90	1.65
140 x 45	2.25	2.15	1.85
190 x 45	3.10	2.90	2.50
240 x 45	3.90	3.70	3.20
290 x 45	4.75	4.45	3.85

* May be increased by 10 % for joists continuous over 2 or more spans.

Table 14.9 – Strip flooring for 3 kPa floor loads (see 7.2.2.1)

Maximum spacing of joists	**Minimum dry dressed thickness of tongued and grooved strip flooring of species listed below as:**	
	Type A	**Type B**
(mm)	(mm)	(mm)
400	22	19
450	22	22
600	25	25
Type A timbers:	Radiata pine, matai, rimu, red beech, silver beech, Douglas fir, larch.	
Type B timbers:	Tawa, hard beech, jarrah, karri, blackbutt, tallowwood, New Zealand-grown hardwoods.	

Table 14.10 – Studs in loadbearing walls for all wind zones for 3 kPa floor loads – SG 8 (see 8.5.1.1)

Wind zone	Loaded dimen-sion* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(a) Lower of 2 storeys or subfloor beneath 1 storey										
Extra high	2.0	–	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	4.0	–	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 X 45
	6.0	–	90 x 70	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 45
Very high	2.0	–	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70	90 x 45	90 x 70	90 x 90
	4.0	–	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 45	90 x 70	90 x 90
	6.0	–	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
High	2.0	–	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70
	4.0	–	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	6.0	–	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
Medium	2.0	–	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	4.0	–	90 x 35	90 x 45	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70
	6.0	–	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
Low	2.0	–	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	4.0	–	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 45
	6.0	–	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
Internal walls in all wind zones	2.0	–	70 x 45	90 x 35	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45
	4.0	–	70 x 45	90 x 35	70 x 45	70 x 45	90 x 45	70 x 45	90 x 35	90 x 45
	6.0	–	70 x 45	90 x 35	90 x 35	90 x 35	90 x 45	70 x 45	90 x 35	90 x 70

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall (lower or subfloor as appropriate) at floor level and the loaded dimension of the walls above at floor and roof levels and use the greatest value in this table.

(2) Studs 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 90 mm stud they are replacing.

(3) Studs 90 mm thick may be substituted with built-up (or laminated) members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table 14.10 – Studs in loadbearing walls for all wind zones for 3 kPa floor loads – SG 8 (continued)
(see 8.5.1.1)

Wind zone	Loaded dimension* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(b) Subfloor beneath 2 storeys										
Extra high	3.0 4.5 6.0	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 70 90 x 90 90 x 90	90 x 45 90 x 45 90 x 70	90 x 70 90 x 70 90 x 70	90 x 90 90 x 90 140 x 45	90 x 70 90 x 70 90 x 70	90 x 90 90 x 90 90 x 90	140 x 45 140 x 45 140 x 45
Very high	3.0 4.5 6.0	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 90 90 x 90 90 x 90	90 x 70 90 x 70 90 x 70	90 x 70 90 x 70 90 x 70	140 x 45 140 x 45 140 x 45
High	3.0 4.5 6.0	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 70 90 x 70 90 x 70	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 90 90 x 90 90 x 90
Medium	3.0 4.5 6.0	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 70 90 x 70 90 x 70	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70
Low	–	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 45	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 45	90 x 70 90 x 70 90 x 70
Internal walls in all wind zones	3.0 4.5 6.0	70 x 45 70 x 45 70 x 45	70 x 45 70 x 45 90 x 35	90 x 35 90 x 35 90 x 45	70 x 45 70 x 45 90 x 35	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 45	90 x 70 90 x 70 90 x 70

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall (lower or subfloor as appropriate) at floor level and the loaded dimension of the walls above at floor and roof levels and use the greatest value in this table.

(2) Studs 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 90 mm stud they are replacing.

(3) Studs 90 mm thick may be substituted with built-up (or laminated) members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table 14.11 – Reference table for lintel load cases

Supporting			Load type				Table no.
Roof	Walls	Floor	Roof	Snow	Walls	Floor	
				(kPa)		(kPa)	
✓	✓	✓	Light	–	Light	3	14.12
✓	✓	✓	Light	–	Medium	3	
✓	✓	✓	Heavy	–	Light	3	
✓	✓	✓	Heavy	–	Medium	3	
–	✓	✓	–	–	Light	3	14.13
–	✓	✓	–	–	Medium	3	
–	–	✓	–	–	–	3	14.14

Table 14.12 – Lintel supporting roof, wall and floor for 3 kPa floor loads – SG 8 (see figure 8.9)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)							
		140 x 70	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	2	0.9	1.1	1.2	1.5	1.5	1.9	1.9	2.3
	3	0.8	1.0	1.2	1.4	1.5	1.8	1.8	2.2
	4	0.8	1.0	1.1	1.4	1.4	1.8	1.8	2.1
	6	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.0
Light roof Medium wall	2	0.8	1.0	1.2	1.4	1.5	1.8	1.8	2.2
	3	0.8	1.0	1.1	1.4	1.4	1.8	1.8	2.1
	4	0.7	0.9	1.0	1.3	1.3	1.6	1.6	1.9
	6	0.7	0.9	1.0	1.2	1.2	1.5	1.5	1.8
Heavy roof Light wall	2	0.8	1.0	1.1	1.4	1.5	1.8	1.8	2.2
	3	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.1
	4	0.8	0.9	1.1	1.3	1.3	1.6	1.6	2.0
	6	0.7	0.9	1.0	1.2	1.3	1.5	1.5	1.9
Heavy roof Medium wall	2	0.8	1.0	1.1	1.4	1.4	1.7	1.7	2.1
	3	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.0
	4	0.7	0.9	1.0	1.3	1.3	1.6	1.6	1.9
	6	0.7	0.9	1.0	1.2	1.2	1.5	1.5	1.8

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table 14.13 – Lintel supporting wall and floor only for 3 kPa floor loads – SG 8 (see figure 8.10)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)							
		140 x 70	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light wall	3.0	1.0	1.2	1.3	1.6	1.7	2.0	2.0	2.5
Medium wall	3.0	1.0	1.2	1.3	1.6	1.7	2.0	2.0	2.4

* For definition of loaded dimension see 1.3.
NOTE – Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table 14.14 – Lintel supporting floor only for 3 kPa floor loads – SG 8 (see figure 8.11)

Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)							
	140 x 70	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
2.0	1.2	1.5	1.7	2.1	2.1	2.6	2.6	3.2
4.0	0.9	1.0	1.2	1.4	1.5	1.8	1.8	2.2
6.0	–	0.8	1.1	1.2	1.2	1.5	1.5	1.8

* For definition of loaded dimension see 1.3.
NOTE – Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table 14.15 – Top and bottom plates for loadbearing walls, 3 kPa floor loads – SG 8 (see 8.7.2.1)

Plate size (mm x mm)	Maximum loaded dimension* of wall supporting floor	Maximum spacing of trusses or rafters (mm)	Light roof			Heavy roof		
			Stud spacing (mm)					
			300	400	600	300	400	600
			Maximum loaded dimension* of wall (m)					
(a) Top plate of lower wall of 2 storeys and subfloor supporting 1 storey								
90 x 45	1.5	400	6.0	6.0	4.1	6.0	6.0	2.3
		450	6.0	6.0	2.7	6.0	5.5	1.5
		600	6.0	4.9	–	6.0	2.8	–
	3.0	400	6.0	4.8	–	6.0	2.7	–
		450	6.0	2.6	–	5.9	–	–
		600	3.7	–	–	2.0	–	–
90 x 45 plus 90 x 35 (or greater) or 2/90 x 45 (** or)	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	5.7	6.0	6.0	3.3
	3.0	400	6.0	6.0	6.0	6.0	6.0	3.5
		450	6.0	6.0	3.7	6.0	6.0	2.1
		600	6.0	6.0	–	6.0	4.3	–
(b) Bottom plate of lower wall of 2 storeys and subfloor supporting 1 storey								
90 x 45	1.5	400	6.0	6.0	2.0	6.0	4.5	–
		450	6.0	5.7	–	6.0	3.3	–
		600	5.2	1.8	–	2.6	–	–
	3.0	400	6.0	–	–	3.9	–	–
		450	4.1	–	–	2.3	–	–
		600	–	–	–	–	–	–
90 x 70	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	6.0	6.0	6.0	5.3
	3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	4.9
		600	6.0	6.0	2.2	6.0	6.0	–
(c) Top plate of subfloor wall supporting 2 storeys								
90 x 45 plus 90 x 35 or greater or 2/90 x 45 (** or)	1.5	400	6.0	6.0	5.1	6.0	6.0	2.9
		450	6.0	6.0	2.7	6.0	6.0	–
		600	6.0	6.0	–	6.0	3.7	–
	3.0	400	6.0	4.1	–	6.0	2.3	–
		450	6.0	–	–	6.0	–	–
		600	2.2	–	–	–	–	–
90 x 70	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
		450	6.0	6.0	6.0	6.0	6.0	6.0
		600	6.0	6.0	4.1	6.0	6.0	2.3
	3.0	400	6.0	6.0	–	6.0	6.0	–
		450	6.0	6.0	–	6.0	5.0	–
		600	–	–	–	–	–	–

* For definition of loaded dimension see 1.3.

** Use of 90 x 35 shall be limited by the requirements of 8.7.4.2.

NOTE – Substitution with built-up members is not allowed.

Table 14.16 – Structural plywood flooring (see 7.2.3.5)

Maximum spacing of joists (mm)	Minimum thickness (mm) of plywood for floor loads	
	3 kPa office General	3 kPa assembly, educational, restaurants
400	15	17
450	15	19
600	19	21

APPENDIX A – SG 6 AND SG 10 TABLES

(Normative)

Table A14.4 – Bearers, 3 kPa floor loads – SG 6 (see 6.12.2.1)

Maximum span of bearer continuous over 2 or more spans (m)	**Loaded dimension* of bearer** (m)	**Bearer size (width x thickness)** (mm x mm)
1.30	0.7 1.4 1.8 2.5	90 x 90 140 x 70 140 x 90 190 x 70
1.65	0.8 1.1 1.6	140 x 70 140 x 90 190 x 70
2.00	0.7 1.0	140 x 90 190 x 70

* For definition of loaded dimension see 1.3.
NOTE – Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A14.4 – Bearers, 3 kPa floor loads – SG 10 (see 6.12.2.1)

Maximum span of bearer continuous over 2 or more spans (m)	**Loaded dimension* of bearer** (m)	**Bearer size (width x thickness)** (mm x mm)
1.30	1.4 2.8 3.6 5.1	90 x 90 140 x 70 140 x 90 190 x 70
1.65	1.7 2.2 3.2	140 x 70 140 x 90 190 x 70
2.00	1.5 2.1	140 x 90 190 x 70

* For definition of loaded dimension see 1.3.
NOTE – Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A14.5 – Subfloor jack studs, 3 kPa floor loads – SG 6 (see 6.10.2.1)

Maximum span of bearers (m)	**Jack stud** (mm x mm)	**Maximum jack stud height for loaded dimension* of the bearer of:** (m)		
		2.0 (m)	**3.5** (m)	**5.0** (m)
Supporting 1 storey				
1.30	90 x 70 90 x 90	1.9 2.8	1.8 2.6	1.6 2.4
1.65	90 x 70 90 x 90	1.7 2.5	1.5 2.3	1.4 2.1
2.00	90 x 70 90 x 90	1.5 2.3	1.4 2.1	1.2 1.9
Supporting 2 storeys				
1.30	90 x 70 90 x 90	1.6 2.4	1.4 2.1	1.2 1.9
1.65	90 x 70 90 x 90	1.4 2.1	1.2 1.8	0.9 1.6
2.00	90 x 70 90 x 90	1.2 1.9	0.9 1.6	– 1.3
Supporting 3 storeys				
1.30	90 x 70 90 x 90	1.4 2.1	1.1 1.8	– 1.5
1.65	90 x 70 90 x 90	1.2 1.9	– 1.5	– 0.8
2.00	90 x 70 90 x 90	0.9 1.6	– 1.0	– –

* For definition of loaded dimension see 1.3.
NOTE – Substitution with built-up members is not allowed.

Table A14.5 – Subfloor jack studs, 3 kPa floor loads – SG 10 (see 6.10.2.1)

Maximum span of bearers (m)	**Jack stud** (mm x mm)	**Maximum jack stud height for loaded dimension* of the bearer of:** (m)		
		2.0 (m)	**3.5** (m)	**5.0** (m)
Supporting 1 storey				
1.30	90 x 70 90 x 90	2.2 3.2	2.0 2.9	1.8 2.7
1.65	90 x 70 90 x 90	1.9 2.8	1.7 2.6	1.6 2.4
2.00	90 x 70 90 x 90	1.7 2.5	1.6 2.3	1.4 2.1
Supporting 2 storeys				
1.30	90 x 70 90 x 90	1.8 2.7	1.6 2.4	1.4 2.2
1.65	90 x 70 90 x 90	1.6 2.4	1.4 2.1	1.2 1.9
2.00	90 x 70 90 x 90	1.4 2.2	1.2 1.9	0.9 1.6
Supporting 3 storeys				
1.30	90 x 70 90 x 90	1.6 2.4	1.4 2.1	1.1 1.8
1.65	90 x 70 90 x 90	1.4 2.1	1.1 1.8	0.6 1.5
2.00	90 x 70 90 x 90	1.2 1.9	0.6 1.5	– 1.0

* For definition of loaded dimension see 1.3.

NOTE – Substitution with built-up members is not allowed.

Table A14.8 – Floor joists for 3 kPa floor loads – SG 6 (see 7.1.1.1)

Floor joist size	Maximum span* of joists at a maximum spacing (mm) of:		
	400	**450**	**600**
(mm x mm)	(m)	(m)	(m)
90 x 45	1.20	1.15	1.00
140 x 35	1.70	1.60	1.35
140 x 45	1.90	1.80	1.55
190 x 45	2.60	2.45	2.15
240 x 45	3.30	3.10	2.70
290 x 45	4.00	3.75	3.25
* May be increased by 10 % for joists continuous over 2 or more spans.			

Table A14.8 – Floor joists for 3 kPa floor loads – SG 10 (see 7.1.1.1)

Floor joist size	Maximum span* of joists at a maximum spacing (mm) of:		
	400	**450**	**600**
(mm x mm)	(m)	(m)	(m)
90 x 45	1.55	1.50	1.30
140 x 35	2.25	2.15	1.90
140 x 45	2.70	2.55	2.15
190 x 45	3.70	3.50	3.00
240 x 45	4.65	4.40	3.80
290 x 45	5.60	5.35	4.60
* May be increased by 10 % for joists continuous over 2 or more spans.			

Table A14.10 – Studs in loadbearing walls for all wind zones for 3 kPa floor loads – SG 6 (see 8.5.1.1)

Wind zone	Loaded dimen-sion* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(a) Lower of 2 storeys or subfloor beneath 1 storey										
Extra high	2.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 90	140 x 90	90 x 70	140 x 45	140 x 90
	4.0	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90	90 x 90	140 x 45	140 x 90
	6.0	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90	90 x 90	140 x 45	140 x 90
Very high	2.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90
	4.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90
	6.0	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45	90 x 70	90 x 90	140 x 90
High	2.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	4.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
	6.0	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90	90 x 70	90 x 70	140 x 45
Medium	2.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70
	4.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	6.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
Low	2.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70
	4.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
Internal walls in all wind zones	2.0	70 x 45	70 x 45	90 x 45	70 x 45	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70
	4.0	70 x 45	70 x 45	90 x 45	70 x 45	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	70 x 45	90 x 35	90 x 45	70 x 45	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall (lower or subfloor as appropriate) at floor level and the loaded dimension of the walls above at floor and roof levels and use the greatest value in this table.

(2) Studs 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 90 mm stud they are replacing.

(3) Studs 90 mm thick may be substituted with built-up (or laminated) members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A14.10 – Studs in loadbearing walls for all wind zones for 3 kPa floor loads – SG 6 (continued)
(see 8.5.1.1)

Wind zone	Loaded dimension* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(b) Subfloor beneath 2 storeys										
Extra high	2.0 4.0 6.0	90 x 70 90 x 70 90 x 70	90 x 70 90 x 70 90 x 70	140 x 45 140 x 45 140 x 45	90 x 70 90 x 70 90 x 70	90 x 90 90 x 90 90 x 90	140 x 90 140 x 90 140 x 90	90 x 90 90 x 90 90 x 90	140 x 45 140 x 45 140 x 45	140 x 90 140 x 90 140 x 90
Very high	2.0 4.0 6.0	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 90 90 x 90 90 x 90	90 x 70 90 x 70 90 x 70	90 x 70 90 x 70 90 x 90	140 x 45 140 x 45 140 x 45	90 x 70 90 x 70 90 x 70	90 x 90 90 x 90 90 x 90	140 x 90 140 x 90 140 x 90
High	2.0 4.0 6.0	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 90 90 x 90 90 x 90	90 x 70 90 x 70 90 x 70	90 x 70 90 x 70 90 x 90	140 x 45 140 x 45 140 x 45
Medium	2.0 4.0 6.0	90 x 35 90 x 35 90 x 45	90 x 35 90 x 35 90 x 45	90 x 70 90 x 70 90 x 70	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 70	90 x 70 90 x 70 90 x 70	90 x 45 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 90 90 x 90 90 x 90
Low	2.0 4.0 6.0	90 x 35 90 x 35 90 x 35	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	90 x 35 90 x 35 90 x 35	90 x 35 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 70	90 x 70 90 x 70 90 x 70
Internal walls in all wind zones	2.0 4.0 6.0	70 x 45 70 x 45 70 x 45	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 45	70 x 45 90 x 35 90 x 35	90 x 35 90 x 45 90 x 45	90 x 70 90 x 70 90 x 70	90 x 35 90 x 35 90 x 35	90 x 45 90 x 45 90 x 70	90 x 70 90 x 70 90 x 70

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall (lower or subfloor as appropriate) at floor level and the loaded dimension of the walls above at floor and roof levels and use the greatest value in this table.

(2) Studs 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 90 mm stud they are replacing.

(3) Studs 90 mm thick may be substituted with built-up (or laminated) members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A14.10 – Studs in loadbearing walls for all wind zones for 3 kPa floor loads – SG 10 (see 8.5.1.1)

Wind zone	Loaded dimension* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(a) Lower of 2 storeys or subfloor beneath 1 storey										
Extra high	2.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	4.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	6.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
Very high	2.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	4.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
High	2.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	4.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70
	6.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
Medium	2.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	4.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	6.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 45
Low	2.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35
	4.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35
	6.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
Internal walls in all wind zones	2.0	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	90 x 35	70 x 45	70 x 45	90 x 35
	4.0	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	90 x 35	70 x 45	70 x 45	90 x 35
	6.0	70 x 45	70 x 45	70 x 45	70 x 45	70 x 45	90 x 35	70 x 45	70 x 45	90 x 45

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall (lower or subfloor as appropriate) at floor level and the loaded dimension of the walls above at floor and roof levels and use the greatest value in this table.

(2) Studs 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 90 mm stud they are replacing.

(3) Studs 90 mm thick may be substituted with built-up (or laminated) members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A14.10 – Studs in loadbearing walls for all wind zones for 3 kPa floor loads – SG 10 (continued)
(see 8.5.1.1)

Wind zone	Loaded dimension* of wall	Stud sizes for maximum length (height) of: (m)								
		2.4			2.7			3.0		
		At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)			At maximum stud spacing of: (mm)		
		300	400	600	300	400	600	300	400	600
	(m)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
		(width x thickness)								
(b) Subfloor beneath 2 storeys										
Extra high	2.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	4.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
	6.0	90 x 35	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70	90 x 45	90 x 70	90 x 90
Very high	2.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 45	90 x 70	90 x 35	90 x 45	90 x 70
	4.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 35	90 x 70	90 x 70
	6.0	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70	90 x 45	90 x 70	90 x 90
High	2.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	4.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
	6.0	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70	90 x 35	90 x 45	90 x 70
Medium	2.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 45
	4.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
	6.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
Low	2.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45
	4.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 45
	6.0	90 x 35	90 x 35	90 x 35	90 x 35	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70
Internal walls in all wind zones	2.0	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 35	70 x 45	90 x 35	90 x 45
	4.0	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45	90 x 35	90 x 35	90 x 45
	6.0	70 x 45	70 x 45	90 x 35	70 x 45	90 x 35	90 x 45	90 x 35	90 x 35	90 x 70

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the wall (lower or subfloor as appropriate) at floor level and the loaded dimension of the walls above at floor and roof levels and use the greatest value in this table.

(2) Studs 90 mm thick may be replaced with studs of 35 mm and 45 mm thickness respectively, provided they are placed at no more than one half the spacing required for the 90 mm stud they are replacing.

(3) Studs 90 mm thick may be substituted with built-up (or laminated) members sized in accordance with 8.5.1.2 and nailed together in accordance with 2.4.4.7.

Table A14.12 – Lintels supporting roof, wall and floor for 3 kPa floor loads – SG 6 (see figure 8.9)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)							
		140 x 70	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	2	0.7	0.9	1.0	1.2	1.3	1.6	1.6	1.9
	3	0.7	0.9	1.0	1.2	1.3	1.5	1.5	1.9
	4	0.7	0.8	1.0	1.2	1.2	1.5	1.5	1.8
	6	0.7	0.8	0.9	1.1	1.2	1.4	1.4	1.7
Light roof Medium wall	2	0.7	0.9	1.0	1.2	1.3	1.5	1.5	1.9
	3	0.7	0.8	1.0	1.2	1.2	1.5	1.5	1.8
	4	–	0.8	0.9	1.1	1.1	1.3	1.3	1.6
	6	–	0.7	0.8	1.0	1.0	1.3	1.3	1.5
Heavy roof Light wall	2	0.7	0.9	1.0	1.2	1.2	1.5	1.5	1.8
	3	0.7	0.8	0.9	1.1	1.2	1.4	1.4	1.7
	4	–	0.8	0.9	1.1	1.1	1.4	1.4	1.7
	6	–	0.7	0.8	1.0	1.1	1.3	1.3	1.6
Heavy roof Medium wall	2	0.7	0.8	0.9	1.1	1.2	1.5	1.5	1.8
	3	–	0.8	0.9	1.1	1.1	1.4	1.4	1.7
	4	–	0.8	0.9	1.1	1.1	1.3	1.3	1.6
	6	–	0.7	0.8	1.0	1.0	1.3	1.3	1.5

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A14.12 – Lintels supporting roof, wall and floor for 3 kPa floor loads – SG 10 (see figure 8.9)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)							
		140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light roof Light wall	2	1.1	1.3	1.4	1.8	1.8	2.2	2.2	2.7
	3	1.0	1.2	1.4	1.7	1.8	2.2	2.2	2.6
	4	1.0	1.2	1.4	1.7	1.7	2.1	2.1	2.6
	6	0.9	1.2	1.3	1.6	1.7	2.0	2.0	2.4
Light roof Medium wall	2	1.0	1.2	1.4	1.7	1.8	2.2	2.2	2.6
	3	1.0	1.2	1.4	1.7	1.7	2.1	2.1	2.6
	4	0.9	1.1	1.2	1.5	1.6	1.9	1.8	2.3
	6	0.8	1.0	1.2	1.4	1.5	1.8	1.6	2.1
Heavy roof Light wall	2	1.0	1.2	1.4	1.7	1.8	2.1	2.1	2.6
	3	1.0	1.2	1.3	1.6	1.7	2.1	2.0	2.5
	4	0.9	1.1	1.3	1.6	1.6	2.0	1.9	2.4
	6	0.9	1.1	1.2	1.4	1.5	1.8	1.7	2.2
Heavy roof Medium wall	2	1.0	1.2	1.3	1.6	1.7	2.1	2.1	2.5
	3	0.9	1.1	1.3	1.6	1.6	2.0	2.0	2.4
	4	0.9	1.1	1.2	1.5	1.6	1.9	1.8	2.3
	6	0.8	1.0	1.2	1.4	1.5	1.8	1.6	2.1

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A14.13 – Lintels supporting wall and floor only for 3 kPa floor loads – SG 6 (see figure 8.10)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)							
		140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light wall	3.0	0.8	1.0	1.1	1.4	1.4	1.7	1.7	2.1
Medium wall	3.0	0.8	1.0	1.1	1.4	1.4	1.7	1.7	2.1

* For definition of loaded dimension see 1.3.
NOTE – Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A14.13 – Lintels supporting wall and floor only for 3 kPa floor loads – SG 10 (see figure 8.10)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)							
		140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light wall	3.0	1.2	1.4	1.6	1.9	2.0	2.5	2.4	3.0
Medium wall	3.0	1.2	1.4	1.6	1.9	2.0	2.4	2.4	2.9

* For definition of loaded dimension see 1.3.
NOTE – Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A14.14 – Lintels supporting floor only for 3 kPa floor loads – SG 6 (see figure 8.11)

Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)							
	140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
2.0	1.0	1.3	1.4	1.7	1.8	2.2	2.2	2.7
4.0	–	0.9	1.0	1.2	1.3	1.5	1.5	1.9
6.0	–	–	0.8	1.0	1.0	1.2	1.2	1.5

* For definition of loaded dimension see 1.3.
NOTE – Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A14.14 – Lintels supporting floor only for 3 kPa floor loads – SG 10 (see figure 8.11)

Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)							
	140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
2.0	1.5	1.8	2.0	2.4	2.6	3.1	3.1	3.7
4.0	1.0	1.3	1.4	1.7	1.8	2.2	2.2	2.7
6.0	0.8	1.0	1.2	1.4	1.5	1.8	1.6	2.0

* For definition of loaded dimension see 1.3.
NOTE – Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A14.15 – Top and bottom plates for loadbearing walls, 3 kPa floor loads – SG 6 (see 8.7.2.1)

Plate size (mm x mm)		Maximum loaded dimension* of wall supporting floor	Maximum spacing of trusses or rafters (mm)	Light roof			Heavy roof		
				Stud spacing (mm)					
				300	400	600	300	400	600
				Maximum loaded dimension* of wall (m)					
(a) Top plate of lower wall of 2 storeys and subfloor supporting 1 storey									
90 x 45		1.5	400	6.0	5.8	–	6.0	3.4	–
			450	6.0	4.2	–	5.6	2.4	–
			600	5.0	–	–	2.9	–	–
		3.0	400	5.0	–	–	2.9	–	–
			450	2.8	–	–	1.5	–	–
			600	–	–	–	–	–	–
90 x 45 plus 90 x 35 (or greater) or 2/90 x 45	** or	1.5	400	6.0	6.0	6.0	6.0	6.0	3.9
			450	6.0	6.0	5.0	6.0	6.0	2.9
			600	6.0	6.0	1.7	6.0	4.5	–
		3.0	400	6.0	6.0	–	6.0	5.3	–
			450	6.0	6.0	–	6.0	3.6	–
			600	6.0	–	–	4.4	–	–
(b) Bottom plate of lower wall of 2 storeys and subfloor supporting 1 storey									
90 x 45		1.5	400	6.0	2.8	–	4.0	1.5	–
			450	5.0	–	–	2.9	–	–
			600	–	–	–	–	–	–
		3.0	400	–	–	–	–	–	–
			450	–	–	–	–	–	–
			600	–	–	–	–	–	–
90 x 70		1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	4.8
			600	6.0	6.0	3.7	6.0	6.0	2.0
		3.0	400	6.0	6.0	3.5	6.0	6.0	2.0
			450	6.0	6.0	–	6.0	6.0	–
			600	6.0	3.5	–	6.0	2.0	–
(c) Top plate of subfloor wall supporting 2 storeys									
90 x 45 plus 90 x 35 or greater or 2/90 x 45	** or	1.5	400	6.0	6.0	–	6.0	4.7	–
			450	6.0	5.2	–	6.0	3.0	–
			600	6.0	–	–	3.8	–	–
		3.0	400	4.0	–	–	2.5	–	–
			450	–	–	–	–	–	–
			600	–	–	–	–	–	–
90 x 70		1.5	400	6.0	6.0	5.5	6.0	6.0	3.2
			450	6.0	6.0	3.1	6.0	6.0	1.7
			600	6.0	6.0	–	6.0	4.0	–
		3.0	400	6.0	4.9	–	6.0	2.8	–
			450	6.0	–	–	6.0	–	–
			600	–	–	–	–	–	–

* For definition of loaded dimension see 1.3.
** Use of 90 x 35 shall be limited by the requirements of 8.7.4.2.
NOTE – Substitution with built-up members is not allowed.

Table A14.15 – Top and bottom plates for loadbearing walls, 3 kPa floor loads – SG 10 (see 8.7.2.1)

Plate size (mm x mm)		Maximum loaded dimension* of wall supporting floor	Maximum spacing of trusses or rafters (mm)	Light roof			Heavy roof		
				Stud spacing (mm)					
				300	400	600	300	400	600
				Maximum loaded dimension* of wall (m)					
(a) Top plate of lower wall of 2 storeys and subfloor supporting 1 storey									
90 x 45		1.5	400	6.0	6.0	6.0	6.0	6.0	5.7
			450	6.0	6.0	6.0	6.0	6.0	4.4
			600	6.0	6.0	3.5	6.0	5.9	2.0
		3.0	400	6.0	6.0	2.8	6.0	6.0	1.5
			450	6.0	6.0	–	6.0	5.5	–
			600	4.1	3.2	–	2.3	1.7	–
90 x 45 plus 90 x 35 (or greater) or 2/90 x 45	** or	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	6.0
		3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	5.1	6.0	6.0	2.9
(b) Bottom plate of lower wall of 2 storeys and subfloor supporting 1 storey									
90 x 45		1.5	400	6.0	6.0	6.0	6.0	6.0	4.0
			450	6.0	6.0	5.0	6.0	6.0	2.9
			600	6.0	5.7	–	5.6	3.0	–
		3.0	400	6.0	6.0	–	6.0	4.9	–
			450	6.0	5.5	–	6.0	2.3	–
			600	5.3	–	–	2.8	–	–
90 x 70		1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	6.0
		3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	6.0
(c) Top plate of subfloor wall supporting 2 storeys									
90 x 45 plus 90 x 35 or greater or 2/90 x 45	** or	1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	4.1	6.0	6.0	2.3
		3.0	400	6.0	6.0	–	6.0	6.0	–
			450	6.0	6.0	–	6.0	6.0	–
			600	6.0	2.5	–	3.9	–	–
90 x 70		1.5	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	6.0	6.0
			600	6.0	6.0	6.0	6.0	6.0	6.0
		3.0	400	6.0	6.0	6.0	6.0	6.0	6.0
			450	6.0	6.0	6.0	6.0	5.0	3.9
			600	–	–	–	–	–	–

* For definition of loaded dimension see 1.3.

** Use of 90 x 35 shall be limited by the requirements of 8.7.4.2.

NOTE – Substitution with built-up members is not allowed.

SECTION 15

1.5 kPa AND 2.0 kPa SNOW LOADING

Table

Figure

15 1.5 kPa AND 2.0 kPa SNOW LOADING

15.1 GENERAL

NZS 3604 as modified by this section shall be used for the design of buildings that are required to carry *snow loadings* of 1.5 and 2.0 kPa. See tables 15.1 to 15.8. For *purlins* on their flat and *purlins* on their edge see tables 15.9 and 15.10.

NOTE – SG 8 tables are used in this section. For the corresponding SG 6 and SG 10 tables, see the 'A tables' appended to this section.

C15.1

AS/NZS 1170.3 Supplement 1 provides useful information on the architectural design of buildings subject to snow loading.

15.2 SNOW LOADING

15.2.1

An allowance of 1.0 kPa *ground snow load* is incorporated in the provisions of sections 1 to 14.

No further allowance for *snow loading* is required for Zone N0 (see figure 15.1). Buildings in Snow Zones N1 to N5 shall be designed to carry *snow loadings* of 1.5 or 2.0 kPa depending on the altitude of a building site as given in the *snow loadings* table in figure 15.1.

15.2.2

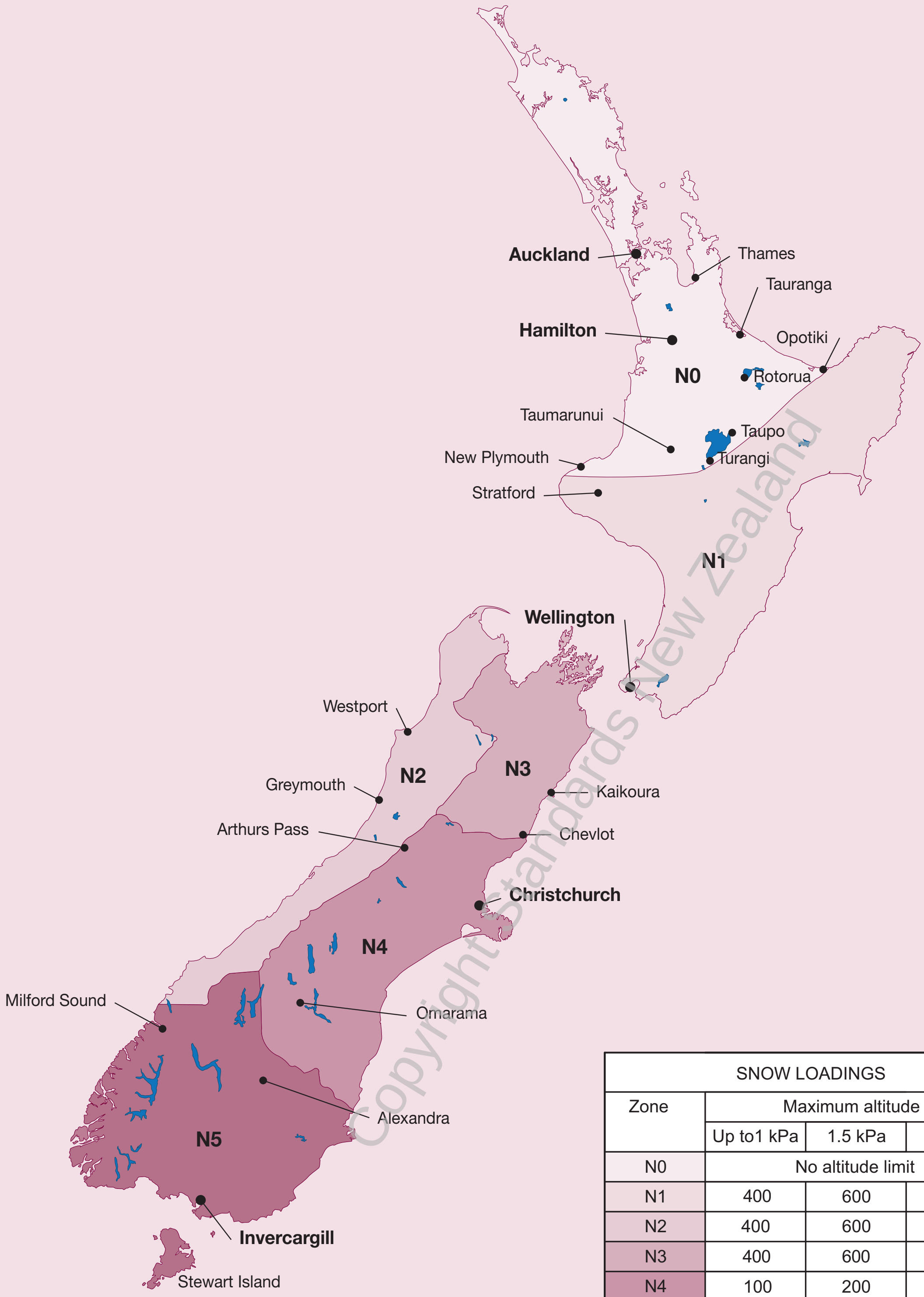
At altitudes higher than those given in figure 15.1 the building shall be the subject of *specific engineering design*.

15.2.3

For 1.5 kPa *snow loading*, member sizes, *spans* and fixings shall comply with tables 15.2 to 15.8.

For 2.0 kPa *snow loading*, member sizes and fixings shall be read directly from tables 15.2 to 15.8 as if the *snow loading* was 1.5 kPa. *Member spans* however shall be multiplied by the following factors:

Description of member	Factor for 2 kPa snow load	Table
Lintel supporting roof only	0.8	15.2, A15.2
Lintel supporting roof and wall	0.8	15.3, A15.3
Lintel supporting roof, floor and wall with 1.5 or 2 kPa floor loads	0.9	15.4, A15.4
Lintel supporting roof, floor and wall with 3 kPa floor loads	0.9	15.5, A15.5
Rafters, light and heavy roofs	0.85	15.6, A15.6
Valley rafters, light and heavy roofs	1.0	15.6 (b), A15.6 (b)
Ridge beams	0.85	15.7, A15.7
Verandah beams	0.9	15.8, A15.8



SNOW LOADINGS			
Zone	Maximum altitude (m)		
	Up to1 kPa	1.5 kPa	2 kPa
N0	No altitude limit		
N1	400	600	850
N2	400	600	850
N3	400	600	850
N4	100	200	350
N5	200	300	400

NOTE – Altitudes above the values given for 2 kPa require specific engineering design.

Figure 15.1 – Snow zones

Table 15.1 – Reference table for lintel load cases

Supporting			Load type				Table no.
Roof	Walls	Floor	Roof	Snow*	Walls	Floor	
				(kPa)		(kPa)	
✓	–	–	Light	1.5	–	–	15.2
✓	–	–	Heavy	1.5	–	–	
✓	✓	–	Light	1.5	Light	–	15.3
✓	✓	–	Light	1.5	Medium	–	
✓	✓	–	Heavy	1.5	Light	–	
✓	✓	–	Heavy	1.5	Medium	–	
✓	✓	✓	Light	1.5	Light	1.5 or 2	15.4
✓	✓	✓	Light	1.5	Medium	1.5 or 2	
✓	✓	✓	Heavy	1.5	Light	1.5 or 2	
✓	✓	✓	Heavy	1.5	Medium	1.5 or 2	
✓	✓	✓	Light	1.5	Light	3	15.5
✓	✓	✓	Light	1.5	Medium	3	
✓	✓	✓	Heavy	1.5	Light	3	
✓	✓	✓	Heavy	1.5	Medium	3	

* For 2.0 kPa snow loads see 15.2.3.

15.3 ROOF ABUTTING AN UPPER WALL

Where a *rafter*, veranda beam, or *purlin* (on the flat or on edge) forms part of a lower *roof* meeting an upper *wall* and the exposed height of the upper *wall* is greater than 0.6 m, the *roof* is defined as an abutting *roof* (see figure 15.2).

In this situation the *span* or *spacing* determined from the relevant table shall be reduced as specified in the note section of the table.

C15.3

In this situation, the snow forms a drift which will increase the depth of snow on the lower roof, thereby increasing the load.

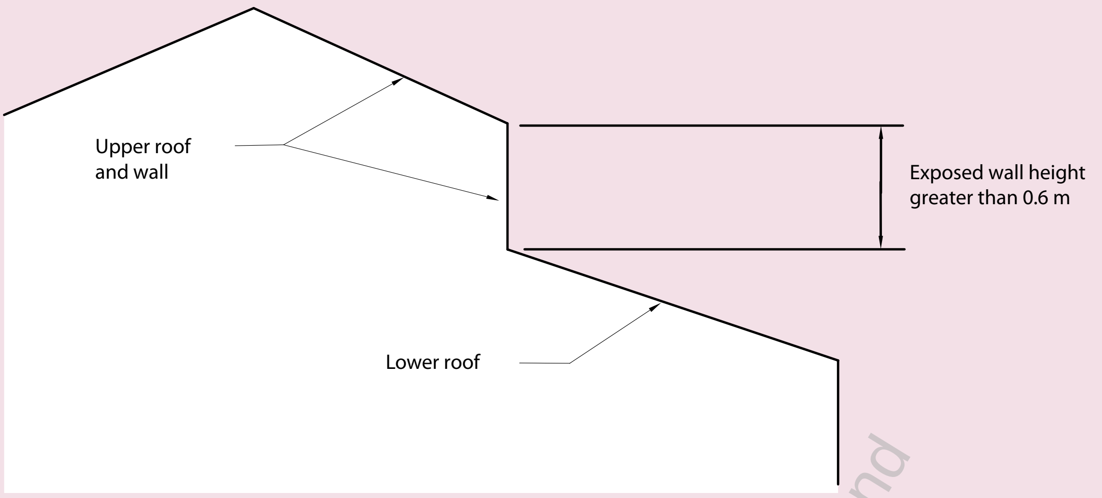


Figure 15.2 – Roof abutting upper wall (see 15.3)

Table 15.2 – Lintel supporting roof only for all wind zones up to 1.5 kPa snow load – SG 8 (see figure 8.7)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m)									
		width x thickness (mm)									
		90 x 70	**90 x 90**	**140 x 70**	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof	3	0.8	1.0	1.3	1.6	1.8	2.2	2.3	2.8	2.8	3.4
	4	0.7	0.9	1.2	1.5	1.6	2.0	2.1	2.5	2.5	3.1
	5	0.7	0.8	1.1	1.3	1.5	1.8	1.9	2.3	2.3	2.8
	6	0.6	0.8	1.0	1.2	1.4	1.7	1.7	2.1	2.1	2.6
Heavy roof	3	0.8	0.9	1.2	1.5	1.7	2.0	2.1	2.6	2.6	3.1
	4	0.7	0.8	1.1	1.3	1.5	1.8	1.9	2.3	2.3	2.8
	5	0.6	0.7	1.0	1.2	1.3	1.6	1.7	2.1	2.1	2.5
	6	0.6	0.7	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.8.

Table 15.3 – Lintel supporting roof and wall for all wind zones up to 1.5 kPa snow load – SG 8
(see figure 8.8)

	Loaded dimension* **of lintel** (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)									
		90 x 70	**90 x 90**	**140 x 70**	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	3	0.8	1.0	1.3	1.5	1.7	2.1	2.2	2.7	2.7	3.2
	4	0.7	0.9	1.1	1.4	1.5	1.9	2.0	2.4	2.4	2.9
	5	0.6	0.8	1.0	1.3	1.4	1.7	1.8	2.2	2.2	2.7
	6	0.6	0.7	1.0	1.2	1.3	1.6	1.7	2.0	2.0	2.5
Light roof Medium wall	3	0.7	0.9	1.2	1.4	1.6	2.0	2.1	2.5	2.5	3.0
	4	0.7	0.8	1.1	1.3	1.5	1.8	1.9	2.3	2.3	2.8
	5	0.6	0.7	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
	6	0.5	0.6	0.8	1.0	1.2	1.4	1.5	1.8	1.8	2.2
Heavy roof Light wall	3	0.7	0.9	1.1	1.4	1.6	1.9	2.0	2.4	2.4	2.9
	4	0.6	0.8	1.0	1.3	1.4	1.7	1.8	2.2	2.2	2.7
	5	0.6	0.7	0.9	1.1	1.3	1.6	1.6	2.0	2.0	2.4
	6	0.5	0.7	0.9	1.1	1.2	1.5	1.5	1.8	1.8	2.2
Heavy roof Medium wall	3	0.7	0.8	1.1	1.3	1.5	1.8	1.9	2.3	2.3	2.7
	4	0.6	0.8	1.0	1.2	1.4	1.7	1.7	2.1	2.1	2.5
	5	0.6	0.7	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
	6	0.5	0.6	0.8	1.0	1.2	1.4	1.5	1.8	1.8	2.2

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.8.

Table 15.4 – Lintel supporting roof, floor and wall for all wind zones up to 1.5 kPa snow load – SG 8 (see figure 8.9)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)							
		140 x 70	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	3	1.0	1.2	1.3	1.6	1.7	2.1	2.1	2.5
	4	0.9	1.1	1.3	1.6	1.6	2.0	2.0	2.4
	5	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
	6	0.9	1.0	1.2	1.4	1.5	1.8	1.8	2.2
Light roof Medium wall	3	0.9	1.1	1.3	1.6	1.6	2.0	2.0	2.4
	4	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
	5	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.1
	6	0.8	0.9	1.1	1.3	1.3	1.6	1.6	2.0
Heavy roof Light wall	3	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
	4	0.9	1.0	1.2	1.4	1.5	1.8	1.8	2.2
	5	0.8	1.0	1.1	1.4	1.4	1.7	1.7	2.1
	6	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.0
Heavy roof Medium wall	3	0.9	1.1	1.2	1.5	1.5	1.9	1.8	2.2
	4	0.8	1.0	1.1	1.4	1.5	1.8	1.8	2.1
	5	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.1
	6	0.8	0.9	1.1	1.3	1.3	1.6	1.6	2.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.9.

Table 15.5 – Lintel supporting roof, floor and wall in all wind zones for 3 kPa floor load and up to 1.5 kPa snow load – SG 8 (see figure 8.9)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)							
		140 x 70	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	3	1.0	1.2	1.3	1.6	1.7	2.1	2.1	2.5
	4	0.9	1.1	1.3	1.6	1.6	2.0	2.0	2.4
	5	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
	6	0.9	1.0	1.2	1.4	1.5	1.8	1.8	2.2
Light roof Medium wall	3	0.9	1.1	1.3	1.6	1.6	2.0	2.0	2.4
	4	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
	5	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.1
	6	0.8	0.9	1.1	1.3	1.3	1.6	1.6	2.0
Heavy roof Light wall	3	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
	4	0.9	1.0	1.2	1.4	1.5	1.8	1.8	2.2
	5	0.8	1.0	1.1	1.4	1.4	1.7	1.7	2.1
	6	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.0
Heavy roof Medium wall	3	0.9	1.1	1.2	1.4	1.5	1.8	1.8	2.2
	4	0.8	1.0	1.1	1.4	1.5	1.8	1.8	2.1
	5	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.1
	6	0.8	0.9	1.1	1.3	1.3	1.6	1.6	2.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.9.

Table 15.6 – Rafters for all wind zones up to 1.5 kPa snow load – SG 8 (see 10.2.1.3.2)

Rafter size (width x thickness)	Rafter spacing (mm)							
	480		600		900		1200	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(a) Ordinary rafters for light and heavy roofs								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	1.3	E	1.3	E	1.2	E	1.3	E
140 x 45	2.7	E	2.5	E	2.2	E	2.2	E
190 x 45	3.5	E	3.3	E	2.8	E	2.5	E
240 x 45	3.8	E	3.5	E	3.1	E	2.8	E
290 x 45	4.1	E	3.8	E	3.3	E	3.0	E
140 x 70	3.1	E	2.9	E	2.5	E	2.6	E
190 x 70	4.3	E	4.0	E	3.5	E	3.5	E
240 x 70	5.4	E	5.0	E	4.4	E	4.3	F
290 x 70	6.4	E	5.9	E	5.1	E	4.6	F
140 x 90	3.4	E	3.2	E	2.8	E	2.8	E
190 x 90	4.7	E	4.3	E	3.8	E	3.8	E
240 x 90	5.9	E	5.5	E	4.8	E	4.9	F
290 x 90	7.1	E	6.6	E	5.8	F	5.9	F

The table gives maximum spans for Extra high wind zone.
In other wind zones, span lengths shall be multiplied by the following factors:

Light and Medium: **1.3** **High and Very high:** **1.1**

Fixing type	Fixing to resist uplift	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

NOTE –
(1) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.85.
(2) Rafter spacing of 1200 mm does not include heavy roofs.

Table 15.6 – Rafters for all wind zones up to 1.5 kPa snow load – SG 8 (continued) (see 10.2.1.3.2)

Rafter size (width x thickness)	Light roof		Heavy roof	
	Rafter span	Fixing	Rafter span	Fixing
(b) Valley rafters for light and heavy roofs				
(mm x mm)	(m)	(type)	(m)	(type)
90 x 45	1.6	E	1.4	E
140 x 45	2.2	E	2.0	E
190 x 45	2.7	E	2.5	E
240 x 45	3.2	E	3.0	E
290 x 45	3.7	E	3.4	E
90 x 70	1.8	E	1.6	E
140 x 70	2.5	E	2.3	E
190 x 70	3.2	E	2.9	E
240 x 70	3.7	E	3.4	E
290 x 70	4.2	E	3.9	E

Fixing type	Description	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7

NOTE – Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 1.0.

Table 15.7 – Ridge beams for all wind zones up to 1.5 kPa snow load – SG 8 (see 10.2.1.5)

Underpurlin or ridge beam size (width x thickness)	**Loaded dimension* of underpurlin or ridge beam** (m)							
	1.8		**2.7**		**3.6**		**4.2**	
	Span	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**
(a) Light roof								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
240 x 45	2.3	H	1.9	H	1.7	H	1.6	H
290 x 45	2.4	H	2.1	H	1.9	H	1.8	I
190 x 70	2.7	H	2.2	H	1.9	H	1.7	I
240 x 70	4.3	I	3.8	I	3.4	I	3.1	I
290 x 70	4.8	I	4.1	I	3.7	I	3.5	J
190 x 90	3.7	H	3.2	I	2.9	I	2.8	I
240 x 90	4.7	I	4.1	I	3.7	I	3.5	J
290 x 90	5.7	I	5.0	I	4.5	J	4.3	J
(b) Heavy roof								
240 x 45	2.1	G	1.7	H	1.5	H	1.4	H
290 x 45	2.5	G	2.0	H	1.7	H	1.6	H
190 x 70	2.3	G	1.8	H	1.6	H	1.5	H
240 x 70	3.6	H	3.2	I	2.9	I	2.7	I
290 x 70	4.4	H	3.8	I	3.5	I	3.2	I
190 x 90	3.1	H	2.7	H	2.5	I	2.3	I
240 x 90	4.0	H	3.5	I	3.1	I	3.0	I
290 x 90	4.8	I	4.2	I	3.8	I	3.6	I

* For definition of loaded dimension see 1.3.

Fixing type	**Fixing to resist uplift**		**Alternative fixing capacity** (kN)
	Base connection for built-up studs	**Ridge beam to built-up studs**	
G	6 / 90 x 3.15 skew nails into bottom plate	10 / 90 x 3.15 nails (5 each side)	4.7
H	25 x 1 strap with 12 nails to stud	1 / M12 Bolt	8.5
I	2 / 25 x 1 straps with 6 nails to stud and plate. 24 nails total	2 / M12 Bolts	16.0
J	3 / 25 x 1 straps with 12 nails to stud and plate. 36 nails total	2 / M16 Bolts	24.0

NOTE –
(1) Spans may be increased by 10 % for underpurlins over 2 or more spans.
(2) Fixing types for continuous spans shall have double the capacity to that listed in the table.
(3) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table 15.8 – Verandah beams for all wind zones up to 1.5 kPa snow load – SG 8 (see 10.2.1.12)

Beam size (width x thickness)	**Loaded dimension of verandah beam** (m)							
	0.9		**1.4**		**1.8**		**2.1**	
	Span	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**
(a) Light roof								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
140 x 45	1.7	N	1.5	N	1.4	N	1.4	N
190 x 45	2.1	N	2.0	N	1.8	O	1.8	O
240 x 45	2.4	N	2.2	O	2.1	O	2.0	O
290 x 45	2.5	O	2.3	O	2.2	O	2.1	O
140 x 70	2.1	N	1.9	N	1.8	O	1.7	O
190 x 70	2.8	O	2.6	O	2.5	O	2.3	P
220 x 70	3.3	O	3.0	P	2.9	P	2.7	P
240 x 70	3.5	O	3.2	P	3.0	P	2.9	P
290 x 70	3.9	P	3.6	P	3.4	P	3.3	P
140 x 90	2.2	N	2.1	O	2.0	O	1.9	O
190 x 90	3.1	O	2.8	O	2.7	P	2.6	P
240 x 90	3.9	P	3.6	P	3.4	P	3.3	P
290 x 90	5.9	P	5.5	P	5.2	Q	5.1	Q
(b) Heavy roof								
140 x 45	1.5	N	1.3	N	1.2	N	1.1	N
190 x 45	2.0	N	1.7	N	1.6	N	1.5	N
240 x 45	2.3	N	2.1	N	2.0	N	1.9	O
290 x 45	2.5	N	2.3	N	2.1	O	2.1	O
140 x 70	1.8	N	1.7	N	1.5	N	1.5	N
190 x 70	2.4	N	2.3	N	2.1	O	2.0	O
220 x 70	2.8	N	2.6	O	2.4	O	2.3	O
240 x 70	3.1	O	2.9	O	2.7	O	2.5	O
290 x 70	3.8	O	3.5	P	3.2	P	3.1	P
140 x 90	1.9	N	1.8	N	1.7	N	1.7	N
190 x 90	2.7	N	2.5	O	2.3	O	2.3	O
240 x 90	3.4	O	3.1	O	3.0	P	2.9	P
290 x 90	5.2	P	4.8	P	4.6	P	4.4	P

Fixing type	**Fixing to resist uplift (see figure 10.11)**	**Alternative fixing capacity** (kN)
N	6 / 100 x 4.0 nails (hand-driven)	4.7
O	2 / M12 bolts (figure 9.3 (C))	6.8
P	2 HDG ‘flat’ straps (see figure 9.3 (B))	13.7
Q	2 HDG ‘tee’ straps (see figure 9.3 (A))	25.5

NOTE –

(1) This table includes provision for the rafters cantilevering a maximum of 750 mm beyond the verandah beam to support a soffit.

(2) Fixing type for continuous spans shall have double the capacity to that listed in the table.

(3) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table 15.9 – Purlins on their flat in all wind zones up to 1.5 kPa snow load – SG 8 (see 10.2.1.16.1)

Purlin size	Max. span (Rafter spacing)	Maximum spacing and fixing in the following wind zones														
		Low			Medium			High			Very high			Extra high		
		Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity
(mm x mm)	(mm)	(mm)			(mm)			(mm)			(mm)			(mm)		
70 x 45	900	900	900	S	900	900	T	900	900	T	900	900	T	900	900	T
70 x 45	900	1200	1150	T	1200	1150	T	1200	1150	T	1050	1050	T	900	900	T
70 x 45	900	1700	1150	T	1700	1150	T	1400	1150	T	1050	1050	T	900	900	T
70 x 45	1200	950	650	T	950	650	T	800	650	T	600	600	T	500	500	T
70 x 45	1200	950	650	T	950	650	T	800	650	T	600	600	T	500	500	T
90 x 45	1200	1200	850	T	1200	850	T	1000	850	T	750	750	T	650	650	T

Fixing type	Description	Alternative fixing capacity (kN)
S	2 / 90 X 3.15 gun nails	0.8
T	1 / 10g self-drilling screw, 80 mm long	2.4

* For roof abutting an upper storey wall see 15.3.

NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

Table 15.10 – Purlins on their edge for all wind zones up to 1.5 kPa snow load – SG 8 (see 10.2.1.16.6)

Purlin size (depth x thickness)	Maximum spacing and fixing in the following wind zones											
	600			900			1200			1800		
	Spacing	*Abutting	Fixing capacity	Span	*Abutting	Fixing capacity	Span	*Abutting	Fixing capacity	Span	*Abutting	Fixing capacity
(mm x mm)	(m)			(m)			(m)			(m)		
140 x 45	2.8	2.5	E	2.4	2.2	E	2.2	2.0	F	1.9	1.7	F
190 x 45	3.8	3.5	E	3.3	3.0	E	3.0	2.7	F	2.6	2.3	F
240 x 45	4.9	4.4	E	4.2	3.8	F	3.8	3.5	F	3.1	2.9	SED
290 x 45	5.8	5.3	F	4.8	4.6	F	4.1	4.1	SED	3.4	3.4	SED

Fixing type	Description	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs.	4.7
F	2 / 90 x 3.15 skew nails + strap fixings (see figure 10.6).	7.0

* For roof abutting an upper storey wall see 15.3.

NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

APPENDIX A – SG 6 AND SG 10 TABLES

(Normative)

Table A15.2 – Lintel supporting roof only for all wind zones up to 1.5 kPa snow load – SG 6 (see figure 8.7)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)									
		90 x 70	**90 x 90**	**140 x 70**	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof	3	0.8	1.0	1.3	1.5	1.7	2.1	2.2	2.7	2.7	3.3
	4	0.7	0.9	1.1	1.4	1.5	1.9	2.0	2.4	2.4	2.9
	5	–	0.8	1.0	1.2	1.4	1.7	1.8	2.2	2.2	2.6
	6	–	0.7	0.9	1.1	1.3	1.6	1.6	2.0	2.0	2.4
Heavy roof	3	0.7	0.8	1.1	1.3	1.5	1.8	2.0	2.3	2.4	2.8
	4	–	0.8	1.0	1.2	1.4	1.7	1.7	2.1	2.1	2.6
	5	–	0.7	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
	6	–	–	0.8	1.0	1.1	1.4	1.4	1.8	1.8	2.1

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.8.

Table A15.2 – Lintel supporting roof only for all wind zones up to 1.5 kPa snow load – SG 10
(see figure 8.7)

	Loaded dimension* **of lintel** (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)									
		90 x 70	**90 x 90**	**140 x 70**	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof	3	1.1	1.2	1.8	2.0	2.5	2.7	3.1	3.4	3.8	4.1
	4	1.0	1.1	1.6	1.8	2.2	2.5	2.8	3.1	3.4	3.8
	5	0.9	1.1	1.5	1.7	2.0	2.3	2.5	3.0	3.1	3.6
	6	0.8	1.0	1.3	1.6	1.8	2.2	2.3	2.8	2.8	3.4
Heavy roof	3	1.0	1.0	1.5	1.7	2.1	2.3	2.6	2.9	3.2	3.5
	4	0.9	1.0	1.4	1.5	1.9	2.1	2.4	2.7	3.0	3.2
	5	0.8	0.9	1.3	1.4	1.8	2.0	2.2	2.5	2.7	3.0
	6	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4	2.5	2.9

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.8.

Table A15.3 – Lintel supporting roof and wall for all wind zones up to 1.5 kPa snow load – SG 6
(see figure 8.8)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)									
		90 x 70	90 x 90	140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light roof Light wall	3	0.7	0.9	1.2	1.4	1.6	2.0	2.0	2.5	2.5	3.0
	4	0.7	0.8	1.1	1.3	1.4	1.8	1.8	2.2	2.2	2.7
	5	–	0.7	1.0	1.2	1.3	1.6	1.7	2.0	2.0	2.5
	6	–	0.7	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
Light roof Medium wall	3	0.7	0.8	1.1	1.3	1.5	1.8	1.9	2.3	2.3	2.8
	4	–	0.8	1.0	1.2	1.4	1.7	1.7	2.1	2.1	2.6
	5	–	–	0.8	1.0	1.1	1.4	1.4	1.8	1.8	2.1
	6	–	–	0.8	0.9	1.1	1.3	1.3	1.6	1.6	2.0
Heavy roof Light wall	3	0.7	0.8	1.0	1.2	1.4	1.7	1.8	2.2	2.2	2.6
	4	–	0.7	0.9	1.1	1.3	1.6	1.6	2.0	2.0	2.4
	5	–	0.7	0.9	1.0	1.2	1.4	1.5	1.8	1.8	2.2
	6	–	–	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.1
Heavy roof Medium wall	3	–	0.7	1.0	1.2	1.4	1.6	1.7	2.0	2.1	2.5
	4	–	0.7	0.9	1.1	1.2	1.5	1.6	1.9	1.9	2.3
	5	–	–	0.8	1.0	1.1	1.4	1.4	1.8	1.8	2.1
	6	–	–	0.8	0.9	1.1	1.3	1.3	1.6	1.6	2.0

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.8.

Table A15.3 – Lintel supporting roof and wall for all wind zones up to 1.5 kPa snow load – SG 10
(see figure 8.8)

	Loaded dimension* **of lintel** (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)									
		90 x 70	**90 x 90**	**140 x 70**	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	3	1.1	1.2	1.7	1.8	2.3	2.5	2.9	3.2	3.5	3.8
	4	1.0	1.1	1.5	1.7	2.1	2.4	2.6	3.0	3.2	3.6
	5	0.9	1.0	1.4	1.6	1.9	2.2	2.4	2.8	2.9	3.4
	6	0.8	1.0	1.3	1.6	1.8	2.1	2.2	2.7	2.7	3.3
Light roof Medium wall	3	1.0	1.1	1.5	1.7	2.1	2.3	2.7	2.9	3.3	3.5
	4	0.9	1.0	1.4	1.6	1.9	2.2	2.5	2.8	3.0	3.4
	5	0.7	0.8	1.2	1.3	1.6	1.8	2.1	2.3	2.5	2.7
	6	0.7	0.8	1.1	1.2	1.5	1.7	1.9	2.2	2.3	2.6
Heavy roof Light wall	3	0.9	1.0	1.4	1.5	1.9	2.1	2.5	2.7	3.0	3.2
	4	0.8	0.9	1.3	1.4	1.8	2.0	2.3	2.5	2.8	3.0
	5	0.8	0.9	1.2	1.4	1.7	1.9	2.1	2.4	2.6	2.9
	6	0.7	0.8	1.1	1.3	1.6	1.8	2.0	2.3	2.4	2.7
Heavy roof Medium wall	3	0.8	0.9	1.3	1.4	1.8	2.0	2.3	2.5	2.8	3.1
	4	0.8	0.9	1.3	1.4	1.7	1.9	2.2	2.4	2.6	2.9
	5	0.7	0.8	1.2	1.3	1.6	1.8	2.1	2.3	2.5	2.7
	6	0.7	0.8	1.1	1.2	1.5	1.7	1.9	2.2	2.3	2.6

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.8.

Table A15.4 – Lintel supporting roof, floor and wall for all wind zones up to 1.5 kPa snow load – SG 6 (see figure 8.9)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m)							
		width x thickness (mm)							
		140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light roof Light wall	3	0.8	1.0	1.1	1.4	1.4	1.7	1.7	2.1
	4	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.0
	5	0.8	0.9	1.0	1.3	1.3	1.6	1.6	2.0
	6	0.7	0.9	1.0	1.2	1.3	1.6	1.6	1.9
Light roof Medium wall	3	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.0
	4	0.8	0.9	1.0	1.3	1.3	1.6	1.6	2.0
	5	0.7	0.8	0.9	1.1	1.2	1.4	1.4	1.7
	6	–	0.8	0.9	1.1	1.1	1.4	1.4	1.7
Heavy roof Light wall	3	0.7	0.9	1.0	1.3	1.3	1.6	1.6	2.0
	4	0.7	0.9	1.0	1.2	1.3	1.5	1.5	1.9
	5	0.7	0.8	0.9	1.1	1.2	1.5	1.5	1.8
	6	0.7	0.8	0.9	1.1	1.2	1.4	1.4	1.7
Heavy roof Medium wall	3	0.7	0.9	1.0	1.2	1.3	1.6	1.6	1.9
	4	0.7	0.8	1.0	1.2	1.2	1.5	1.5	1.8
	5	0.7	0.8	0.9	1.1	1.2	1.4	1.4	1.7
	6	–	0.8	0.9	1.1	1.1	1.4	1.4	1.7

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.9.

Table A15.4 – Lintel supporting roof, floor and wall for all wind zones up to 1.5 kPa snow load – SG 10 (see figure 8.9)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)							
		140 x 70	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	3	1.2	1.4	1.6	1.9	2.0	2.4	2.5	3.0
	4	1.1	1.4	1.5	1.9	2.0	2.4	2.4	2.9
	5	1.1	1.3	1.5	1.8	1.9	2.3	2.3	2.8
	6	1.1	1.3	1.4	1.8	1.8	2.2	2.2	2.7
Light roof Medium wall	3	1.1	1.3	1.5	1.8	2.0	2.3	2.4	2.8
	4	1.1	1.3	1.5	1.8	1.9	2.3	2.3	2.8
	5	1.0	1.1	1.3	1.6	1.7	2.0	2.0	2.4
	6	0.9	1.1	1.3	1.5	1.6	1.9	1.9	2.4
Heavy roof Light wall	3	1.1	1.3	1.5	1.7	1.9	2.2	2.3	2.7
	4	1.0	1.2	1.4	1.7	1.8	2.1	2.2	2.6
	5	1.0	1.2	1.4	1.6	1.7	2.1	2.1	2.5
	6	0.9	1.1	1.3	1.6	1.7	2.0	2.0	2.4
Heavy roof Medium wall	3	1.0	1.2	1.4	1.7	1.8	2.1	2.2	2.6
	4	1.0	1.2	1.4	1.6	1.7	2.1	2.1	2.5
	5	1.0	1.1	1.3	1.6	1.7	2.0	2.0	2.4
	6	0.9	1.1	1.3	1.5	1.6	1.9	1.9	2.4

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.9.

Table A15.5 – Lintel supporting roof, floor and wall in all wind zones for 3 kPa floor load and up to 1.5 kPa snow load – SG 6 (see figure 8.9)

	Loaded dimension* of lintel (m)	**Maximum span for lintel sizes listed below** (m) **width x thickness** (mm)							
		140 x 70	**140 x 90**	**190 x 70**	**190 x 90**	**240 x 70**	**240 x 90**	**290 x 70**	**290 x 90**
Light roof Light wall	3	0.8	1.0	1.1	1.4	1.4	1.7	1.7	2.1
	4	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.0
	5	0.8	0.9	1.0	1.3	1.3	1.6	1.6	2.0
	6	0.7	0.9	1.0	1.2	1.3	1.6	1.6	1.9
Light roof Medium wall	3	0.8	1.0	1.1	1.3	1.4	1.7	1.7	2.0
	4	0.8	0.9	1.0	1.3	1.3	1.6	1.6	2.0
	5	0.7	0.8	0.9	1.1	1.2	1.4	1.4	1.7
	6	–	0.8	0.9	1.1	1.1	1.4	1.4	1.7
Heavy roof Light wall	3	0.7	0.9	1.0	1.3	1.3	1.6	1.6	2.0
	4	0.7	0.9	1.0	1.2	1.3	1.5	1.5	1.9
	5	0.7	0.8	0.9	1.1	1.2	1.5	1.5	1.8
	6	0.7	0.8	0.9	1.1	1.2	1.4	1.4	1.7
Heavy roof Medium wall	3	0.7	0.9	1.0	1.2	1.3	1.6	1.6	1.9
	4	0.7	0.8	1.0	1.2	1.2	1.5	1.5	1.8
	5	0.7	0.8	0.9	1.1	1.2	1.4	1.4	1.7
	6	–	0.8	0.9	1.1	1.1	1.4	1.4	1.7

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.9.

Table A15.5 – Lintel supporting roof, floor and wall in all wind zones for 3 kPa floor load and up to 1.5 kPa snow load – SG 10 (see figure 8.9)

	Loaded dimension* of lintel (m)	Maximum span for lintel sizes listed below (m) width x thickness (mm)							
		140 x 70	140 x 90	190 x 70	190 x 90	240 x 70	240 x 90	290 x 70	290 x 90
Light roof Light wall	3	1.2	1.3	1.6	1.8	2.0	2.3	2.5	2.8
	4	1.1	1.3	1.5	1.8	2.0	2.3	2.4	2.7
	5	1.1	1.3	1.5	1.7	1.9	2.2	2.3	2.7
	6	1.1	1.2	1.4	1.7	1.8	2.2	2.2	2.6
Light roof Medium wall	3	1.1	1.3	1.5	1.7	2.0	2.2	2.4	2.7
	4	1.1	1.2	1.5	1.7	1.9	2.2	2.3	2.6
	5	1.0	1.1	1.3	1.5	1.7	1.9	2.0	2.3
	6	0.9	1.1	1.3	1.5	1.6	1.9	1.9	2.3
Heavy roof Light wall	3	1.1	1.2	1.5	1.7	1.9	2.1	2.3	2.6
	4	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.5
	5	1.0	1.1	1.4	1.6	1.7	2.0	2.1	2.4
	6	0.9	1.1	1.3	1.5	1.7	1.9	2.0	2.3
Heavy roof Medium wall	3	1.0	1.2	1.4	1.6	1.8	2.1	2.2	2.5
	4	1.0	1.1	1.4	1.6	1.7	2.0	2.1	2.4
	5	1.0	1.1	1.3	1.5	1.7	1.9	2.0	2.3
	6	0.9	1.1	1.3	1.5	1.6	1.9	1.9	2.3

* For definition of loaded dimension see 1.3.

NOTE –

(1) Determine the loaded dimension of the lintel at floor level and the loaded dimension of the wall above the lintel at roof level and use the greater value in this table.

(2) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

(3) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.9.

Table A15.6 – Rafters for all wind zones up to 1.5 kPa snow load – SG 6 (see 10.2.1.3.2)

Rafter size (width x thickness)	**Rafter spacing** (mm)							
	480		**600**		**900**		**1200**	
	Span	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**
(a) Ordinary rafters for light and heavy roofs								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	1.0	E	0.9	E	0.9	E	0.9	E
140 x 45	2.1	E	2.0	E	1.8	E	1.9	E
190 x 45	3.1	E	2.9	E	2.5	E	2.2	E
240 x 45	3.4	E	3.2	E	2.7	E	2.5	E
290 x 45	3.6	E	3.4	E	2.9	E	2.7	E
140 x 70	2.8	E	2.6	E	2.3	E	2.3	E
190 x 70	3.9	E	3.6	E	3.1	E	3.2	E
240 x 70	4.9	E	4.6	E	4.0	E	3.7	E
290 x 70	5.7	E	5.2	E	4.5	E	4.1	F
140 x 90	3.1	E	2.9	E	2.5	E	2.5	E
190 x 90	4.2	E	3.9	E	3.4	E	3.5	E
240 x 90	5.3	E	5.0	E	4.3	E	4.4	F
290 x 90	6.5	E	6.0	E	5.2	F	5.2	F

The table gives maximum spans for Extra high wind zone.
In other wind zones, span lengths shall be multiplied by the following factors:

Light and Medium:	**1.3**	**High and Very high:**	**1.1**

Fixing type	**Fixing to resist uplift**	**Alternative fixing capacity** (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

NOTE –
(1) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.85.
(2) Rafter spacing of 1200 mm does not include heavy roofs.

Table A15.6 – Rafters for all wind zones up to 1.5 kPa snow load – SG 6 (continued) (see 10.2.1.3.2)

Rafter size (width x thickness)	Light roof		Heavy roof	
	Rafter span	Fixing	Rafter span	Fixing
(b) Valley rafters for light and heavy roofs				
(mm x mm)	(m)	(type)	(m)	(type)
90 x 45	1.5	E	1.3	E
140 x 45	2.0	E	1.8	E
190 x 45	2.4	E	2.3	E
240 x 45	2.9	E	2.6	E
290 x 45	3.3	E	3.0	E
90 x 70	1.7	E	1.5	E
140 x 70	2.3	E	2.1	E
190 x 70	2.8	E	2.6	E
240 x 70	3.3	E	3.1	E
290 x 70	3.8	E	3.5	E

Fixing type	Description	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7

NOTE – Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 1.0.

Table A15.6 – Rafters for all wind zones up to 1.5 kPa snow load – SG 10 (see 10.2.1.3.2)

Rafter size (width x thickness)	Rafter spacing (mm)							
	480		600		900		1200	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(a) Ordinary rafters for light and heavy roofs								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
90 x 45	1.8	E	1.7	E	1.5	E	1.6	E
140 x 45	3.0	E	2.8	E	2.4	E	2.5	E
190 x 45	4.0	E	3.7	E	3.2	E	2.9	E
240 x 45	4.3	E	4.0	E	3.5	E	3.2	E
290 x 45	4.6	E	4.3	E	3.7	E	3.4	E
140 x 70	3.5	E	3.3	E	2.8	E	2.9	E
190 x 70	4.8	E	4.4	E	3.9	E	3.9	E
240 x 70	6.1	E	5.6	E	4.9	E	4.9	F
290 x 70	7.2	E	6.7	E	5.8	F	5.2	F
140 x 90	3.8	E	3.5	E	3.1	E	3.1	E
190 x 90	5.2	E	4.8	E	4.2	E	4.3	F
240 x 90	6.6	E	6.1	E	5.3	F	5.4	F
290 x 90	7.8	E	7.4	E	6.5	F	6.4	F

The table gives maximum spans for Extra high wind zone.
In other wind zones, span lengths shall be multiplied by the following factors:

Light and Medium:	**1.3**	**High and Very high:**	**1.1**

Fixing type	Fixing to resist uplift	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixing (see figure 10.6)	7.0

NOTE –
(1) Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 0.85.
(2) Rafter spacing of 1200 mm does not include heavy roofs.

Table A15.6 – Rafters for all wind zones up to 1.5 kPa snow load – SG 10 (continued) (see 10.2.1.3.2)

Rafter size (width x thickness)	Light roof		Heavy roof	
	Rafter span	Fixing	Rafter span	Fixing
(b) Valley rafters for light and heavy roofs				
(mm x mm)	(m)	(type)	(m)	(type)
90 x 45	1.8	E	1.6	E
140 x 45	2.5	E	2.2	E
190 x 45	3.1	E	2.8	E
240 x 45	3.6	E	3.3	E
290 x 45	4.1	E	3.8	E
90 x 70	2.0	E	1.8	E
140 x 70	2.8	E	2.5	E
190 x 70	3.5	E	3.1	E
240 x 70	4.2	E	3.7	E
290 x 70	4.8	E	4.3	E

Fixing type	Description	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7

NOTE – Where the roof abuts an upper storey wall, (see 15.3), multiply the above spans by 1.0.

Table A15.7 – Ridge beams for all wind zones up to 1.5 kPa snow load – SG 6 (see 10.2.1.5)

Underpurlin or ridge beam size (width x thickness)	Loaded dimension* of underpurlin or ridge beam (m)							
	1.8		2.7		3.6		4.2	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(a) Light roof								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
240 x 45	2.0	G	1.7	H	1.5	H	1.4	H
290 x 45	2.1	G	1.9	H	1.7	H	1.6	H
190 x 70	2.3	H	1.8	H	1.6	H	1.5	H
240 x 70	3.9	H	3.3	I	2.9	I	2.6	I
290 x 70	4.2	I	3.7	I	3.3	I	3.1	I
190 x 90	3.4	H	2.9	I	2.6	I	2.4	I
240 x 90	4.3	I	3.7	I	3.2	I	3.0	I
290 x 90	5.2	I	4.5	I	3.9	J	3.6	J
(b) Heavy roof								
240 x 45	1.8	G	1.5	G	1.3	H	1.2	H
290 x 45	2.1	G	1.7	H	1.5	H	1.3	H
190 x 70	1.9	G	1.6	G	1.3	H	1.2	H
240 x 70	3.3	H	2.8	H	2.4	I	2.2	I
290 x 70	4.0	H	3.4	I	2.9	I	2.7	I
190 x 90	2.8	H	2.5	H	2.2	H	2.0	I
240 x 90	3.6	H	3.1	I	2.8	I	2.6	I
290 x 90	4.3	H	3.8	I	3.3	I	3.1	I

* For definition of loaded dimension see 1.3.

Fixing type	Fixing to resist uplift		Alternative fixing capacity (kN)
	Base connection for built-up studs	Ridge beam to built-up studs	
G	6 / 90 x 3.15 skew nails into bottom plate	10 / 90 x 3.15 nails (5 each side)	4.7
H	25 x 1 strap with 12 nails to stud	1 / M12 Bolt	8.5
I	2 / 25 x 1 straps with 6 nails to stud and plate. 24 nails total	2 / M12 Bolts	16.0
J	3 / 25 x 1 straps with 12 nails to stud and plate. 36 nails total	2 / M16 Bolts	24.0

NOTE –
(1) Spans may be increased by 10 % for underpurlins over 2 or more spans.
(2) Fixing types for continuous spans shall have double the capacity to that listed in the table.
(3) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A15.7 – Ridge beams for all wind zones up to 1.5 kPa snow load – SG 10 (see 10.2.1.5)

Underpurlin or ridge beam size (width x thickness)	**Loaded dimension* of underpurlin or ridge beam** (m)							
	1.8		**2.7**		**3.6**		**4.2**	
	Span	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**
(a) Light roof								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
240 x 45	2.6	H	2.2	H	2.0	I	1.9	I
290 x 45	2.7	H	2.4	H	2.1	I	2.0	I
190 x 70	3.0	H	2.6	H	2.3	I	2.1	I
240 x 70	4.8	I	4.2	I	3.8	J	3.6	J
290 x 70	5.4	I	4.7	I	4.2	J	4.0	J
190 x 90	4.2	I	3.6	I	3.3	I	3.1	I
240 x 90	5.3	I	4.6	I	4.2	J	4.0	J
290 x 90	6.4	I	5.6	J	5.0	J	4.8	J
(b) Heavy roof								
240 x 45	2.6	H	2.1	H	1.8	H	1.7	H
290 x 45	2.9	H	2.4	H	2.1	H	1.9	H
190 x 70	2.5	H	2.2	H	1.9	H	1.8	H
240 x 70	4.1	H	3.5	I	3.2	I	3.1	I
290 x 70	4.9	I	4.3	I	3.9	I	3.7	I
190 x 90	3.5	H	3.0	H	2.8	I	2.6	I
240 x 90	4.4	H	3.9	I	3.5	I	3.3	I
290 x 90	5.4	I	4.7	I	4.2	I	4.0	J

* For definition of loaded dimension see 1.3.

Fixing type	**Fixing to resist uplift**		**Alternative fixing capacity** (kN)
	Base connection for built-up studs	**Ridge beam to built-up studs**	
H	25 x 1 strap with 12 nails to stud	1 / M12 Bolt	8.5
I	2 / 25 x 1 straps with 6 nails to stud and plate. 24 nails total	2 / M12 Bolts	16.0
J	3 / 25 x 1 straps with 12 nails to stud and plate. 36 nails total	2 / M16 Bolts	24.0

NOTE –
(1) Spans may be increased by 10 % for underpurlins over 2 or more spans.
(2) Fixing types for continuous spans shall have double the capacity to that listed in the table.
(3) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A15.8 – Verandah beams for all wind zones up to 1.5 kPa snow load – SG 6 (see 10.2.1.12)

Beam size (width x thickness)	**Loaded dimension* of verandah beam** (m)							
	0.9		**1.4**		**1.8**		**2.1**	
	Span	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**	**Span**	**Fixing**
(a) Light roof								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
140 x 45	1.5	N	1.3	N	1.2	N	1.1	N
190 x 45	1.9	N	1.7	N	1.6	N	1.5	N
240 x 45	2.1	N	1.9	N	1.8	O	1.7	O
290 x 45	2.2	N	2.1	O	2.0	O	1.9	O
140 x 70	1.8	N	1.6	N	1.5	N	1.4	N
190 x 70	2.5	O	2.3	O	2.1	O	2.0	O
220 x 70	2.9	O	2.6	O	2.4	O	2.3	P
240 x 70	3.1	O	2.8	O	2.6	P	2.5	P
290 x 70	3.4	O	3.2	P	3.0	P	2.8	P
140 x 90	2.0	N	1.9	N	1.7	O	1.6	O
190 x 90	2.8	O	2.6	O	2.4	O	2.2	P
240 x 90	3.5	O	3.2	P	3.0	P	2.8	P
290 x 90	5.4	P	5.0	P	4.7	P	4.6	Q
(b) Heavy roof								
140 x 45	1.2	N	1.1	N	1.0	N	1.0	N
190 x 45	1.6	N	1.5	N	1.4	N	1.3	N
240 x 45	2.0	N	1.8	N	1.7	N	1.6	N
290 x 45	2.2	N	2.0	N	1.9	N	1.8	O
140 x 70	1.6	N	1.4	N	1.3	N	1.2	N
190 x 70	2.1	N	1.9	N	1.8	N	1.7	N
220 x 70	2.5	N	2.2	N	2.1	O	1.9	O
240 x 70	2.7	N	2.4	O	2.2	O	2.1	O
290 x 70	3.3	O	2.9	O	2.7	O	2.6	O
140 x 90	1.8	N	1.6	N	1.5	N	1.4	N
190 x 90	2.4	N	2.2	N	2.0	O	1.9	O
240 x 90	3.0	O	2.8	O	2.6	O	2.4	O
290 x 90	4.7	P	4.3	P	4.1	P	4.0	P

Fixing type	**Fixing to resist uplift (see figure 10.11)**	**Alternative fixing capacity** (kN)
N	6 / 100 x 4.0 nails (hand-driven)	4.7
O	2 / M12 bolts (figure 9.3 (C))	6.8
P	2 HDG 'flat' straps (see figure 9.3 (B))	13.7
Q	2 HDG 'tee' straps (see figure 9.3 (A))	25.5

* For definition of loaded dimension see 1.3.

NOTE –

(1) This table includes provision for the rafters cantilevering a maximum of 750 mm beyond the verandah beam to support a soffit.

(2) Fixing type for continuous spans shall have double the capacity to that listed in the table.

(3) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A15.8 – Verandah beams for all wind zones up to 1.5 kPa snow load – SG 10 (see 10.2.1.12)

Beam size (width x thickness)	Loaded dimension* of verandah beam (m)							
	0.9		1.4		1.8		2.1	
	Span	Fixing	Span	Fixing	Span	Fixing	Span	Fixing
(a) Light roof								
(mm x mm)	(m)	(type)	(m)	(type)	(m)	(type)	(m)	(type)
140 x 45	2.0	N	1.8	N	1.7	O	1.6	O
190 x 45	2.4	N	2.2	O	2.1	O	2.0	O
240 x 45	2.7	O	2.5	O	2.3	O	2.3	P
290 x 45	2.9	O	2.7	O	2.5	P	2.4	P
140 x 70	2.3	N	2.1	O	2.0	O	2.0	O
190 x 70	3.1	O	2.9	P	2.8	P	2.7	P
220 x 70	3.7	P	3.4	P	3.2	P	3.1	P
240 x 70	4.0	P	3.7	P	3.5	P	3.4	P
290 x 70	4.4	P	4.1	P	3.9	P	3.7	P
140 x 90	2.5	O	2.3	O	2.2	O	2.1	O
190 x 90	3.4	O	3.2	P	3.0	P	2.9	P
240 x 90	4.3	P	4.0	P	3.8	P	3.7	P
290 x 90	6.6	P	6.2	Q	5.9	Q	5.6	Q
(b) Heavy roof								
140 x 45	1.7	N	1.6	N	1.5	N	1.4	N
190 x 45	2.3	N	2.1	N	1.9	N	1.8	O
240 x 45	2.6	N	2.4	O	2.3	O	2.2	O
290 x 45	2.8	N	2.6	O	2.4	O	2.4	O
140 x 70	2.0	N	1.9	N	1.8	N	1.7	N
190 x 70	2.7	N	2.5	O	2.4	O	2.3	O
220 x 70	3.2	O	2.9	O	2.8	O	2.7	P
240 x 70	3.5	O	3.2	O	3.1	P	2.9	P
290 x 70	4.2	O	3.9	P	3.7	P	3.6	P
140 x 90	2.2	N	2.0	N	1.9	N	1.8	O
190 x 90	3.0	O	2.8	O	2.6	O	2.5	O
240 x 90	3.8	O	3.5	P	3.3	P	3.2	P
290 x 90	5.8	P	5.4	P	5.1	P	4.9	P

Fixing type	Fixing to resist uplift (see figure 10.11)	Alternative fixing capacity (kN)
N	6 / 100 x 4.0 nails (hand-driven)	4.7
O	2 / M12 bolts (figure 9.3 (C))	6.8
P	2 HDG 'flat' straps (see figure 9.3 (B))	13.7
Q	2 HDG 'tee' straps (see figure 9.3 (A))	25.5

* For definition of loaded dimension see 1.3.

NOTE –

(1) This table includes provision for the rafters cantilevering a maximum of 750 mm beyond the verandah beam to support a soffit.

(2) Fixing type for continuous spans shall have double the capacity to that listed in the table.

(3) Members 90 mm thick may be substituted with built-up members sized and nailed in accordance with 2.4.4.7.

Table A15.9 – Purlins on their flat in all wind zones up to 1.5 kPa snow load – SG 6 (see 10.2.1.16.1)

Purlin size	Max. span (Rafter spacing)	Maximum spacing and fixing in the following wind zones														
		Low			Medium			High			Very high			Extra high		
		Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity
(mm x mm)	(mm)	(mm)			(mm)			(mm)			(mm)			(mm)		
70 x 45	900	900	850	S	900	850	T	900	850	T	750	750	T	600	600	T
70 x 45	900	1200	850	T	1200	850	T	1000	850	T	750	750	T	600	600	T
70 x 45	900	1200	850	T	1200	850	T	1000	850	T	750	750	T	600	600	T
70 x 45	1200	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
70 x 45	1200	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
90 x 45	1200	850	600	T	850	600	T	700	600	T	550	550	T	450	450	T

Fixing type	Description	Alternative fixing capacity (kN)
S	2 / 90 X 3.15 gun nails	0.8
T	1 / 10g self-drilling screw, 80 mm long	2.4

* For roof abutting an upper wall see 15.3.
NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

Table A15.9 – Purlins on their flat in all wind zones up to 1.5 kPa snow load – SG 10 (see 10.2.1.16.1)

Purlin size	Max. span (Rafter spacing)	Maximum spacing and fixing in the following wind zones														
		Low			Medium			High			Very high			Extra high		
		Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity	Spacing	*Abutting	Fixing capacity
(mm x mm)	(mm)	(mm)			(mm)			(mm)			(mm)			(mm)		
70 x 45	900	900	900	S	900	900	T	900	900	T	900	900	T	900	900	T
70 x 45	900	1200	1200	T	1200	1200	T	1200	1200	T	1200	1200	U	1200	1200	U
70 x 45	900	1800	1700	T	1800	1700	T	1800	1700	U	1550	1550	U	1250	1250	U
70 x 45	1200	1200	950	T	1200	950	T	1150	950	U	850	850	U	700	700	U
70 x 45	1200	1350	950	T	1350	950	T	1150	950	U	850	850	U	700	700	U
90 x 45	1200	1750	1200	T	1750	1200	U	1450	1200	U	1100	1100	U	900	900	U

Fixing type	Description	Alternative fixing capacity (kN)
S	2 / 90 X 3.15 gun nails	0.8
T	1 / 10g self-drilling screw, 80 mm long	2.4
U	1 / 14g self-drilling type 17 screw, 100 mm long	5.5

* For roof abutting an upper wall see 15.3.
NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

Table A15.10 – Purlins on their edge for all wind zones up to 1.5 kPa snow load – SG 6 (see 10.2.1.16.6)

Purlin size (depth x thickness)	Maximum spacing and fixing in the following wind zones											
	600			900			1200			1800		
	Spacing	*Abutting	Fixing capacity	Span	*Abutting	Fixing capacity	Span	*Abutting	Fixing capacity	Span	*Abutting	Fixing capacity
(mm x mm)	(m)			(m)			(m)			(m)		
140 x 45	2.3	2.3	E	2.2	2.0	E	2.0	1.8	E	1.6	1.4	E
190 x 45	3.5	3.1	E	3.0	2.7	F	2.7	2.4	E	2.2	1.9	F
240 x 45	4.4	4.0	F	3.7	3.5	F	3.2	3.0	F	2.6	2.5	F
290 x 45	4.9	4.8	E	4.0	4.0	F	3.5	3.5	F	2.8	2.8	SED

Fixing type	Description	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixings (see figure 10.6)	7.0

* For roof abutting an upper storey wall see 15.3.
NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

Table A15.10 – Purlins on their edge for all wind zones up to 1.5 kPa snow load – SG 10 (see 10.2.1.16.6)

Purlin size (depth x thickness)	Maximum spacing and fixing in the following wind zones											
	600			900			1200			1800		
	Spacing	*Abutting	Fixing capacity	Span	*Abutting	Fixing capacity	Span	*Abutting	Fixing capacity	Span	*Abutting	Fixing capacity
(mm x mm)	(m)			(m)			(m)			(m)		
140 x 45	3.1	2.8	E	2.7	2.5	F	2.5	2.2	E	2.2	2.0	F
190 x 45	4.3	3.9	F	3.7	3.4	F	3.4	3.1	F	3.0	2.7	SED
240 x 45	5.4	4.9	E	4.7	4.3	F	4.3	3.9	SED	3.7	3.4	SED
290 x 45	6.4	5.9	F	5.7	5.2	SED	4.9	4.7	SED	4.0	4.0	SED

Fixing type	Description	Alternative fixing capacity (kN)
E	2 / 90 x 3.15 skew nails + 2 wire dogs	4.7
F	2 / 90 x 3.15 skew nails + strap fixings (see figure 10.6)	7.0

* For roof abutting an upper storey wall see 15.3.
NOTE – All fixing types are determined as required for the higher uplift loads at the periphery of the roof (based on local pressure factors in AS/NZS 1170.2).

SECTION 16

COMPOSITE CONSTRUCTION LINTEL TABLES

Table

Figure

16 COMPOSITE CONSTRUCTION LINTEL TABLES

16.1 PLYWOOD BOX BEAM LINTELS

Plywood box beam *lintels* shall be constructed as shown in figures 16.1 and 16.2 and may be used instead of those given in 8.6 to support *roofs* that are not subjected to *snow loading*. Beam sizes shall be as given in table 16.1 depending on *roof* type and pitch, and the *loaded dimension*. Other requirements shall be as given in 8.6. The fixings shall be in accordance with table 8.14. Use only SG 8 or SG 10 for top and bottom chords of box beams. *Lintels* supporting *walls*, floors or *snow loading* shall be to *specific engineering design*.

Table 16.1 – Plywood box beam lintels supporting roof only (see 8.6.1.2)

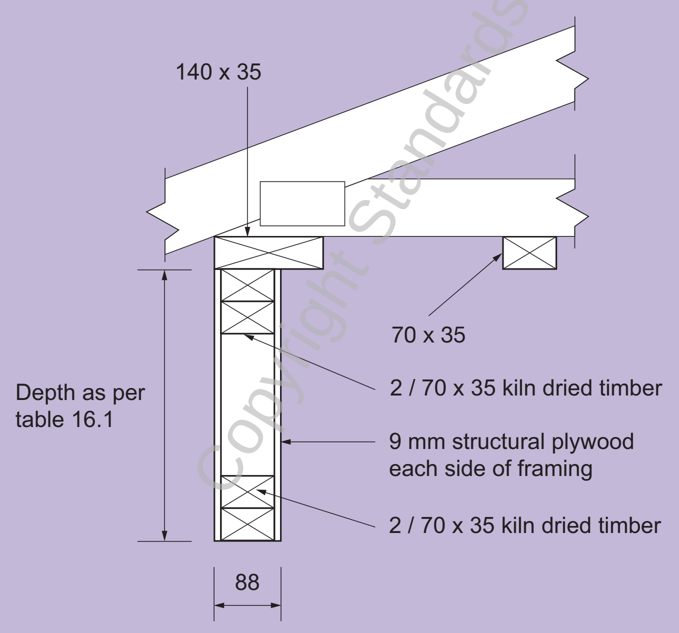
Lintel size		Roof pitch (degrees)	Maximum span of lintel for loaded dimension of (m)			
Depth (mm)	Width (mm)		3.0	4.0	5.0	6.0
(a) Light roof						
400	88	15	4.8	4.5	4.3	4.1
		25	4.7	4.4	4.2	4.0
		45	4.4	4.2	4.0	3.8
360	88	15	4.5	4.2	4.0	3.8
		25	4.4	4.1	3.9	3.7
		45	4.1	3.9	3.7	3.3
(b) Heavy roof						
400	88	25	4.0	3.8	3.4	2.9
		45	3.8	3.2	2.7	2.3
360	88	25	3.8	3.5	3.0	2.5
		45	3.5	2.8	2.3	2.0

16.2 GLUE-LAMINATED TIMBER LINTELS

Glue-laminated timber *lintels* manufactured in accordance with AS/NZS 1328: Parts 1 and 2, as given in table 16.2, may be substituted for plywood box beam *lintels* in table 16.1.

Table 16.2 – Glue-laminated timber lintel equivalents to plywood box beam lintels in table 16.1 (see 8.6.1.2)

Plywood box beam lintel framing chords		Equivalent glue laminated beam					
		Glulam grade					
		GL8		GL10		GL12	
Depth (mm)	Width (mm)	Depth (mm)	Width (mm)	Depth (mm)	Width (mm)	Depth (mm)	Width (mm)
400	88	355	90	329	90	310	90
360	88	324	90	301	90	283	90



Unless otherwise stated, all dimensions are in mm.

Figure 16.1 – Built-up plywood box beam lintel – Vertical section (see 8.6.1.7)

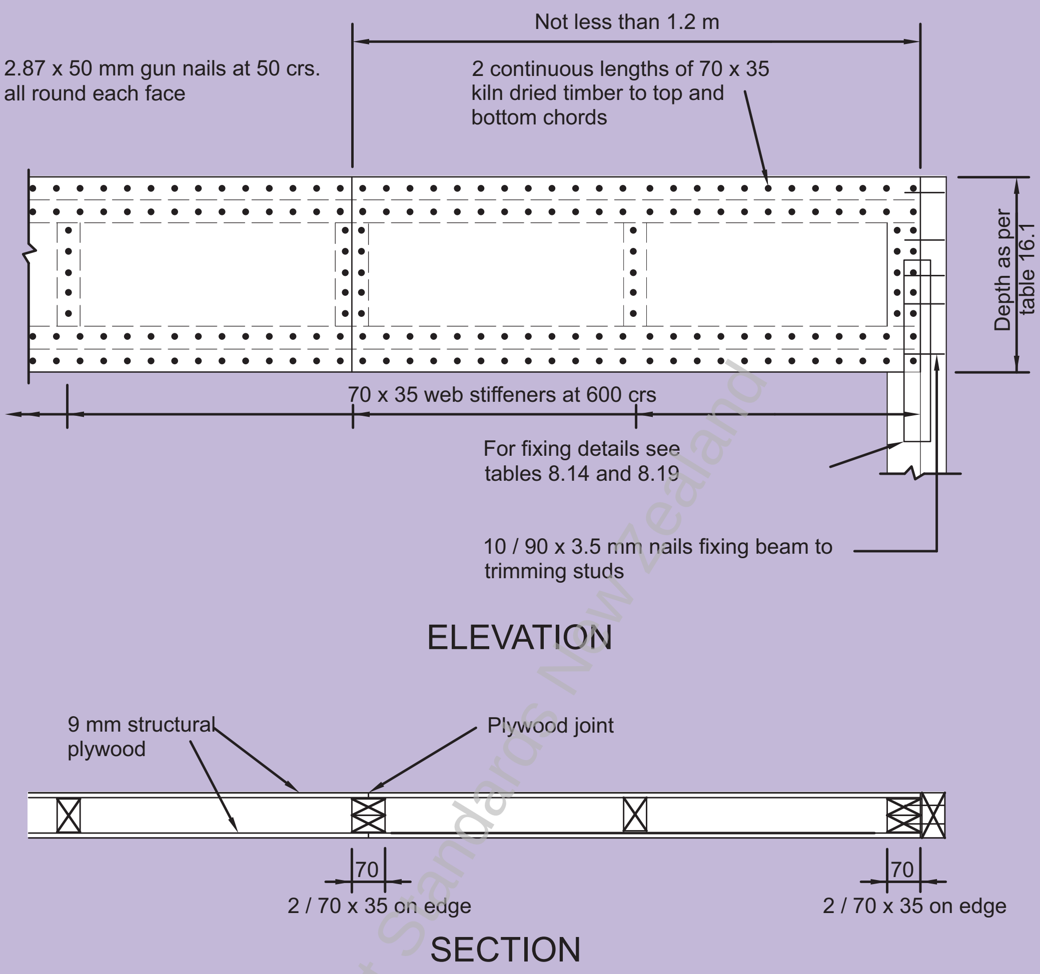


Figure 16.2 – Built-up plywood box beam lintel – Elevation and longitudinal section (see 8.6.1.7)

SECTION 17

EXPANSIVE SOILS

17 EXPANSIVE SOILS

17.1 GENERAL

Section 17 of NZS 3604 is informative only.

17.1.1

Expansive soils with a liquid limit more than 50 % when tested in accordance with NZS 4402 Test 2.2, and a linear shrinkage of more than 15 % when tested in accordance with NZS 4402 Test 2.6, are excluded from *good ground* defined in 1.3.

17.1.2

This is because they cover reactive soils, such as expansive clay soils, which swell on wetting and shrink on drying by an amount that can damage buildings on light strip *footings* or unstiffened slabs.

17.1.3

Not all clays are expansive to the degree which will cause damage to buildings. *Foundations* supported on such clays are covered in section 6.

17.1.4

The liquid limit and linear shrinkage properties of a soil need to be classified by a soil mechanics laboratory. Reactive clay soils cannot be clearly evaluated by these engineering index properties which on their own may not be reliable.

C17.1.4

Reference to liquid limit results should be indicative only, and used with care, as the mechanical mixing of the test procedure, and oven drying of the sample can break down the chemical structure of some soils such as allophanes, releasing "adsorbed water" to add to the existing pore water. Because of the likely unpredictable conversion of adsorbed water, these tests are considered unreliable as a means of estimating the degree of expansiveness.

17.1.5

For this reason, sites need to be classified into one of the classes (S, M, H or E) as set out in AS 2870 so that standard *footing* designs set out in section 3 of AS 2870 can be used on sites with expansive soils.

17.2 BUILDING SITES

Building sites which contain expansive soils as defined in item (b) of the definition for *good ground* in 1.3 should be classified into class S, M, H or E in accordance with the provisions of AS 2870.

C17.2

This clause requires the input of a geomechanical engineer or soils laboratory. Useful information relating to this subject is contained in the commentary to AS 2870.

The design engineer may wish to refer to AS 2870, or provide a specific engineering design for the proposed building.

17.3 FOUNDATIONS

The *foundations* for buildings supported on sites identified as containing expansive soils should be detailed to the provisions contained in sections 3, 5 and 6 of AS 2870.

17.4 REINFORCEMENT

Reinforcement specified in AS 2870 refers to Trench Mesh (TM), Square Fabric (F) and reinforcing steel (Y) to the provisions of AS/NZS 4671 and AS 1302.

INDEX

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PUBLISHING HISTORY

First published:	November 1978
Reprinted incorporating Amendments:	August 1981
Revised:	October 1984
Revised:	October 1990
Reprinted incorporating Corrigenda, Supplement and Amendment No. 1:	November 1992
Revised:	June 1999
Reprinted incorporating Amendment No. 1:	September 2001
Reprinted incorporating Amendments No. 1 and No. 2:	July 2006
Limited technical revision:	February 2011

Approved by the Standards Council on 17 December 2010 to be a New Zealand Standard pursuant to the provisions of section 10 of the Standards Act 1988.

First published: 14 February 2011

The following SNZ references relate to this Standard:

Project No. P 3604

Draft for comment No. DZ 3604

Typeset by: Standards New Zealand

Printed by: The Colour Guy