NZS 4229:2013

New Zealand Standard

Concrete masonry buildings not requiring specific engineering design

Superseding NZS 4229:1999

NZS 4229:2013

Single User PDF Terms & Conditions

COMMITTEE REPRESENTATION

This Standard was prepared under the supervision of the P 4229 Committee the Standards Council established under the Standards Act 1988.

The committee consisted of representatives of the following nominating organisations:

BRANZ

Cement and Concrete Association of New Zealand

Design Association of New Zealand

Institution of Professional Engineers New Zealand

Ministry of Business, Innovation and Employment – Building and Housing Group

University of Auckland

ACKNOWLEDGEMENT

Standards New Zealand gratefully acknowledges the contribution of time and expertise from all those involved in developing this Standard. Standards New Zealand also gratefully acknowledges the New Zealand Concrete Masonry Association for the figures provided for Appendix A.

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AMENDMENTS

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

NZS 4229:2013

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ISBN (Print) 978-1-86975-586-7
ISBN (PDF) 978-1-86975-587-4

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REFERENCED DOCUMENTS

Reference is made in this document to the following:

New Zealand Standards

NZS 1170:----	Structural design actions
Part 5:2004	Earthquake actions – New Zealand
Part 5: Supplement 1: 2004	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 3112:----	Methods of test for concrete
Part 1:1986	Tests relating to fresh concrete
Part 2:1986	Tests relating to the determination of strength of concrete
Part 4:1986	Tests relating to grout
NZS 3604:2011	Timber-framed buildings
NZS 4210:2001	Masonry construction: Materials and workmanship
NZS 4230:2004	Design of reinforced concrete masonry structures
NZS 4402:----	Methods of testing soils for civil engineering purposes
Test 2.2:1986	Soil classification tests – Test 2.2 Determination of the liquid limit
Test 2.6:1986	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:----	Structural design actions
Part 0:2002	General principles
Part 1:2002	Permanent, imposed and other actions
Part 2:2011	Wind actions
Part 3:2003	Snow and ice actions

AS/NZS 2699:----	Built-in components for masonry construction
Part 1:2000	Wall ties
Part 3:2002	Lintels and shelf angles (durability requirements)
AS/NZS 4455:----	Masonry units, pavers, flags and segmental retaining wall units
Part 1:2008	Masonry units
AS/NZS 4671:2001	Steel reinforcing materials

American Standard

ASTM E96/E96M-12	Standard test methods for water vapor transmission of materials

Other publications

Cement and Concrete Association of New Zealand. *CCANZ CP 01:2011 Code of practice for weathertight concrete and concrete masonry construction*. Wellington: Cement and Concrete Association of New Zealand, June 2011.

New Zealand Concrete Masonry Association Inc. *2011 New Zealand concrete masonry manual*. Available at: www.nzcma.org.nz/manual.html

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

Local Government Act 2002

Resource Management Act 1991

Websites

Building and Housing Group, Ministry of Business, Innovation and Employment	www.dbh.govt.nz
New Zealand Concrete Masonry Association Inc.	www.nzcma.org.nz
New Zealand Legislation	www.legislation.govt.nz

RELATED DOCUMENTS

See Appendix D for a list of related documents used to prepare this Standard.

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 4229:2013 *Concrete masonry buildings not requiring specific engineering design* sets a minimum standard for the design and construction of reinforced concrete masonry buildings. When applied by architects, designers, builders, engineers, apprentices, building consent authorities, and building industry regulators, NZS 4229 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 4229 provides prescribed methods for the design and construction of reinforced concrete masonry buildings up to 10 metres in height, including domestic dwellings and most other residential buildings, and some commercial buildings.

The use of NZS 4229 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 2013 limited revision has been brought about by the replacement of NZS 4203:1992 *General structural design and design loadings for buildings* with the AS/NZS 1170 *Structural design actions* Standard series with a consequent change to the applied actions on structures, particularly earthquake actions.

The earthquake zones have been aligned with those in NZS 3604:2011 *Timber-framed buildings*, introducing four zones instead of three. Earthquake actions may now be calculated specifically for a site's subsoil classification. The earthquake actions have increased in some areas as a result of the change in earthquake demand and the greater spread in demand over the country as detailed in NZS 1170.5. An extra high wind zone has also been introduced to align with NZS 3604.

In addition, the durability provisions now align with current requirements by reference to the NZS 3604 requirements.

The opportunity has been taken to correct errors in the 1999 edition of the Standard, although a full detailed review of the document was not undertaken in 2013. Appendix B has been detailed to comply with the revised earthquake demands and the retaining walls in Appendix A have been aligned with the latest designs available in the New Zealand Concrete Masonry Association's *New Zealand concrete masonry manual*.

This limited revision also incorporates changes introduced to New Zealand Building Code compliance documents by the Ministry of Business, Innovation and Employment (previously the Department of Building and Housing) in 2011, which modified its referencing of NZS 3604:2011 and NZS 4229:1999. These changes include amendments to the definition of 'good ground' for the Canterbury earthquake region and new requirements for concrete slab floors and foundations. The Ministry has published guidance for designers in Canterbury that may inform design for locations other than the Canterbury earthquake region. Amendments can be considered to NZS 4229 or other documents when further information and evidence about liquefaction and lateral spread are available for use nationally.

New Zealand Standard

Concrete masonry buildings not requiring specific engineering design

1 SCOPE AND INTERPRETATION

1.1 Scope

1.1.1

This Standard sets out construction requirements for concrete masonry buildings not requiring specific engineering design within the limitations specified by 1.1.3. It is intended as a means of compliance with the following requirements of the New Zealand Building Code (NZBC):

(a) Clause B1 Structure

Masonry constructed in accordance with this Standard and NZS 4210 will meet the requirements of B1.3.1, B1.3.2, and B1.3.4 for loads from B1.3.3(a), (b), (d), (f), (h), and (j), that is for loads arising from gravity, earth pressure, earthquake, wind, and human impact. This Standard covers masonry constructed to Observation Type B as defined in NZS 4230. Appendix A gives details of concrete masonry walls that are retaining soil. Appendix B gives details of free-standing cantilevered concrete masonry walls;

(b) Clause B2 Durability

Masonry constructed in accordance with this Standard will be durable for at least 50 years and will therefore meet B2.3.1(a) of the New Zealand Building Code;

(c) Clause E2 External Moisture

Construction in accordance with this Standard will ensure against damage to building components or dampness in the building as a result of external moisture entering through the masonry walls or the concrete slab-on-ground. This Standard ensures compliance with E2.3.2 and E2.3.3 of the New Zealand Building Code for walls and floors only. This Standard is not a complete solution to Clause E2 as it does not contain provisions for the other elements of the building envelope such as roofing, exterior joinery, and flashings.

Where this Standard has provisions that are in non-specific or unquantified terms (such as where provisions are required to be appropriate, adequate, suitable, and the like), then these do not form part of the means of compliance with the New Zealand Building Code and shall be to the approval of the building consent authority.

1.1.2

This Standard does not provide complete information on the use of timber components and reference to NZS 3604 is required.

1.1.3

This Standard applies only to buildings within its stated limitations, including but not limited to:

(a) Buildings shall be founded on good ground;

(b) Buildings shall be Importance Level 1 or 2 (see Table 1.1);

(c) The total height from the lowest ground level to the highest point of the roof shall not exceed 10 m and no storey height shall exceed 3 m;

(d) The ratio of the total building height to minimum building width shall not exceed 2.5;

(e) The plan footprint floor area and configuration of construction shall comply with the limitations contained in Figure 1.1 and shall not exceed:

(i) 600 m^2 for single-storey masonry buildings

(ii) 250 m^2 for two-storey residential masonry buildings

(iii) 350 m^2 for two-storey residential buildings where the upper storey is constructed of timber and the external wall of the lower storey is of masonry supported on a concrete slab-on-ground, concrete or masonry footings or masonry foundation walls

(iv) 250 m^2 for two and two-storey with attic buildings constructed with upper storey or storeys of timber supported on a lower storey of masonry with the top storey contained within a roof space;

(f) The live load on concrete slab-on-ground shall not exceed a uniformly distributed load of 3.0 kPa nor a concentrated load of 9.0 kN;

(g) Concrete slab-on-ground floors in accordance with 7.8 may be used for vehicle garages for vehicles up to 2500 kg tare;

(h) The slope of any roof plane shall not be steeper than 45° to the horizontal.

> ***C1.1.3(h)***
>
> *Steeper slopes require modification of design tables and hence become specific engineering designs.*
>
> *Roof slopes incorporating diaphragms are not to exceed 25° to the horizontal. (See section 9.)*

(j) Roofs shall be of timber complying with NZS 3604 with the following additional requirements:

(i) The live load on the roof shall not exceed 0.25 kPa

(ii) The top plate supporting the roof shall be 140 mm x 45 mm SG 8 or better graded timber

(iii) The top plate shall be fixed to the top of the masonry wall with M12 bolts cast in a minimum of 75 mm and placed at a maximum of 300 mm from any corner and at a maximum of 1200 mm centres elsewhere in Low and Medium Wind Zones and at a maximum of 600 mm centres in High, Very High, and Extra High Wind Zones;

C1.1.3(j)

Steel framed roofs are the subject of specific engineering design.

(k) Suspended timber floors shall be of timber construction complying with NZS 3604 unless otherwise modified by this Standard;

(m) Suspended concrete floors used as a diaphragm shall meet the requirements of this Standard for horizontal loads and shall for the purposes of other structural functions be required to be specifically designed to NZS 3101. The maximum dead load of suspended concrete floors shall not exceed 4.5 kPa;

(n) All walls shall be constructed in running (or stretcher) bond pattern;

(o) In the case of masonry veneer exterior cladding:

(i) The maximum height of veneer shall be 6 m measured from the top of a supporting concrete masonry or reinforced concrete foundation or a slab edge foundation except that, if at a gable end, the overall height can be increased to 10 m

(ii) All masonry veneers shall be constructed in running (or stretcher) bond pattern

(iii) Where construction adjoins a public place or egress and the veneer is in excess of 6 m in height the veneer construction shall be the subject of specific engineering design

(iv) Where a timber framed upper storey has been used then the maximum height above the masonry substructure shall not exceed the provisions of NZS 3604

(v) The maximum mass of veneer covered by this Standard is 220 kg/m^2.

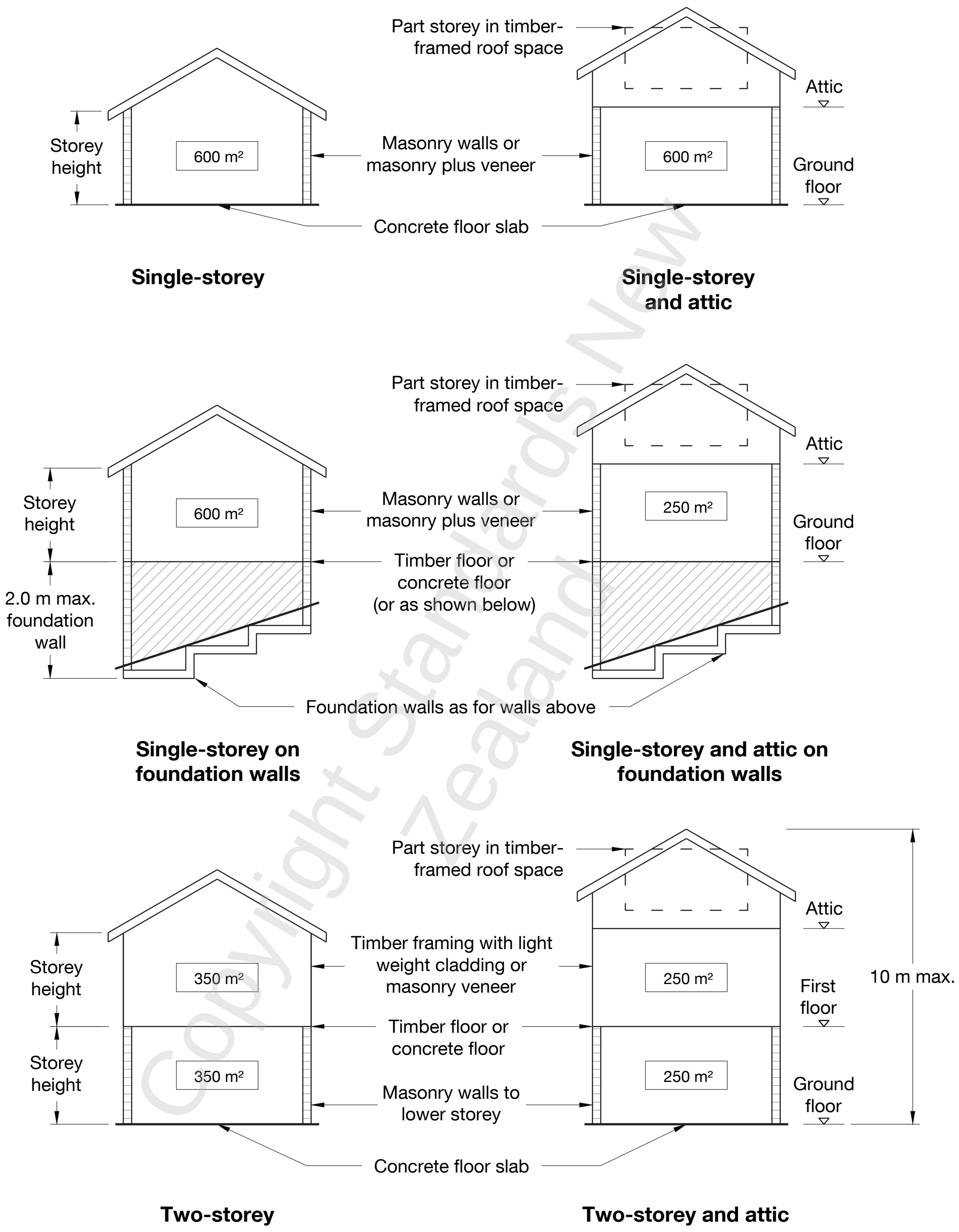
C1.1.3(o)

Veneer detailed construction is controlled by NZS 4210 and Acceptable Solutions E2/AS1 and E2/AS3 in NZBC Compliance Document E2 'External moisture'.

Table 1.1 – Importance levels of buildings
(Based on Table 3.2 of AS/NZS 1170.0 – see 1.1.3)

Importance level	Description
Building types covered by this Standard	
1	Structures of a secondary nature
2	Single family dwellings and structures not in other importance levels
Building types not covered by this Standard	
3	Structures that may contain crowds or contents of a high value to the community
4	Structures with special post-disaster functions
5	Special structures

All dimensions are in mm unless otherwise shown.



NOTE –

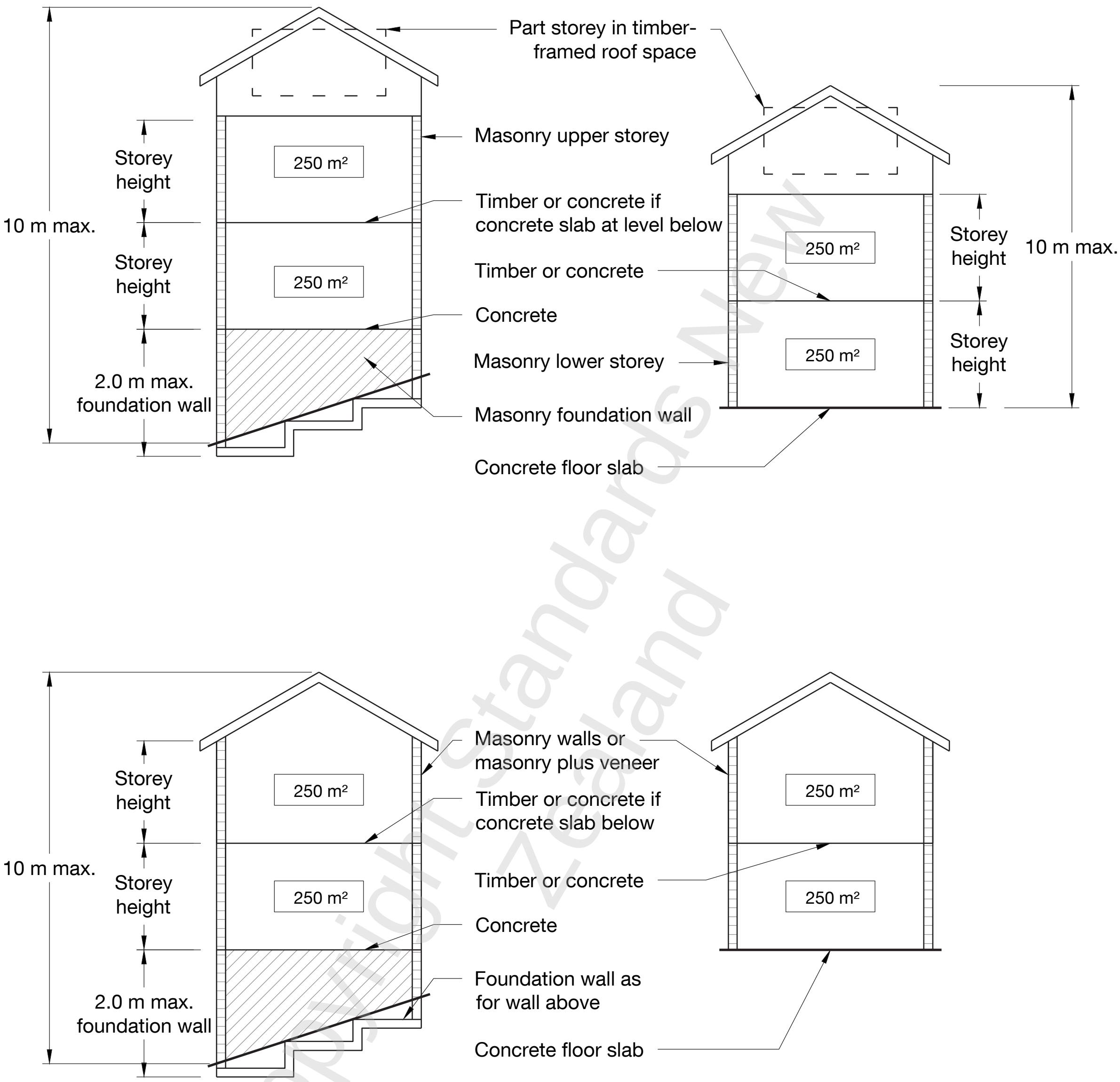
(1) Maximum plan footprint as shown: $\boxed{250\ m^2}$.

(2) Maximum storey height 3.0 m.

(3) Maximum part storey 40% of actual wing or block.

Figure 1.1 – Building types covered by this Standard (see 1.1.3(e))

All dimensions are in mm unless otherwise shown.



NOTE –

(1) Maximum plan footprint as shown: $\boxed{250\ m^2}$.

(2) Maximum storey height 3.0 m.

(3) Maximum part storey 40% of actual wing or block.

Figure 1.1 – Building types covered by this Standard (continued) (see 1.1.3(e))

1.2 Interpretation

1.2.1

For the purposes of this Standard, the word 'shall' identifies a mandatory requirement for compliance with the Standard. The word 'should' refers to practices which are advised or recommended.

1.2.2

Where this Standard has non-specific requirements such as the words 'suitable', 'adequate', 'acceptable', or other similar qualifiers like 'as far as is reasonably practicable', then the method described shall be to the satisfaction of the building consent authority.

Also in this Standard, where reference is made to 'the manufacturer's recommendations or instructions' or similar, these are outside the scope of this Standard as an Acceptable Solution to the NZBC, and shall be to the satisfaction of the building consent authority.

Where this Standard requires specific engineering design (SED) then this is outside the scope of the Standard as an Acceptable Solution to the NZBC and shall be to the satisfaction of the building consent authority.

Use only use the values set out in clauses and tables and do not extrapolate the values.

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 in any way the mandatory requirements of compliance with this Standard. The Standard can be complied with if the comment is ignored.

1.2.4

Where any clause in this Standard 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 this Standard unless the clause specifically states otherwise.

1.2.5

The full titles of referenced documents cited in this Standard are given in the list of referenced documents immediately preceding the Foreword.

1.2.6

The terms 'Normative' and 'Informative' have been used in this Standard to define the application of the Appendix to which they apply. A 'Normative' Appendix is an integral part of a Standard whereas an 'Informative' Appendix is only for information and guidance. Informative provisions do not form part of the mandatory requirements of the Standard nor do they form part of the Standard as an Acceptable Solution to the NZBC.

1.2.7

Unless inconsistent with the context, and subject to 1.3, terms defined in the New Zealand Building Code shall have the same meaning in this Standard.

1.2.8

Masonry units shown in the figures are diagrammatic and do not necessarily represent the actual types of the units.

1.3 Definitions

1.3.1

For the purposes of this Standard the following definitions shall apply. Where definitions applying to timber are not given below, use the definitions contained in NZS 3604.

Bond beam — A horizontal course of concrete masonry containing steel reinforcement and being fully grouted

Bond beam, intermediate — A bond beam situated anywhere except at the top of a wall

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

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 4.3 (wind) or 4.4 (earthquake)

Bracing line — A line along or across a building for controlling the distribution of wall bracing elements

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

Cantilevered wall — A wall receiving lateral support only by means of cantilever action from its footing

Cell — A hole through or along a masonry unit in the plane of a wall where the least dimension of the hole exceeds one-third of the width of the unit

Cleared ground level (CGL)	See definition of Ground level
Column	Isolated – A reinforced, vertical loadbearing member having a cross section with a ratio of depth to breadth of a value lying between 0.33 and 3 Wall – A reinforced, vertical loadbearing member having a cross section with a ratio of wall width to wall length of a value lying between 0.70 and 4
Control joint	A joint or gap constructed in masonry or concrete slabs-on-ground to control and absorb movements
D	A deformed reinforcing bar of the stated diameter in millimetres, for example Grade 300 E (see HD for Grade 500 E)
Damp-proof course (DPC)	A layer 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)
Dimension	Nominal dimensions are used to describe masonry units or types of construction. Actual dimensions shall be used for the purpose of calculations
Finished ground level (FGL)	See definition of Ground level
Floor live load	The basic minimum uniformly distributed live load for floors as specified by 1.1.3(f)
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	See definition of Wall
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 (that is, an allowable bearing pressure of 100 kPa using a factor of safety of 3), 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 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, (liquefaction, lateral spread – for the Canterbury earthquake region only), seasonal swelling and shrinkage, frost heave, changing groundwater level, erosion, dissolution of soil in water, and effects of tree roots

NOTE – The Canterbury earthquake region is the area contained within the boundaries of the Christchurch City Council, the Selwyn District Council, and the Waimakariri District Council.

Ground level Cleared ground level – The ground level after completion of site excavation and removal of all harmful material, but before excavation for foundations

Finished ground level – The level of the ground against any part of a building after all backfilling and/or landscaping and/or surface paving has been completed

Natural ground level – The ground level before the site has been cleared

HD A deformed high strength (Grade 500 E) reinforcing bar of the stated diameter in millimetres

Licensed building practitioner (LBP) A building practitioner whose name is, for the time being, entered in the register established and maintained under section 298(1) of the Building Act 2004, who is licensed to carry out or supervise restricted building work as required by section 84 of the Building Act 2004

Lintel A horizontal member spanning an opening in a wall

Load — Loads are considered to include gravity loads (for example dead and live) earth pressure, earthquake, wind and human impact

NOTE – Loads are referred to as actions in the AS/NZS 1170 suite of Standards. In AS/NZS 1170 dead load is referred to as permanent action and live load is referred to as imposed action.

Loadbearing — An element which serves in providing resistance to loads other than those induced by the weight of the element itself

M — A steel bolt of the stated diameter in millimetres

Masonry — Any construction in units of concrete, laid to a bond in and joined together with mortar

Mortar — The material in which masonry units are bedded

Natural ground level — See definition of Ground level

Partition — See definition of Wall

Plate — A timber member continuous on top of a masonry wall to support and distribute the load from floors, walls, roofs or ceiling

Public place — Any place that, at any material time, is under the control of the territorial authority and is open to, or being used by the public, whether free or on any payment of a charge; and includes any road whether or not it is under the control of the territorial authority

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 and AS/NZS 4671 (see 2.1.4)

Reinforced masonry — Any masonry in which reinforcing steel is so bedded and bonded that the two materials act together in resisting forces

Partially filled reinforced masonry – All hollow cells containing steel reinforcement are filled with grout

Solid-filled reinforced masonry – All hollow cells irrespective of whether they contain steel reinforcement or not are filled with grout

Roof That upper part of the building having its upper surface exposed to the outside and at an angle of 45° or less to the horizontal (see also 1.1.3(h))

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 of light roofing are steel, copper, and aluminium roof claddings of normal thickness, butynol or fabric roofing

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 of heavy roofing are concrete tiles, slates and the like

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)

Roof live load – The basic minimum uniformly distributed live load for roofs as specified by 1.1.3 (j)

Shrinkage control joint A line along which the horizontal strength of the slab-on-ground is deliberately reduced so that any shrinkage will result in a crack forming along that line

Skin or wythe A continuous vertical tier of masonry one unit in thickness

Spacing or spaced The clear distance between supports measured along a member

Specific engineering design (SED) Requires calculation and design beyond the scope of this Standard

Storey That portion of a building included between the upper surface of any floor and the upper surface of the next floor above, except that the topmost storey shall be that portion of a building included between the upper surface of the topmost floor and the ceiling or roof above

Structural A term used to describe an element, or elements which provide resistance to actions from loads on a building

Structural diaphragm A member such as a floor or ceiling as specified in this Standard capable of transferring loads in its own plane to boundary members

Suspended floor A floor which is not directly supported on ground

Territorial authority A territorial authority defined in the Local Government Act 2002

Veneer	A skin of concrete masonry or burnt clay masonry or natural stone of maximum mass of 220 kg/m^2, which is attached to and laterally supported by a structural wall of masonry or timber to NZS 3604
Wall	External wall – An outer wall of a building Foundation wall – That part of the foundation comprising a concrete masonry wall supporting a building or part of a building, and not extending more than 2 m above the underside of the footing Internal wall – A wall other than an external wall Loadbearing wall – A wall supporting vertical loading from floors, ceiling joists, roof, or any combination thereof Non-loadbearing wall – A wall other than a loadbearing wall and may contain bracing panels Structural wall – Any wall which because of its position and shape contributes to the rigidity and strength of the building Thickness – The nominal thickness of masonry is designated 15 series, 20 series, and 25 series, which equates to 140 mm, 190 mm, and 240 mm of actual thickness respectively
Wall bracing panel	A section of wall above the ground level that performs a bracing function. This can be a loadbearing or non-loadbearing 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
Wythe	See definition of Skin

2 GENERAL

2.1 Materials

2.1.1

Masonry materials shall comply with the provisions of NZS 4210.

2.1.2

Concrete shall be produced to comply with the provisions of NZS 3104 and placed to the provisions of NZS 3109 and 7.8.1 of this Standard.

2.1.3

Masonry grout used for the filling of cells shall comply with the provisions of NZS 4210 and NZS 3604 durability provisions.

2.1.4

Reinforcing steel shall comply with Grade 300 E or Grade 500 E provisions of AS / NZS 4671. Reinforcing steel mesh shall comply with Grade 500 E provisions of AS/NZS 4671. Bar reinforcing steel shall be Grade 300 for all applications except masonry retaining walls (see Appendix A) where Grade 500 is specified. Bends, hooks, and other details of reinforcement shall be in accordance with NZS 3109.

2.1.5

Veneer wall ties and other metal components shall comply with the provisions of Acceptable Solutions E2/AS1 or E2/AS3 in NZBC Compliance Document E2 'External moisture'.

2.1.6

Timber components and fixings shall comply with structural and durability provisions of NZS 3604.

2.2 Workmanship, construction, and tolerances

2.2.1

Workmanship unless specifically covered in this Standard shall comply with NZS 4210.

2.2.2

Construction shall be carried out by a suitably qualified tradesperson, skilled in the construction of masonry blockwork.

C2.2.2

The construction requirements satisfy 3.3.2.1 of NZS 4230 Observation Type B, that is, maximum design compressive strength 12 MPa.

A suitably qualified tradesperson includes a person accredited with masonry construction skills as defined by the Licensed Building Practitioner scheme for blocklaying and holding a current practising certificate.

2.2.3

The permissible tolerances shall be as set out in NZS 4210.

2.3 Surface coatings

2.3.1

External masonry walls, except veneer walls, shall be weather protected by a surface coating complying in specification and application to the requirements of Acceptable Solution E2/AS3 in NZBC Compliance Document E2 'External moisture'.

C2.3.1

Acceptable Solution E2/AS3 (CCANZ CP 01:2011 Code of practice for weathertight concrete and concrete masonry construction) gives a series of surface coating applications that are applicable to the construction range of buildings covered by this Standard.

2.4 Maintenance

The completed coating system shall be regularly maintained to ensure continued resistance to water entry. Maintenance shall include the removal of dirt, mould, and other organic deposits, the repair of cracks or other defects, and repainting as necessary to preserve the waterproof finish.

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).

C3.1.1

Section 17 of NZS 3604 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.

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.

C3.1.2

(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 3.1.3(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.

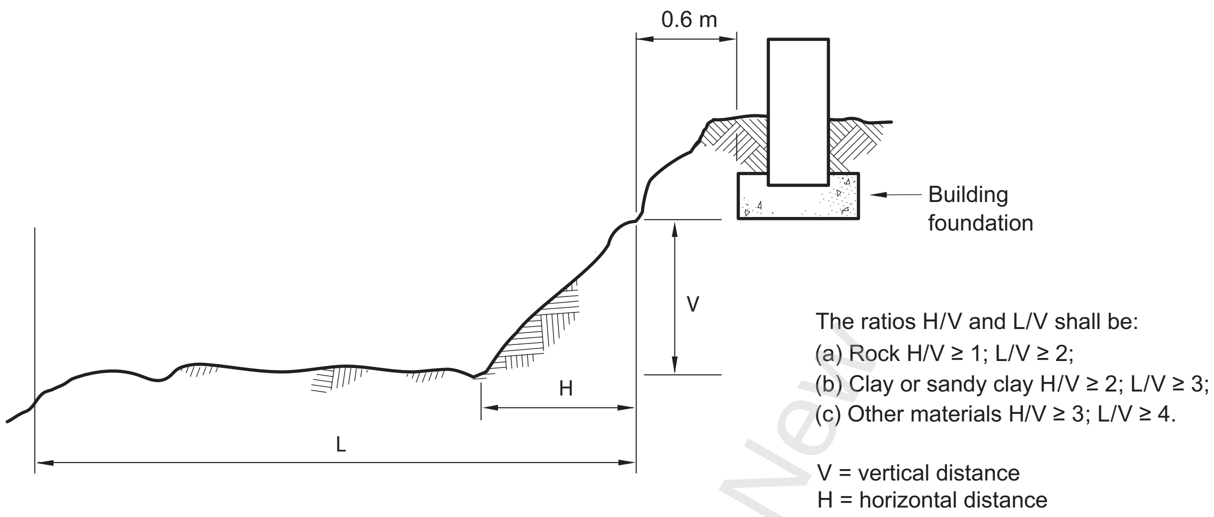


Figure 3.1 – Relationship of foundation to sloping ground surface

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;

> ***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.*

(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.

C3.1.3(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.

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 Soil types

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 the NZGS report *Field description of soil and rock – Guideline for the field classification and description of soil and rock for engineering purposes* 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;

> ***C3.3.7.1(a)***
>
> *Scala Penetrometer 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.*

(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.

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 on solid bottom in undisturbed good ground material or on 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 7.8) 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.

4 BRACING DEMAND

4.1 General

4.1.1

Foundation walls and masonry walls shall be constructed to resist the greater bracing demand imposed on the building by horizontal wind forces calculated as described in 4.3 or earthquake forces for different zones (see 4.2) calculated as described in 4.4.

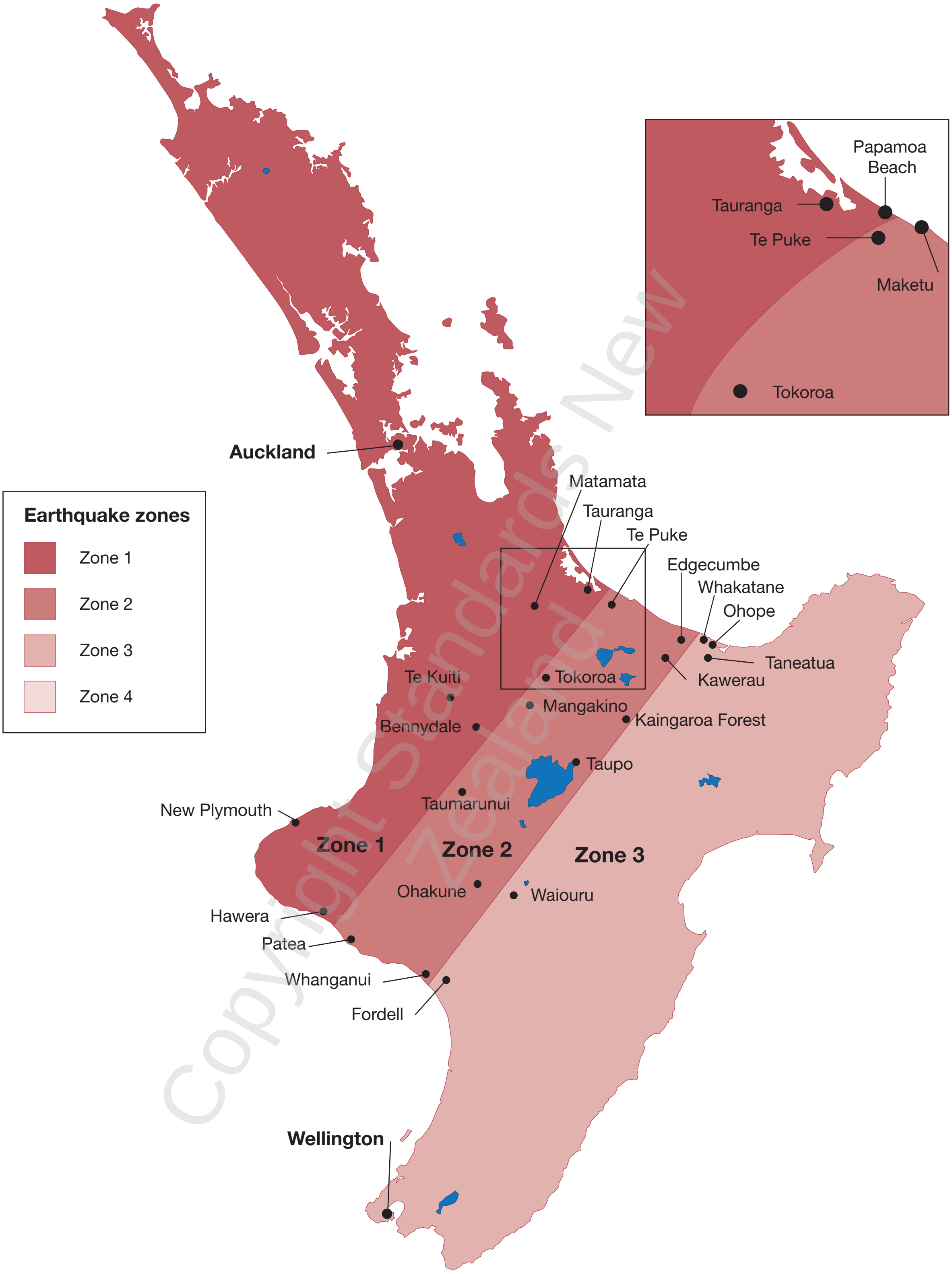
4.1.2

The construction requirements of bracing structures and their bracing capacity to resist the bracing demand are contained in section 5.

4.2 Earthquake zones

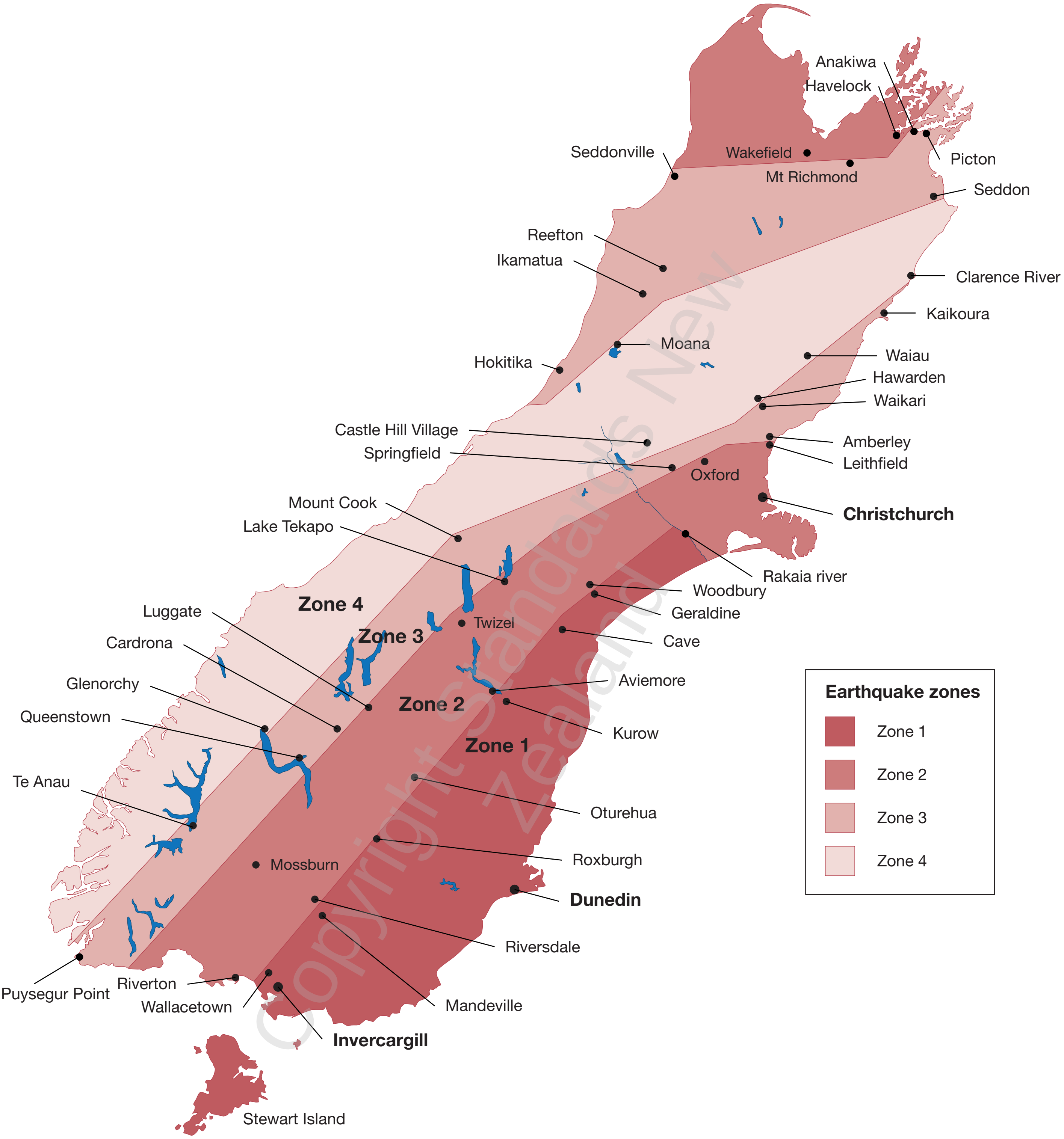
The zoning in Figure 4.1 shall be used in the determination of the bracing demands for buildings located in different regions of New Zealand.

Table 4.1 sets out the earthquake zones for principal localities in New Zealand.



NOTE – This figure is taken from NZS 3604:2011 and incorporates a correction to the zoning of Whakatane.

Figure 4.1 – Earthquake zones (see 4.2)



NOTE – This figure is taken from NZS 3604:2011 and incorporates changes to the Canterbury earthquake region.

Figure 4.1 – Earthquake zones (continued) (see 4.2)

Table 4.1 – Earthquake zones (see 4.2)

Locality	Earthquake zone
North Island	
Kaitaia	1
Whangarei	1
Dargaville	1
Helensville	1
Auckland	1
Thames	1
Paeroa	1
Coromandel	1
Whitianga	1
Hamilton	1
Waihi	1
Tauranga	1
Rotorua	2
Taumaranui	2
Taupo	2
Gisborne	3
Napier	3
Hastings	3
New Plymouth	1
Whanganui	2
Palmerston North	3
Dannevirke	3
Wellington	3

Locality	Earthquake zone
South Island	
Nelson	2
Blenheim	3
Christchurch	2
Lyttleton	2
Timaru	1
Oamaru	1
Westport	3
Greymouth	3
Hokitika	3
Dunedin	1
Invercargill	1
Alexandra	2

4.3 Calculations of bracing demand – Wind

The minimum number of bracing units per lineal metre transverse to the wind direction shall be taken from Table 4.2.

See Figure 4.2 for wind direction and bracing information.

C4.3

Because in the majority of building applications permitted by this Standard, horizontal loading requirements are dominated by earthquake forces a simplified approach to the wind force determinations has been applied.

If the bracing demand for wind exceeds the earthquake demand, the wind loading may be re-evaluated using the wind zones determined in NZS 3604 and the multipliers given in the notes in Table 4.2.

Table 4.2 – Wind bracing demand per lineal metre (see 4.3)

Single-storey or upper-storey walls: Minimum bracing demand (Bracing units per lineal metre)

Single or upper floor level to apex H, (m)	Roof height above eaves, h (m)	Extra High Wind Zone	
		Across ridge	Along ridge
3	0	56	56
	1	48	56
4	0	72	72
	1	64	72
	2	64	72
5	0	88	88
	1	80	88
	2	80	88
	3	96	88
6	1	96	104
	2	96	104
	3	120	104
	4	152	104
7	2	120	128
	3	136	128
	4	168	128
	5	216	128
8	3	152	144
	4	184	144
	5	232	144
	6	248	144
9	4	200	160
	5	248	160
	6	264	160
	7	288	160
10	5	264	176
	6	288	176
	7	304	176
	8	320	176

NOTE –

(1) The tabulated values are the worst case figures (Extra High Wind) used in NZS 3604.

(2) In wind zones other than Extra High Wind, multiply the figure from the table by the appropriate factor given opposite.

Low	0.31
Medium	0.43
High	0.63
Very High	0.81

(3) See Figure 4.2 for clarification of height to apex, H, and roof height above eaves, h.

Table 4.2 – Wind bracing demand per lineal metre (continued) (see 4.3)

Lower of two storeys: Minimum bracing demand (Bracing units per lineal metre)

Lower floor level to apex H, (m)	Roof height above eaves, h (m)	Extra High Wind Zone	
		Across ridge	Along ridge
6	0	160	160
	1	128	144
	2	120	128
	3	120	112
7	0	192	192
	1	168	176
	2	152	160
	3	152	144
	4	168	128
8	0	232	232
	1	200	216
	2	192	192
	3	192	176
	4	200	160
	5	232	144
9	0	264	264
	1	240	248
	2	224	232
	3	224	216
	4	240	192
	5	264	176
	6	264	160
10	0	304	304
	1	272	288
	2	256	264
	3	256	248
	4	272	232
	5	304	216
	6	304	192
	7	304	176

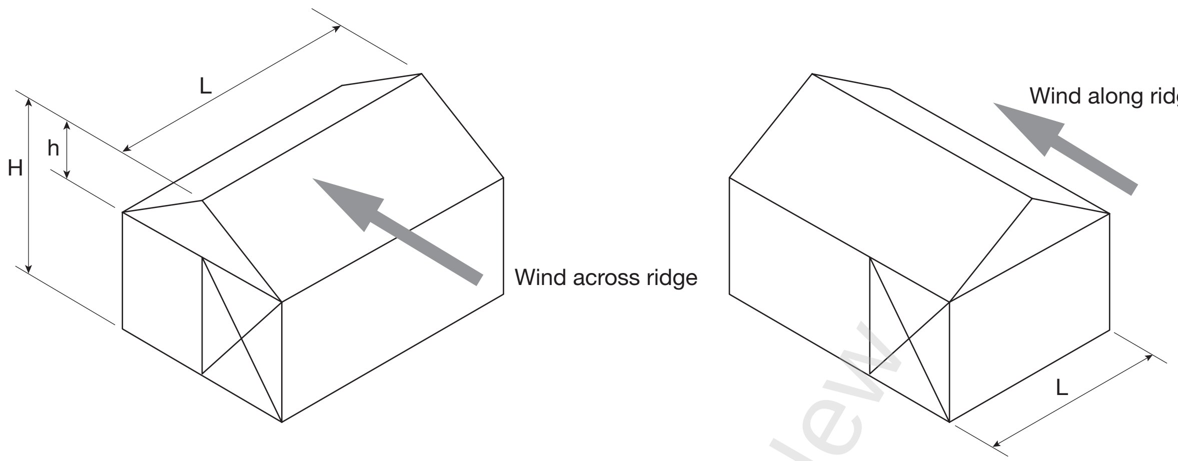
NOTE –

(1) The tabulated values are the worst case figures (Extra High Wind) used in NZS 3604.

(2) In wind zones other than Extra High Wind, multiply the figure from the table by the appropriate factor given opposite.

Low	0.31
Medium	0.43
High	0.63
Very High	0.81

(3) See Figure 4.2 for clarification of height to apex, H, and roof height above eaves, h.



(a) Across ridge
(Shall be also used for hip roofs)

(b) Along ridge

NOTE – Braced walls are parallel to the wind direction and L is at right angles to the wind direction.

Figure 4.2 – Directions of wind and braced walls (see Table 4.2)

4.4 Calculation of bracing demand – Earthquake

4.4.1

The minimum number of bracing units per square metre of floor area per storey shall be selected by reference to Table 4.3 which covers the combinations of construction permitted by this Standard. See Figure 4.3 for building storeys covered by Table 4.3.

4.4.2

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

C4.4.2

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

Site subsoil classifications in accordance with 4.4.2 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.

***C4.4.2** (continued)*

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 this Standard 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 Site Subsoil Class E (very soft soils) being a catch-all value where no soil classification has been provided or Site Subsoil Class E is present.

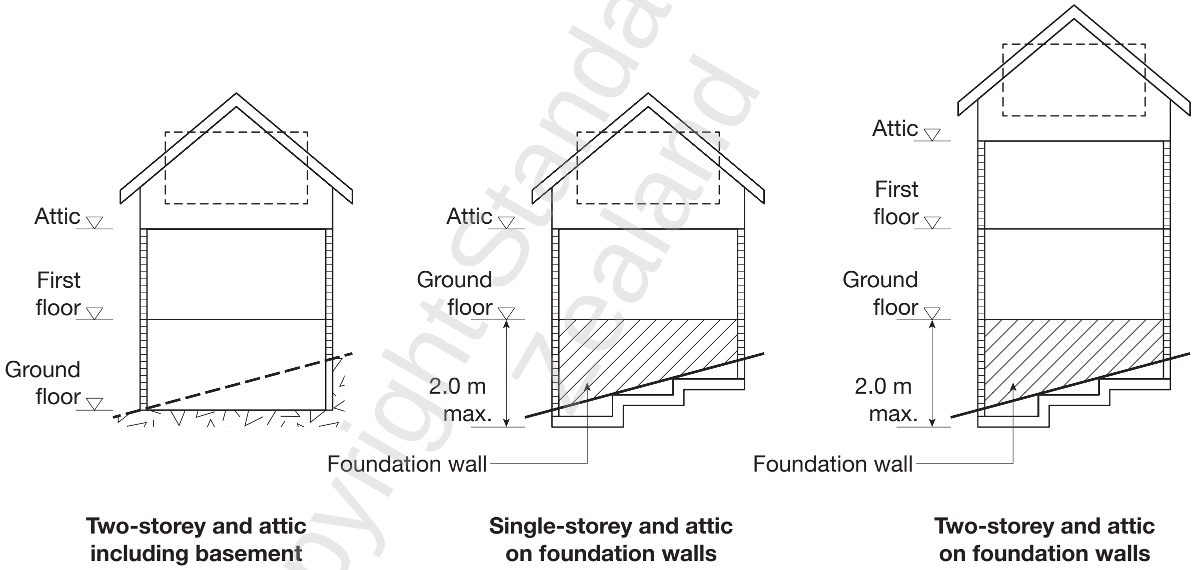


Figure 4.3 – Building storeys (see Table 4.3)

Table 4.3 – Earthquake bracing demand

Single-storey or top storey (with light roof)	Masonry wall series	Concrete slab-on-ground: Minimum bracing units /m² in Earthquake zone				
		Zone 1	Zone 2	Zone 3	Zone 4	
Partially filled masonry	15 20 25	11 12 15	17 18 21	27 28 32	35 37 43	
For solid-filled masonry	Multiply	x 1.4	x 1.4	x 1.4	x 1.4	For top storey timber construction refer to NZS 3604
For heavy roof	Add	4	4	4	6	
Veneer with partially filled masonry	15 20	16 17	25 26	38 39	50 52	
For solid-filled masonry	Multiply	x 1.4	x 1.4	x 1.4	x 1.4	
For heavy roof	Add	4	4	4	6	

Bottom of two-storey (with light roof)	Masonry wall series	Intermediate concrete floor				Intermediate timber floor			
		Minimum bracing units /m² in Earthquake zone							
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
Partially filled masonry for both storeys	15 20 25	51 55 60	75 80 89	116 123 135	152 161 178	29 32 37	43 47 55	65 72 85	85 94 111
For solid-filled masonry	Multiply	x 1.3	x 1.3	x 1.3	x 1.3	x 1.3	x 1.3	x 1.3	x 1.3
For heavy roof	Add	4	4	4	6	4	4	4	6
First storey partially filled masonry. No veneer with a second storey timber with veneer	15 20 25	52 53 56	79 80 82	120 121 125	157 159 165	31 33 35	46 48 50	69 72 76	91 94 100
For solid-filled masonry	Multiply	x 1.1	x 1.1	x 1.1	x 1.15	x 1.15	x 1.15	x 1.15	x 1.15
For heavy roof	Add	4	4	4	6	4	4	4	6
First storey partially filled masonry. No veneer with a second storey timber lightweight cladding	15 20 25	41 42 45	62 63 66	94 96 100	124 126 131	20 21 22	28 31 33	44 47 51	57 61 67
For solid-filled masonry	Multiply	x 1.15	x 1.15	x 1.15	x 1.2	x 1.2	x 1.2	x 1.2	x 1.2
For heavy roof	Add	4	4	4	6	4	4	4	6

NOTE – Table 4.3 has been derived for a Site Subsoil Class of ‘D’ or ‘E’. For sites where it can be proven (from geotechnical investigation) that the site subsoil class is better than ‘D’ then the values in Table 4.3 may be multiplied by the factors given opposite, with the exception that for all rows that have multipliers, the multipliers do not change.

Site Subsoil Class A	0.63
Site Subsoil Class B	0.63
Site Subsoil Class C	0.79

Table 4.3 – Earthquake bracing demand (continued)

Bottom of two-storey (with light roof)	Masonry wall series	Intermediate concrete floor				Intermediate timber floor			
		Minimum bracing units /m² in Earthquake zone							
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
Veneer with partially filled masonry for both stories	15 20	66 69	98 102	149 157	196 205	43 47	65 69	99 106	130 139
For solid-filled masonry	Multiply	x 1.2	x 1.2	x 1.2	x 1.2	x 1.2	x 1.2	x 1.2	x 1.2
For heavy roof	Add	4	4	4	6	4	4	4	6
Veneer with first storey partially filled masonry with a second storey timber with veneer	15 20	57 58	86 87	131 134	172 176	36 37	53 54	80 83	105 109
For solid-filled masonry	Multiply	x 1.1	x 1.1	x 1.1	x 1.15	x 1.15	x 1.15	x 1.15	x 1.15
For heavy roof	Add	4	4	4	6	4	4	4	6
Veneer with first storey partially filled masonry with a second storey timber lightweight cladding	15 20	46 47	69 70	106 109	139 142	25 26	36 38	55 58	72 76
For solid-filled masonry	Multiply	x 1.15	x 1.15	x 1.15	x 1.2	x 1.2	x 1.2	x 1.2	x 1.2
For heavy roof	Add	4	4	4	6	4	4	4	6

Foundation wall	Masonry wall series	Intermediate concrete floor				Intermediate timber floor			
		Minimum bracing units /m² in Earthquake zone							
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
Foundations 2 m maximum height including concrete suspended floor at ground level	Any	133	198	303	398	112	165	252	331

NOTE – Table 4.3 has been derived for a Site Subsoil Class of ‘D’ or ‘E’. For sites where it can be proven (from geotechnical investigation) that the site subsoil class is better than ‘D’ then the values in Table 4.3 may be multiplied by the factors given opposite, with the exception that for all rows that have multipliers, the multipliers do not change.

Site Subsoil Class A	0.63
Site Subsoil Class B	0.63
Site Subsoil Class C	0.79

5 WALL BRACING CAPACITY

5.1 General

5.1.1

For the purpose of this section a wall bracing panel shall be any partial or solid-filled structural masonry panel and rated at the number of bracing units given in Table 5.1.

C5.1.1

Wall bracing elements of materials other than masonry may be used provided they are rated at a level having the equivalent strength and stiffness to the masonry wall bracing panels provided in this Standard.

5.1.2

The use of partial and solid-filled structural masonry panels together in any bracing series shall be permitted and the bracing capacity of the series is the total summation of individual panel capacities from Table 5.1.

C5.1.2

While at serviceability state levels the solid-filled panels will attract higher loads, testing has demonstrated that their capacities are reached at similar displacement.

5.2 Bracing panels within structural walls

5.2.1

Structural walls shall be subdivided into bracing panels of various heights and lengths as dictated by wall openings, control joints, and wall ends for the purpose of obtaining the contribution of each wall bracing element.

C5.2.1

An example calculation in Appendix D illustrates the principles of application of this clause.

Note that maximum lengths of bracing panels in long walls without openings are controlled by the maximum spacing of control joints specified in section 12.

5.2.2

The total bracing capacity for a structural wall shall be the summation of the bracing capacities for all the bracing panels within the wall.

5.2.3

The length of a bracing panel shall be that length along the wall between wall ends, openings, and control joints.

5.2.4

Openings not more than 400 mm x 400 mm and spaced at 1.8 m centres or greater may be included in the length and height of a bracing panel.

5.2.5

The height of a bracing panel shall be the lesser of the height of the structural wall or the minimum height of any adjacent wall opening.

5.2.6

Panels less than 800 mm in length or greater than 3 m in height shall not be included in the bracing value of a wall.

5.3 Reinforcement of bracing panels

5.3.1

All bracing panels of partially filled masonry shall be reinforced both horizontally and vertically in accordance with Table 8.2 and all bracing panels of solid-filled masonry shall be reinforced both vertically and horizontally in accordance with Table 8.3. The end of each horizontal bar shall be either hooked around the end vertical reinforcement or bent down beside it for a distance of not less than 250 mm.

5.4 Non-continuous walls

5.4.1

Where a bracing panel is an isolated structural wall, additional lengths of foundations shall be provided in accordance with 6.8 to prevent the wall bracing panel from overturning.

5.5 Masonry frames

5.5.1

Masonry frames shall be the subject of specific engineering design and are outside the scope of this Standard.

> ***C5.5.1***
>
> *Such frames are often required when design constraints mean insufficient wall lengths are available to meet the bracing demand such as at a garage door opening.*

Table 5.1 – Bracing capacity of panels (bracing units) (see 5.1.1)

15 Series Partial Fill

Panel height (m)	**Panel length** (m)													
	0.8	**1.2**	**1.6**	**2.0**	**2.4**	**2.8**	**3.2**	**3.6**	**4.0**	**4.4**	**4.8**	**5.2**	**5.6**	**6.0**
0.8	385	650	1005	1425	1935	2505	2525	3110	3755	4455	5220	6040	6930	7870
1.0	330	560	865	1230	1670	2165	2185	2690	3245	3855	4520	5225	5995	6810
1.2	275	470	730	1035	1405	1825	1840	2265	2740	3250	3810	4415	5060	5750
1.4	245	420	650	930	1260	1635	1650	2030	2460	2920	3420	3960	4540	5160
1.6	215	370	575	820	1115	1445	1460	1800	2175	2580	3030	3505	4020	4575
1.8	195	335	525	750	1020	1325	1340	1650	1995	2370	2780	3220	3695	4200
2.0	180	305	480	680	925	1205	1220	1500	1815	2155	2530	2930	3360	3825
2.2	165	280	445	635	860	1120	1135	1400	1690	2005	2360	2730	3135	3565
2.4	155	260	410	585	800	1040	1050	1295	1565	1860	2185	2530	2905	3305
2.6	145	245	385	550	750	980	985	1220	1475	1755	2060	2385	2740	3115
2.8	130	230	360	515	705	915	925	1140	1380	1645	1930	2240	2570	2920
3.0	125	215	340	490	665	870	880	1085	1315	1560	1835	2125	2440	2780

20 Series Partial Fill

Panel height (m)	**Panel length** (m)													
	0.8	**1.2**	**1.6**	**2.0**	**2.4**	**2.8**	**3.2**	**3.6**	**4.0**	**4.4**	**4.8**	**5.2**	**5.6**	**6.0**
0.8	390	655	1015	1445	1955	2535	2560	3145	3800	4510	5285	6120	7015	7970
1.0	335	565	875	1245	1690	2195	2215	2720	3290	3905	4580	5300	6080	6905
1.2	280	475	740	1050	1430	1855	1870	2300	2780	3300	3870	4480	5140	5840
1.4	250	425	660	940	1280	1665	1680	2065	2500	2965	3480	4030	4620	5255
1.6	220	375	585	835	1130	1475	1485	1830	2215	2635	3085	3575	4100	4660
1.8	200	345	535	765	1040	1350	1365	1680	2035	2420	2840	3285	3770	4285
2.0	180	310	485	695	945	1230	1245	1535	1855	2205	2590	3000	3440	3910
2.2	170	290	450	650	880	1150	1160	1430	1730	2060	2415	2800	3210	3655
2.4	155	270	420	600	820	1065	1075	1325	1605	1910	2240	2600	2980	3395
2.6	145	250	395	565	770	1005	1015	1250	1515	1800	2115	2450	2815	3200
2.8	135	235	370	530	720	945	950	1175	1420	1695	1990	2305	2645	3010
3.0	130	220	350	500	685	895	905	1115	1350	1610	1890	2195	2520	2865

NOTE – There is a change in the permitted bracing capacity of panels at lengths 3.0 m and larger. See Appendix D4.2.

Table 5.1 – Bracing capacity of panels (bracing units) (continued) (see 5.1.1)

25 Series Partial Fill														
Panel height (m)	**Panel length** (m)													
	0.8	**1.2**	**1.6**	**2.0**	**2.4**	**2.8**	**3.2**	**3.6**	**4.0**	**4.4**	**4.8**	**5.2**	**5.6**	**6.0**
0.8	390	660	1025	1465	1980	2565	2590	3180	3845	4560	5350	6195	7100	8070
1.0	335	570	885	1265	1715	2225	2240	2760	3335	3960	4640	5375	6160	7005
1.2	285	480	750	1065	1450	1880	1900	2335	2820	3350	3935	4555	5220	5940
1.4	250	430	670	955	1300	1690	1705	2100	2540	3020	3540	4100	4700	5345
1.6	220	380	595	850	1150	1505	1515	1865	2255	2685	3140	3640	4185	4760
1.8	200	350	545	780	1060	1380	1390	1715	2075	2470	2895	3355	3855	4380
2.0	180	320	495	710	970	1255	1270	1565	1900	2255	2645	3065	3520	4000
2.2	170	295	460	665	905	1175	1185	1460	1775	2110	2475	2865	3290	3740
2.4	160	275	425	615	835	1090	1100	1360	1650	1960	2300	2670	3060	3480
2.6	150	255	400	575	790	1030	1040	1280	1555	1850	2175	2520	2890	3290
2.8	140	235	375	540	740	970	980	1200	1460	1740	2045	2375	2720	3100
3.0	135	225	355	515	705	920	935	1150	1390	1660	1950	2260	2595	2955

15 Series Solid Fill														
Panel height (m)	**Panel length** (m)													
	0.8	**1.2**	**1.6**	**2.0**	**2.4**	**2.8**	**3.2**	**3.6**	**4.0**	**4.4**	**4.8**	**5.2**	**5.6**	**6.0**
0.8	385	700	1020	1445	1965	2545	2570	3160	3815	4530	5310	6145	7050	8010
1.0	330	605	880	1250	1700	2205	2225	2740	3310	3930	4605	5340	6120	6955
1.2	280	510	740	1055	1435	1865	1880	2320	2805	3330	3905	4525	5190	5900
1.4	250	460	665	950	1290	1675	1695	2085	2520	3000	3515	4075	4675	5315
1.6	220	405	590	840	1145	1490	1500	1855	2240	2665	3125	3620	4160	4725
1.8	200	370	540	770	1050	1370	1380	1705	2060	2450	2880	3335	3825	4355
2.0	185	340	495	705	960	1250	1260	1555	1885	2240	2630	3045	3500	3980
2.2	170	315	460	655	895	1165	1180	1455	1760	2095	2460	2850	3270	3720
2.4	155	290	425	605	830	1080	1095	1350	1635	1945	2285	2650	3045	3460
2.6	145	270	400	575	780	1020	1035	1275	1545	1840	2160	2505	2880	3275
2.8	135	255	375	540	735	960	975	1200	1455	1730	2035	2360	2705	3085
3.0	130	240	355	510	700	915	925	1140	1385	1650	1940	2245	2580	2940

NOTE – There is a change in the permitted bracing capacity of panels at lengths 3.0 m and larger. See Appendix D4.2.

Table 5.1 – Bracing capacity of panels (bracing units) (continued) (see 5.1.1)

20 Series Solid Fill														
Panel height (m)	**Panel length** (m)													
	0.8	**1.2**	**1.6**	**2.0**	**2.4**	**2.8**	**3.2**	**3.6**	**4.0**	**4.4**	**4.8**	**5.2**	**5.6**	**6.0**
0.8	395	665	1040	1480	2010	2605	2625	3245	3920	4925	5780	6320	7250	8240
1.0	340	575	905	1285	1745	2265	2285	2825	3415	4290	5035	5510	6320	7190
1.2	285	485	765	1090	1485	1925	1945	2405	2910	3655	4285	4700	5395	6135
1.4	255	435	690	980	1340	1735	1760	2170	2630	3300	3870	4250	4880	5550
1.6	225	390	610	875	1195	1550	1570	1940	2350	2940	3460	3800	4365	4965
1.8	205	355	560	805	1100	1430	1445	1790	2170	2720	3195	3515	4040	4595
2.0	185	325	515	735	1005	1310	1325	1640	1990	2495	2930	3230	3710	4220
2.2	175	305	480	690	940	1225	1240	1540	1865	2335	2745	3030	3480	3960
2.4	160	280	445	640	875	1145	1160	1440	1740	2180	2560	2830	3255	3700
2.6	150	265	420	605	830	1080	1100	1360	1650	2065	2425	2685	3085	3515
2.8	145	250	395	575	780	1020	1035	1285	1560	1950	2295	2540	2920	3320
3.0	135	235	380	545	750	975	990	1230	1495	1860	2190	2430	2795	3180

25 Series Solid Fill														
Panel height (m)	**Panel length** (m)													
	0.8	**1.2**	**1.6**	**2.0**	**2.4**	**2.8**	**3.2**	**3.6**	**4.0**	**4.4**	**4.8**	**5.2**	**5.6**	**6.0**
0.8	405	580	1065	1515	2055	2660	2685	3335	4030	5360	6295	6500	7460	8480
1.0	350	505	925	1320	1795	2325	2350	2915	3520	4680	5500	5690	6530	7430
1.2	295	425	790	1125	1530	1985	2010	2495	3020	4005	4705	4880	5605	6380
1.4	265	390	710	1015	1390	1800	1825	2260	2740	3625	4265	4440	5095	5800
1.6	235	350	630	905	1245	1610	1640	2030	2460	3250	3825	3990	4580	5220
1.8	210	320	585	840	1150	1495	1515	1880	2280	3015	3540	3705	4260	4845
2.0	190	295	535	770	1055	1375	1395	1735	2105	2775	3260	3420	3930	4480
2.2	180	275	505	725	990	1290	1310	1630	1980	2605	3070	3220	3705	4220
2.4	165	260	470	675	930	1210	1230	1530	1855	2440	2875	3025	3480	3960
2.6	160	245	445	640	880	1145	1165	1455	1765	2320	2730	2880	3315	3770
2.8	150	230	420	610	835	1085	1100	1380	1680	2195	2585	2740	3150	3580
3.0	140	215	400	580	800	1040	1055	1320	1610	2105	2480	2625	3020	3440
NOTE – There is a change in the permitted bracing capacity of panels at lengths 3.0 m and larger. See Appendix D4.2.														

6 FOOTINGS

6.1 General

6.1.1

Every masonry wall, whether loadbearing or non-loadbearing, shall be supported by a continuously reinforced masonry or reinforced concrete foundation of the dimensions and reinforcement given in this section.

C6.1.1

For retaining and cantilevered walls see Appendices A and B.

6.1.2

The foundation footing shall be formed symmetrically about the centre line of the wall or as shown in Figure 6.6. Where this is not possible, then the design shall be the subject of specific engineering design.

C6.1.2

Sometimes 6.1.2 cannot be complied with because a wall is to be built up to a boundary or for some other reason a footing cannot be formed symmetrically. Then it will be necessary to consider alternative design methods.

6.1.3

The foundation footing shall have all soil bearing surfaces horizontal but may be stepped to accommodate variations in cleared ground level or variations in depth of formation level to provide a safe bearing pressure as defined in 3.3.

C6.1.3

Where the formation level is excavated to some depth and variation of position below ground, then the subfooting or the trench fill method outlined in 6.5 may be used to bring the footing to a coordinated datum in relation to the foundation wall above the footing, for example, coursing of blocks.

6.1.4

Balconies shall be subject to specific engineering design along with the footing supporting balconies.

6.2 Width of footings

6.2.1

The width of a footing shall be determined from the sum of the loads that it supports (that is from walls, floors, and roof) derived in 6.2.2, except that when supported on sand the width of a footing shall not be less than 400 mm.

6.2.2

The load on a foundation shall be calculated using the following procedure.

(1) Determine the wall height in metres.

(2) Multiply the wall height by the factored unit weight of the wall from Table 6.1 to obtain the contributing weight to the footing (= A).

NOTE – For walls with a change of construction over the height, calculate the weights of the components and sum.

(3) Determine the span of the roof being supported by the wall (= distance between supporting walls).

(4) Determine the contributing weight to the footing (= B) from Figure 6.1.

NOTE – If there is more than one span of roof supported on a wall then calculate the weights of the roofs individually from steps 3 and 4 and sum.

(5) At each storey, determine the suspended floor span on each side of the supporting wall (= the distance between supporting walls).

(6) Determine the contributing weights to the footing (= C1 & C2 & C3 & C4) from Figure 6.2.

NOTE – If there is more than one span of floor supported on a wall then calculate the weights of the floors individually from steps 5 and 6 and sum.

Where concrete floors are used, the weight of the floor shall be known and the appropriate line used. Interpolation between the lines is allowed where the floor weights differ from those shown.

NOTE – Footings for walls which have floors cantilevering over the supporting wall are the subject of specific engineering design.

(7) Sum the contributing weights to the footing (= A+B+∑C) to obtain the total contributing weight.

(8) Using the total contributing load, determine the footing dimensions and reinforcement details from Table 6.2.

C6.2.2

The width of a footing is determined from the consideration of loads on the foundation, which consist of the following:

(a) The total weight of the wall in kN/m calculated from the summation of component weights;

(b) The floor live loads of the building limited by 1.1.3;

(c) The roof span supported by the wall;

***C6.2.2** (continued)*

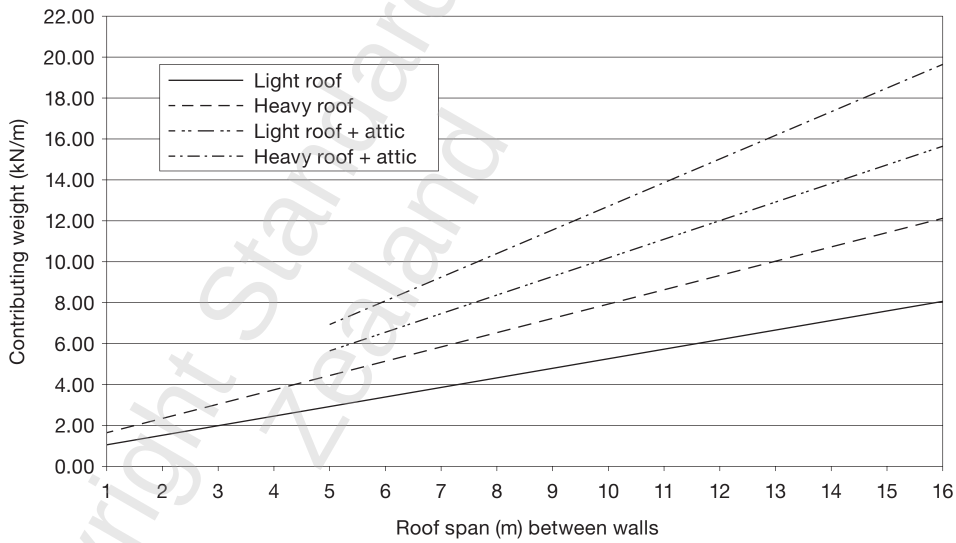
(d) The roof covering (heavy or light);

(e) The sum of loads transferred by floor spans supported by the wall (maximum of two floors supported on each side of the wall). For this Figure 6.2 has identified three types of floor:

(i) Heavyweight concrete floors (maximum dead load = 4.5 kPa). Systems such as pre-stressed flat slabs with structural topping and cast-in-situ floors

(ii) Lightweight concrete floors (maximum dead load = 3.5 kPa). Systems such as pre-stressed beams with timber infill and structural topping and composite steel floors

(iii) Timber floors.



NOTE –

(1) Roof weight values include a maximum ceiling weight of 0.1 kPa.

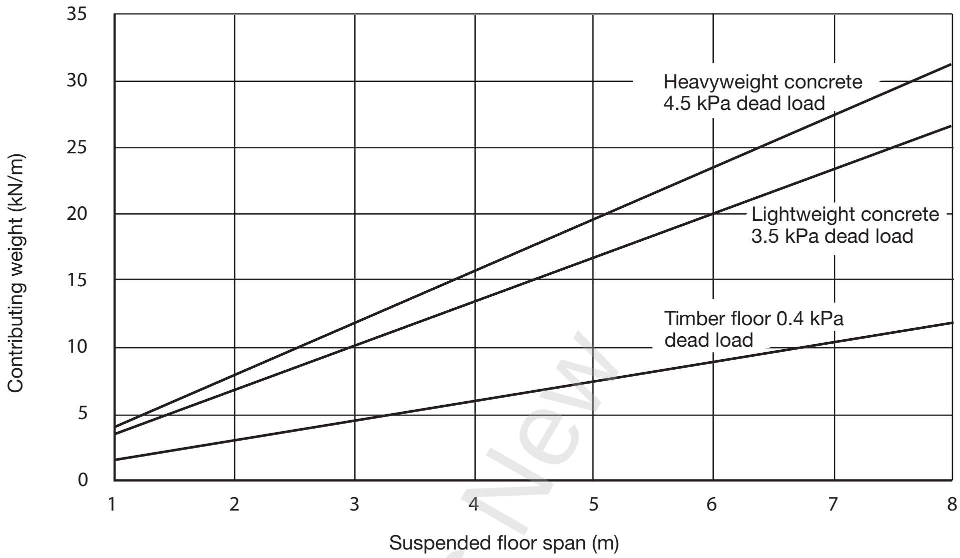
(2) A 0.75 m eaves overhang is included.

Figure 6.1 – Roof weight contribution kN/m (see 6.2.2)

Table 6.1 – Wall types and wall weights (see 6.2.2)

Form of construction (Type)	Nominal wall thickness (mm)	Mass of wall (kg/m^2)	Unit weight of wall (kN/m^2)	Factored unit weight of wall (kN/m^2) (see note)
Single skin block density 1850 kg/m^3 Solid filled with grout	100	170	1.7	2.0
	150	270	2.6	3.1
	200	370	3.6	4.3
	250	465	4.6	5.5
	150 + 100 veneer	440	4.3	5.2
	200 + 100 veneer	540	5.3	6.4
Single skin block density 1850 kg/m^3 fourth cores filled with grout (800 mm centres)	100	115	1.1	1.3
	150	160	1.6	1.9
	200	220	2.2	2.6
	250	275	2.7	3.2
	150 + 100 veneer	330	3.2	3.9
	200 + 100 veneer	390	3.8	4.6
Single skin block density 2200 kg/m^3 Solid filled with grout	100	185	1.8	2.2
	150	290	2.8	3.4
	200	400	3.9	4.6
	250	505	5.0	6.0
	150 + 100 veneer	460	4.5	5.4
	200 + 100 veneer	570	5.6	6.7
Single skin block density 2200 kg/m^3 fourth cores filled with grout (800 mm centres)	100	145	1.4	1.7
	150	210	2.1	2.5
	200	245	2.4	2.9
	250	310	3.0	3.6
	150 + 100 veneer	380	3.7	4.5
	200 + 100 veneer	415	4.1	4.9
Timber frame + heavyweight cladding (for example clay or concrete masonry veneer)	–	242	2.4	2.9
Timber frame + medium weight cladding (such as stucco cladding)	–	102	1.0	1.2
Timber frame + lightweight cladding (such as weatherboards)	–	52	0.5	0.6

NOTE – Factored unit weight is to be used in this Standard (see Appendix D).



NOTE –

(1) Graphs include live loads as specified in 1.1.3(f).

(2) The weight of a concrete floor will need to be ascertained from the specific design of that floor. Typically, constructions for the above concrete floor weights are:

(a) 4.5 kPa: In situ concrete slabs 190 mm thick or prestressed flat slabs with concrete toppings;

(b) 3.5 kPa: Prestressed beams with timber infills and concrete toppings or composite steel and concrete floors.

(3) Timber floors allow for 20 mm particle board flooring, floor framing, and a 12 mm plasterboard ceiling lining.

Figure 6.2 – Suspended floor weight contribution (see 6.2.2)

Table 6.2 – Dimensions and reinforcement details for footings (see 6.3.1)

	Contributing load on footing (kN/m)				
	0 – 40	**41 – 60**	**61 – 75**	**76 – 90**	**91 – 100**
Width (mm)	300	450	550	650	750
Depth (mm)	200	250	300	350	400
Steel (Grade 300)	2/D12 R6 @ 600	2/D16 R6 @ 600	3/D16 R6 @ 600	4/D16 R6 @ 600	5/D16 R6 @ 600

NOTE –

(1) 2/D12 bars may be substituted for 1/D16 bar.

(2) Minimum width in sand to be 400 mm (see 6.2.1).

(3) Minimum width for supporting masonry walls plus masonry veneer to be 450 mm.

6.3 Reinforced concrete footings

6.3.1

The dimensions shall be selected from Table 6.2 as appropriate to the calculated vertical load except where a subfooting complying with 6.5 has been used below the footing.

6.4 Reinforced masonry footings

6.4.1

For vertical loads up to 40 kN/m of reinforced masonry footings may be used provided that they shall comply with the requirements of Figure 6.3.

6.4.2

The reinforcement and concrete grout shall be placed in the footing before proceeding with the construction of the wall.

C6.4

The maximum footing width commonly available with the construction technique described under this clause is 300 mm. However, by the provision of the subfooting as given in 6.5, a much greater range of application is available.

All dimensions are in mm unless otherwise shown.

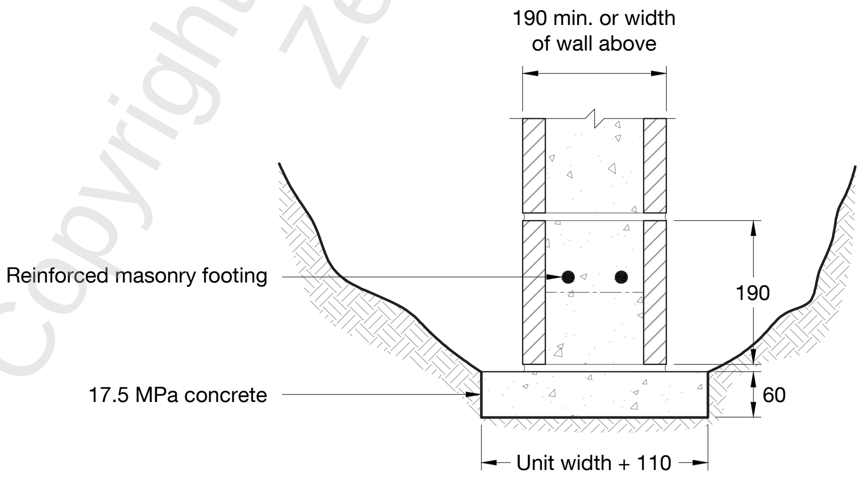


Figure 6.3 – Reinforced masonry footing (see 6.4.1)

6.5 Mass concrete subfootings

6.5.1

Where a subfooting is provided and it is required to spread the load from the reinforced concrete or reinforced masonry footing above, the subfooting shall have:

(a) A width equal to that required from Table 6.2;

(b) A minimum thickness of 200 mm or d_2 + 100 mm, whichever is the greater, where d_2 is the projection of the subfooting from the face of the reinforced concrete or reinforced masonry footing. (See Figure 6.4.)

> ***C6.5.1(b)***
>
> *The width of the reinforced concrete footing may be reduced from the provisions of Table 6.2 provided the requirements of (b) are met.*

6.5.2

Where a subfooting is provided and its width is equal to that of the reinforced concrete or reinforced masonry footing and equal to that width required from 6.2, then the minimum thickness shall be 50 mm.

6.5.3

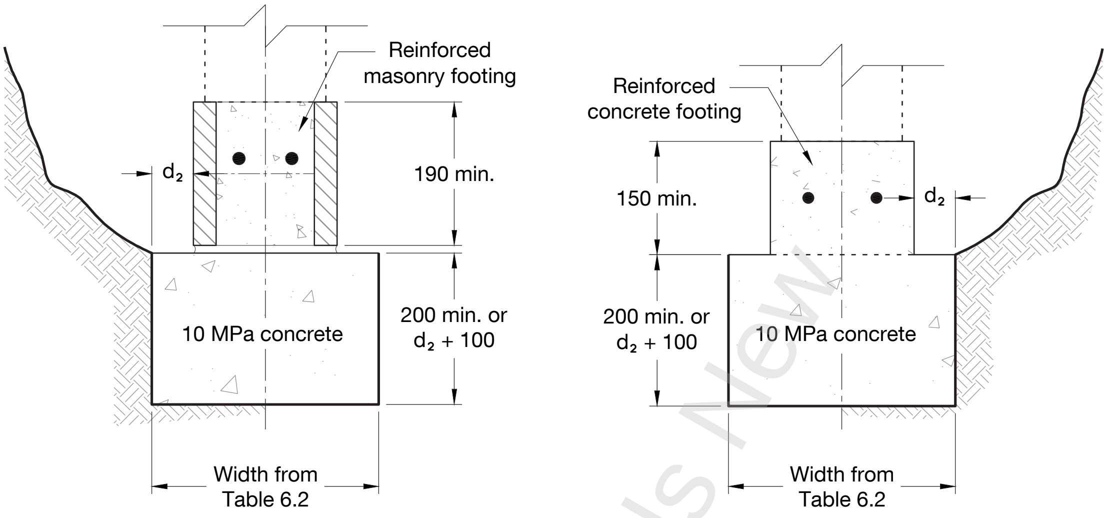
The concrete used for subfootings shall have a minimum compressive strength of 10 MPa as measured and tested in accordance with NZS 3109 and NZS 3112.

6.5.4

Every subfooting shall have a reinforced concrete or reinforced masonry footing cast on top.

> ***C6.5***
>
> *The main advantage of the subfooting or the trench fill technique is that it is a convenient way to allow for variations in formation level and to regulate the course heights or standard formwork heights in relation to the masonry walls constructed above.*
>
> *The method also widens the scope for using reinforced masonry footings and simplifies the details for using thickened floor edge construction when founding in soils which require a foundation depth of 400 mm.*

All dimensions are in mm unless otherwise shown.



NOTE – Reinforcement complies with Table 6.2.

Figure 6.4 – Mass concrete subfooting (see 6.5.1(b))

6.6 Reinforcement of footings

6.6.1

Longitudinal footing reinforcement shall be as specified in Table 6.2.

6.6.2

Footing reinforcement shall be tied with R6 at 600 mm centres and placed as shown in Figure 6.5 or R10 at 600 mm centres as shown in Figure 6.6.

Where footing concrete is protected by a damp-proof membrane, the 75 mm cover shown in Figures 6.5 and 6.6 may be reduced to 50 mm.

C6.6.2

It is recognised that some flexibility in placement will be required to suit tying of wall starter bars. Provided the reinforcement is placed 'in the vicinity' of that shown in Figures 6.5 and 6.6, and cover requirements are complied with, then placement will be deemed to be acceptable.

6.6.3

Continuity of footing reinforcement shall be maintained by lapping bars with a lap length of not less than 40 times the diameter of the bar.

6.6.4

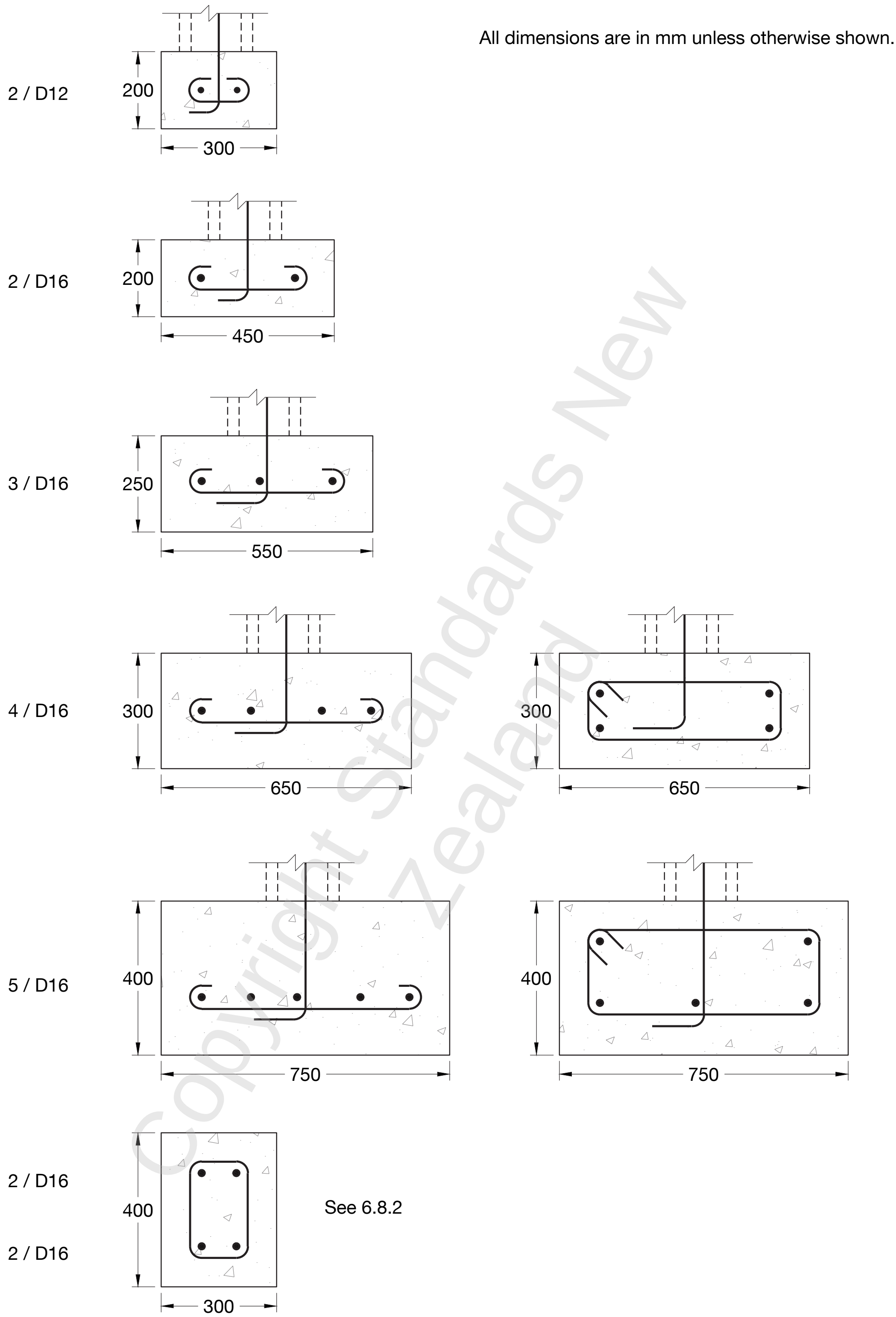
Where the footing of a foundation wall is stepped an equivalent of 50% of the area of reinforcement in the lower footing shall be turned up the vertical face of the step and extended 450 mm beyond the step intersection. Fifty per cent of the upper footing reinforcement shall also project into the wall 450 mm beyond the intersection, or 350 mm if provided with a standard hook. (See Figure 6.7.)

C6.6.4

The hooked overlap condition relates to the use of a masonry bond beam unit normally 400 mm in length.

6.6.5

Reinforcement at intersections of footings shall be as detailed in Figure 6.8.



NOTE –

(1) Cover to be 75 mm. If DPM protects footings then cover may be reduced to 50 mm.

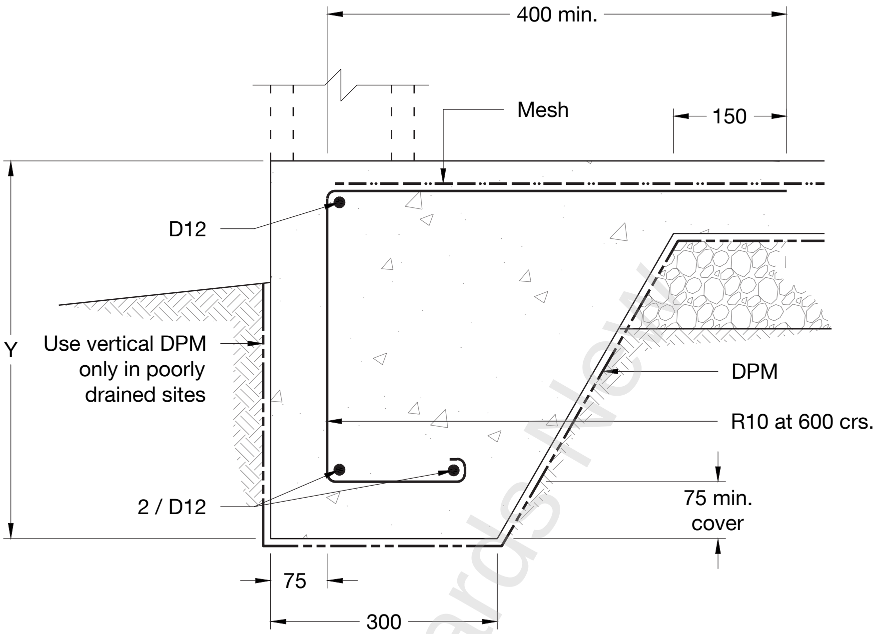
(2) Concrete strength minimum of 17.5 MPa.

(3) For stirrups see Table 6.2.

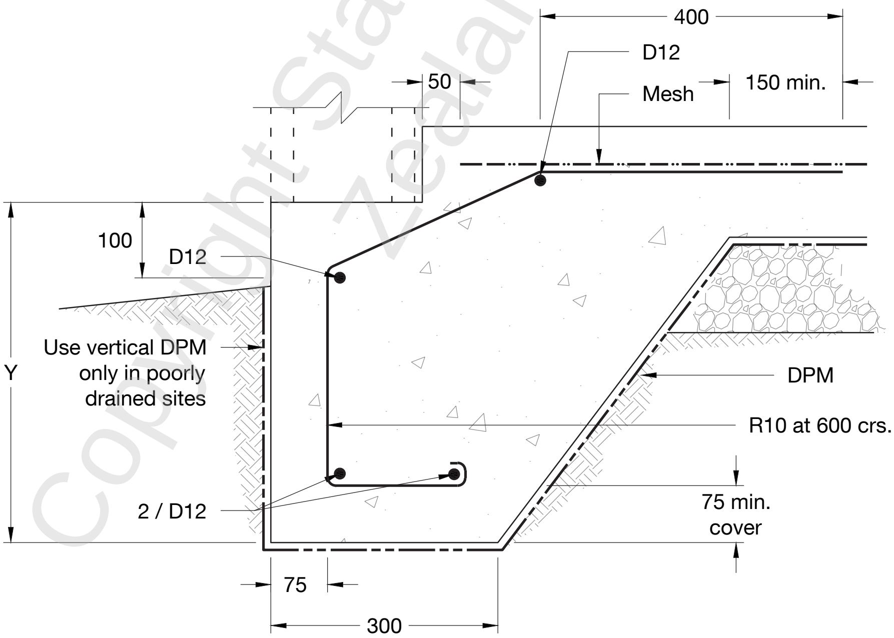
(4) Reinforcing hook and bend detail shall be in accordance with 3.3 of NZS 3109.

Figure 6.5 – Reinforcement of footings (see Table 6.2 and 6.6.2)

All dimensions are in mm unless otherwise shown.



(a) Edge thickened slab – no recess
(wall shall be solid filled)



(b) Edge thickened slab – recessed
(wall may be partial or solid filled)

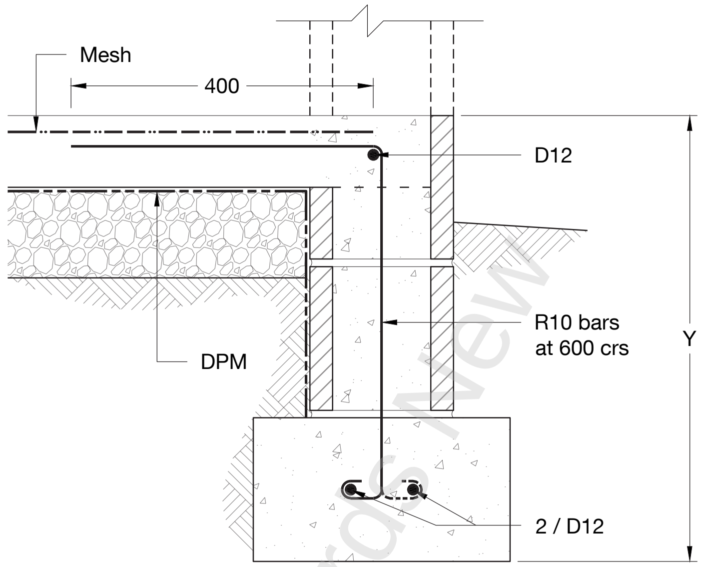
NOTE –

(1) Where maximum loading exceeds 40 kN/m then footing in accordance with Figure 6.5 shall be used.

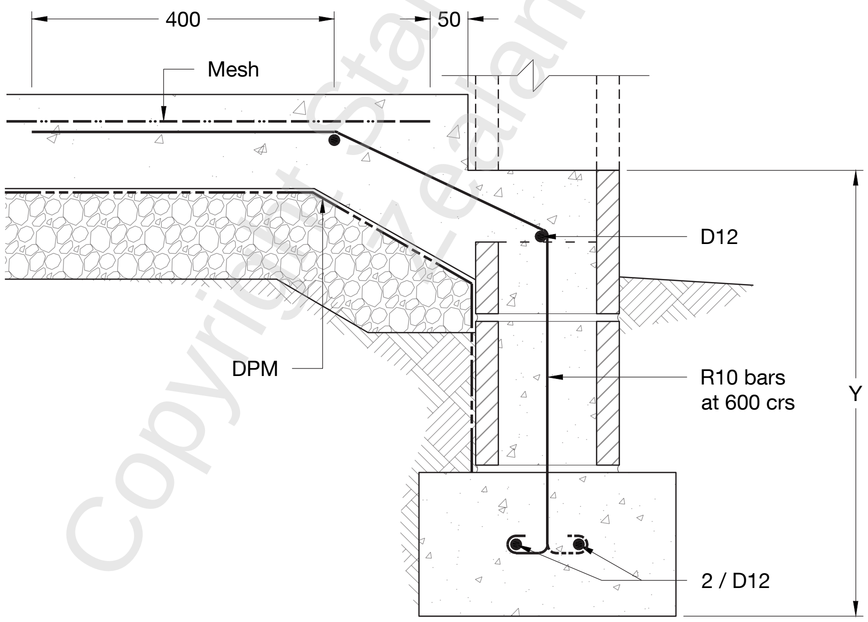
(2) Where Y exceeds 600 mm an additional horizontal D12 bar shall be used at mid height.

Figure 6.6 – Edge foundations (see 6.6.2)

All dimensions are in mm unless otherwise shown.



(c) Header block masonry edge – no recess
(wall shall be solid filled)



(d) Header block masonry edge – recessed
(wall may be partial or solid filled)

NOTE –

(1) Where maximum loading exceeds 40 kN/m then footing in accordance with Figure 6.5 shall be used.

(2) Where Y exceeds 600 mm an additional horizontal D12 bar shall be used at mid height.

(3) For (c) and (d) concrete block foundation elements shall be solid filled.

Figure 6.6 – Edge foundations (continued) (see 6.6.2)

6.7 Vertical wall starter reinforcement

6.7.1

Vertical wall starter reinforcement of the same diameter, type, spacing, and location as the wall vertical reinforcement shall be provided in every footing so as to penetrate the wall to a distance of not less than 600 mm.

6.7.2

Vertical wall starter reinforcement shall be tied and anchored by the provision of at least one 90° bend to a longitudinal bar contained in the footing. (See Figure 6.5.)

6.8 Footings for isolated transverse walls

6.8.1

Isolated transverse structural walls which are not part of a continuous wall shall be provided with a footing which shall extend beyond the wall to a foundation which is continuous and supports at least one other masonry wall.

6.8.2

The footings for isolated transverse structural walls shall be:

(a) Not less than 400 mm in depth and 300 mm in width;

(b) Reinforced with 4/D16 bars and R10 ties at 200 mm centres. (See Figure 6.5.)

All dimensions are in mm unless otherwise shown.

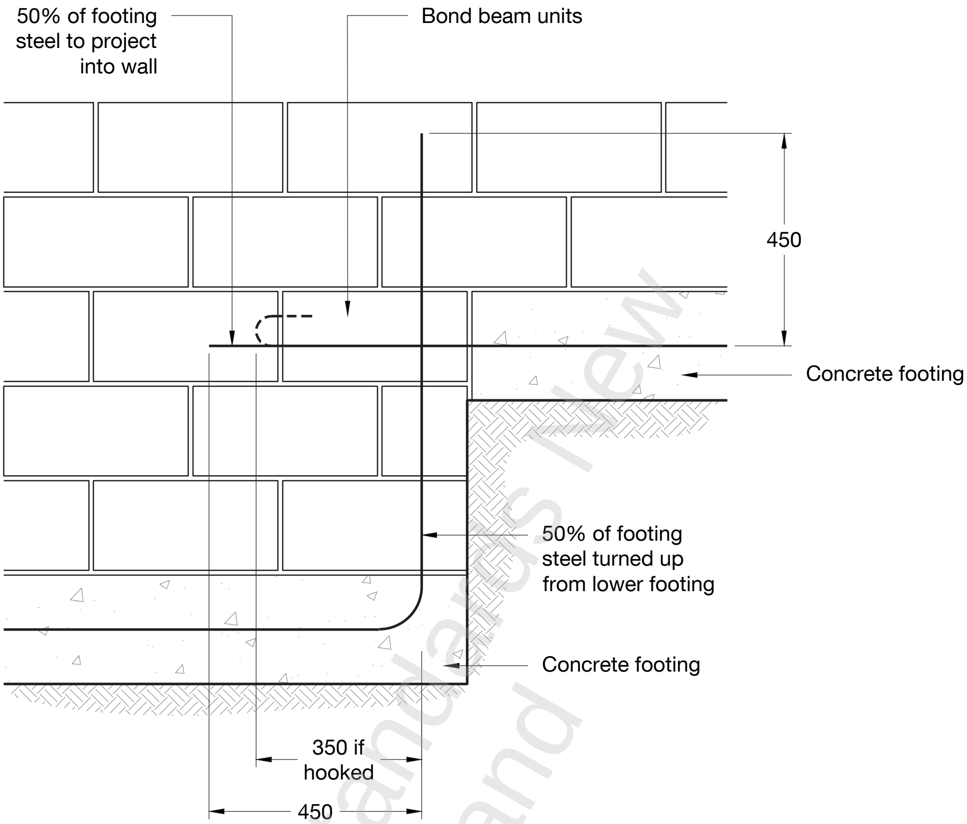
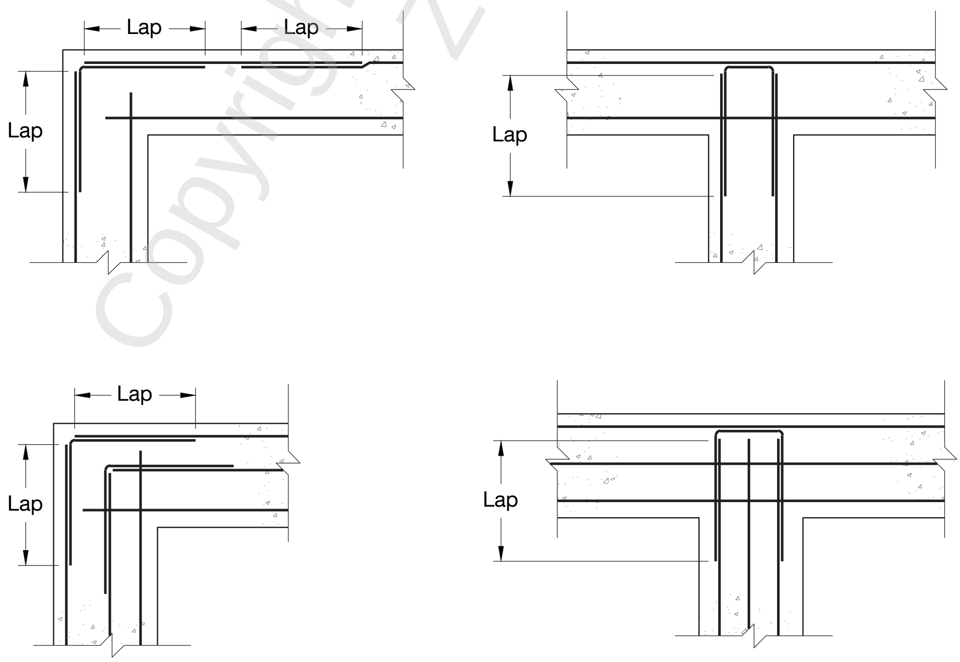


Figure 6.7 – Stepped footing (see 6.6.4)



NOTE – All lap lengths shall comply with 8.1.5.

Figure 6.8 – Reinforcement at footing intersections (see 6.6.5)

7 FOUNDATION WALLS AND CONCRETE SLAB-ON-GROUND

7.1 Foundation walls

7.1.1

Reinforced masonry foundation walls shall be constructed to the provisions set out in section 8.

7.1.2

The thickness of a foundation wall shall be no less than the thickness of the wall above. Where the load bearing wall is constructed of timber and provides lateral support for a masonry veneer the foundation shall be of sufficient thickness to support both the veneer and the timber frame.

7.1.3

Foundation walls subject to horizontal earth pressure shall comply with section 8 and Appendix A.

> ***C7.1.3***
>
> *Appendix A sets out details of the more commonly encountered conditions for retaining walls. Where specific soil, site conditions, and loading are not covered by these conditions the wall will be required to be specifically designed.*

7.1.4

Bond beams shall be provided at the top of all masonry foundation walls in accordance with section 10 where lateral support is provided by bracing lines.

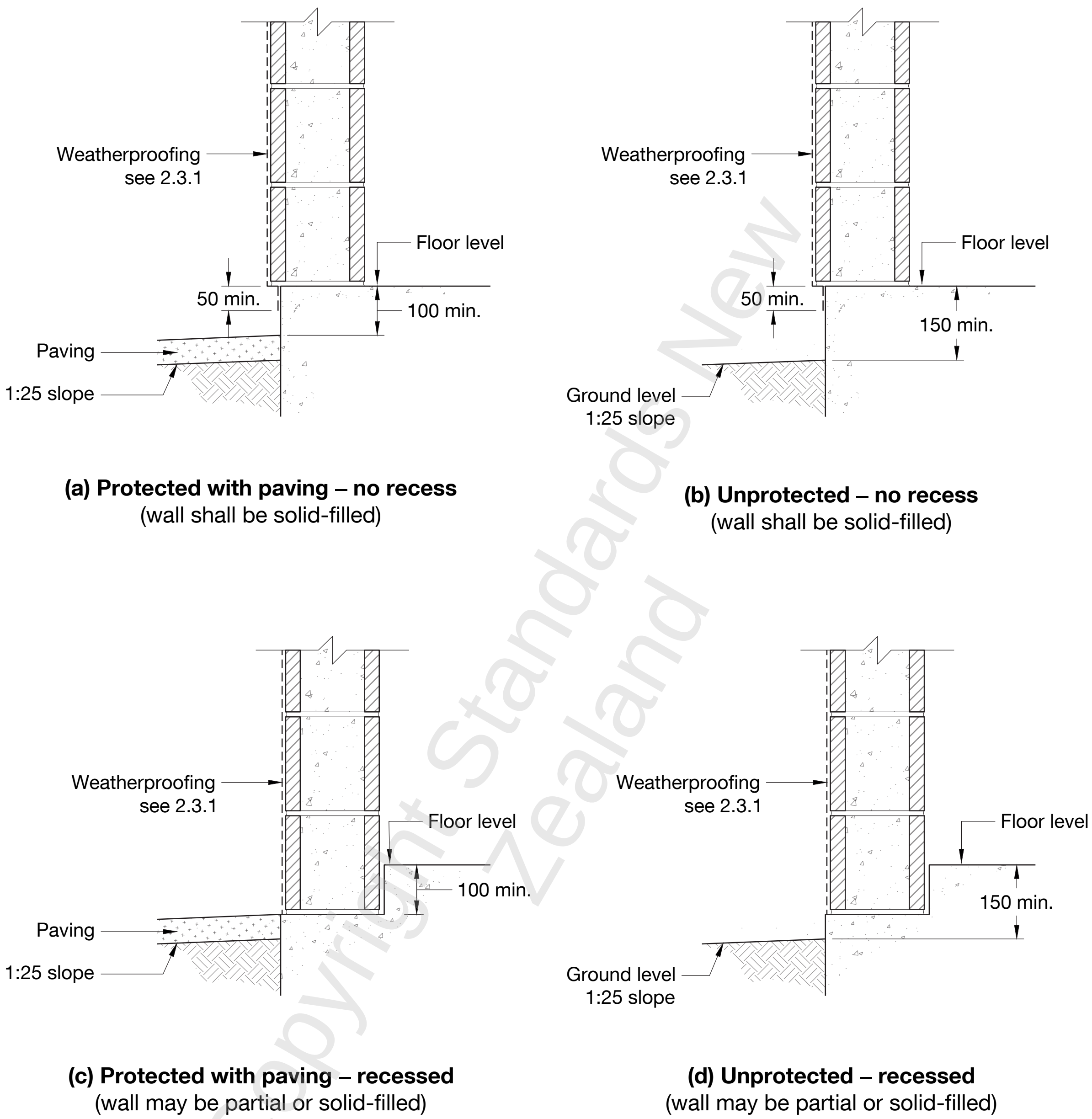
7.2 Slab-on-ground

7.2.1 Floor levels

The finished level of a concrete slab-on-ground floor shall be a minimum height above the adjoining finished ground level of 150 mm or above paving of 100 mm in accordance with the provisions of Figure 7.1.

> ***C7.2.1***
>
> *At a garage entrance, the minimum height may be reduced to 40 mm for this non-habitable area. Where the driveway slopes towards the slab-on-ground, then a drainage channel should also be provided to collect and dispose of surface water.*

All dimensions are in mm unless otherwise shown.



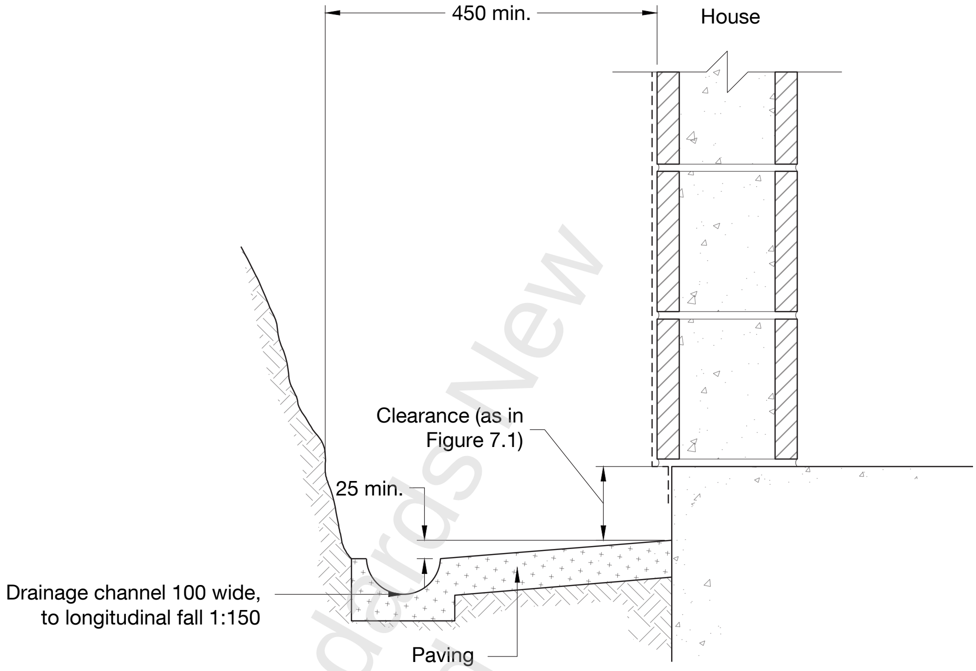
NOTE –

(1) Maximum overhang of masonry wall over the concrete foundation is 20 mm.

(2) (a) and (b) apply in conditions where no rebate is required.

Figure 7.1 – Minimum heights of finished concrete slab-on-ground floors above adjoining finished ground level (see 7.2.1)

All dimensions are in mm unless otherwise shown.



NOTE – This figure applies in conditions where no rebate is required.

Figure 7.2 – Permanent paving adjoining buildings with slab-on-ground floors (see 7.2.2)

7.2.2

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 not less than 1 in 25 for a distance of at least 1 m from the building, or where site conditions do not allow such a 1 m wide strip to be formed, then permanent paving shall be laid to the falls and dimensions shown in Figure 7.2.

7.2.3

The concrete foundation edge details shall be constructed to comply with Figure 6.6.

7.3 Granular base

7.3.1

Granular rock fill material complying with 7.3.2 shall be placed in layers not less than 100 mm and not more than 150 mm thick over the area beneath the proposed slab-on-ground so that the total thickness of granular base is not less than 75 mm nor more than 600 mm.

> ***C7.3.1***
>
> *Specific engineering design is required if filling in excess of 600 mm.*

7.3.2

Granular rock fill material shall be composed of rounded gravel, crushed rock, or scoria and:

(a) Not more than 5% shall pass a 2.2 mm sieve;

(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.

Fill material shall not be subject to deterioration nor significant expansion when in contact with water. Demonstration of these properties shall be to the satisfaction of the building consent authority.

Further the grading requirements for the 2.2 mm size may be waived where it can be shown that capillary water is unlikely to reach the underside of the slab. Such demonstration however is outside the scope of this Standard and shall be to the satisfaction of the building consent authority.

C7.3.2

Proper grading of granular fill is important. Avoid excessive fine material such as sand, as this will cause problems with drainage, capillary action, compaction, and settlement.

7.3.3

The top surface of the granular base shall be treated as necessary to receive the damp-proof membrane (DPM) in accordance with 7.4 to 7.7.

7.4 Damp-proof membrane

7.4.1

Every slab-on-ground floor shall incorporate a continuous DPM between the ground and the floor surface (see Figure 7.3). 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 concrete slab-on-ground and be protected by a concrete slab not less than 50 mm thick.

C7.4.1

A minimum slab thickness of 50 mm is required to resist vapour pressure and protect the DPM.

The requirement for an edge vapour barrier up to the face of external slab edge can be dispensed with in well-drained sites.

7.4.2

The DPM shall be comprised of one or more of the materials given in 7.5, 7.6, and 7.7 and shall:

(a) Have a water vapour flow resistance not less than 90 MNs/g when tested in accordance with ASTM E96, using 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.

C7.4.2

Various damp-proof membranes are available. Typical examples are polythene sheet, bituminous sheets, and rubber emulsions. The specification details set out in this section are deemed to satisfy the requirements of 7.4.2.

All dimensions are in mm unless otherwise shown.

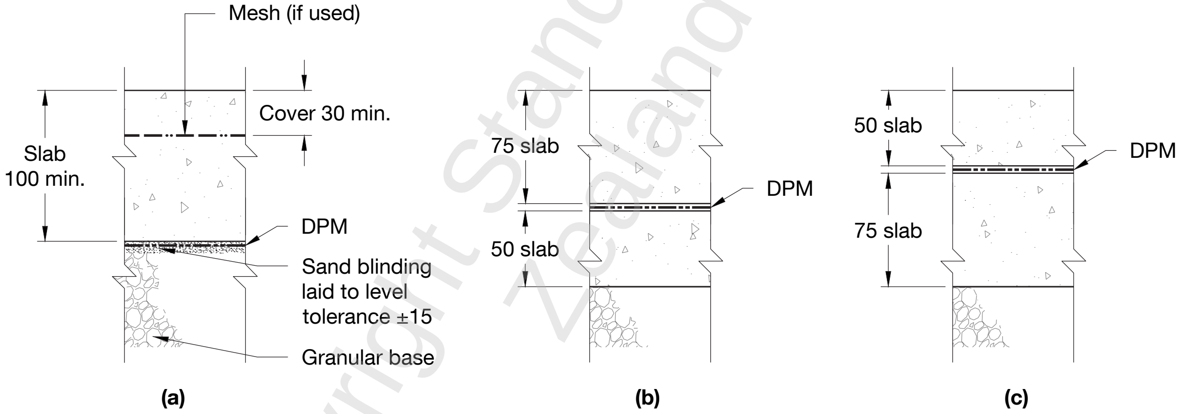


Figure 7.3 – Construction of slabs-on-ground (see 7.4.1)

7.4.3

Any damp-proof membrane material and its receiving surface specified in 7.5 to 7.8 inclusive shall be accepted as complying with 7.4.2.

7.4.4

More than one type of damp-proof membrane material may be used provided that there shall be adequate lapping between different materials.

7.4.5

Any penetrations through the DPM shall be sealed.

C7.4.5

Penetrations by services or by reinforcing steel may be sealed by taping or by the use of a wet-applied damp-proof membrane material or by other means appropriate to the type of material.

7.4.6

Damp-proof membrane materials shall be repaired or replaced if necessary before concrete is placed over them.

7.5 Bituminous sheet damp-proof membranes

7.5.1

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.

C7.5.1

Vertical faces cannot be exposed in any situation where the sheet might suffer damage.

7.5.2

Bituminous sheet DPM material shall be laid over:

(a) A smooth-surfaced blinding layer not less than 10 mm thickness of coarse sand or a sand cement slurry; or

(b) Heavyweight building paper.

7.6 Polyethylene (polythene) sheet damp-proof membranes

C7.6

Polyethylene is usually referred to as 'polythene' in the New Zealand building industry.

7.6.1

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 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, provided that such tape need not be used with self-sealing polyethylene sheets;

(c) Be protected from damage.

C7.6.1

Vertical faces cannot be exposed in any situation where the sheet might suffer damage.

7.6.2

Where the granular surface is likely to cause intrusions into the vapour barrier polyethylene sheet, the vapour barrier material shall be protected by:

(a) Surface blinded with sand to form a smooth layer or a cement sand screed can be used; or by

(b) Heavyweight building paper.

C7.6.2

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 method for the slab. A nominal 5 – 10 mm thickness of sand to fill gaps in the base course material plus a base course tolerance ±15 mm results in a maximum compacted thickness of 25 mm.

7.7 Rubber emulsion damp-proof membranes

7.7.1

Rubber emulsion DPM material shall:

(a) Contain not less than 10% rubber latex;

(b) Be applied in at least two coats at right angles to each other and in accordance with the manufacturer's specification to the approval of the building consent authority.

C7.7.1

The information supplied by the manufacturer should take account of the shrinkage cracking that will occur in the supporting concrete layer.

7.7.2

Rubber emulsion damp-proof membrane (DPM) material shall be laid on a layer of concrete not less than 50 mm thick.

7.8 Slab-on-ground construction

7.8.1 General

The use of concrete slabs-on-ground shall be divided into the following applications:

(a) All slab-on-ground floors shall be reinforced in accordance with 7.8.3, 7.8.4, and 7.8.5.2. All reinforcing steel, including welded mesh, shall be Ductility Class E in accordance with AS/NZS 4671;

(b) Where the slab forms a thickened perimeter foundation, it shall be continuously reinforced to comply with 6.6;

(c) Concrete shall conform with the requirements of NZS 3104 and NZS 3109 and the minimum specified compressive strength of concrete at 28 days shall be:

(i) 17.5 MPa for reinforced concrete either not exposed to weather or exposed to the weather in Zone B as shown in Figure 4.2 of NZS 3604

(ii) 20 MPa for reinforced concrete exposed to weather, at least 500 m from mean high tide mark in Zone C as shown in Figure 4.2 of NZS 3604

(iii) 25 MPa for reinforced concrete exposed to weather and within 500 m of the mean high tide mark in Zone D as shown in Figure 4.2 of NZS 3604

(iv) Specially selected from Table 3.8 of NZS 3101 where a direct wearing concrete floor is required

(v) To SED for geothermal hot spots.

C7.8.1

The experience of the Canterbury earthquakes has led to changes to the reinforcement requirements in slabs-on-ground. Steel mesh to Grade 500 E or bars to Grade 300 E are now required in all slabs. See 7.8.3.

Polypropylene fibres cannot be used unless they are used as a supplementary early age anti-cracking measure with the steel reinforcement.

7.8.2 Slab thickness and dimensions

7.8.2.1 Slab thickness

Except as required by 7.11.1 beneath certain loadbearing walls, the minimum thickness of a slab-on-ground shall be:

(a) 100 mm when placed on a bituminous or polyethylene sheet damp-proof membrane (DPM) laid on a specifically prepared granular base (see Figure 7.3);

(b) 75 mm when laid on rubber emulsion DPM over a 50 mm of concrete slab (see Figure 7.3);

(c) 75 mm when the vapour barrier is laid over this lower layer of concrete and protected by 50 mm of concrete (see Figure 7.3).

7.8.2.2 Dimensions

The maximum continuous length of slab reinforced in accordance with 7.8.3 shall not exceed 18 m.

C7.8.2

A reduction of the slab thickness can be considered by specific engineering design if steel fibre reinforcement is used, in which case the slab thickness must be taken in accordance with the manufacturer's specifications. The maximum joint spacing is a function of slab thickness and special care is required in determining the bay dimensions of the slab. Certain composite construction will create two separate concrete layers totalling 125 mm.

7.8.3 Concrete slab reinforcement

All slab-on-ground reinforcing shall extend to within 75 mm of the outside edge of the slab (including the foundation wall) and shall consist of a minimum 2.27 kg/m^2 welded Grade 500 E reinforcing mesh sheets (1.14 kg/m^2 in each direction), which shall be lapped at sheet joints by 225 mm or in accordance with the manufacturer's requirements, whichever is greater. Slabs shall have a maximum dimension of 18 m between free joints.

C7.8.3

If using an alternative mesh option or an alternative reinforcing bar option ensure the reinforcement is Ductility Class E, conforming with AS/NZS 4671 and of equivalent capacity. An equivalent capacity mesh means meeting each of the following:

(a) The amount of steel (kg/m^2) necessary to achieve the equivalent capacity is determined as:

2.27 x 500 divided by the strength grade of steel (where the strength grade of the steel is the verified lower characteristic yield strength of the steel bar in MPa);

(b) The uniform elongation A_{gt} (refer to Table 2 of AS/NZS 4671) equals or exceeds 10%;

➤

***C7.8.3** (continued)*

(c) Properties are determined in accordance with Appendix C of AS/NZS 4671. Testing is to be carried out by independent qualified testing organisations and evidence presented to Building Consent Authorities and to others on request. Extensometer measurement taken across the necked portion of the test specimen is to be ignored;

(d) Reinforcing mesh fabric laps are a minimum of one grid wire spacing plus 50 mm but not less than 150 mm. Where deformed mesh wire with no cross wires is lapped with another sheet also with no cross wires, or where reinforcing bars are used, a lap length of 40 wire diameters or reinforcing bar diameters is to be provided;

(e) Reinforcement is required to be supported on chairs to ensure the reinforcement position and 30 mm top cover is maintained;

(f) Mesh is to be suitably identified to confirm conformance with these requirements.

Equivalent reinforcing bar options are:

(g) Grade 300 E D10 reinforcing steel bars (conforming with AS/NZS 4671) at 300 mm centres each way with 30 mm top cover; or

(h) Grade 300 E D12 reinforcing steel bars (conforming with AS/NZS 4671) at 450 mm centres each way with 30 mm top cover.

Continuous slabs longer than 18 m in length are outside the scope of this section and should be the subject of specific engineering design. It is possible to use a free joint between adjacent slabs which may total up to a length greater than 18 m, for example 24 m may be formed by 2 x 12 m long slabs.

In the controlled applications of this Standard, minor shrinkage cracking is of no structural consequence but care should be taken to follow the bay size requirements to ensure shrinkage cracking does not appear in areas where special thin or hard finishes are to be applied, such as vinyl sheeting or ceramic/stone tiles.

7.8.4 Cover from top surface

Reinforcing steel shall have a cover of 30 mm from the top surface of the slab-on-ground and shall be placed in such a manner as to avoid damage to the DPM.

7.8.5 Shrinkage control joints

7.8.5.1 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.

C7.8.5.1

A shrinkage control joint permits the concrete slab to shrink and allow movement. This can be done by saw cutting to create a weakness to encourage the crack to form at this point or by including a debonded construction joint device within the slab during construction (ensuring that anchorage of the device does not damage the DPM). Typically the depth of cut will be 25 mm with a single saw blade width of approximately 5 mm.

Some variations in time for cutting may need to be considered for special weather, particularly temperature conditions.

Special techniques are also available to cut the joint in the concrete's plastic state.

7.8.5.2 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 7.4.

(b) Supplementary steel shall be placed as shown in Figure 7.5 but not across shrinkage control joints;

(c) Supplementary shrinkage control joints shall be used such that intermediate bay sizes do not exceed 6 m;

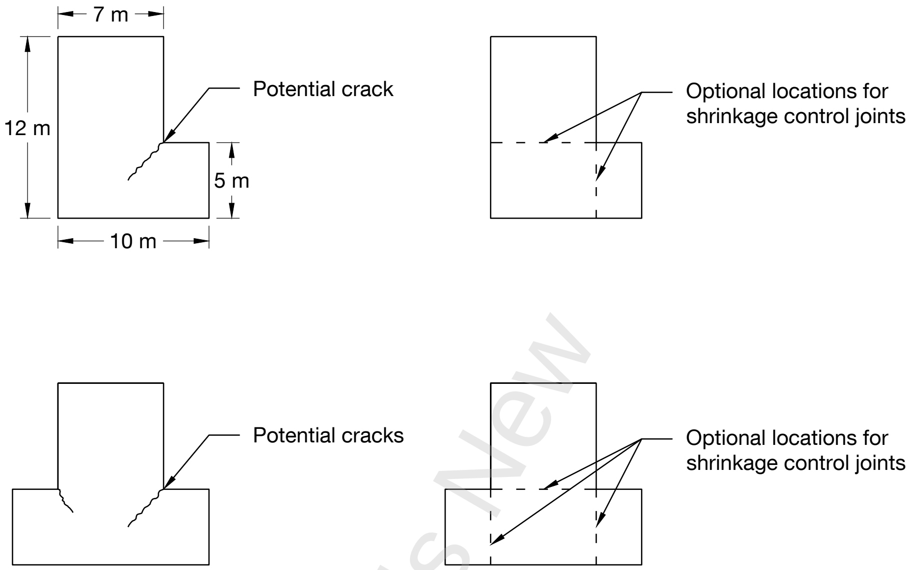
(d) Panels shall be formed as close as practicable to length to width ratios of between 2:1 and 1:1 and shall have a maximum length in any direction of 6 m.

C7.8.5.2

The slab reinforcement and control joints provided will not totally eliminate the formation of non-structural shrinkage cracks.

Supplementary shrinkage control joints should be used such that intermediate bay sizes do not exceed 6 m for slabs where there is exposed concrete or where finishes may be damaged by the formation of controlled shrinkage cracks.

Where significant areas of direct wearing concrete, vinyl, and ceramic tiles are to be used, it is recommended that specific engineering design be used which would consider reducing the maximum bay dimension and a preference to produce a bay shape that is approximately square.



NOTE – Only one shrinkage control joint is required at each slab corner.

Figure 7.4 – Positioning of shrinkage control joints (see 7.8.5.2(a))

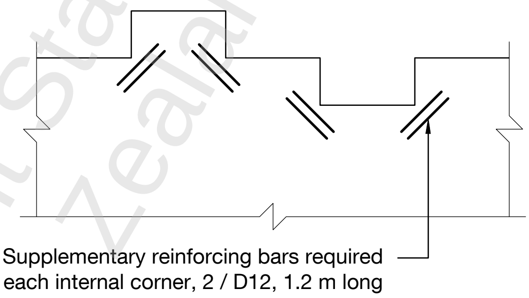


Figure 7.5 – Supplementary steel (see 7.8.5.2)

7.8.5.3 Free joints

At free joints, slab reinforcement shall be terminated and there shall be no bonding between vertical concrete faces (prevented by using building paper or a bituminous coating). R12 dowel bars 600 mm long shall be placed at 300 mm centres along the free joint and lapped 300 mm with slab reinforcement on both sides of the joint. All dowel bars on one side of the joint shall have a bond breaker applied, for example by wrapping dowel bars for 300 mm with petrolatum tape. Joint dowel bars shall be installed in a single plane, in true alignment and parallel.

7.9 Bearing

7.9.1

Clause 3.4.1 shall apply to the foundation walls but not to the slab-on-ground itself. The depth shall be measured from the cleared ground level outside the foundation wall and not from the cleared ground level beneath the slab-on-ground.

C7.9.1

The cleared ground level beneath the slab will need to be such that:

(a) The granular fill material can be placed on a solid bottom or firm fill where a certificate of suitability has been issued under NZS 4431 (see 3.4.1); and

(b) The thickness of granular fill complies with 7.3.1; and

(c) The finished floor level complies with 7.2.1.

7.9.2

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 top soil;

(b) Soft or very soft peat;

(c) Loose uncompacted sand;

(d) Fill material without a 'Statement of suitability' under NZS 4431;

(e) Expansive clay as set out in 3.2.2.

7.10 Underfloor thermal insulation

Where thermal insulating material is included under a floor slab, it may be placed in any appropriate position to achieve the desired effect provided that no reduction of any concrete thickness dimension given by this Standard shall be permitted.

7.11 Support of loadbearing internal walls

7.11.1

The slab beneath a loadbearing internal wall that supports one of the following:

(a) Two timber floors and a light roof;

(b) One suspended timber floor and a heavy roof; or

(c) A concentrated load from trusses or beams supporting a total roof area not exceeding a tributary area of 20 m^2;

shall be 200 mm thick over a minimum width of 450 mm and reinforced with 2/D12 bars as shown in Figure 7.6. In the case of (c) above the minimum length of floor thickening shall be 450 mm.

C7.11.1

The requirements of this clause cover loadbearing walls only and can not be used to satisfy point loadings which require specific engineering design. All internal walls of a single-storey structure supporting only a roof and ceiling rafters can be loadbearing without slab thickening.

7.11.2

Where concrete suspended floors have been used, a separate foundation and footing complying with section 6 shall be provided.

All dimensions are in mm unless otherwise shown.

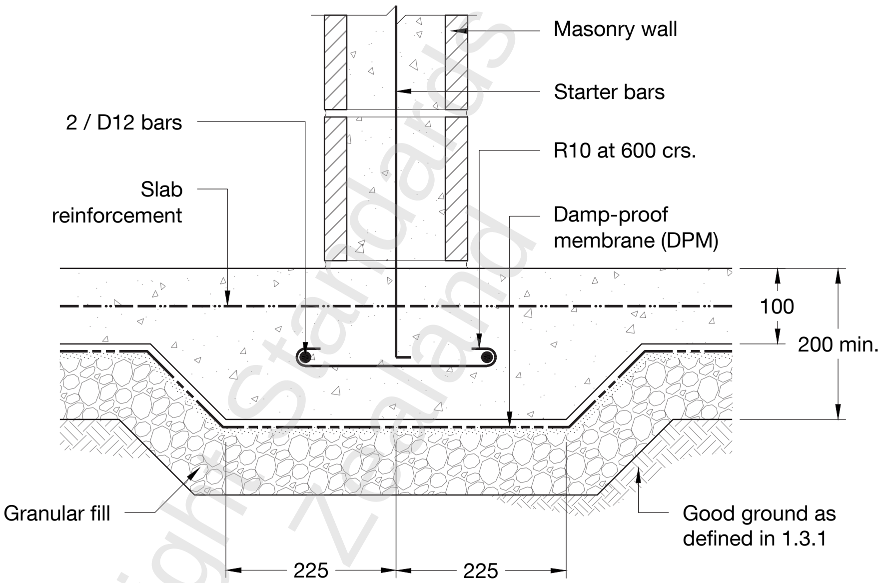


Figure 7.6 – Support of loadbearing internal walls (see 7.11.1)

8 WALLS

8.1 General

8.1.1

The wall system of each storey shall consist of:

(a) Structural masonry walls with or without loadbearing light timber framing to resist vertical loads complying with 8.2; combined with

(b) Structural masonry walls to resist horizontal loads complying with 8.4.

8.1.2

No masonry wall shall be of a lesser thickness than a wall it supports.

8.1.3

All cells containing reinforcement in partially filled structural masonry shall be filled with grout in accordance with NZS 4210.

8.1.4

Cells and cavities in solid-filled structural masonry walls shall be filled with grout in accordance with NZS 4210.

8.1.5

Joints in deformed reinforcing steel Grade 300 E shall be lapped for a minimum length of 40 bar diameters. Round steel Grade 300 E shall be lapped 80 bar diameters.

8.1.6

Bond beams complying with section 10 shall be provided at the top of all structural masonry walls and at floor and ceiling levels.

8.1.7

Concrete masonry shall have minimum cover to steel reinforcement from an uncoated masonry external face and minimum grout strength of:

(a) 45 mm and 17.5 MPa for interior conditions and Exposure Zone B as shown in Figure 4.2 of NZS 3604;

(b) 50 mm and 20 MPa for Exposure Zone C as shown in Figure 4.2 of NZS 3604;

(c) 60 mm and 25 MPa for Exposure Zone D as shown in Figure 4.2 of NZS 3604.

8.2 Wall systems to resist vertical loads

8.2.1

Wall systems to resist vertical loads shall be a combination of the following types:

(a) Structural walls constructed of solid or partially filled masonry or both with reinforcement complying with 8.3.2;

(b) Loadbearing timber framing in accordance with NZS 3604 which may be supported on masonry walls;

(c) Reinforced masonry lintels complying with section 11;

(d) Reinforced masonry or concrete foundation walls and footings.

Except that when a suspended concrete floor is used, it shall not be supported by a loadbearing timber frame.

8.2.2

No masonry wall shall be supported on a timber structure.

8.2.3

The vertical load capacity of the wall system shown in Table 8.1 shall not be exceeded.

> ***C8.2.3***
>
> *It is important to check that loads imposed from lintels with other direct loading conditions on the wall do not exceed the capacities in Table 8.1 for wall sections between openings.*

Table 8.1 – Vertical load capacity of wall (see 8.2.3)

	Partial fill			**Solid fill**		
	Wall series			**Wall series**		
	15	20	25	15	20	25
Wall length (mm)	**Load capacity** (kN)			**Load capacity** (kN)		
800 nominal	55	71	88	57	78	98
1000 nominal	68	90	113	72	98	223
1200 nominal	81	107	133	86	117	148

8.3 Structural walls

8.3.1

All structural walls shall be centrally reinforced both horizontally and vertically in accordance with Tables 8.2 or 8.3.

> ***C8.3.1***
>
> *Note there is no difference in the vertical reinforcement detailing. The spacing of the horizontal reinforcing for the solid fill situation is reduced to 1.2 m which permits an increase in the bracing capacity of the wall.*

8.3.2

Vertical bars as specified in Tables 8.2 and 8.3 shall be provided:

(a) At all corners and ends of walls;

(b) On each side of wall openings exceeding 400 mm in width;

(c) Either side of shrinkage control joints.

8.3.3

All vertical reinforcing steel shall extend from the foundation or lower bond beam to the upper bond beam.

8.3.4

All vertical reinforcement shall be located in the same cell as the starter bar provided from the footing or lower structural wall.

8.3.5

Horizontal reinforcement steel immediately above and below openings shall be provided and shall be anchored as shown in Figure 8.1.

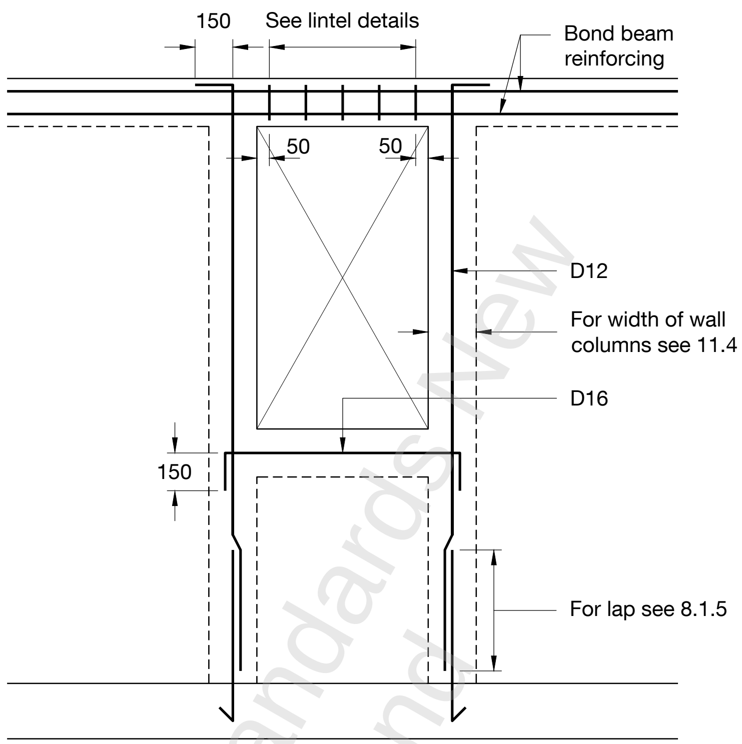
Table 8.2 – Reinforcement for partially filled masonry structural walls (see 8.3.1 and 8.3.2)

All earthquake zones	Vertical reinforcement				Horizontal reinforcement			
	Max. spacing of vertical bars (mm)	Block used			Max. spacing of horizontal bars (mm)	Block used		
		15 series	20 series	25 series		15 series	20 series	25 series
	800	D12	D12	D12	2800	D16	D16	D16

Table 8.3 – Reinforcement for solid-filled masonry structural walls (see 8.3.1 and 8.3.2)

All earthquake zones	Vertical reinforcement				Horizontal reinforcement			
	Max. spacing of vertical bars (mm)	Block used			Max. spacing of horizontal bars (mm)	Block used		
		15 series	20 series	25 series		15 series	20 series	25 series
	800	D12	D12	D12	1200	D12	D12	D16

All dimensions are in mm unless otherwise shown.



NOTE – When the bond beam does not combine to form the lintel (see section 11), separate lintel steel shall be used over the opening.

Figure 8.1 – Reinforcement above and below openings (see 8.3.5)

8.4 Systems to resist horizontal forces

8.4.1

All masonry buildings shall be braced to resist horizontal wind and seismic forces.

8.4.2

Horizontal forces in the plane of suspended floor and roof levels shall be resisted by one of the following methods:

(a) Bond beams spanning between structural walls, containing bracing panels (see Figure 8.2);

(b) Structural diaphragms (see Figure 8.3);

(c) A combination of (a) and (b) above.

C8.4.2

Bond beams or diaphragms are needed to transfer wind or seismic forces on the face of a wall or loads from parts of the structure above the bond beam or diaphragm, to walls which run parallel to the direction of the force.

It should be noted for (c) that due to other provisions of this Standard, the bond beam/ bracing line method can only be used in storeys below those using the diaphragm method.

8.4.3

Structural walls to resist horizontal forces in any storey shall contain wall bracing panels complying with 8.4 in the following walls:

(a) External walls as required by 8.6; and

(b) Internal walls on bracing lines as required by 8.7; or

(c) Walls supporting the four edges of a structural diaphragm complying with 8.8.

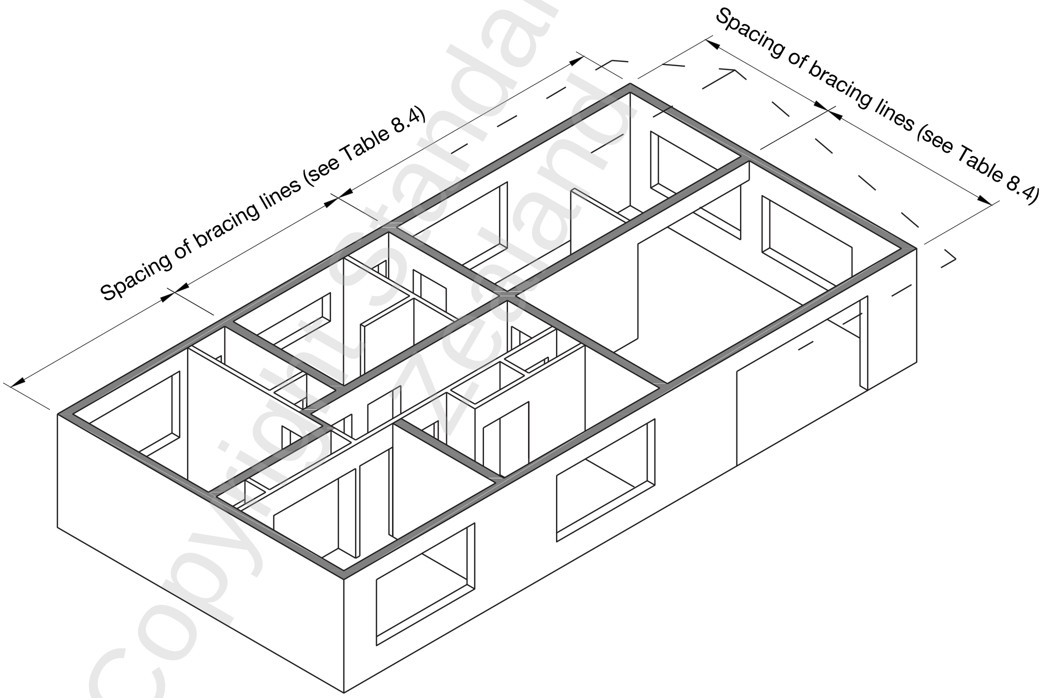


Figure 8.2 – Bracing line support system (see 8.4.2(a))

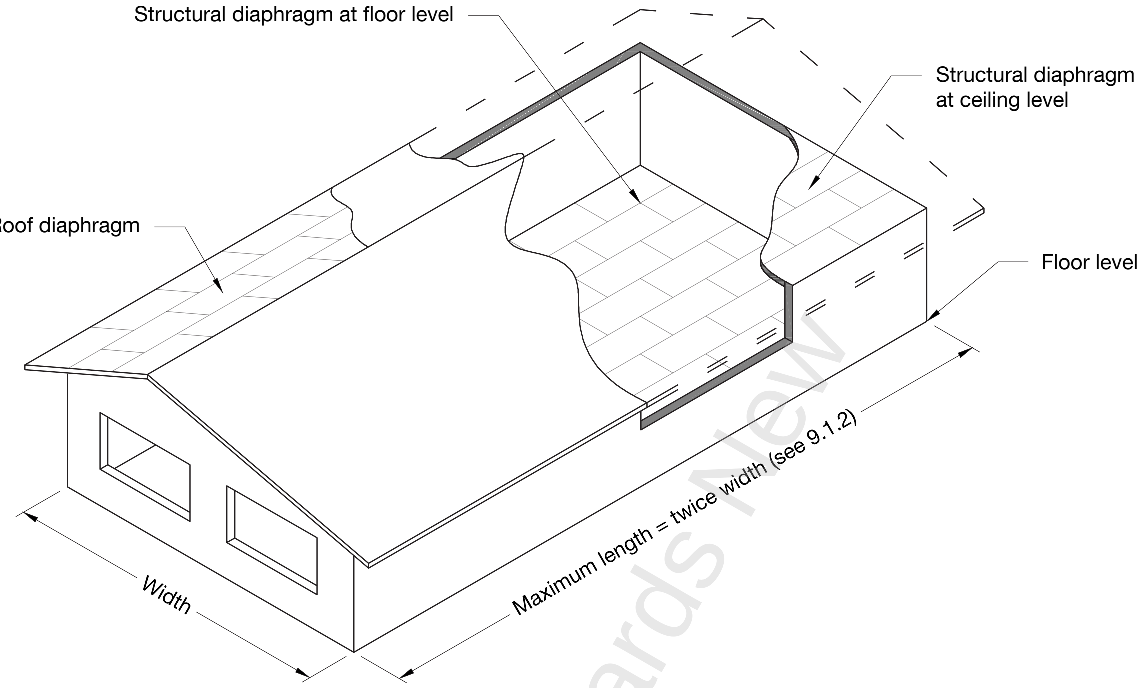


Figure 8.3 – Structural diaphragm support systems (see 8.4.2(b))

8.5 Bracing units and elements

8.5.1

Each individual wall bracing panel shall be rated at the capacity in bracing units given in section 5. Each bracing line consisting of a number of panels shall be rated as the sum of the individual panels as described by the bracing line capacity calculation process in section 5.

C8.5.1

The calculation procedures for determining bracing demand and capacity are set out in sections 4 and 5.

8.5.2

The total bracing capacity of all wall bracing panels in each of two directions at right angles to each other in any storey shall be not less than the greater of:

(a) The bracing demand in bracing units/m^2 given by Table 4.3 for earthquake multiplied by the gross floor plan area in m^2 of the storey being considered;

(b) The bracing demand in bracing units/m given by Table 4.2 for wind multiplied by the maximum horizontal dimension of the roof above the storey being considered measured at right angles to the wall bracing elements being considered.

C8.5.2

The total number given by Table 4.3 for earthquake bracing demand will be the same for each of the two directions that are to be considered in each storey. The total number given by Table 4.2 for wind bracing demand will be different for the two directions (except for square buildings).

8.5.3

The total bracing capacity of all wall bracing panels in each of two directions at right angles to each other in any one storey shall be at least equal to the requirements of 4.3 and 4.4. Where in any building consisting of wings or blocks that are not at right angles to each other, this requirement shall be satisfied individually for each such wing or block. Where the limiting shape and size of diaphragms restrict their use in buildings consisting of wings or blocks then diaphragms shall be considered for each individual wing or block separately for the purposes of bracing.

8.6 Wall bracing elements in external walls not connected to a structural diaphragm

8.6.1

Each external wall not connected to a structural diaphragm and exceeding 2.4 m in length shall contain a total number of bracing units not less than that required for a 2 m wide tributary floor area or wall length for the storey being considered calculated as follows:

(a) For earthquake: The length of the wall in metres multiplied by the tributary floor width (2 m minimum) multiplied by the number of bracing units required in Table 4.3;

(b) For wind: The greatest width of either 2 m or half the spacing to the next parallel bracing line multiplied by the number of bracing units from Table 4.2.

C8.6.1

This clause requires a minimum bracing capacity equivalent to that needed to laterally support a floor or roof width of 2 m at any external wall.

The tributary floor width is half the distance between the adjacent bracing lines directly bearing on the wall or 2 m minimum.

8.6.2

For the purpose of 8.6.1 only, where offsets occur along the side of a building, the wall length shall be taken as the total length of all parallel external walls that are offset not more than 2 m from one another.

8.7 Wall bracing elements in internal walls on bracing lines

8.7.1

Bracing lines shall be parallel to external walls except as provided by 8.5.3.

8.7.2

Bracing lines in any storey shall not be set at centres greater than those shown in Table 8.4, provided that there need be no bracing lines within the area covered by a structural diaphragm complying with section 9 supported by walls complying with 8.8.

8.7.3

Bracing lines in each storey shall be considered separately but shall coincide with those of the storey below unless a concrete suspended floor is being used and that floor shall be specifically designed to cope with all loads resulting from the offset walls.

C8.7.3

Bracing walls on an upper storey may be shorter than the corresponding bracing walls on the storey below.

8.7.4

For the storey being considered, each internal wall not connected to a structural diaphragm and exceeding 3 m in length shall contain a total number of bracing units not less than:

(a) For earthquake: The length of the wall in metres multiplied by the tributary floor width (4 m minimum) multiplied by the number of bracing units required by Table 4.3;

(b) For wind: The greatest width of either 4 m or half the spacing to the next parallel bracing line multiplied by the number of bracing units from Table 4.2.

C8.7.4

This clause defines the minimum width of floor to be laterally supported by any one bracing line.

8.7.5

Each bracing line shall contain either or both of the following:

(a) Wall bracing panels in structural walls on the bracing line;

(b) Pairs of wall bracing panels in structural walls parallel to the bracing line such that one wall bracing element is on each side of the bracing line and each wall bracing element is not more than 1 m from the bracing line.

8.7.6

Walls of length less than 12 times their nominal thickness may be laterally supported at one end only.

8.8 Structural diaphragms

8.8.1

A structural diaphragm system with masonry walls to resist horizontal loads shall be directly supported by the masonry walls in the storey being considered and shall be:

(a) A combination of a floor diaphragm complying with 9.3 and a ceiling diaphragm complying with 9.2;

(b) A floor diaphragm complying with 9.3; or

(c) Where a bracing line system has been used to first storey only, a ceiling diaphragm complying with 9.2.

8.8.2

Except as provided in 8.8.4, the structural walls along each edge of the diaphragm and parallel to the direction of the loading being considered shall contain not less than 60% of the total number of bracing units required for the storey or part storey covered by the diaphragm.

C8.8.2

This provision has been included to strengthen outer walls against torsionally induced seismic forces.

8.8.3

Where two diaphragms are connected to a common wall, as shown in Figure 8.4, then the maximum bracing value of that wall shall be not less than 40% of the sum of the requirements of the two diaphragms.

C8.8.3

Two diaphragms can be connected to one common wall or in the case of an L-shape building which can be broken into two diaphragms, the re-entry wall can support two diaphragms.

Table 8.4 – Maximum spacing for bracing lines (see 8.7.2)

Storey height up to 2.6 m(1)	Construction type Wall series	Maximum spacing in m (Bracing lines) Earthquake zones			
		1	2	3	4
Single-storey Partially filled	15	8.0	7.2	6.1	5.3
	20	9.0	8.11	7.6	6.6
	25	9.0	9.0	8.8	7.8
	15 + 100 mm veneer	7.6	6.7	5.2	4.5
	20 + 100 mm veneer	8.0	7.2	6.4	5.6
Single-storey Solid filled	15	8.0	7.2	5.7	5.0
	20	9.0	7.7	6.4	5.6
	25	9.0	8.1	7.6	6.6
	15 + 100 mm veneer	7.5	6.3	5.0	4.4
	20 + 100 mm veneer	7.7	6.8	5.9	5.1
Two-storey Partially filled	15	7.0	6.0	4.7	4.1
	20	8.0 (2)	7.2	5.9	5.1
	25	8.0	8.0	6.7	5.9
	15 + 100 mm veneer	5.9	4.9	4.0	3.5
	20 + 100 mm veneer	7.2	6.3	5.0	4.4
Two-storey Solid filled	15	6.6	5.4	4.4	3.8
	20	7.2	6.3	5.0	4.4
	25	8.0	7.2	5.9	5.1
	15 + 100 mm veneer	5.7	4.75	3.2	3.2
	20 + 100 mm veneer	6.6	5.6	4.4	3.8

NOTE –

(1) For a storey height greater than 2.6 m and less than 3.0 m the maximum spacings shall be reduced by 8%, that is the values in the table are to be multiplied by 0.92.

(2) A maximum spacing permitted is 8.0 m for two-storey and 9.0 m for single-storey.

(3) Where a permitted offset to 8.7.5 occurs, it shall not cause the bond beam span to exceed the maximum values in Table 10.1.

(4) Bond beam (Types B2 and B3) capacities are detailed in Table 10.1.

(5) Where it is found that required spans are greater than those given, specific engineering design using the diaphragm method may be appropriate.

(6) This table has been derived for a Site Subsoil Class of 'D' or 'E'. The spacing can be modified for other subsoil classes by multiplying the values in the table by the appropriate factor given opposite.

Site Subsoil Class A	1.26
Site Subsoil Class B	1.26
Site Subsoil Class C	1.13

8.8.4

Walls supporting one edge of a diaphragm and parallel to the direction of loading being considered shall not contain less than 30% of the total number of bracing units (see Figure 8.5) required for the storey or part storey covered by the diaphragm, provided that:

(a) The opposite wall contains at least 100% of the total number of bracing units required by the diaphragm for loading parallel to these walls; and

(b) The adjacent perpendicular walls supporting each of the other edges of the diaphragm each contain at least 60% of the total number of bracing units required in (a), or if this is not possible that these walls be reinforced with D16 bars instead of D12 bars, at the same spacings required by Tables 8.2 and 8.3.

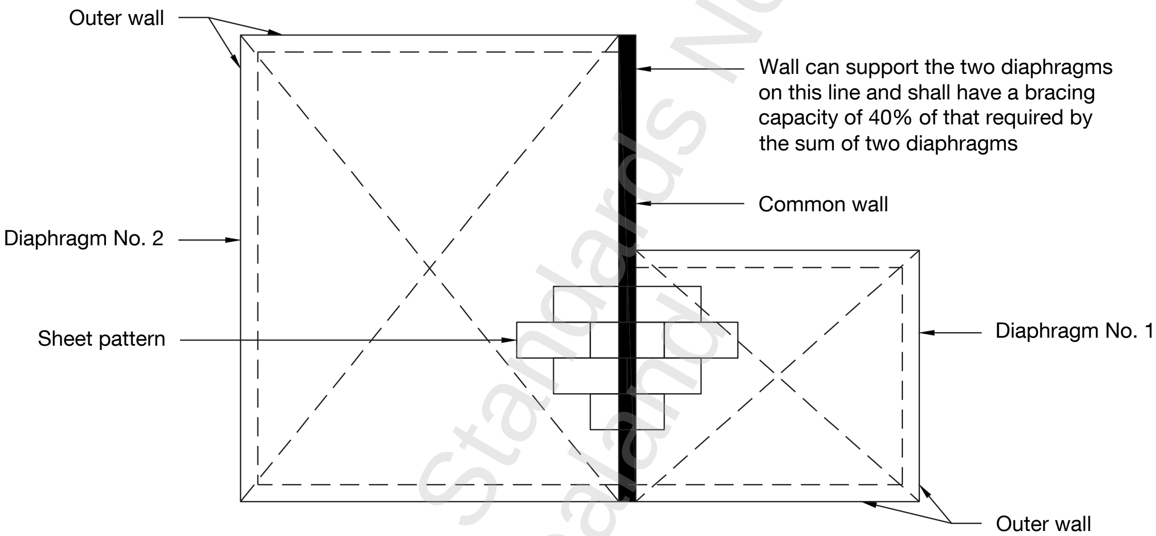
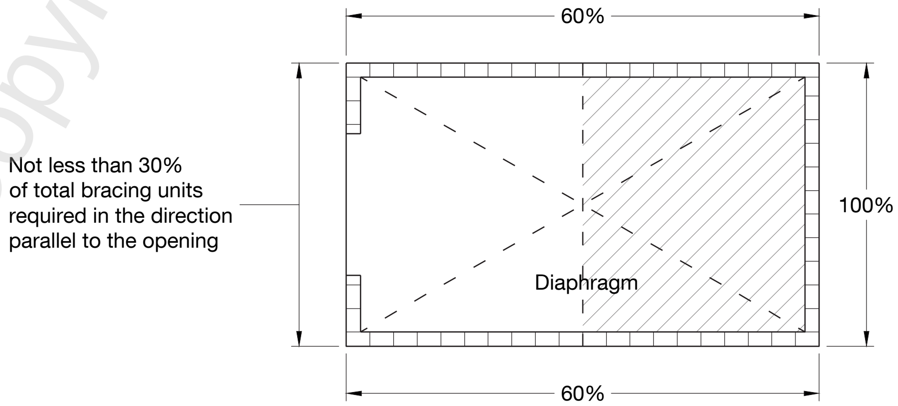


Figure 8.4 – Two diaphragms braced by a common wall (see 8.8.3)



NOTE – Nail centres to hatched half of diaphragm to be reduced to 1/2 the nail spacing required by Table 9.2.

Figure 8.5 – One wall containing 30% of total bracing units (see 8.8.4)

9 DIAPHRAGMS

9.1 General

9.1.1

All structural diaphragms supporting masonry walls against horizontal forces shall be constructed in accordance with this section, except that in all Soil Classes in Earthquake Zone 4, and Soil Classes D and E in Earthquake Zone 3, the diaphragms and their connections shall be specifically designed.

Diaphragms shall be constructed as follows:

(a) Timber and plasterboard diaphragms: clauses 9.1.2 to 9.3.4 for all horizontal loading conditions including for loads arising from cavity wall construction, that is, two leaves of masonry 100 mm + 150 mm or 100 + 200 mm;

(b) Concrete diaphragm: clause 9.4.

9.1.2

Timber and plasterboard structural diaphragms complying with 9.2 and 9.3 shall in addition be constructed as follows (see Figures 8.3 and 9.1):

(a) Diaphragm or part of a diaphragm shall have a length not exceeding 2 times its width except when the diaphragm is supporting a solid-filled 200 mm or 250 mm wall, when the length shall not exceed 1.5 times its width;

(b) The length and width of a diaphragm as referred to in (a) shall be between supporting walls at right angles to each other;

(c) The floor decking shall consist of a sheet flooring material complying with 9.3.2 over the entire area of the diaphragm;

(d) The minimum sheet size shall be 2400 mm x 1200 mm except where the building dimensions prevent the use of a complete sheet;

(e) Each sheet shall be fastened along each edge to boundary members with nails at the centres specified in 9.2 and 9.3 and shall also be fastened to every intermediate framing member at 300 mm centres. Joints in sheet material shall be made over supports. Timbers measuring 100 mm x 50 mm fixed between joists with their top surfaces set to a common level shall be provided as necessary for this purpose;

(f) Fastenings shall be not less than 10 mm from sheet edges.

C9.1.2

This clause requires more stringent requirements for structural diaphragms than those provided in NZS 3604 for supporting masonry foundation walls where the upper storeys are constructed of light timber frame.

9.2 Roof and ceiling diaphragms

C9.2

This clause refers to the slope (if any) of the ceiling, not the roof. However, sloping ceilings are generally at the same slope as the roof above.

Where for special reasons a ceiling diaphragm system is required at a steeper pitch, specific engineering design is required.

9.2.1

Roof and sloping ceiling diaphragms shall not be of greater dimensions nor steeper than as provided in 9.2.2 or 9.2.3.

9.2.2

Roof and sloping ceiling diaphragms not steeper than 25° to the horizontal and not exceeding 16 m long under light or heavy roofs shall be one of:

(a) Plywood not less than 6 mm thick three-ply;

(b) Any other wood-based product not less than 4.5 mm thick having a density not less than 880 kg/m^3;

(c) Any other wood-based product not less than 6 mm thick having a density not less than 600 kg/m^3; or

(d) High density plasterboard lining not less than 9.5 mm thick and having a density of not less than 880 kg/m^3 and be nail fixed in accordance with Table 9.1.

Plywood shall be H3 treated where used in situations where it is likely to become wet in service. The durability of wood-based products shall be demonstrated to the satisfaction of the building consent authority.

C9.2.2

Where ceiling or roof diaphragms exceed this dimension they become the subject of specific engineering design.

Clause 2.1.6 refers users to NZS 3604 for the specification of timber and wood-based products.

9.2.3

Roof and ceiling diaphragms steeper than 25° to the horizontal shall be the subject of specific engineering design.

9.2.4

Horizontal ceiling diaphragms not exceeding 16 m long under light or heavy roofs shall comply with 9.2.2.

9.2.5

Nail fixing shall comply with Table 9.1.

> ***C9.2.5***
>
> *For equivalency of power-driven nails refer to NZS 3604.*

All dimensions are in mm unless otherwise shown.

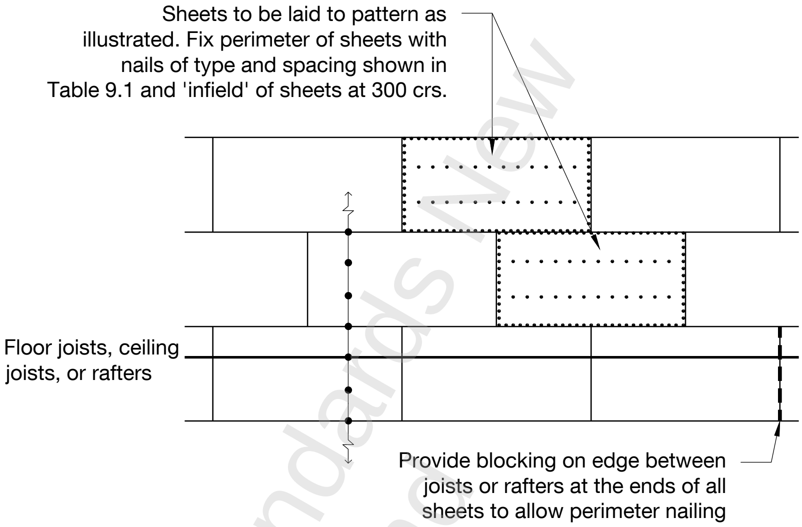


Figure 9.1 – Diaphragm construction (see 9.1.2)

Table 9.1 – Nail fixing for ceiling and roof diaphragms (see 9.2.5)

Masonry wall series	Storey height		Max. length/ width ratio
	Up to 2.6 (m)	> 2.6 to 3.0 (m)	
	Nail dia. x centres	Nail dia. x centres	
15 P	2.5 x 150	2.5 x 150	2
15 S	2.5 x 150	2.5 x 150	2
20 P	2.5 x 150	2.5 x 150	2
20 S	2.5 x 150	2.5 x 100	2
or 15 P + 100 veneer		2.5 x 150	1.5
25 P	2.5 x 150	2.5 x 150	2
25 S	2.5 x 150		1.5
or 15 S + 100 veneer	2.5 x 150	2.5 x 100	2
or 20 P + 100 veneer			
20 S + 100 veneer	2.5 x 100	2.5 x 100	2

NOTE –

(1) ‘P’ means partially filled and ‘S’ means solid-filled.

(2) Interior fixings of the sheet material to be nailed at 300 mm centres.

(3) When using the special conditions permitted by 8.8.4, the nailing centres shall be required to be halved on half the diaphragm area adjoining the wall required to carry 100% of the bracing demand.

(4) Minimum length of nails shall be 30 mm or 2.5 times the thickness of the diaphragm sheets, whichever is greater.

9.2.6 Connection of roof and ceiling diaphragms to masonry walls

9.2.6.1

Roof and ceiling diaphragms shall be connected to either a horizontal bond beam at eaves level or a sloping bond beam at the top of a sloping gable end wall.

9.2.6.2

Roof or ceiling diaphragms shall be connected to a bond beam as shown in Figures 9.2, 9.3, and 9.4.

C9.2.6

Closed coupled roofs are not detailed in Figures 9.2 to 9.4 because it is considered that specific engineering design is required for using such roofs as diaphragms.

9.3 Timber floor diaphragms

9.3.1

The maximum dimension of any timber floor diaphragm shall be 16 m.

C9.3.1

Where timber diaphragms are in excess of this dimension they become the subject of specific engineering design.

9.3.2

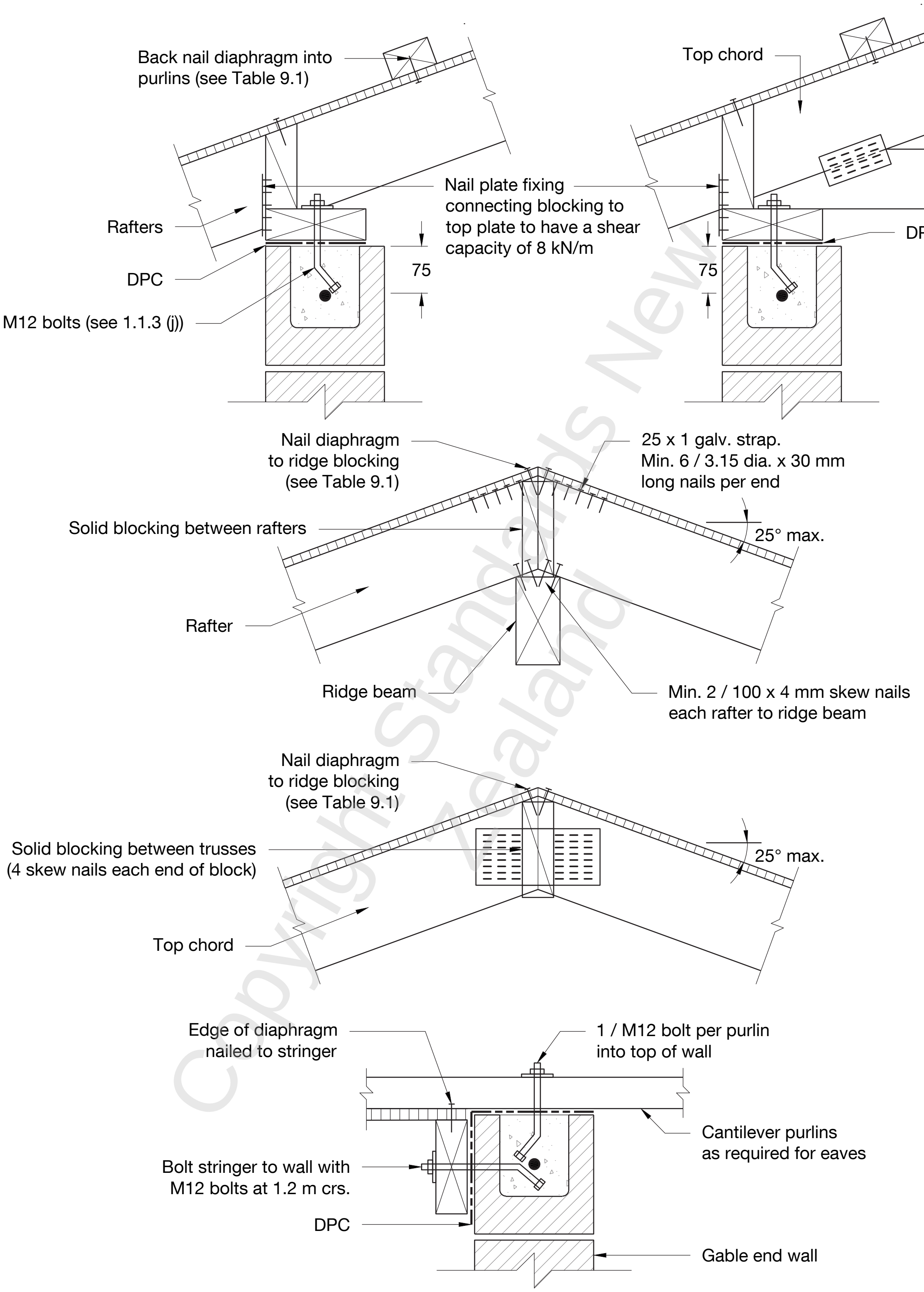
Sheet material shall be:

(a) Plywood not less than 18 mm in thickness; or

(b) Any other wood-based product not less than 18 mm thick having a density of not less than 600 kg/m^3.

All plywood shall be H3 treated when used in situations where it is likely to become wet in service. The durability of wood-based products shall be demonstrated to the satisfaction of the building consent authority.

All dimensions are in mm unless otherwise shown.



NOTE –

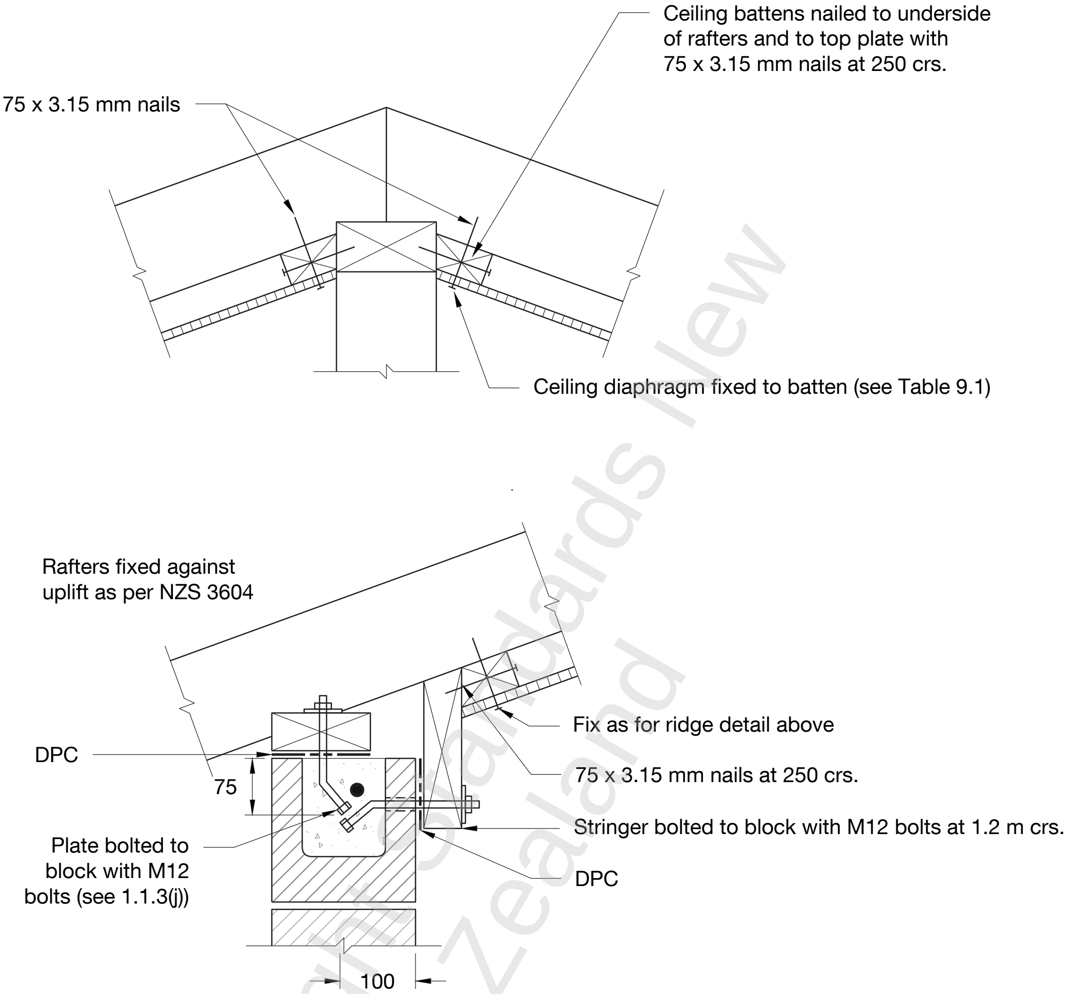
(1) Minimum embedment length of all M12 bolts shall be 75 mm.

(2) The length of the bolt is determined by the thickness of the members to be attached.

(3) Use mild steel galvanised washers, 50 mm x 50 mm x 3 mm between bolt head and timber member.

Figure 9.2 – Roof diaphragms (see 9.2.6.2)

All dimensions are in mm unless otherwise shown.



NOTE –

(1) Minimum embedment length of all M12 bolts shall be 75 mm.

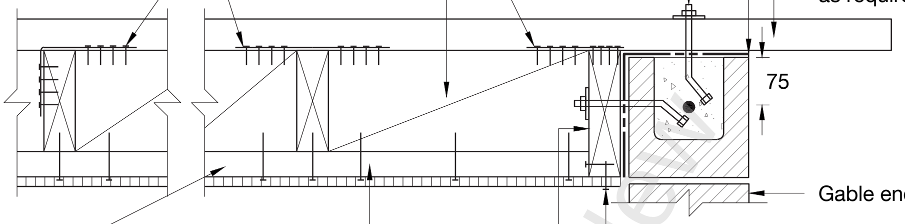
(2) The length of the bolt is determined by the thickness of the members to be attached.

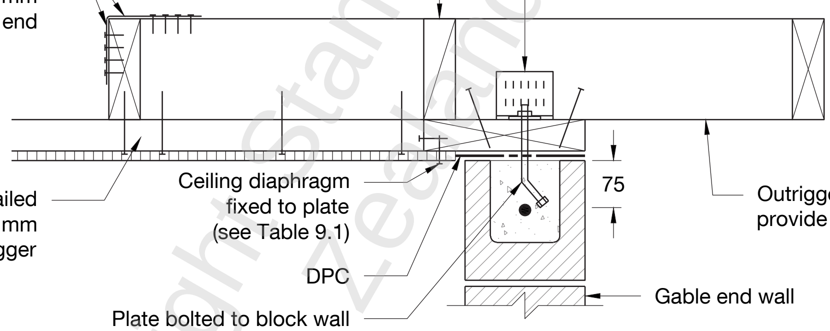
(3) Use mild steel galvanised washers, 50 mm x 50 mm x 3 mm between bolt head and timber member.

(4) In the case of a battened ceiling with high density plasterboard ceiling lining, pack between plasterboard and rafters at not more than 1.2 m crs. for a slope distance of 1.2 m from the walls and ridge. Nail packing to rafter with 3/100 mm x 3.75 mm nails between battens. Nail ceiling to packing at 150 crs. except as required by Table 9.1.

Figure 9.3 – Sloping ceiling diaphragms – Sheet material on battened rafters (see 9.2.6.2)

All dimensions are in mm unless otherwise shown.





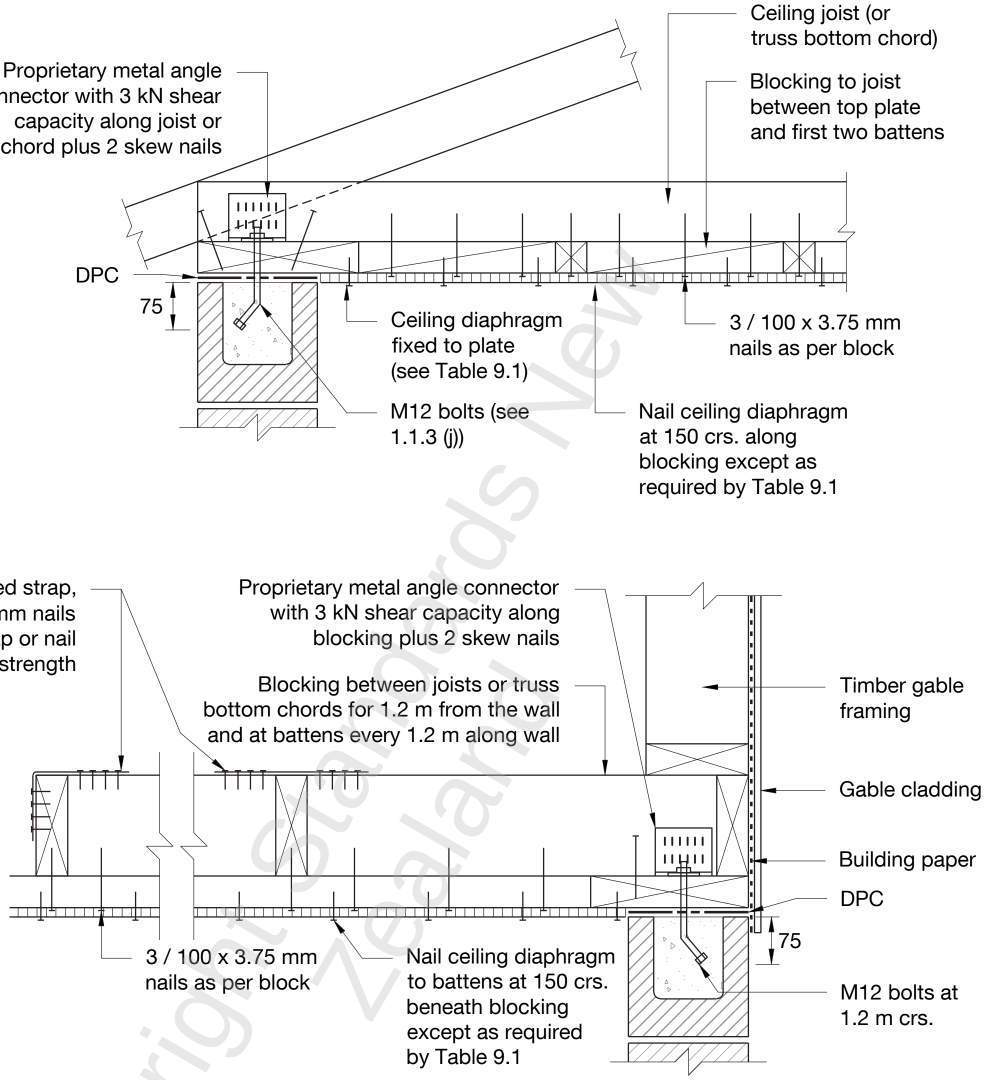
NOTE –

(1) Minimum embedment length of all M12 bolts shall be 75 mm.

(2) The length of the bolt is determined by the thickness of the members to be attached.

(3) Use mild steel galvanised washers, 50 mm x 50 mm x 3 mm between bolt head and timber member.

Figure 9.3 – Sloping ceiling diaphragms – Sheet material on battened rafters (continued) (see 9.2.6.2)



NOTE –

(1) Minimum embedment length of all M12 bolts shall be 75 mm.

(2) The length of the bolt is determined by the thickness of the members to be attached.

(3) Use mild steel galvanised washers, 50 mm x 50 mm x 3 mm between bolt head and timber member.

Figure 9.4 – Horizontal ceiling diaphragms (see 9.2.6.2)

9.3.3

Nail fixing shall comply with Table 9.2 and Figure 9.1.

C9.3.3

For equivalency of power-driven nails refer to NZS 3604.

9.3.4 Connection of timber floor diaphragms to masonry walls

9.3.4.1

All floor timber diaphragms shall be provided with a boundary joist of dimensions not less than the attached joists.

9.3.4.2

Where a floor diaphragm is fixed to the face of structural walls it shall be bolted and anchored to the wall as detailed in Figure 9.5(a), (b), and (c).

9.3.4.3

Where a floor diaphragm is supported on top of a structural wall a continuous timber plate shall be bolted to the top of the wall to which the boundary joists shall be fixed. Connection of floor diaphragms to the tops of walls shall be as detailed in Figure 9.5(d), (e), and (f).

Table 9.2 – Nail fixing for floor diaphragm (see 9.3.3)

Masonry wall series	Storey height		Max. length/ width ratio
	Up to 2.6 (m)	> 2.6 to 3.0 (m)	
	Nail dia. x centres	Nail dia. x centres	
15 P	2.8 x 150	2.8 x 150	2
15 S	2.8 x 150	2.8 x 100 3.15 x 150	2
20 P	2.8 x 100 3.15 x 150	2.8 x 100 3.15 x 150	2
20 S or 15 P + 100 veneer	2.8 x 100 3.15 x 150	2.8 x 100 3.15 x 150	1.5
25 P	2.8 x 100 3.55 x 150	2.8 x 100 3.55 x 150	2
25 S or 15 S + 100 veneer	3.15 x 100	3.55 x 100	2
or 20 P + 100 veneer	2.8 x 100	3.15 x 100	1.5
20 S + 100 veneer	2.8 x 100	3.15 x 100	1.5

NOTE –

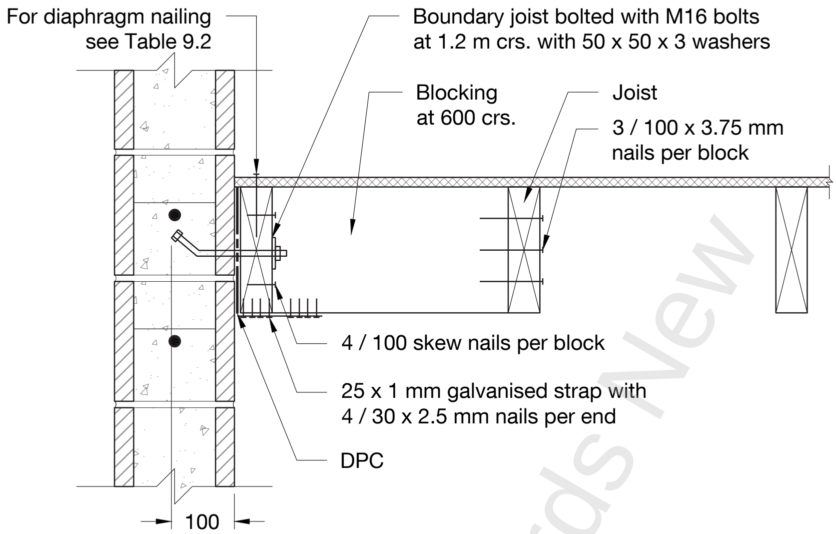
(1) 'P' means partially filled and 'S' means solid-filled.

(2) Interior fixings of the sheet material to be nailed at 300 mm centres.

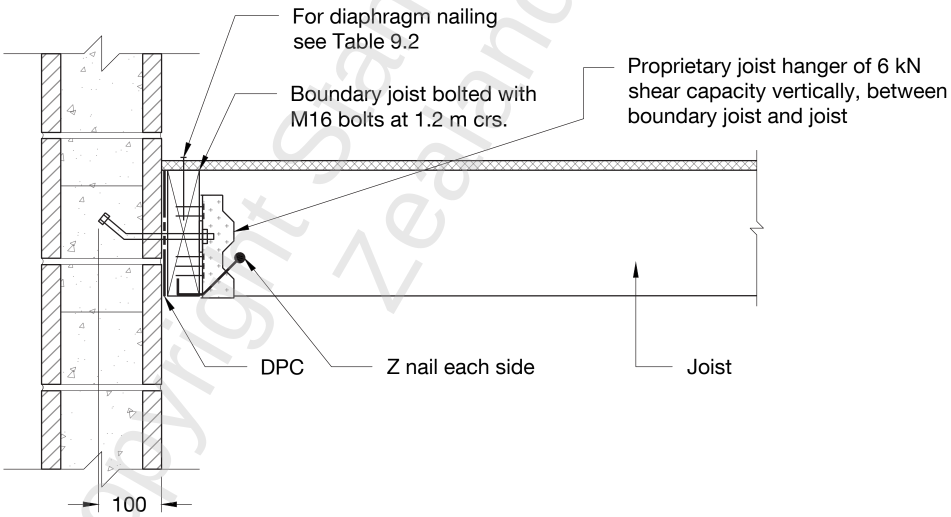
(3) When using the special conditions permitted by 8.8.4, the nailing centres shall be required to be halved on half the diaphragm area adjoining the wall required to carry 100% of the bracing demand.

(4) Minimum length of nails shall be 60 mm or 2.5 times the thickness of the diaphragm sheets, whichever is greater.

All dimensions are in mm unless otherwise shown.



(a) Joists parallel to wall



(b) Joists normal to wall

NOTE –

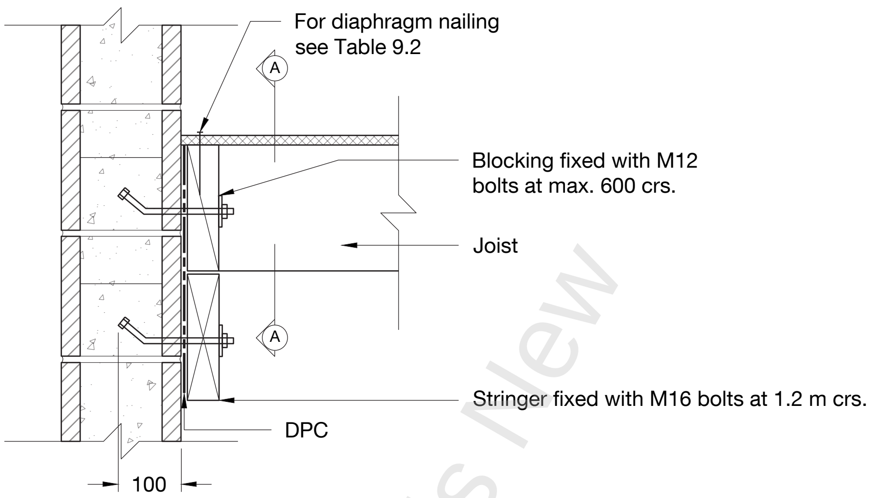
(1) Minimum embedment length of all M12 bolts shall be 75 mm.

(2) The length of the bolt is determined by the thickness of the members to be attached.

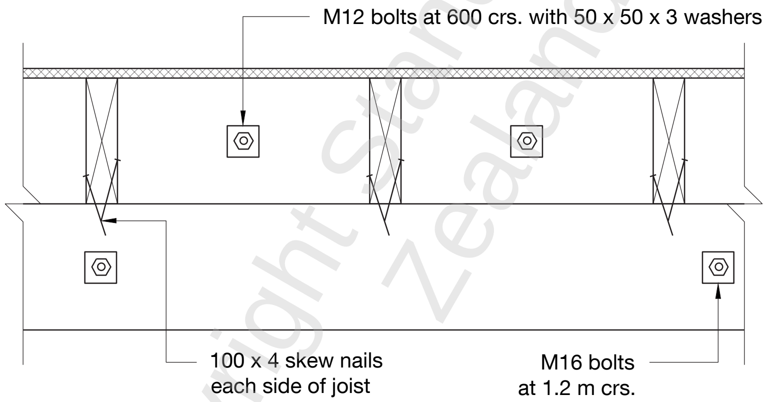
(3) Use mild steel galvanised washers, 50 mm x 50 mm x 3 mm between bolt head and timber member.

Figure 9.5 – Timber floor diaphragms connections (see 9.3.4.2)

All dimensions are in mm unless otherwise shown.



(c) Joists normal to wall



Section A - A

NOTE –

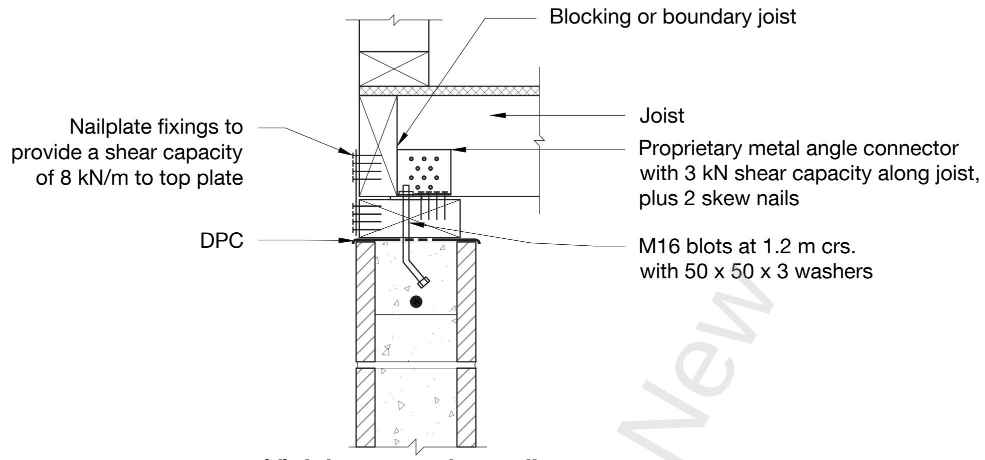
(1) Minimum embedment length of all M12 bolts shall be 75 mm.

(2) The length of the bolt is determined by the thickness of the members to be attached.

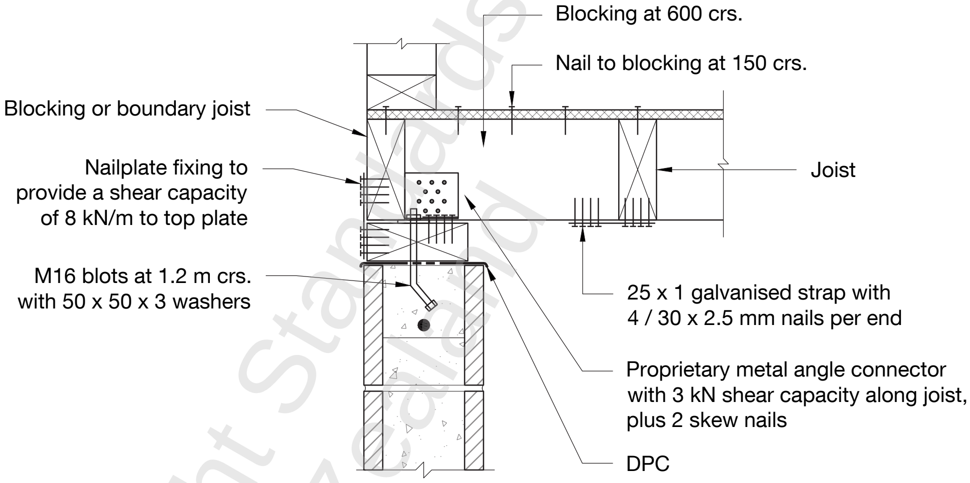
(3) Use mild steel galvanised washers, 50 mm x 50 mm x 3 mm between bolt head and timber member.

Figure 9.5 – Timber floor diaphragms connections (continued) (see 9.3.4.2)

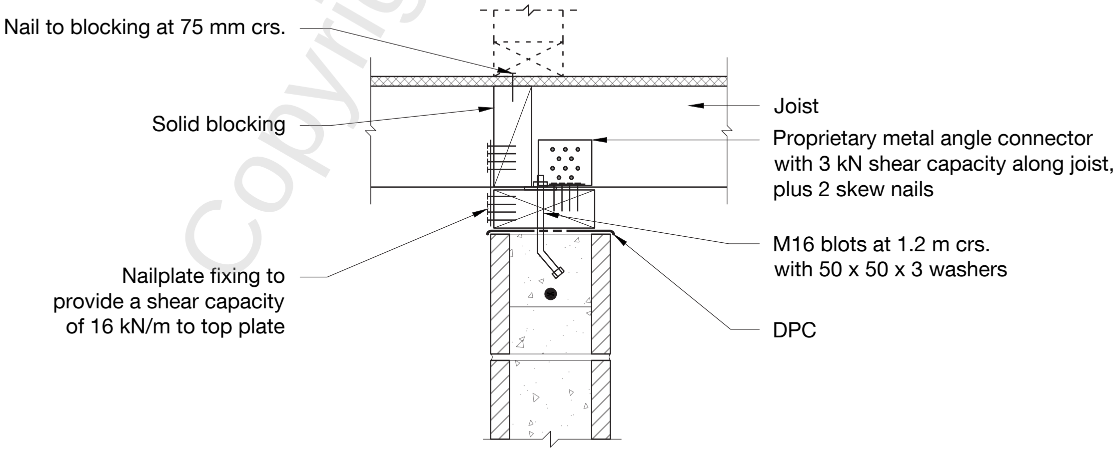
All dimensions are in mm unless otherwise shown.



(d) Joists normal to wall



(e) Joists parallel to wall



(f) Joists normal to wall

NOTE –

(1) Minimum embedment length of all M12 bolts shall be 75 mm.

(2) The length of the bolt is determined by the thickness of the members to be attached.

(3) Use mild steel galvanised washers, 50 mm x 50 mm x 3 mm between bolt head and timber member.

Figure 9.5 – Timber floor diaphragms connections (continued) (see 9.3.4.3)

9.4 Concrete diaphragms

9.4.1

Concrete structural diaphragms shall be constructed as follows:

(a) A diaphragm or part of a diaphragm shall have a length not exceeding 3.0 times its width;

(b) The length and width of a diaphragm as referred to in (a) shall be between supporting walls at right angles to each other;

(c) The concrete floor or in situ topping over a precast concrete floor system shall include a minimum amount of steel mesh reinforcement of 2.27 kg/m^2 Grade 500 E;

> ***C9.4.1(c)***
>
> *Additional reinforcement may be required by the proprietary floor supply for the purposes of shrinkage control.*

(d) The concrete floor or in situ topping shall be connected to the supporting bracing walls by D16 bars at 800 mm as shown in Figure 9.6.

9.4.2

The design of the concrete floor to meet strength and serviceability criteria for resisting gravity loads is outside the scope of this Standard.

> ***C9.4.2***
>
> *Concrete floors designed to NZS 3101 and AS/NZS 1170 are acceptable. Other designs will need to demonstrate compliance with the New Zealand Building Code to the satisfaction of the building consent authority.*

9.5 Openings in diaphragms

9.5.1 Timber

9.5.1.1

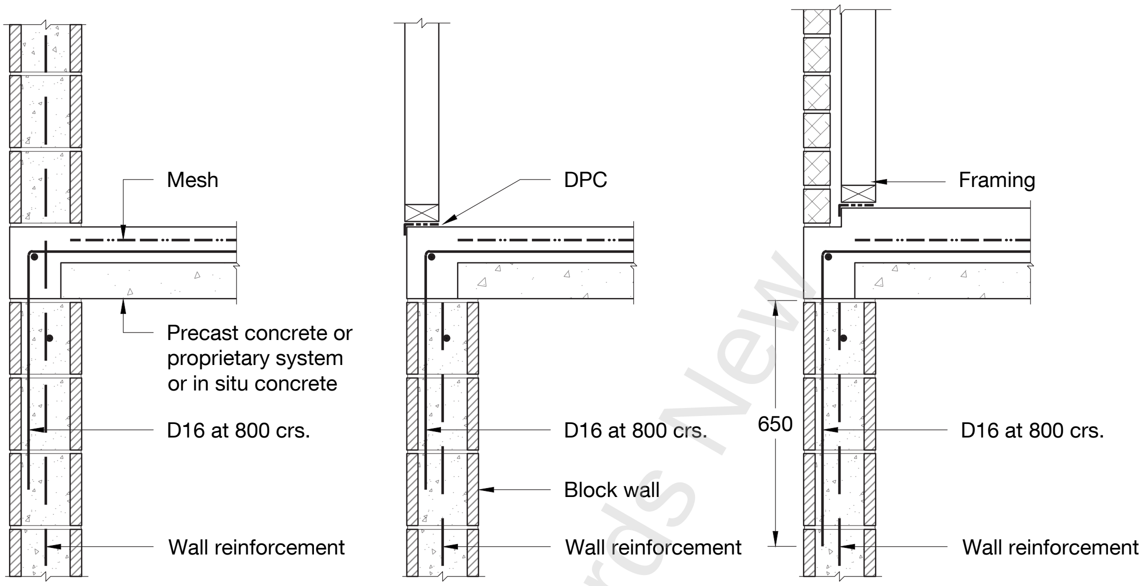
Openings in diaphragms shall be trimmed with continuous boundary members on all sides of openings. Boundary members shall be as specified below:

(a) The bond beam on adjoining structural walls where the sides of the opening are supported on masonry;

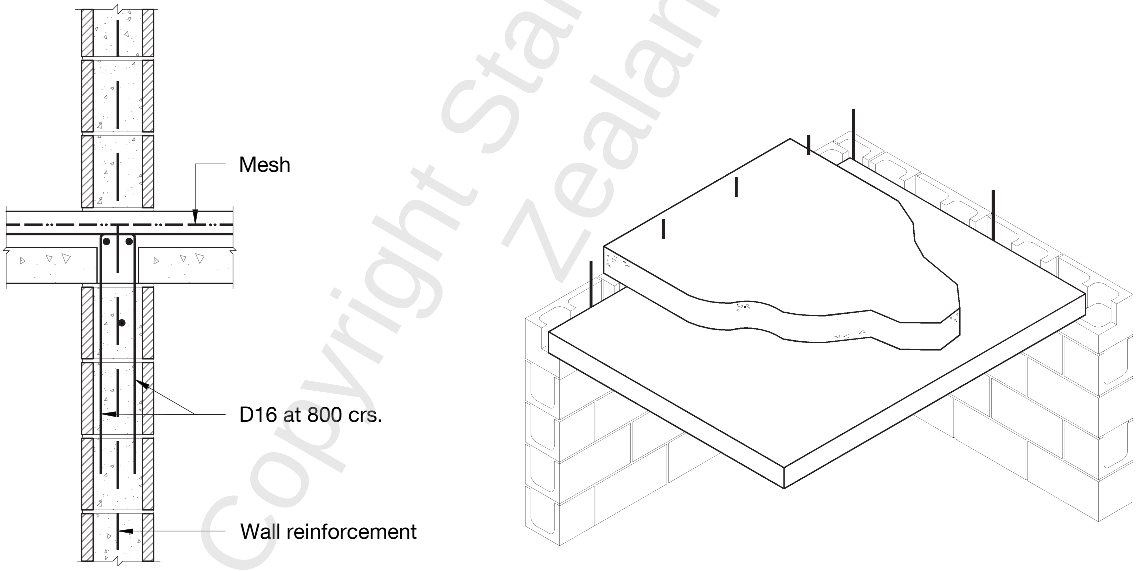
(b) Trimmer and trimming joists as required by 7.1.6 of NZS 3604 for openings in floors;

(c) Rafters and trimming rafters as required by 13.3 of NZS 3604 for openings in roofs or ceilings.

All dimensions are in mm unless otherwise shown.



(a) Concrete block **(b) Timber frame** **(c) Masonry veneer**



(d) Masonry two-storey

Figure 9.6 – Concrete floor diaphragm details (see 9.4.1)

9.5.1.2

Except as provided in 9.5.1.3, the dimensions of any single opening in a diaphragm in each of the 2 principal directions at right angles shall not exceed the following percentages of the respective parallel overall dimensions of the diaphragm:

(a) Where the opening is located wholly within the middle half area of the diaphragm as defined in Figure 9.7 .... 40%;

(b) Where the opening is located other than wholly within the middle half area of the diaphragm .... 20%.

In addition the sum of the areas of all openings in a diaphragm shall not exceed the following percentages of the total area of the diaphragm (inclusive of openings):

(c) Where all the openings are located wholly within the middle half area of the diaphragm 16%;

(d) Where any opening is located other than wholly within the middle half area of the diaphragm .... 4%.

9.5.1.3

Diaphragms with openings which do not comply with 9.5.1.2 shall be subject to specific engineering design.

9.5.2 Concrete

The provision of openings in a concrete diaphragm shall require specific engineering design.

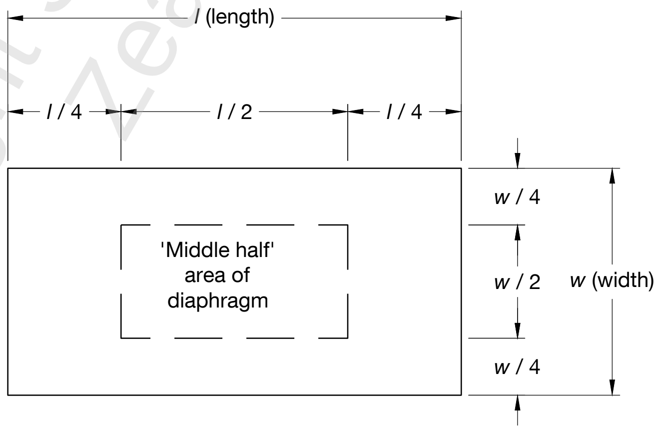


Figure 9.7 – Location of openings in diaphragm (see 9.5.1.2(a))

10 BOND BEAMS

10.1 General

10.1.1

All masonry walls shall be provided with bond beams at top courses and connections with floors, ceilings, and roofs in order to:

(a) Transfer lateral loads by spanning between adjacent transverse structural walls or other specifically designed lateral supporting structures;

(b) Provide anchorage of floor and roof members;

(c) Tie the masonry walls together;

(d) Provide a continuous boundary member to structural diaphragms.

10.1.2

Bond beams shall be constructed of reinforced masonry. The beam width shall be not less than the wall thickness.

10.2 Bracing line support systems

10.2.1

For bracing line support systems continuous bond beams shall be provided at the tops of all walls and at floor levels. Dimensions and steel layout shall be as shown in Table 10.1 and Figure 10.1.

10.2.2

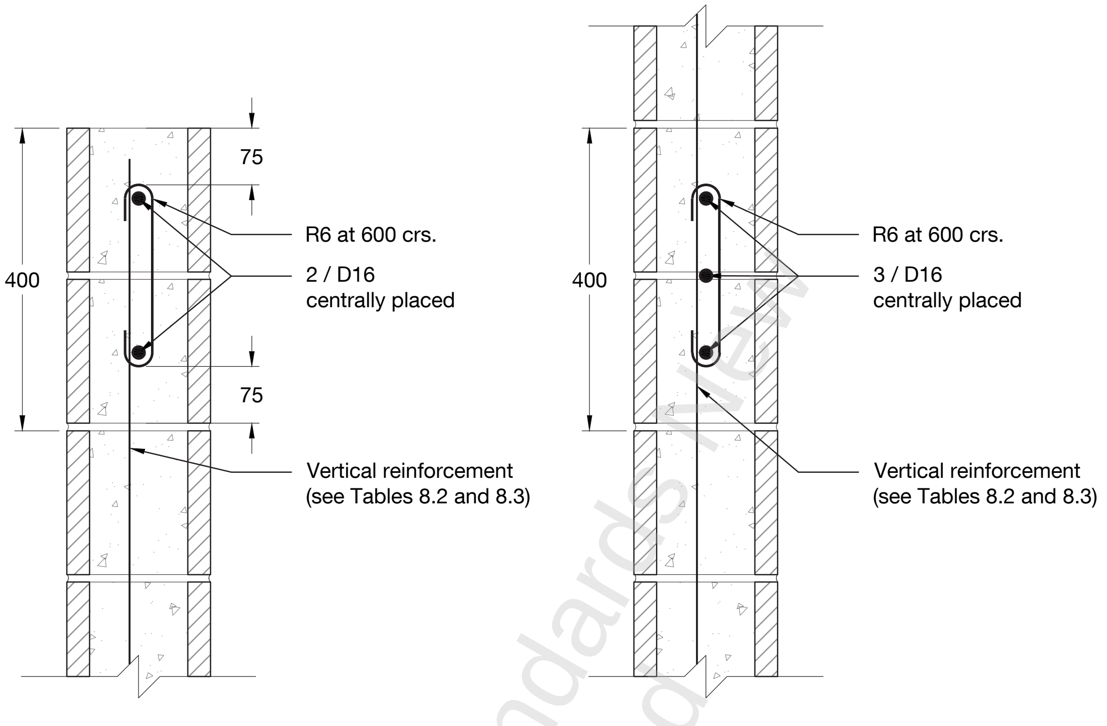
For wall heights 800 mm and less, a single D16 trimming bar shall be used in the top course of blockwork.

> ***C10.2.2***
>
> *This clause relaxes the bond beam requirements for low-rise walls such as parapets.*

10.2.3

Where bracing line construction is adopted, the roof structure shall be fixed to the bond beams which comply with Figure 10.1.

All dimensions are in mm unless otherwise shown.



(a) Type B2 bond beam
(see Table 10.1)

(b) Type B3 bond beam
(see Table 10.1)

Figure 10.1 – Bond beam details – Bracing line system (see 10.2.1)

Table 10.1 – Bond beam – Maximum spans (see 10.2.1)

Bond beam type	Storey height up to 2.6 m(1)	Construction type Wall series	Maximum spacing in m (Bracing lines) Earthquake zones 1	2	3	4
B2 See Figure 10.1	Single-storey Partially filled	15	8.0	7.2	6.1	5.3
		20	9.0	8.1	7.6	6.6
		25	9.0	9.0	8.8	7.8
		15 + 100 mm veneer	7.6	6.7	5.2	4.5
		20 + 100 mm veneer	8.0	7.2	6.4	5.6
	Single-storey Solid filled	15	8.0	7.2	5.7	5.0
		20	9.0	7.7	6.4	5.6
		25	9.0	8.1	7.6	6.6
		15 + 100 mm veneer	7.2	6.3	5.0	4.4
		20 + 100 mm veneer	7.7	6.8	5.9	5.1
B3 See Figure 10.1	Two-storey Partially filled	15	7.0	6.0	4.7	4.1
		20	8.0	7.2	5.9	5.1
		25	8.0	8.0	6.7	5.9
		15 + 100 mm veneer	5.9	4.9	4.0	3.5
		20 + 100 mm veneer	7.2	6.3	5.0	4.4
	Two-storey Solid filled	15	6.6	5.4	4.4	3.8
		20	7.2	6.3	5.0	4.4
		25	8.0	7.2	5.9	5.1
		15 + 100 mm veneer	5.7	4.7	3.7	3.2
		20 + 100 mm veneer	6.6	5.6	4.4	3.8

NOTE –

(1) For storey height greater than 2.6 m and less than 3.0 m the maximum spans shall be reduced by 8%, that is the values in the table to be multiplied by 0.92.

(2) Where a permitted offset to 8.7.5 occurs, it shall not cause the bond beam to exceed these maximum span values.

(3) Bond beam span is measured between the centre lines of the supporting bracing walls.

(4) There are maximum span limitations of 9.0 m in single-storey and 8.0 m in two-storey buildings.

(5) This table has been derived for a Site Subsoil Class of 'D' or 'E'. The span can be modified for other subsoil classes by multiplying the values in the table by the appropriate factor given opposite.

Site Subsoil Class A	1.26
Site Subsoil Class B	1.26
Site Subsoil Class C	1.13

10.3 Structural diaphragm systems

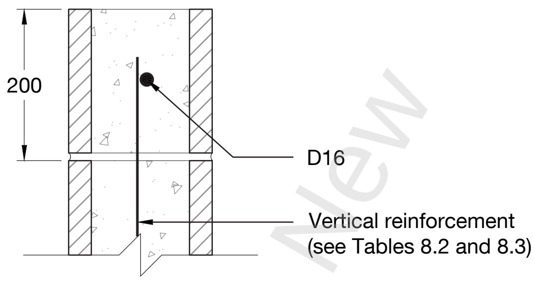
10.3.1

Bond beams shall be provided as a continuous boundary member for all structural diaphragms and shall be reinforced with at least 1/D16 bar.

10.3.2

The depth of bond beams for use with structural diaphragms shall not be less than 200 mm as per Figure 10.2. Two/D12 reinforcing bars may be substituted for 1/D16 reinforcing bar.

All dimensions are in mm unless otherwise shown.



Type B1 bond beam

NOTE – See 10.3.

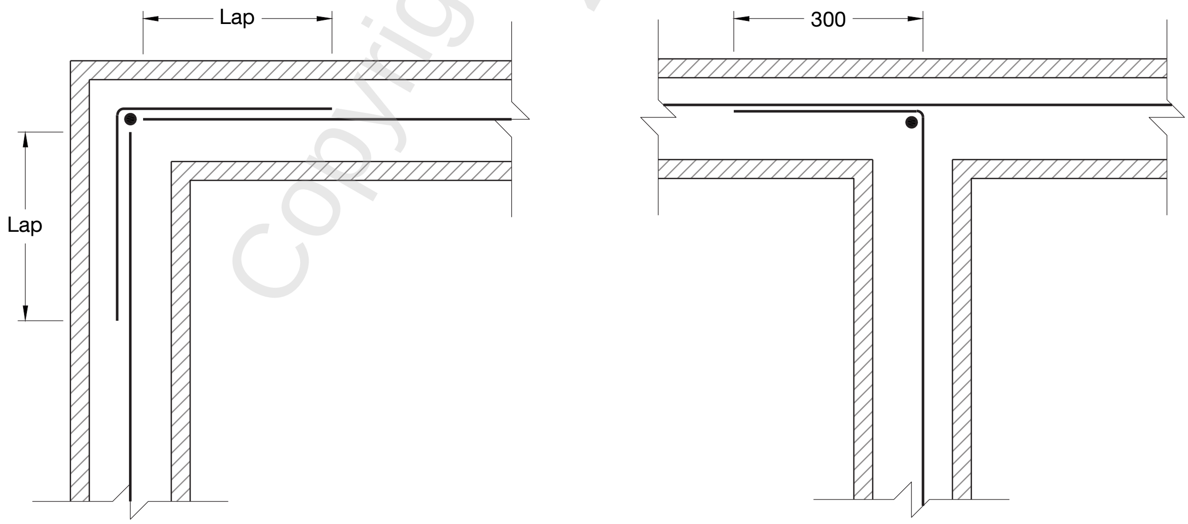
Figure 10.2 – Bond beam details – Diaphragm system (see 10.3.2)

10.4 Intersection of bond beams

10.4.1

The intersection of bond beams shall be as detailed in Figure 10.3.

All dimensions are in mm unless otherwise shown.



NOTE –

(1) Laps are in accordance with 8.1.5.

(2) For 4 bar bond beams see Figure 6.8 for lapping requirements.

Figure 10.3 – Bond beam intersections (see 10.4.1)

10.5 Gable-shaped walls

10.5.1

A raking bond beam Type B2 shall be provided at the top of every gable-shaped wall and shall be connected to and continuous with other adjoining bond beams.

10.5.2

The size of raking bond beams shall be determined from Table 10.1 in accordance with the sloping distance between bracing lines.

10.5.3

An intermediate bond beam Type B3 shall be provided at the top of the wall immediately beneath the gable-shaped wall and be connected to, and continuous with adjoining bond beams.

11 LINTELS AND COLUMNS

11.1 General

11.1.1

Lintels shall be provided over all openings and shall be constructed of reinforced masonry.

C11.1.1

See also 8.3.5 and Figure 8.1.

11.1.2

The width of the lintel shall not be less than the total thickness of the supported wall.

11.1.3

Point loads on lintels are not covered by this Standard.

C11.1.3

Point loads occur when a load from a beam or column is not uniformly distributed over the entire span of the lintel. The most common type of point load is a steel beam supporting a timber floor which may become supported near the mid-span of a lintel. Since the design of the steel beam will require specific design the modification of the lintel design to carry the point load can be considered at this time.

Rafters or trusses landing on lintels are considered to be uniformly distributed loads.

11.1.4

Isolated single columns are not covered by this Standard except as provided for in 11.5.

11.2 Size and reinforcement of lintels

11.2.1

Lintels shall be reinforced in accordance with Tables 11.1 to 11.6.

C11.2.1

If a solution is not found in these tables then specific engineering design will be required. Lintel dimensions and span are usually determined from architectural considerations.

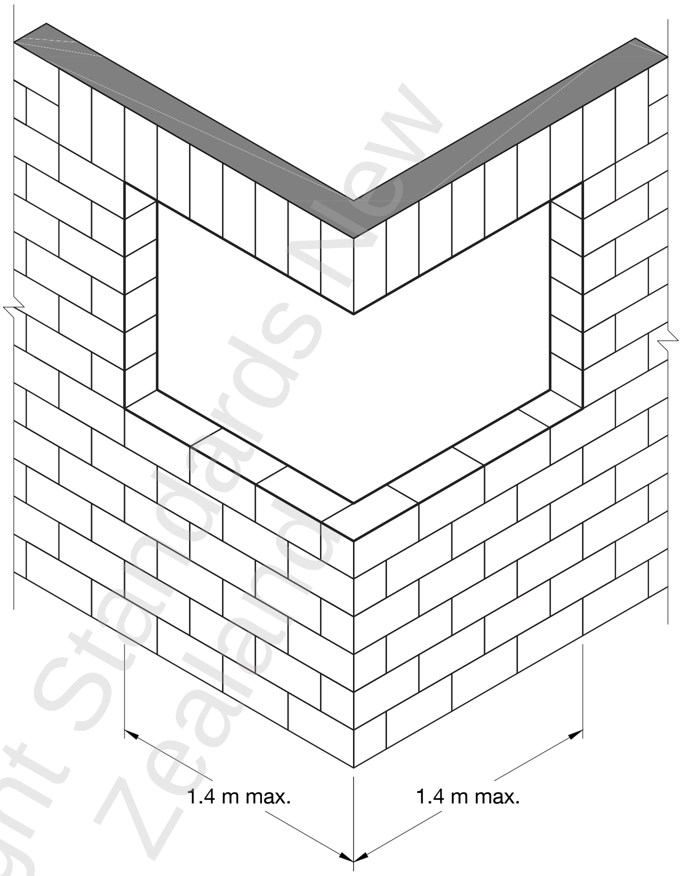
11.2.2

Determine the sum of the loads on the lintel from Table 6.1 (wall weight) and Figures 6.1 (roof load) and 6.2 (suspended floor load). This total load shall then be used to determine the steel required from Tables 11.1 to 11.6.

If the lintel is supporting loading from both sides (such as in an interior wall) both contributing weights shall be summed to determine the loading on the lintel.

11.2.3

Lintels around corners shall be a minimum of 390 mm deep and shall span no more than 1.4 m (see Figure 11.1). Loadings shall be from a roof load only. The span of the roof loading the lintel shall not exceed 12 m. Longitudinal reinforcing shall be 2/D16 bars with R6 shear reinforcement at 200 corners.



NOTE – See 11.2.3.

Figure 11.1 – Maximum lintel span at corner (see 11.2.3)

11.2.4

The location of reinforcement in lintels from Tables 11.1 to 11.6 shall be as follows:

(a) Where two bars are required in 190 mm deep lintels, they shall be placed one above the other as per Figure 11.2;

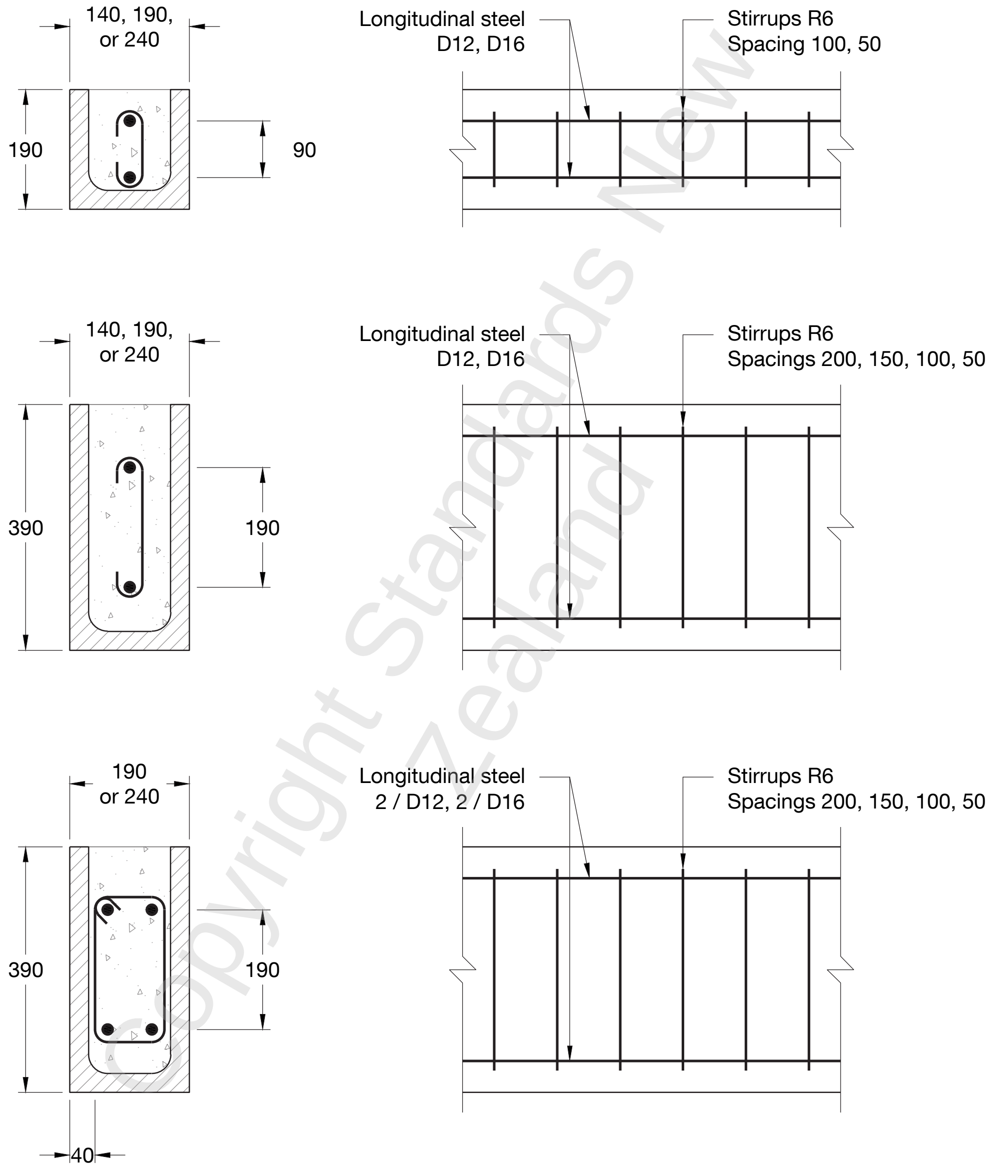
(b) Where two bars are required in 390 mm deep lintels, one bar shall be placed at the bottom and one at the top of the lintel.

> ***C11.2.4***
> *Figure 11.1 details the reinforcing layout for masonry lintels. Tables 11.1 to 11.6 specify the reinforcement requirements depending on load and span. Each cell in Tables 11.1 to 11.6 has two lines. The first line specifies the longitudinal reinforcement requirements. The second line details the shear steel (stirrups) spacing. All shear steel is R6 plain bar.*

11.3 Combination of lintels and bond beams

Where it is necessary to combine a lintel with a bond beam in a wall of a building, the reinforcement shall be continued across the combined member and shall be the maximum amount required by either the lintel or the bond beam.

All dimensions are in mm unless otherwise shown.



NOTE – For selection of steel see Tables 11.1, 11.2, 11.4, and 11.5.

Figure 11.2 – Lintel reinforcement layouts (see 11.2.4)

Table 11.1 – 190 mm deep lintels: 15 Series (see 11.2.1 and 11.2.2)

Load (kN/m)	15 Series 190 mm deep – Clear span (m)														
	0.6	1.0	1.4	1.8	2.2	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.8	6.2
2										2/D16 R6 @ 100	2/D16 R6 @ 100	2/D16 R6 @ 100	–	–	–
4								2/D16 R6 @ 100	2/D16 R6 @ 100	–	–	–	–	–	–
6		ALL 2/D12 R6 @ 100				2/D16 R6 @ 100	2/D16 R6 @ 100	–	–	–	–	–	–	–	–
8						2/D16 R6 @ 100	–	–	–	–	–	–	–	–	–
10					2/D16 R6 @ 100	–	–	–	–	–	–	–	–	–	–
12					2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–
14				2/D16 R6 @ 100	–	–	Beyond the scope of this Standard					–	–	–	–
16				2/D16 R6 @ 50	–	–						–	–	–	–
18				2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–
20			2/D12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
22			2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
24			2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
26		2/D12 R6 @ 50	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
28		2/D12 R6 @ 50	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
30		2/D12 R6 @ 50	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
32		2/D12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–	–
34		2/D12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–	–
36		2/D12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–	–

NOTE – R10 @ 100 mm can replace R6 @ 50 mm

Table 11.2 – 190 mm deep lintels: 20 Series (see 11.2.1 and 11.2.2)

Load (kN/m)	20 Series 190 mm deep Clear span (m)														
	0.6	1.0	1.4	1.8	2.2	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.8	6.2
2											2/D16 R6 @ 100	2/D16 R6 @ 100	2/D16 R6 @ 100	–	–
4								2/D16 R6 @ 100	2/D16 R6 @ 100	4/D12 R6 @ 100	–	–	–	–	–
6		ALL 2/D12 R6 @ 100					2/D16 R6 @ 100	4/D12 R6 @ 100		–	–	–	–	–	–
8						2/D16 R6 @ 100	4/D12 R6 @ 100	–	–	–	–	–	–	–	–
10					2/D16 R6 @ 100	2/D16 R6 @ 100	–	–	–	–	–	–	–	–	–
12					2/D16 R6 @ 100	–	–	–	–	–	–	–	–	–	–
14				2/D16 R6 @ 100	2/D16 R6 @ 50	–	Beyond the scope of this Standard					–	–	–	–
16				2/D16 R6 @ 50	–	–						–	–	–	–
18				2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–
20			2/D12 R6 @ 50	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–
22			2/D16 R6 @ 50	4/D12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–
24			2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
26		2/D12 R6 @ 50	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
28		2/D12 R6 @ 50	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
30		2/D12 R6 @ 50	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
32		2/D12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–	–
34		2/D12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–	–
36		2/D12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–	–

NOTE – R10 @ 100 mm can replace R6 @ 50 mm.

Table 11.3 – 190 mm deep lintels: 25 Series (see 11.2.1 and 11.2.2)

25 Series 190 mm deep															
Load (kN/m)	**Clear span** (m)														
	0.6	1.0	1.4	1.8	2.2	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.8	6.2
2												2/HD12 R6 @ 100	2/HD12 R6 @ 100	2/D16 R6 @ 100	–
4								2/HD12 R6 @ 100	2/HD12 R6 @ 100	2/D16 R6 @ 100	–	–	–	–	–
6		ALL 2/D12 R6 @ 100					2/HD12 R6 @ 100	2/D16 R6 @ 100	–	–	–	–	–	–	–
8						2/HD12 R6 @ 100	4/D12 R6 @ 100	–	–	–	–	–	–	–	–
10					2/HD12 R6 @ 100	2/D16 R6 @ 100	–	–	–	–	–	–	–	–	–
12					2/HD12 R6 @ 100	–	–	–	–	–	–	–	–	–	–
14				2/HD12 R6 @ 100	2/D16 R6 @ 50	–	–	Beyond the scope of this Standard				–	–	–	–
16				2/HD12 R6 @ 100	4/D12 R6 @ 100	–	–					–	–	–	–
18				2/HD12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–
20				2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–
22			2/HD12 R6 @ 50	4/D12 R6 @ 100	–	–	–	–	–	–	–	–	–	–	–
24			2/HD12 R6 @ 50	4/D12 R6 @ 100	–	–	–	–	–	–	–	–	–	–	–
26			2/HD12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
28			2/HD12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
30			2/HD12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
32		2/D12 R6 @ 50	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
34		2/D12 R6 @ 50	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–
36		2/D12 R6 @ 50	–	–	–	–	–	–	–	–	–	–	–	–	–

NOTE – R10 @ 100 mm can replace R6 @ 50 mm.

Table 11.4 – 390 mm deep lintels: 15 Series (see 11.2.1 and 11.2.2)

15 Series 390 mm deep															
Load (kN/m)	**Clear span** (m)														
	0.6	1.0	1.4	1.8	2.2	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.8	6.2
2															
4													2/D16 R6 @ 200	2/D16 R6 @ 200	2/D16 R6 @ 200
6		ALL 2/D12 R6 @ 200									2/D16 R6 @ 200	2/D16 R6 @ 200	2/D16 R6 @ 200	–	–
8									2/D16 R6 @ 200	2/D16 R6 @ 200	2/D16 R6 @ 200	–	–	–	–
10								2/D16 R6 @ 200	2/D16 R6 @ 200	2/D16 R6 @ 150	–	–	–	–	–
12								2/D16 R6 @ 150	2/D16 R6 @ 150	–	–	–	–	–	–
14							2/D16 R6 @ 150	2/D16 R6 @ 150	–	–	–	–	–	–	–
16						2/D12 R6 @ 150	2/D16 R6 @ 150	2/D16 R6 @ 100	–	–	–	–	–	–	–
18						2/D16 R6 @ 150	2/D16 R6 @ 100	–	–	–	–	–	–	–	–
20					2/D12 R6 @ 150	2/D16 R6 @ 100	2/D16 R6 @ 100	–	–		Beyond the scope of this Standard		–	–	–
22					2/D12 R6 @ 100	2/D16 R6 @ 100	–	–	–	–	–	–	–	–	–
24				2/D12 R6 @ 150	2/D16 R6 @ 100	2/D16 R6 @ 100	–	–	–	–	–	–	–	–	–
26				2/D12 R6 @ 150	2/D16 R6 @ 100	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–
28				2/D12 R6 @ 100	2/D16 R6 @ 100	–	–	–	–	–	–	–	–	–	–
30			2/D12 R6 @ 150	2/D12 R6 @ 100	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–
32			2/D12 R6 @ 150	2/D12 R6 @ 100	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–
34			2/D12 R6 @ 150	2/D16 R6 @ 100	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–
36			2/D12 R6 @ 100	2/D16 R6 @ 50	2/D16 R6 @ 50	–	–	–	–	–	–	–	–	–	–

NOTE – R10 @ 100 mm can replace R6 @ 50 mm and R10 @ 200 mm can replace R6 @ 100 mm.

Table 11.5 – 390 mm deep lintels: 20 Series (see 11.2.1 and 11.2.2)

Load (kN/m)	20 Series 390 mm deep Clear span (m)														
	0.6	1.0	1.4	1.8	2.2	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.8	6.2
2															
4													2/D16 R6 @ 200	2/D16 R6 @ 200	2/D16 R6 @ 200
6		ALL 2/D12 R6 @ 200									2/D16 R6 @ 200	2/D16 R6 @ 200	2/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 200
8									2/D16 R6 @ 200	2/D16 R6 @ 200	2/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 200
10								2/D16 R6 @ 200	2/D16 R6 @ 200	2/D16 R6 @ 150	4/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 200	–
12								2/D16 R6 @ 200	2/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 200	–	–
14							2/D16 R6 @ 200	2/D16 R6 @ 150	4/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 150	–	–	–
16							2/D16 R6 @ 150	2/D16 R6 @ 150	4/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 150	–	–	–	–
18						2/D16 R6 @ 200	2/D16 R6 @ 150	4/D16 R6 @ 200	4/D16 R6 @ 200	4/D16 R6 @ 150	–	–	–	–	–
20						2/D16 R6 @ 150	2/D16 R6 @ 100	4/D16 R6 @ 200	4/D16 R6 @ 150	4/D16 R6 @ 150	–	–	–	–	–
22					2/D12 R6 @ 150	2/D16 R6 @ 100	4/D16 R6 @ 150	4/D16 R6 @ 150	4/D16 R6 @ 150	–	–	–	–	–	–
24					2/D16 R6 @ 150	2/D16 R6 @ 100	4/D16 R6 @ 150	4/D16 R6 @ 150	4/D16 R6 @ 100	–	–	–	–	–	–
26					2/D16 R6 @ 100	2/D16 R6 @ 100	4/D16 R6 @ 100	4/D16 R6 @ 100	–	–	Beyond the scope of this Standard				–
28				2/D12 R6 @ 150	2/D16 R6 @ 100	4/D16 R6 @ 100	4/D16 R6 @ 100	4/D16 R6 @ 100	–	–					–
30				2/D12 R6 @ 150	2/D16 R6 @ 100	4/D16 R6 @ 100	4/D16 R6 @ 100	4/D16 R6 @ 100	–	–	–	–	–	–	–
32				2/D12 R6 @ 100	2/D16 R6 @ 50	4/D16 R6 @ 100	4/D16 R6 @ 100	–	–	–	–	–	–	–	–
34			2/D12 R6 @ 150	2/D12 R6 @ 100	2/D16 R6 @ 50	4/D16 R6 @ 100	4/D16 R6 @ 100	–	–	–	–	–	–	–	–
36			2/D12 R6 @ 150	2/D16 R6 @ 100	4/D16 R6 @ 50	4/D16 R6 @ 50	4/D16 R6 @ 50	–	–	–	–	–	–	–	–

NOTE – R10 @ 100 mm can replace R6 @ 50 mm and R10 @ 200 mm can replace R6 @ 100 mm.

Table 11.6 – 390 mm deep lintels: 25 Series (see 11.2.1 and 11.2.2)

Load (kN/m)	**25 Series 390 mm deep** **Clear span** (m)														
	0.6	1.0	1.4	1.8	2.2	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.8	6.2
2															
4													2/HD12 R6 @ 200	2/HD12 R6 @ 200	2/HD12 R6 @ 200
6		ALL 2/D12 R6 @ 200									2/HD12 R6 @ 200	2/HD12 R6 @ 200	2D16 R6 @ 200	2/HD16 R6 @ 200	2/HD16 R6 @ 200
8									2/HD12 R6 @ 200	2/HD12 R6 @ 200	2D16 R6 @ 200	2/HD16 R6 @ 200	2/HD16 R6 @ 200	2/HD16 R6 @ 200	4/D16 R6 @ 200
10								2/HD12 R6 @ 200	2/HD12 R6 @ 200	2/D16 R6 @ 200	2/HD16 R6 @ 200	2/HD16 R6 @ 200	4/HD12 R6 @ 200	4/D16 R6 @ 200	4/HD16 R6 @ 200
12								2/HD12 R6 @ 200	2/D16 R6 @ 200	2/HD16 R6 @ 200	2/HD16 R6 @ 150	4/HD12 R6 @ 200	4/D16 R6 @ 200	4/HD16 R6 @ 200	4/HD16 R6 @ 200
14							2/HD12 R6 @ 200	2/D16 R6 @ 200	2/HD16 R6 @ 200	2/HD16 R6 @ 150	4/HD12 R6 @ 200	4/D16 R6 @ 200	4/HD16 R6 @ 200	4/HD16 R6 @ 150	–
16							2/HD12 R6 @ 200	2/D16 R6 @ 150	2/HD16 R6 @ 150	4/HD12 R6 @ 200	4/D16 R6 @ 200	4/HD16 R6 @ 150	4/HD16 R6 @ 150	–	–
18						2/HD12 R6 @ 200	2/D16 R6 @ 150	2/HD16 R6 @ 100	2/HD16 R6 @ 100	4/D16 R6 @ 200	4/HD16 R6 @ 150	4/HD16 R6 @ 150	–	–	–
20						2/HD12 R6 @ 200	2/D16 R6 @ 150	2/HD16 R6 @ 100	4/HD12 R6 @ 200	4/D16 R6 @ 150	4/HD16 R6 @ 100	–	–	–	–
22						2/HD12 R6 @ 150	2/HD16 R6 @ 100	2/HD16 R6 @ 100	4/D16 R6 @ 150	4/HD16 R6 @ 100	4/HD16 R6 @ 100	–	–	–	–
24					2/HD12 R6 @ 200	2/D16 R6 @ 100	2/HD16 R6 @ 100	4/HD12 R6 @ 150	4/D16 R6 @ 150	4/HD16 R6 @ 100	–	–	–	–	–
26					2/HD12 R6 @ 150	2/D16 R6 @ 100	2/HD16 R6 @ 50	4/HD12 R6 @ 150	4/HD16 R6 @ 100	4/HD16 R6 @ 100	–	Beyond the scope of this Standard			
28					2/HD12 R6 @ 100	2/D16 R6 @ 100	2/HD16 R6 @ 50	4/D16 R6 @ 100	4/HD16 R6 @ 100	4/HD16 R6 @ 100	–				
30				2/D12 R6 @ 150	2/HD12 R6 @ 100	2/HD16 R6 @ 50	2/HD16 R6 @ 50	4/D16 R6 @ 100	4/HD16 R6 @ 100	–	–	–	–	–	–
32				2/D12 R6 @ 150	2/HD12 R6 @ 100	2/HD16 R6 @ 50	4/HD12 R6 @ 100	4/HD16 R6 @ 100	4/HD16 R6 @ 50	–	–	–	–	–	–
34				2/D12 R6 @ 100	2/D16 R6 @ 100	2/HD16 R6 @ 50	4/D16 R6 @ 100	4/HD16 R6 @ 100	4/HD16 R6 @ 50	–	–	–	–	–	–
36				2/HD12 R6 @ 100	2/HD16 R6 @ 50	2/HD16 R6 @ 50	4/D16 R6 @ 100	4/HD16 R6 @ 50	–	–	–	–	–	–	–

NOTE – R10 @ 100 mm can replace R6 @ 50 mm and R10 @ 200 mm can replace R6 @ 100 mm.

11.4 Wall columns

C11.4

Wall columns differ from isolated columns in that while they contain vertical reinforcement they do not contain a reinforcing cage. Wall columns are allocated no bracing capacity.

11.4.1

Wall columns within the thickness of the wall shall be solid filled.

11.4.2

The size of the wall column shall be determined from the vertical loads carried by each lintel on to the column from Tables 11.1 to 11.6 and by reference to axial load capacities in Table 11.7.

Table 11.7 – Capacity of wall columns (see 11.4.2)

Length (mm)	**Axial load capacity** (kN)		
	Wall thickness (series)		
	15	20	25
190	14	19	24
390	29	38	48
590	43	58	72

11.4.3

The loads from the end of lintels are determined by multiplying half the clear span of lintel and the load (kN/m) for each lintel and then summing the loads.

11.4.4

The clear height of a wall column shall not exceed 2.8 m.

11.4.5

No more than two wall columns shall be used in sequence subject also to the limitations of Figure 11.3.

All dimensions are in mm unless otherwise shown.

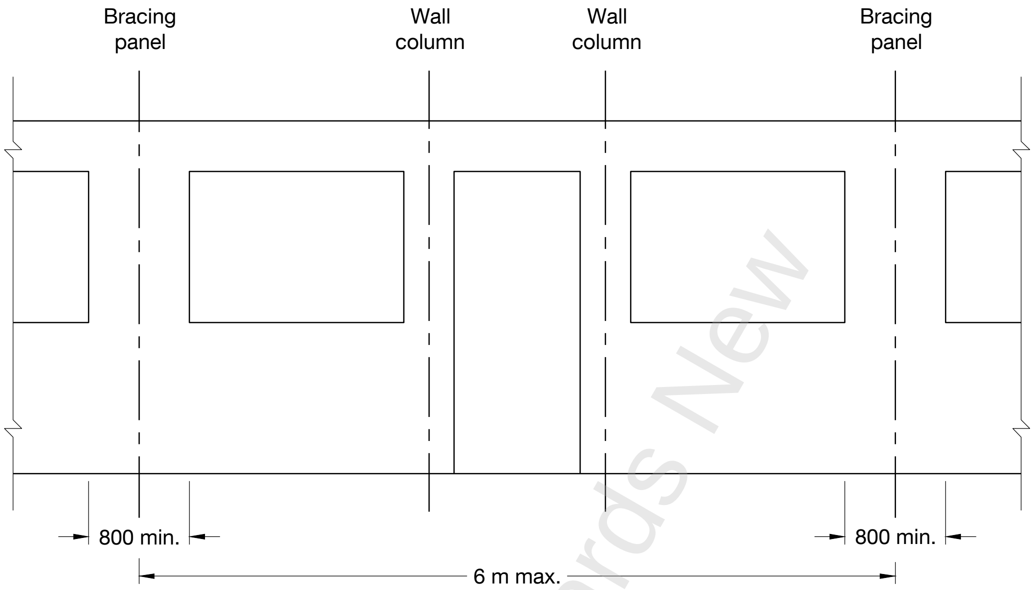


Figure 11.3 – Wall column spacing (see 11.4.5)

11.4.6

A wall bracing panel having a minimum length of 800 mm shall be provided on each side of a pair of wall columns.

11.4.7

Reinforcement shall be placed in the outermost cells of the column as required by 8.3.2 and Figure 8.1.

11.5 Isolated columns

C11.5

Isolated columns are allocated no bracing capacity. The full bracing demand is met by walls in the bracing line or alternatively by masonry frames to specific engineering design.

11.5.1

The requirement for an isolated column not subject to potential damage from vehicles, Type 1, supporting lintel loads arising from roof only shall be as follows:

(a) Minimum dimensions of 190 mm x 190 mm;

(b) Raking of joints shall not be permitted;

(c) Reinforced with 1/D16 bar centrally placed throughout the height, lapped with lintel steel at the head of the column and embedded into a concrete footing 500 mm square by 200 mm thick or into a reinforced concrete foundation beam;

C11.5.1(c)

A D16 bar needs to be securely held in position at the mid-height of the column to prevent displacement during grouting.

(d) Maximum loading on the column determined from lintel Tables 11.1 to 11.6 shall not exceed 25 kN nor shall the span of any lintel on to the column exceed 2.8 m;

(e) Clear height of the column shall not exceed 2.4 m.

C11.5.1

Where the column location is considered vulnerable to vehicle damage a Type 2 column should be used.

11.5.2

The requirement for a single column, Type 2, supporting lintel loads arising from roof, floor, wall, or a combination of these loads shall be as follows:

(a) Minimum dimensions of 390 mm x 190 mm. When used at a garage entrance the 390 mm dimension shall be parallel to the direction of vehicular movement.

(b) Reinforced with 4/D12 bars and R6 links at 200 mm centres, lapped with lintel steel at the head of the column and embedded into a concrete footing 900 mm square by 200 mm thick reinforced with D16 bars at 150 centres each way or into a reinforced foundation beam;

(c) Maximum loading on the column determined from lintel Tables 11.1 to 11.6 shall not exceed 90 kN;

(d) Clear height of the column shall not exceed 2.8 m.

12 SHRINKAGE

12.1 Shrinkage control joints

12.1.1

Longitudinal shrinkage stresses in concrete masonry shall be controlled by providing vertical control joints at not more than 6 m centres.

Vertical control joints shall be located:

(a) Within 600 mm of return angles in T and U-shaped floor structures;

(b) Within 600 mm of L-shaped corners or by restricting the spacing to the next control joint to 3.2 m maximum (see Figure 12.1);

(c) At changes in wall height, exceeding 600 mm;

(d) At changes in wall thickness.

C12.1.1

Generally working range spacing of 5 m to 6 m is recommended with the upper limit used in special cases. Wider spacing can be achieved by considering specific engineering design.

This Standard requires reinforcement and solid filling around each opening and may require the installation of a wall column. Hence it is necessary to position control joints away from these areas.

All dimensions are in mm unless otherwise shown.

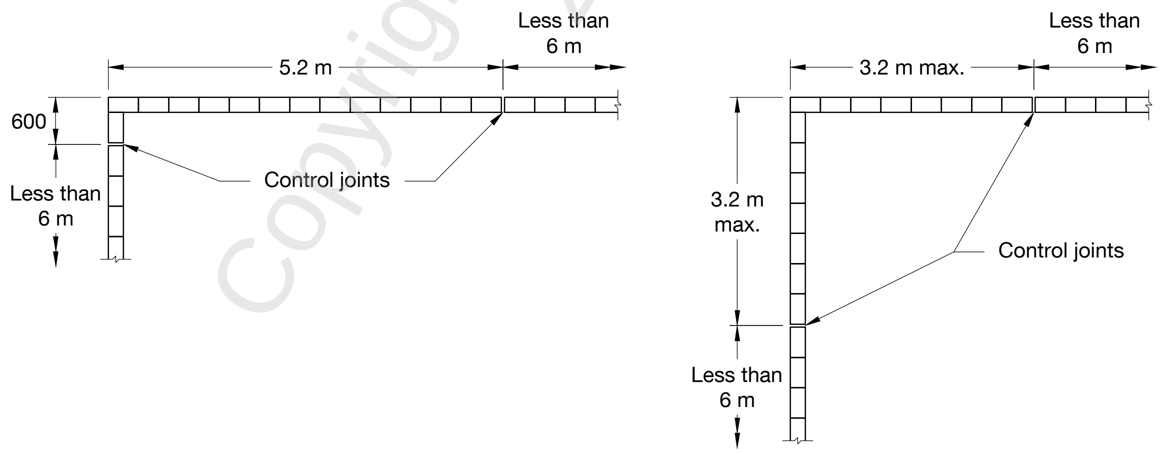


Figure 12.1 – Location of control joints for shrinkage (see 12.1.1)

12.1.2

Reinforcement in bond beams and lintels shall be continuous through control joints.

12.1.3

Horizontal reinforcement defined in Table 8.3 shall be discontinuous at control joints (see Figure 12.2).

12.1.4

Cavities either side of control joints shall be vertically reinforced and grouted.

12.1.5

Control joints shall be weatherproof when located on external walls. Details of how the joint is proposed to be weatherproofed shall be submitted to and approved by the building consent authority as part of the building consent application.

All dimensions are in mm unless otherwise shown.

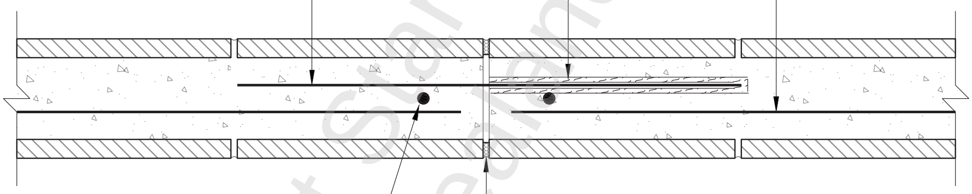


Figure 12.2 – Control joint detail for solid-filled walls and partially filled walls where horizontal bars are placed between floors but not bond beams (see 12.1.3)

13 MASONRY VENEER WALL COVERING

Previously NZS 4229:1999 covered masonry veneer wall covering. This information is to be contained in Acceptable Solution E2/AS3 in NZBC Compliance Document E2 'External Moisture'. In the meantime guidance is provided in Appendix E of this Standard.

Limitations on the use of masonry veneer applied in this Standard are given in 1.1.3(o).

C13

At the time of publication of this Standard, E2/AS3 is due to be amended to contain all requirements for masonry veneer wall covering. Appendix E is included for guidance during the transition period between publication of NZS 4229:2013 and amendment of E2/AS3.

APPENDIX A – MASONRY RETAINING WALLS

(Normative)

A1 Scope

A1.1

The details of retaining walls contained in this Appendix are based on the masonry design requirements of NZS 4230 related to Grade B and that the masonry shall be solid filled.

A1.2

Specific engineering design shall be provided if one or more of the following conditions exist:

(a) Height above limits specified in Figures A1 to A3;

(b) Surcharge above limits specified in Figure A2;

(c) Backslope angle of maximum 10°, see Figure A3;

(d) Soil types not listed in A2.1;

(e) Ultimate bearing pressure of soil less than 300 kPa;

(f) Hydrostatic water head;

(g) Construction in Earthquake Zone 4.

CA1.2

Clause A4 is specifically included to ensure that water behind walls can be freely discharged.

A1.3

Retaining walls shall comply with the following provisions as appropriate:

(a) Vertical superimposed load between 0 – 50 kN/m, use the details contained in Figures A1 to A3.

(b) Vertical superimposed loads over 50 kN/m shall require specific engineering design;

(c) The top of the wall shall not be fixed to a rigid floor diaphragm prior to backfilling.

CA1.3(c)

The propping by diaphragm/floor of the top of retaining walls contained in this Appendix creates a design condition not included in these details.

Additional soil forces need to be considered as does the positioning of reinforcement. For these reasons such walls require specific engineering design.

CA1.3

The vertical loading figures are obtained from the design process of section 6.

Superimposed vertical loading above 50 kN/m has not been considered as this would generally only result from the wall directly supporting a concrete floor(s).

A2 Materials

A2.1 Soil types

Three different soil type characteristics have been used to compile the design details (see Table A1).

Table A1 – Soil type design parameters

Soil type	Classes of soil included	Design parameters		
		γ (kN/m^3)	φ (°)	**C** (kPa)
A	Dense gravel	19.6	30	0
B*	Loose gravel, gravelly sand, sandy gravel, pumice	16.7	30	0
C	Clay	16.7	25	12

* The design parameters for each of the soil classes vary in practice. The most unfavourable conditions for the group have been given.

NOTE – The design parameter γ is the soil density, φ is the friction angle, and **C** is the cohesive strength of the soil.

A2.2 Wall height limits with clay soils

For clay soil, the wall designs in Figures A1 to A3 shall only be used to the height limits imposed.

Where such excavation is not considered to be acceptable then the retaining wall shall be deemed to require specific engineering design.

CA2.2

Considerable variations in pressures on the retaining wall can arise from clay subsoil conditions. Such detail design is outside the scope of this Standard. The 45° excavation line is considered to be the acceptable limiting factor.

Refer to the New Zealand concrete masonry manual for clay soils and timber/veneer loading conditions on the retaining wall.

A2.3 Concrete for footings

Concrete shall comply with NZS 3104 for concrete having a minimum compressive strength of 25 MPa at 28 days and be placed in compliance with NZS 3109.

A2.4 Concrete for infilling

Concrete infill grout shall comply with NZS 4210, having a minimum compressive strength of 20 MPa at 28 days and a spread within the range 450 mm to 530 mm when tested in accordance with the appropriate test requirements of NZS 3112.1.

A2.5 Reinforcing steel

Reinforcing steel shall be deformed bars conforming to Grade E of AS/NZS 4671.

A3 Retaining wall selection

A3.1

The appropriate wall type from Figures A1 to A3 shall be selected considering:

(a) Height of retained soil;

(b) Surcharge loading condition;

> ***CA3.1(b)***
>
> *A load surcharge of 2.5 kPa has been taken for a condition where a domestic driveway abuts the retaining wall.*

(c) Earthquake loading zone.

> ***CA3.1***
>
> *Other wall types (140 and 240) and conditions are shown on the New Zealand Concrete Masonry Association website and other proprietary supplied information.*

A3.2

Construction and reinforcement shall follow the provisions of the selected figure.

A4 Drainage

A4.1

Retaining walls shall be provided with a free falling drainage system that will prevent the build-up of water pressure behind the wall.

Construction of the drainage system shall be as follows or by specific engineering design:

(a) A perforated or porous pipe of 100 mm diameter shall be laid to a minimum fall of 1:150 and the invert at the highest point shall be a minimum of 50 mm below the concrete floor slab level;

(b) The pipe shall be covered with a self-draining granular material to the height of the retaining wall;

(c) The pipe shall be arranged to provide for open discharge.

> ***CA4.1***
>
> *Alternative drainage systems can be considered subject to engineering design ensuring the principles of free drainage are maintained.*

A5 Water and vapour proofing

A5.1

Where the retaining wall forms part of a habitable structure, it shall be provided with:

(a) Drainage as in A4.1;

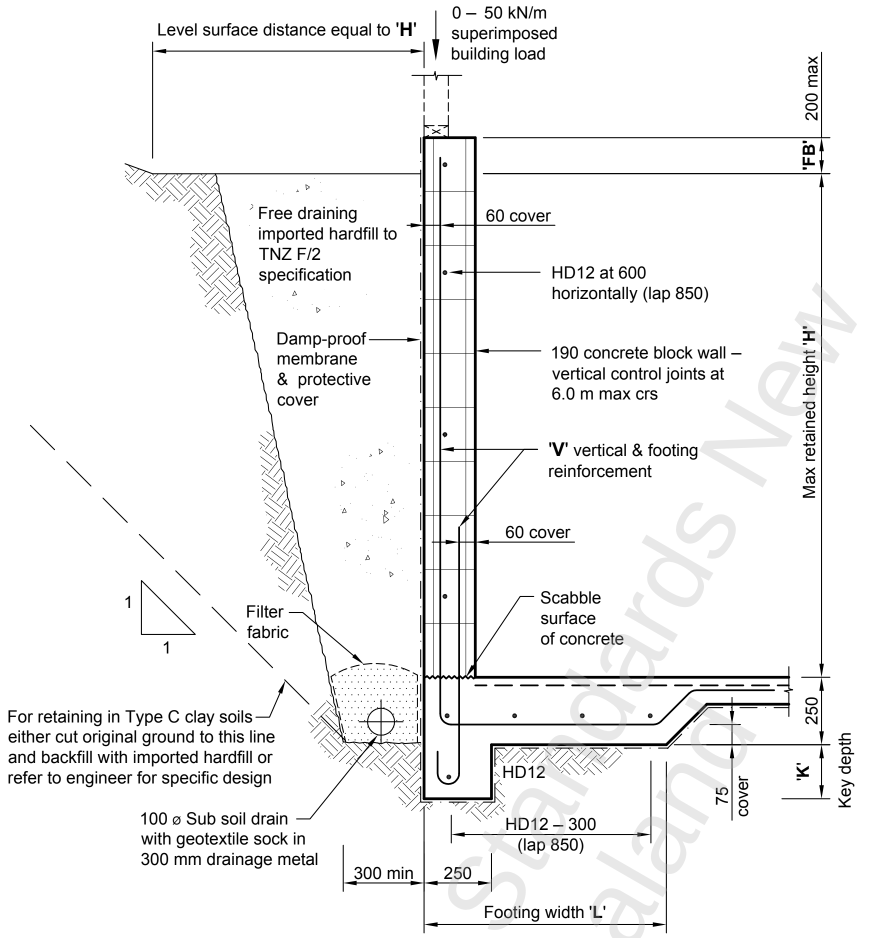
(b) A waterproof vapour barrier system that complies with the requirements of 7.4.2;

(c) The vapour barrier shall be fully protected from damage during the backfilling process.

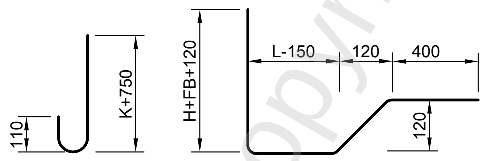
CA5.1

The damp-proof membrane is required to prevent water vapour passing through the wall. When using the requirements of 7.4.2 it is important that drainage of water from the face of the wall must be provided.

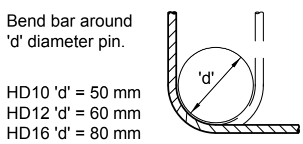
All dimensions are in mm unless otherwise specified.



Cross-section of retaining wall



Bar bending dimensions



Bar bend radii

Maximum Height 'H'	Soils A & C 'L'	Soils A & C 'K'	Soil B 'L'	Soil B 'K'
Table 1 – Zone 1 earthquake actions				
	'V'		'V'	
1200	900	100	800	100
	HD10-600		HD10-600	
1400	1050	150	950	150
	HD10-600		HD10-600	
1600	1200	250	1150	200
	HD12-600		HD10-600	
1800	1350	300	1300	250
	HD12-400		HD12-600	
2000	1550	350	1450	300
	HD16-600		HD12-400	
2200	1750	400	1650	350
	HD16-400		HD16-400	
2300	1850	400	–	
	HD16-400			
2600	–		1800	400
			HD16-400	
Table 2 – Zone 2 earthquake actions				
1200	950	100	900	100
	HD10-600		HD10-600	
1400	1150	150	1050	150
	HD10-600		HD10-600	
1600	1300	250	1250	200
	HD12-400		HD12-600	
1800	1500	300	1400	250
	HD12-400		HD12-400	
2000	1700	350	1600	300
	HD16-400		HD16-600	
2100	1800	400	–	
	HD16-400			
2200	–		1800	350
			HD16-400	
Table 3 – Zone 3 earthquake actions				
1200	1100	200	1050	200
	HD10-600		HD10-600	
1400	1300	300	1250	300
	HD12-400		HD12-600	
1600	1550	350	1450	350
	HD16-400		HD12-400	
1800	1750	450	1650	400
	HD16-400		HD16-400	
1900	–		1750	450
			HD16-400	

NOTE –

(1) Construction to be in accordance with NZS 4210.

(2) Masonry for walls to be Observation Type B.

(3) Concrete for foundation to be 25 MPa at 28 days.

(4) Reinforcement is deformed 500 E grade.

(5) Foundations shall be on good ground, 300 kPa ultimate bearing capacity.

(6) Drainage metal shall be a layer of suitable granular material with perforated pipe to discharge as required by the building consent authority.

(7) Compaction forces from machinery are not included in the design.

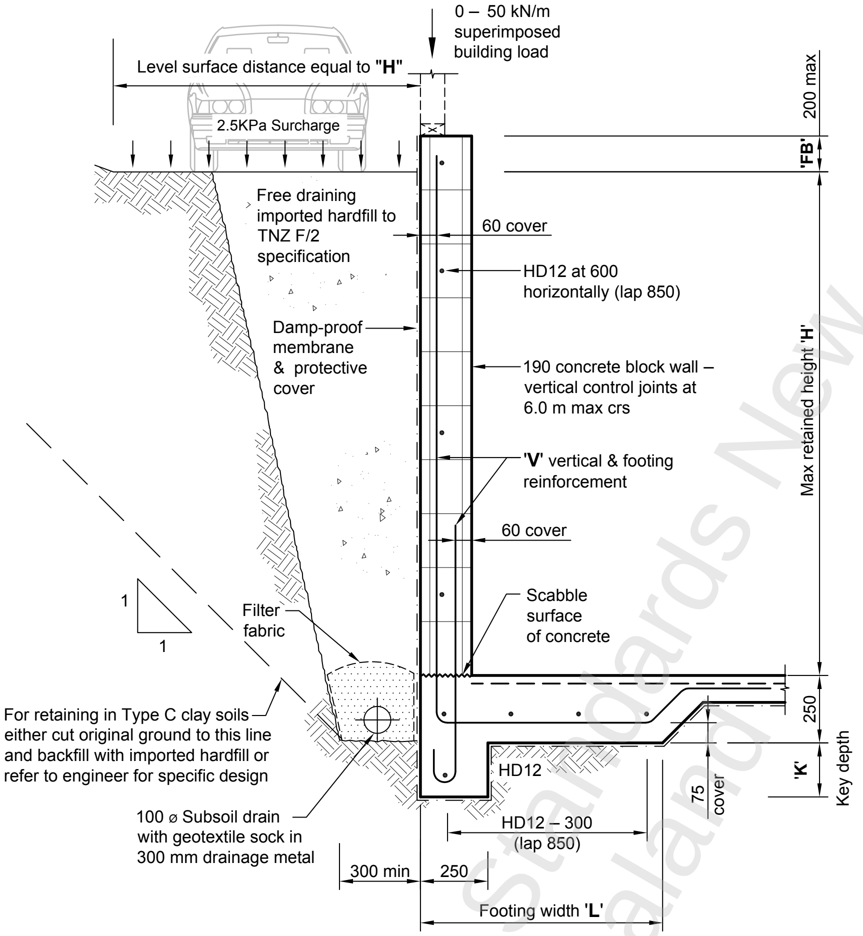
(8)

		γ (kN/m)³	φ	**C** (kPa)
Soil A includes	Dense gravel	19.6	30°	0
Soil B includes	Loose gravel	16.7	30°	0
	Gravely sand	16.7	35°	0
	Pumice soil	12.7	35°	0
Soil C includes	Weak clay	16.7	25°	12

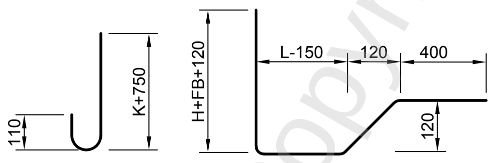
(9) This figure is adapted from the New Zealand Concrete Masonry Association's *New Zealand concrete masonry manual* and used with permission.

Figure A1 – Retaining wall without surcharge

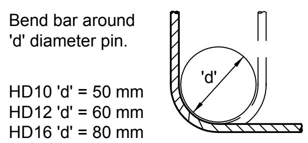
All dimensions are in mm unless otherwise specified.



Cross-section of retaining wall



Bar bending dimensions



Bar bend radii

Table 1 – Zone 1 earthquake actions

Maximum Height 'H'	Soils A & C 'L'	Soils A & C 'K'	Soils A & C 'V'	Soil B 'L'	Soil B 'K'	Soil B 'V'
1200	900	150	HD10-600	850	150	HD10-600
1400	1100	200	HD10-600	1000	200	HD10-600
1600	1250	300	HD12-600	1150	250	HD12-600
1800	1400	350	HD12-400	1350	300	HD12-400
2000	1600	400	HD16-600	1500	350	HD12-400
2200	1800	450	HD16-400	1700	400	HD16-400
2400	–			1850	500	HD16-400

Table 2 – Zone 2 earthquake actions

Maximum Height 'H'	Soils A & C 'L'	Soils A & C 'K'	Soils A & C 'V'	Soil B 'L'	Soil B 'K'	Soil B 'V'
1200	1000	150	HD10-600	950	150	HD10-600
1400	1200	200	HD12-600	1150	200	HD10-600
1600	1350	300	HD12-400	1300	250	HD12-600
1800	1550	350	HD16-600	1500	300	HD12-400
2000	1750	400	HD16-400	1650	400	HD16-400
2100	–			1800	400	HD16-500

Table 3 – Zone 3 earthquake actions

Maximum Height 'H'	Soils A & C 'L'	Soils A & C 'K'	Soils A & C 'V'	Soil B 'L'	Soil B 'K'	Soil B 'V'
1200	1150	300	HD12-600	1100	300	HD10-600
1400	1350	350	HD12-400	1300	350	HD12-600
1600	1550	450	HD16-400	1500	400	HD16-600
1700	1700	450	HD16-400	–		
1800	–			1700	500	HD16-400

NOTE –

(1) Construction to be in accordance with NZS 4210.

(2) Masonry for walls to be Observation Type B.

(3) Concrete for foundation to be 25 MPa at 28 days.

(4) Reinforcement is deformed 500 E grade.

(5) Foundations shall be on good ground, 300 kPa ultimate bearing capacity.

(6) Drainage metal shall be a layer of suitable granular material with perforated pipe to discharge as required by the building consent authority.

(7) Compaction forces from machinery are not included in the design.

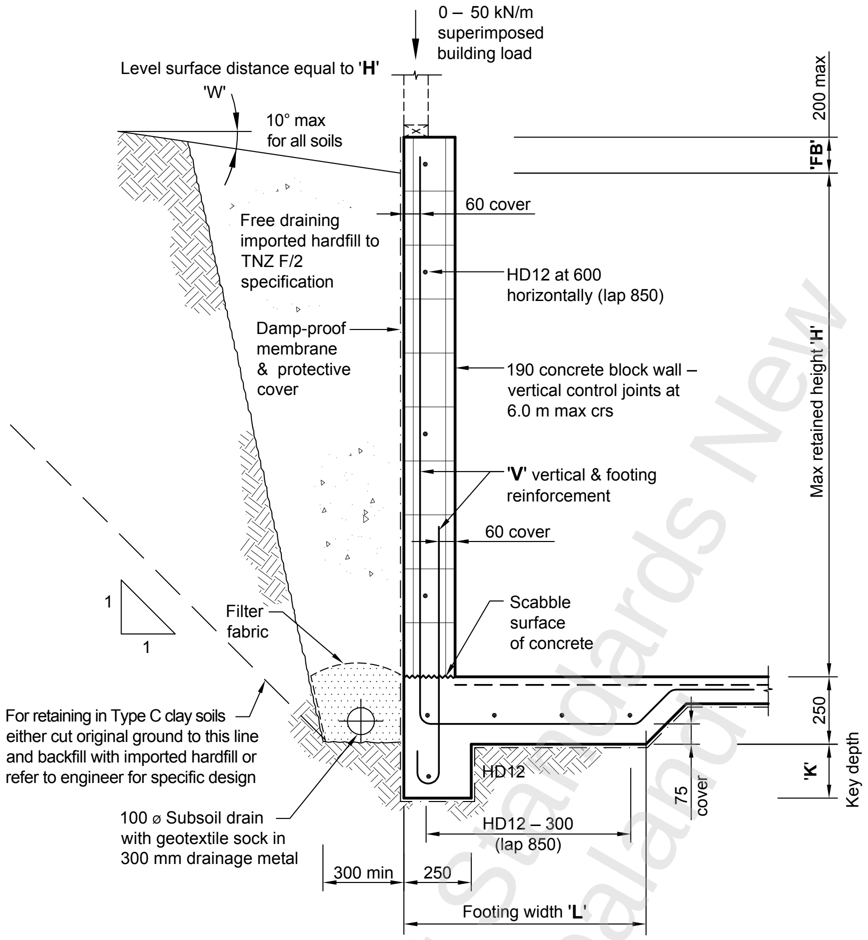
(8)

		γ (kN/m)³	φ	**C** (kPa)
Soil A includes	Dense gravel	19.6	30°	0
Soil B includes	Loose gravel	16.7	30°	0
	Gravely sand	16.7	35°	0
	Pumice soil	12.7	35°	0
Soil C includes	Weak clay	16.7	25°	12

(9) This figure is adapted from the New Zealand Concrete Masonry Association's *New Zealand concrete masonry manual* and used with permission.

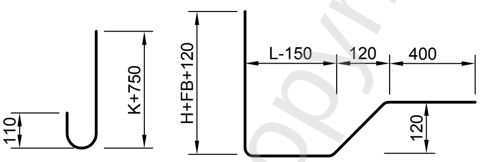
Figure A2 – Retaining wall with surcharge

All dimensions are in mm unless otherwise specified.



Cross-section of retaining wall

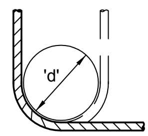
Maximum Height 'H'	Soils A & C 'L'	Soils A & C 'K'	Soil B 'L'	Soil B 'K'
Table 1 – Zone 1 earthquake actions				
	'V'		'V'	
1200	950	150	900	150
	HD10-600		HD10-600	
1400	1150	200	1050	200
	HD10-600		HD10-600	
1600	1300	250	1200	250
	HD12-600		HD12-600	
1800	1500	350	1400	300
	HD12-400		HD12-400	
2000	1700	400	1600	350
	HD16-600		HD16-600	
2100	1800	400	–	
	HD16-600			
2200	–		1800	400
			HD16-400	
Table 2 – Zone 2 earthquake actions				
1200	1050	200	1050	200
	HD10-600		HD10-600	
1400	1300	250	1200	250
	HD12-600		HD12-600	
1600	1500	350	1400	300
	HD16-600		HD12-400	
1800	1700	400	1600	400
	HD16-400		HD16-400	
1900	–		1700	400
			HD16-400	
Table 3 – Zone 3 earthquake actions				
Not applicable				



Bar bending dimensions

Bend bar around
'd' diameter pin.

HD10 'd' = 50 mm
HD12 'd' = 60 mm
HD16 'd' = 80 mm



Bar bend radii

NOTE –

(1) Construction to be in accordance with NZS 4210.

(2) Masonry for walls to be Observation Type B.

(3) Concrete for foundation to be 25 MPa at 28 days.

(4) Reinforcement is deformed 500 E grade.

(5) Foundations shall be on good ground, 300 kPa ultimate bearing capacity.

(6) Drainage metal shall be a layer of suitable granular material with perforated pipe to discharge as required by the building consent authority.

(7) Compaction forces from machinery are not included in the design.

(8)

		γ (kN/m)³	φ	**C** (kPa)
Soil A includes	Dense gravel	19.6	30°	0
Soil B includes	Loose gravel	16.7	30°	0
	Gravely sand	16.7	35°	0
	Pumice soil	12.7	35°	0
Soil C includes	Weak clay	16.7	25°	12

(9) This figure is adapted from the New Zealand Concrete Masonry Association's *New Zealand concrete masonry manual* and used with permission.

Figure A3 – Retaining wall with backslope

APPENDIX B – CANTILEVERED WALLS

(Normative)

B1 Scope

B1.1

This Appendix sets down the structural requirements for free-standing cantilevered concrete masonry walls in the following situations:

(a) Up to 4 m in height, dependent on earthquake zone;

(b) As a free-standing external wall in a maximum High Wind Zone as defined in NZS 3604;

(c) With foundation soils to good ground in accordance with 3.1.3.

CB1.1

Should any of the three conditions not be met then the wall should be subject to specific engineering design.

For free-standing garden or boundary walls up to 2 m in height, reference could be made to details included in the New Zealand concrete masonry manual.

B2 General

CB2

Walls supported by return walls should be in accordance with section 8 of this Standard, provided they are part of a masonry building.

B2.1

Cantilevered masonry walls shall be of 20 series blocks and be:

(a) Constructed in running bond;

(b) Centrally reinforced both vertically and horizontally in accordance with B3;

(c) Provided with a foundation to support the wall against horizontal loads, in accordance with B4; and

(d) Reinforced with Grade 300 reinforcing steel.

B2.2

All construction in this Appendix shall be subject to specific inspection by a Licensed Building Practitioner.

B3 Walls

CB3

Walls supported by return walls should be provided with bond beams in accordance with Table 10.1. The maximum spacing between return walls should not exceed the spans of the bond beam used as permitted in Table 10.1.

B3.1

Walls shall be centrally reinforced in accordance with B3.2 and B3.3 depending on:

(a) The block density of the masonry units and whether the wall is constructed of partially filled or solid-filled masonry;

(b) The type of lateral supporting system;

(c) The height of the wall above the foundation;

(d) The earthquake zone in which the wall is located.

B3.2

Cantilevered walls shall be reinforced in accordance with Tables B5, B6, B7, or B8 as appropriate.

B3.3

Where vertical bars are required to be lapped, the lap shall be not less than 40 bar diameters and shall extend at least to the height required by the figures.

Horizontal bars shall have staggered laps of not less than 40 bar diameters.

B4 Foundations

B4.1 General

B4.1.1

Foundations shall resist vertical loads and provide resistance to overturning forces due to earthquake and wind loads on the wall by one of the following foundation types:

(a) Cast-in-situ concrete piles, see Figure B1;

(b) Strip footings, centrally placed or to one side of the wall (see Figures B2 and B3);

(c) Floor slabs constructed integrally with the concrete or masonry footing (see Figure B4 and Table B4);

(d) Conventional footings being part of a masonry building to which lateral support bracing panels are fixed.

B4.1.2

Concrete for piles and footings shall have a minimum compressive strength of 25 MPa.

B4.2 Concrete pile foundations

B4.2.1

A strip foundation supported by cast-in-situ concrete piles shall be not less than 350 mm wide by 350 mm deep and be reinforced longitudinally with 4/D12 bars with R6 stirrups at 100 mm centres (see Figure B1).

B4.2.2

Cast-in-situ concrete piles shall be centrally reinforced and be at a diameter, spacing, and length as set out in Table B1.

B4.3 Strip foundations

B4.3.1

Strip foundations may be formed to one side of the cantilever wall or be centrally placed under it.

B4.3.2

Foundation dimensions and reinforcement shall be in accordance with Tables B2 and B3 and Figures B2 and B3.

B4.4 Foundations constructed in conjunction with floor slabs

B4.4.1

Floor slabs supporting centrally reinforced cantilevered walls shall be reinforced to 7.8.3 and 7.8.4 and shall be the thickness as detailed in Figure B4.

B4.4.2

Floor slabs shall be built as an integral part of the foundation and wall as detailed in Figure B4.

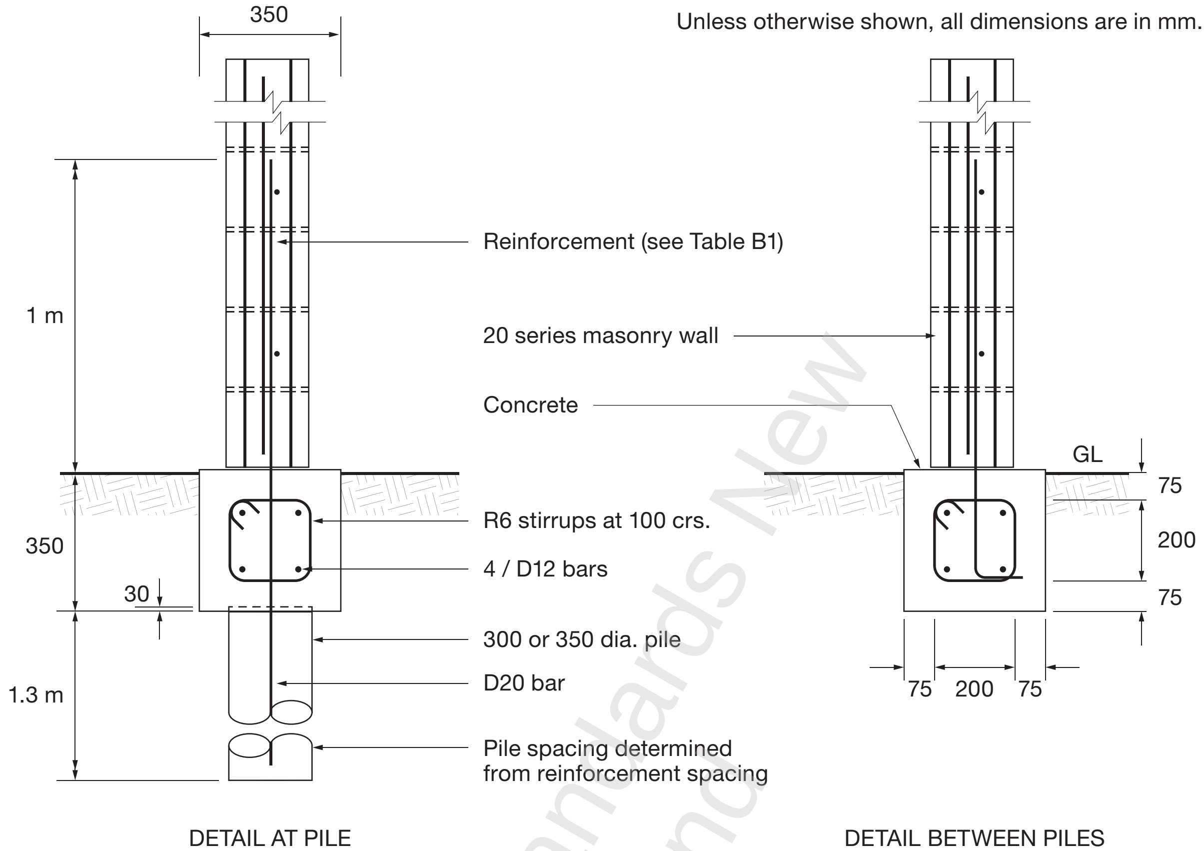


Figure B1 – Cast-in-situ concrete piles centrally reinforced to support cantilevered walls (solid or partially filled)

(For use in conjunction with Table B1 – see B4.1.1(a))

Table B1 – Cast-in-situ concrete piles centrally reinforced to support cantilevered walls (solid or partially filled) (see B4.2.2)

All earthquake zones				
Spacing of vertical wall reinforcement at base of wall (mm)	**Spacing of piles** (mm)	**Diameter of piles** (mm)	**Depth of piles** (mm)	**Reinforcement for piles**
400	1200	350	1300	D20
600	1200	300	1300	D20
800	1600	300	1300	D20

Unless otherwise shown, all dimensions are in mm.

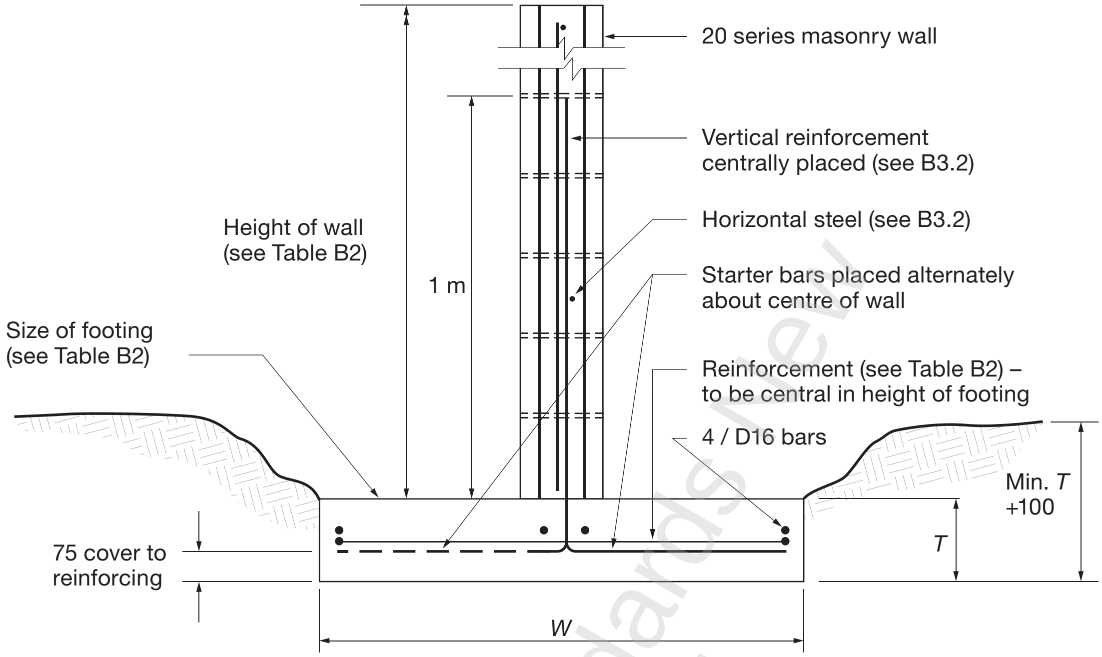


Figure B2 – Strip footing centrally placed under cantilevered walls (solid or partially filled)
(For use in conjunction with Table B2 – see B4.3.2)

Table B2 – Strip footing centrally placed under cantilevered walls (solid or partially filled) (see B4.3.2)

	Earthquake Zone 1		**Earthquake Zone 2**		**Earthquake Zone 3**		**Earthquake Zone 4**	
Max height of wall (mm)	**Footing W X T** (mm)	**Reinforce-ment in footing**	**Footing W X T** (mm)	**Reinforce-ment in footing**	**Footing W X T** (mm)	**Reinforce-ment in footing**	**Footing W X T** (mm)	**Reinforce-ment in footing**
2000	800 X 200	D12 – 400	1000 X 200	D12 – 400	1300 X 200	D12 – 200	1500 X 250	D16 – 400
2400	1000 X 200	D12 – 400	1300 X 200	D12 – 200	1600 X 250	D16 – 400	1500 X 250	D16 – 400
2800	1100 X 200	D12 – 200	1400 X 250	D16 – 400	1800 X 250	D16 – 200	N/A	N/A
3200	1200 X 200	D12 – 200	1600 X 250	D16 – 200	N/A	N/A	N/A	N/A
3600	1400 X 250	D16 – 400	N/A	N/A	N/A	N/A	N/A	N/A
4000	1400 X 250	D16 – 400	N/A	N/A	N/A	N/A	N/A	N/A

NOTE – Bars specified in this table are to be placed centrally in thickness of footing. All bars are to have a minimum 200 mm long return at each end.

Unless otherwise shown, all dimensions are in mm.

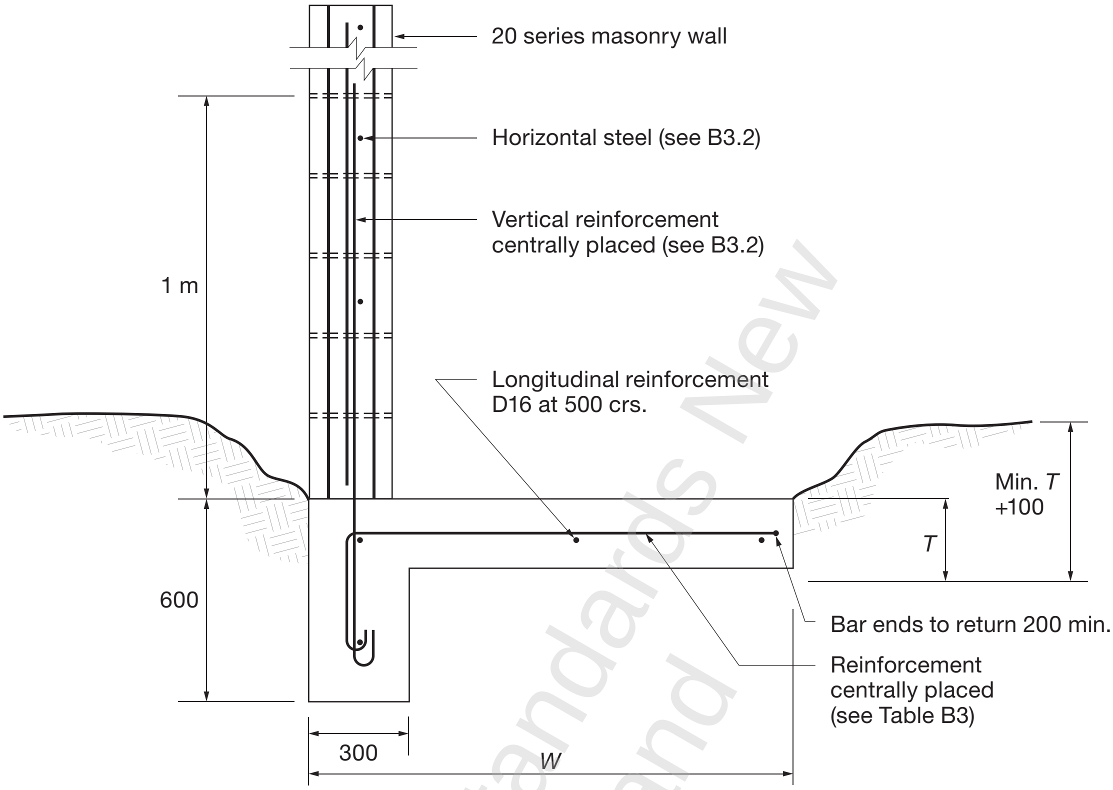


Figure B3 – Strip footing for cantilevered walls (solid or partially filled) where footing is on one side of wall
(For use in conjunction with Table B3 – see B4.3.2)

Table B3 – Strip footing for cantilevered walls (solid or partially filled) where footing is on one side of wall (see B4.3.2)

Vertical wall reinforcement at base of wall (mm)	**All earthquake zones**	
	Footing W X T (mm)	**Reinforcement in slab**
D12 – 400	1600 X 300	D12 – 200
D12 – 600	1300 X 300	D12 – 300
D12 – 800	1100 X 300	D12 – 400
D16 – 400	2100 X 300	D16 – 400
D16 – 600	1700 X 300	D12 – 300

Unless otherwise shown, all dimensions are in mm.

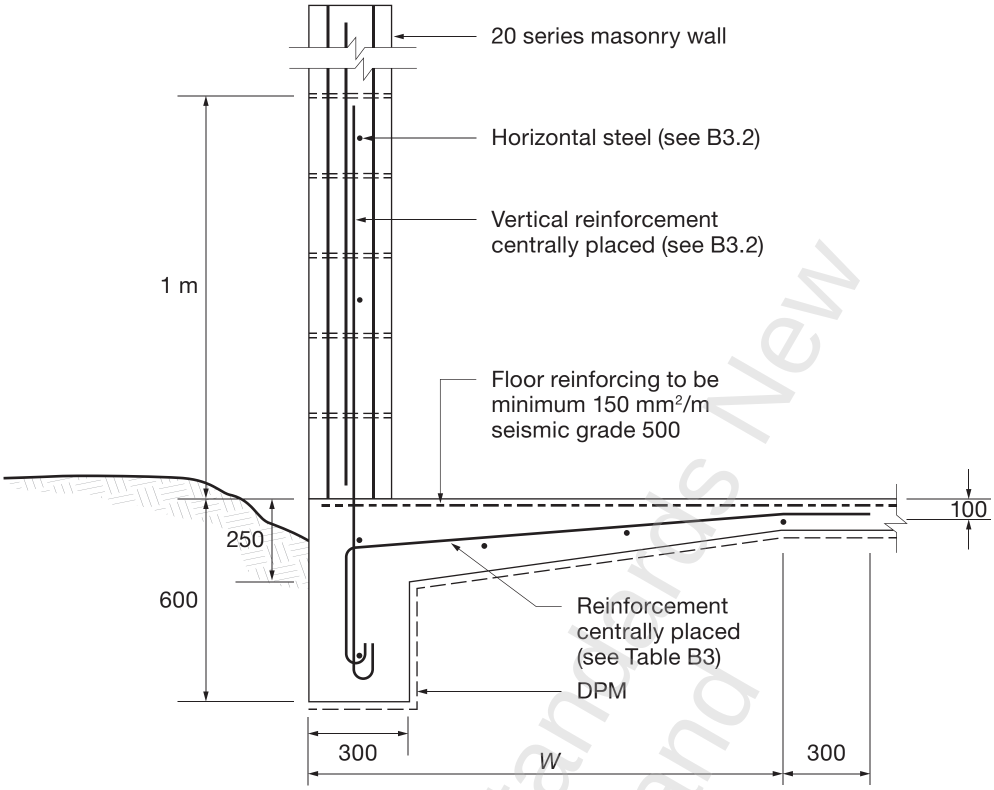


Figure B4 – Strip footing consisting of floor slab on one side of a cantilevered wall
(For use in conjunction with Table B4 – see B4.1.1(c))

Table B4 – Strip footing consisting of floor slab on one side of a cantilevered wall (see B4.1.1(c))

Vertical wall reinforcement at base of wall	All earthquake zones **W** (mm)
D12 – 400	1900
D12 – 600	1500
D12 – 800	1200
D16 – 400	2600
D16 – 600	2000

Table B5 – Maximum spacing (mm) of D12 bar reinforcement for 190 mm cantilevered walls constructed of partially filled masonry (block density 1750 kg/m^3) (see B3.2)

Height (max) of wall (mm)	Earthquake Zone 1			Earthquake Zone 2			Earthquake Zone 3		Earthquake Zone 4	
	Horiz. steel spacing	No. of horiz. bars	Vert. steel spacing	Horiz. steel spacing	No. of horiz. bars	Vert. steel spacing	Horiz. steel spacing	Vert. steel spacing	Horiz. steel spacing	Vert. steel spacing
2000	2000	4	800	2000	4	800	800	800	800	600
2400	2400	4	600	2400	4	600	800	400	800	400
2800	2800	4	400	2800	4	400	N/A	N/A	N/A	N/A
3200	1600	4	400	1600	4	400	N/A	N/A	N/A	N/A
NOTE – 2/D16 can be substituted for 4/D12 provided bars are placed one on each side of the bond beam.										

Table B6 – Maximum spacing (mm) of single D12 or D16 bar reinforcement for 190 mm cantilevered walls constructed of solid-filled masonry (block density 1750 kg/m^3) (see B3.2)

Vert. bar size	Height (max) of wall (mm)	Earthquake Zone 1		Earthquake Zone 2		Earthquake Zone 3		Earthquake Zone 4	
		Horiz. D12 spacing	Vert. spacing	Horiz. D12 spacing	Vert. spacing	Horiz. D12 spacing	Vert. spacing	Horiz. D12 spacing	Vert. spacing
D12	2000	600	600	600	400	600	400	600	600
	2400	800	400	600	400	600	400	600	400
	2800	800	400	600	600	600	400	N/A	N/A
	3200	800	400	800	400	N/A	N/A	N/A	N/A
D16	3600	800	400	N/A	N/A	N/A	N/A	N/A	N/A
	4000	800	400	N/A	N/A	N/A	N/A	N/A	N/A

Table B7 – Maximum spacing (mm) of D12 or D16 bar reinforcement for 190 mm cantilevered walls construction of partially filled masonry (block density 2200 kg/m³) (see B3.2)

Vert. bar size	Height (max) of wall (mm)	Earthquake Zone 1			Earthquake Zone 2			Earthquake Zone 3			Earthquake Zone 4		
		Horiz. steel spacing	No. of horiz. bars	Vert. steel spacing	Horiz. steel spacing	No. of horiz. bars	Vert. steel spacing	Horiz. steel spacing	No. of horiz. bars	Vert. steel spacing	Horiz. steel spacing	No. of horiz. bars	Vert. steel spacing
D12	2000	2000	4/D12	800	2000	4/D12	800	800	1/D12	400	600	1/D12	400
	2400	2400	4/D12	600	2400	4/D12	600	600	1/D12	600	600	1/D12	400
	2800	2800	4/D12	400	2800	4/D12	400	600	1/D12	400	N/A	N/A	N/A
	3200	1600	4/D12	400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

NOTE – 2/D16 can be substituted for 4/D12 provided bars are placed one each side of the bond beam.

Table B8 – Maximum spacing (mm) of single D12 or D16 bar reinforcement for 190 mm cantilevered walls constructed of solid-filled masonry (block density 2200 kg/m³) (see B3.2)

Vert. bar size	Height (max) of wall (mm)	Earthquake Zone 1		Earthquake Zone 2		Earthquake Zone 3		Earthquake Zone 4	
		Horiz. D12 spacing	Vert. steel spacing	Horiz. D12 spacing	Vert. steel spacing	Horiz. D12 spacing	Vert. steel spacing	Horiz. D12 spacing	Vert. steel spacing
D12	2000	600	600	800	400	800	400	800	400
	2400	800	400	800	400	800	400	N/A	N/A
	2800	800	400	800	600	N/A	N/A	N/A	N/A
	3200	800	400	800	400	N/A	N/A	N/A	N/A
D16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(There is no Appendix C to avoid confusion with commentary clauses.)

APPENDIX D – DESIGN EXAMPLES AND BACKGROUND INFORMATION ON DERIVATION OF DESIGN TABLES

(Informative)

D1 General

A set of flow charts for a single-storey structure and a two-storey structure illustrating the design procedures for using the Standard are included.

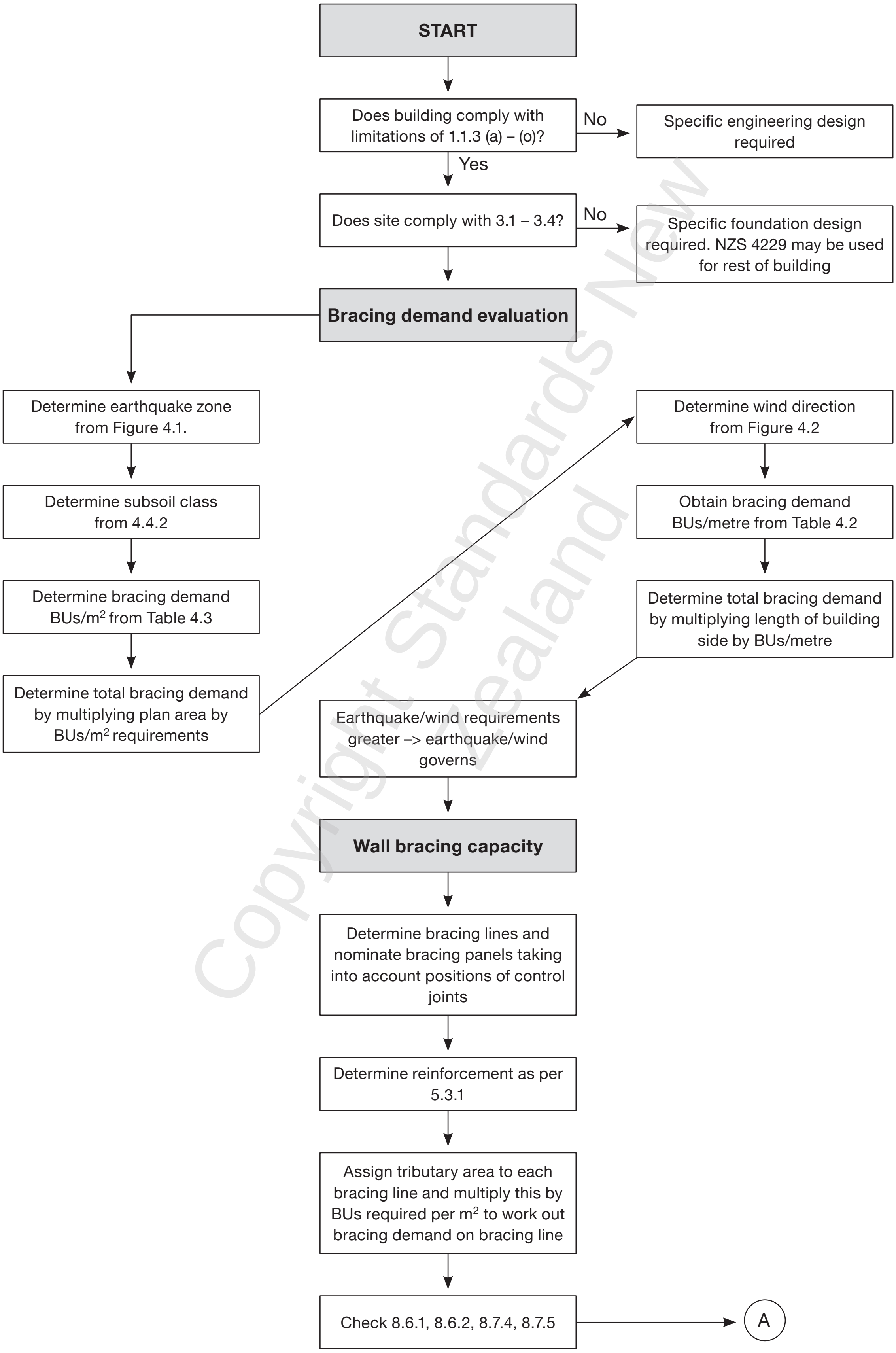
Referenced clauses/sections are included in these charts.

Following the flow charts, examples showing part of the design/calculation process are included.

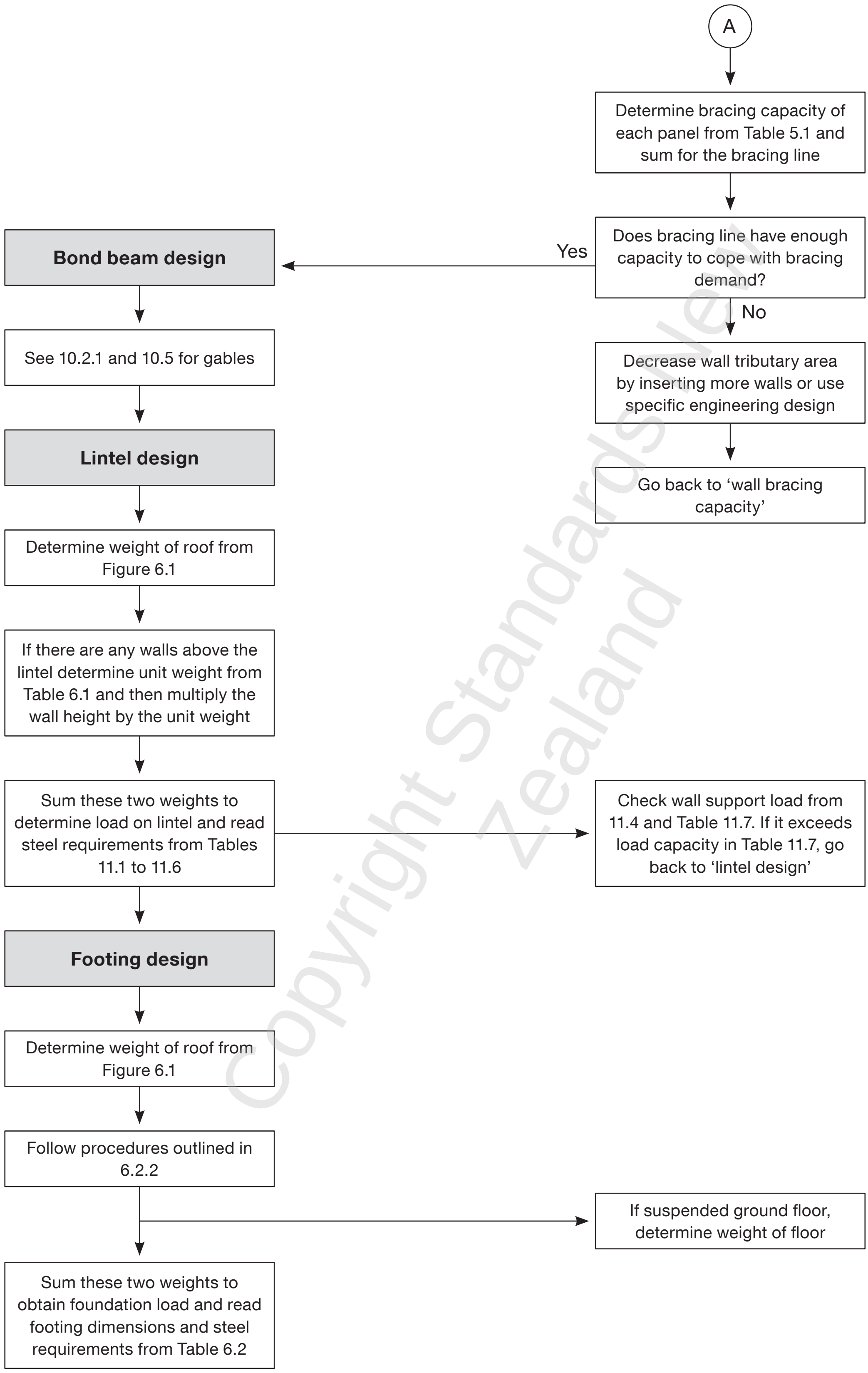
Clause D3 provides details on the research used to develop the requirements of this Standard.

D2 Flow charts

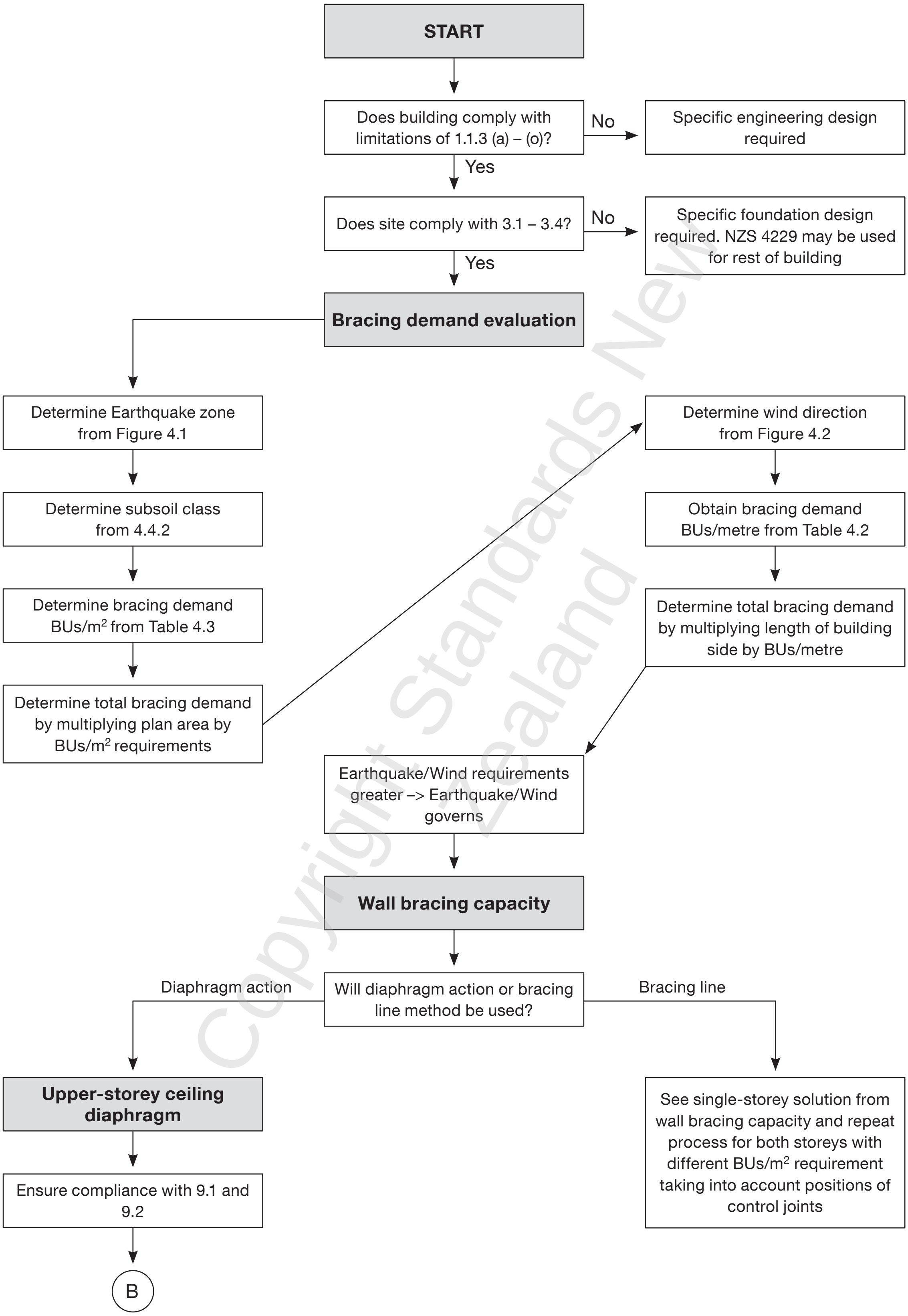
NZS 4229 Flow chart – Single-storey



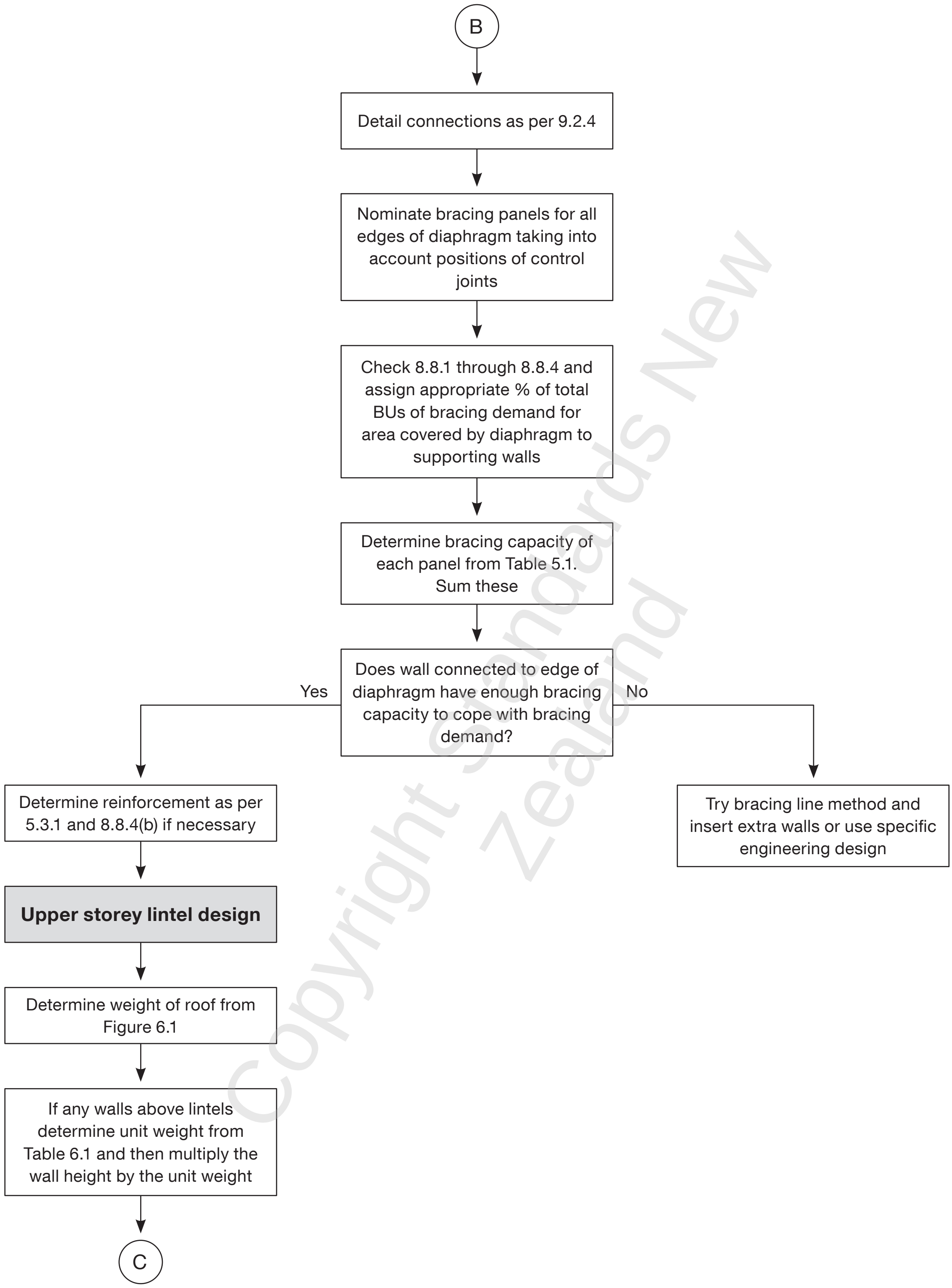
NZS 4229 Flow chart – Single-storey (continued)



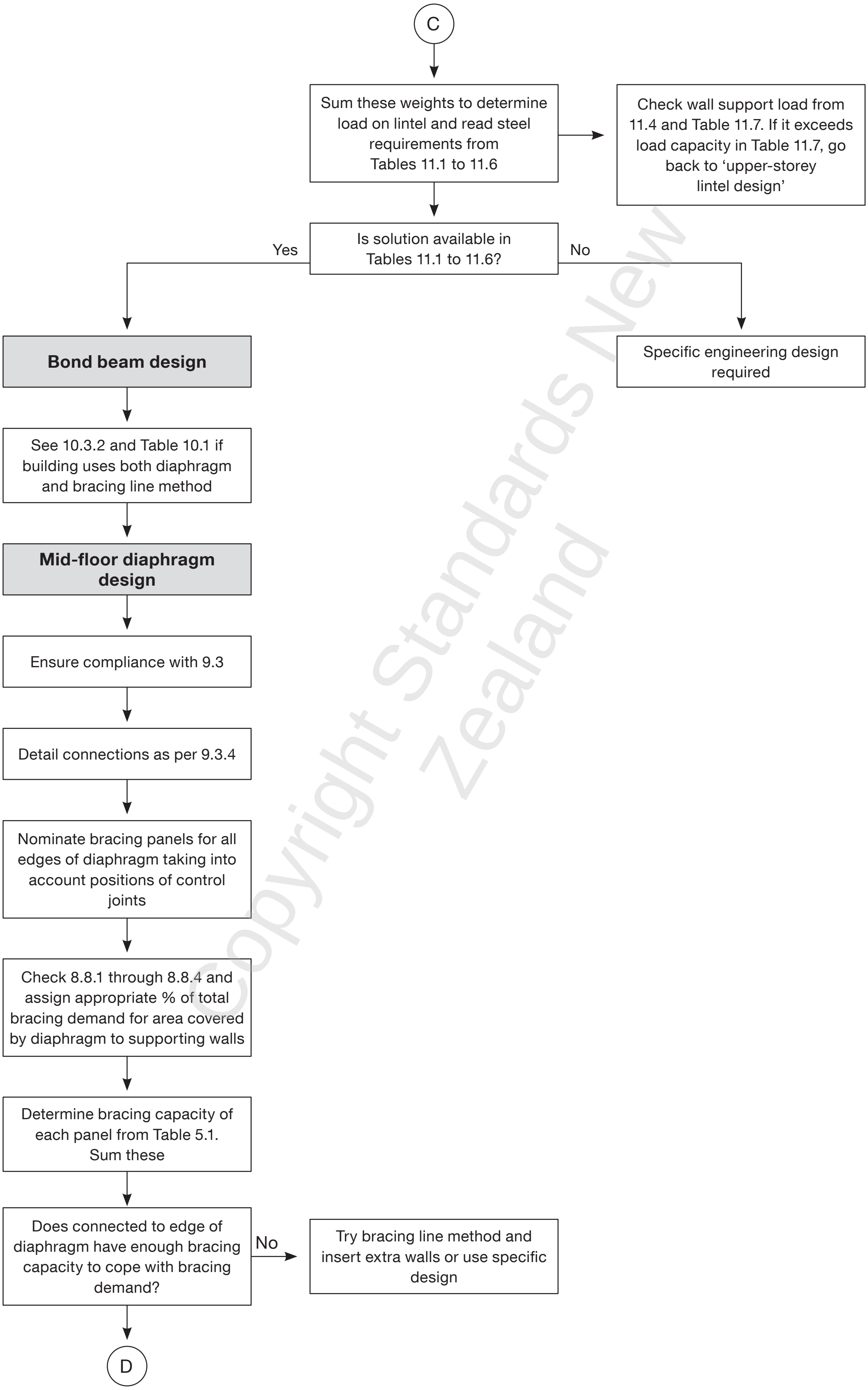
NZS 4229 Flow chart – Two-storey



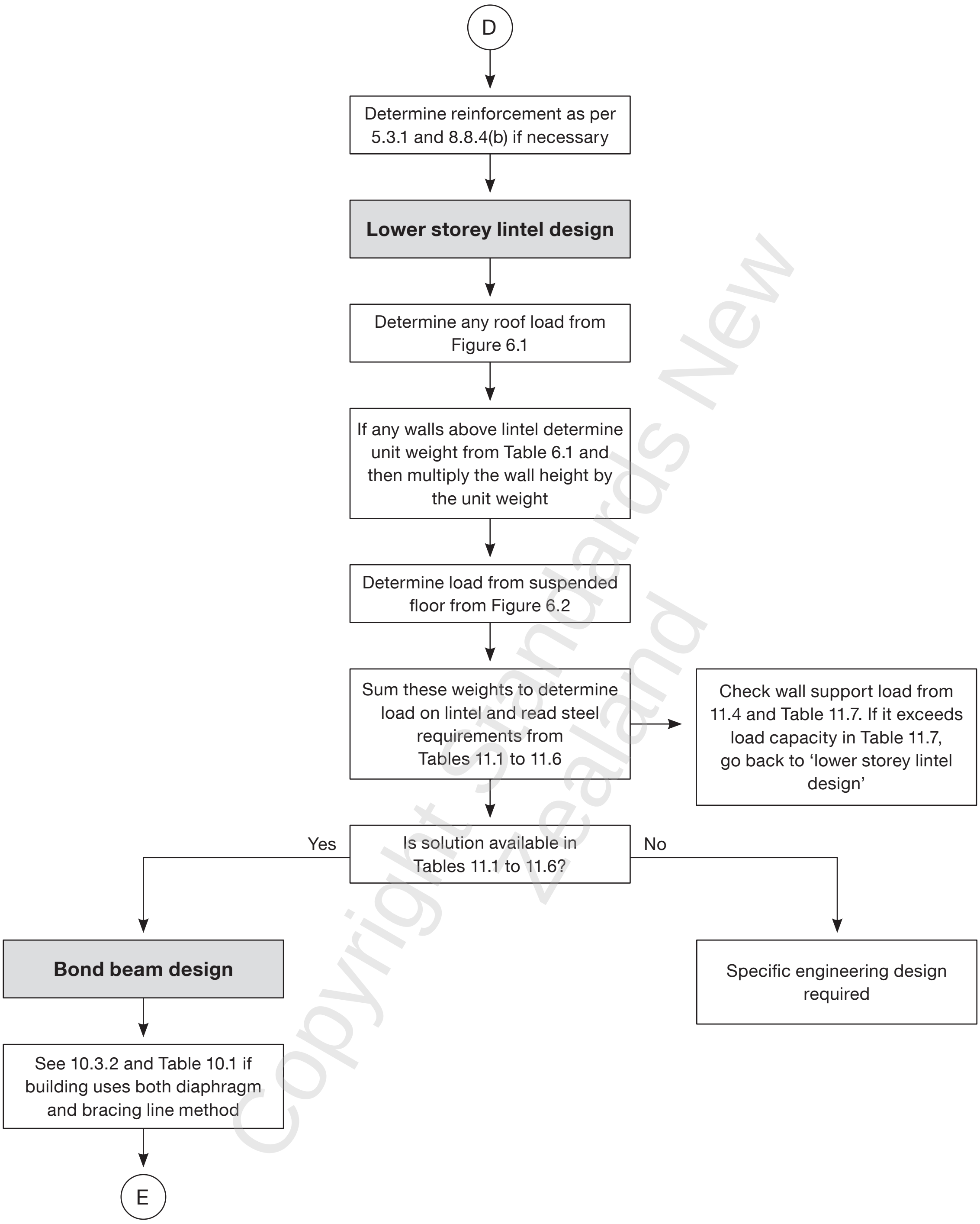
NZS 4229 Flow chart – Two-storey (continued)



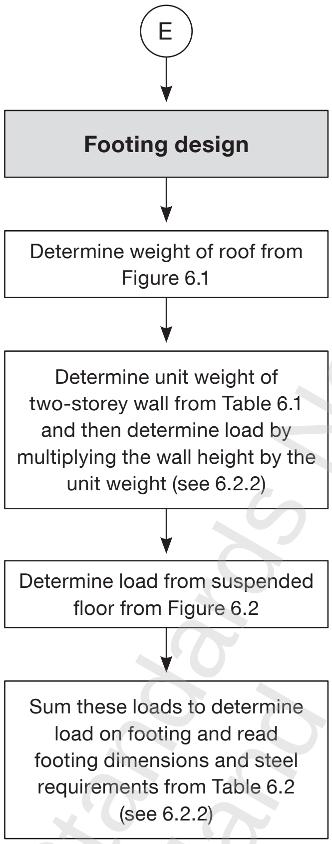
NZS 4229 Flow chart – Two-storey (continued)



NZS 4229 Flow chart – Two-storey (continued)



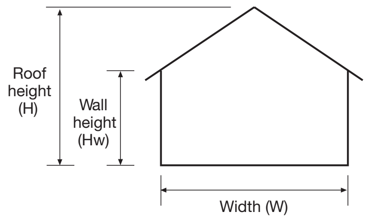
NZS 4229 Flow chart – Two-storey (continued)



D3 Single-storey construction – Worked example

D3.1 Calculation sheet

		Reference to NZS 4229
House:	Single-storey with concrete slab-on-ground floor	
Level:		
Date:		
Earthquake Zone:	1 2 3 4	Figure 4.1
Site Subsoil Class:	A B C D E	
Wind Zone:	Default Extra High	
Walls:	External 20 series partial / solid filled, no veneer	
	Internal 20 series partial / solid filled, no veneer	
Roof:	Heavy / Light Roof slope: <45°	
Floor area (A) 98 m^2	Building length (L) = 14 m (maximum length)	
	Building width (W) = 7 m	
Wall height (Hw) =	2.4 m	
Roof height (H) =	3.0 m	



D3.2 Bracing demand

Basic earthquake load EL =	28	Table 4.3
Heavy roof =	4	
Total EL =	32 BUs/m^2	
Adjust for Site Subsoil Class C using 0.79 factor:	32 x 0.79 = 25.28 BUs/m^2 (say 26 BUs/m^2)	
Total earthquake bracing =	26 BUs/ m^2 (EL) x 98 m^2 (A) = 2548 BUs	
Wind load WL =	48 BUs/m across ridge	Figure 4.2
=	56 BUs/m along ridge	Table 4.2
Total wind bracing across =	48 BUs/m (WL) x 14 m (L) = 672 BUs	
(Total wind bracing along =	56 BUs/m (WL) x 7 m (L) = 392 BUs)	
Therefore	Earthquake / Wind governing	
Total bracing required =	2548 BUs	
Lateral stability from	DIAPHRAGM / BRACING LINE system	

D3.3 Bond beam design

	Reference to NZS 4229
Maximum bond beam span = 6 m	
Span less than 7.6 m x 1.12 = 8.5 m? Yes	From 10.2.1 and Table 10.1 span max. = 7.6 m
Use B2 bond beam	
1/D16 top and bottom, 390 mm deep	Adjust for Site Subsoil Class C

D3.4 Lintel design

Roof span = 7 m — From Figure 6.1 (repeated in Figure D1)

Load = 6.82 kN/m for heavyweight

No walls above lintel, so load is 5.88 kN/m.

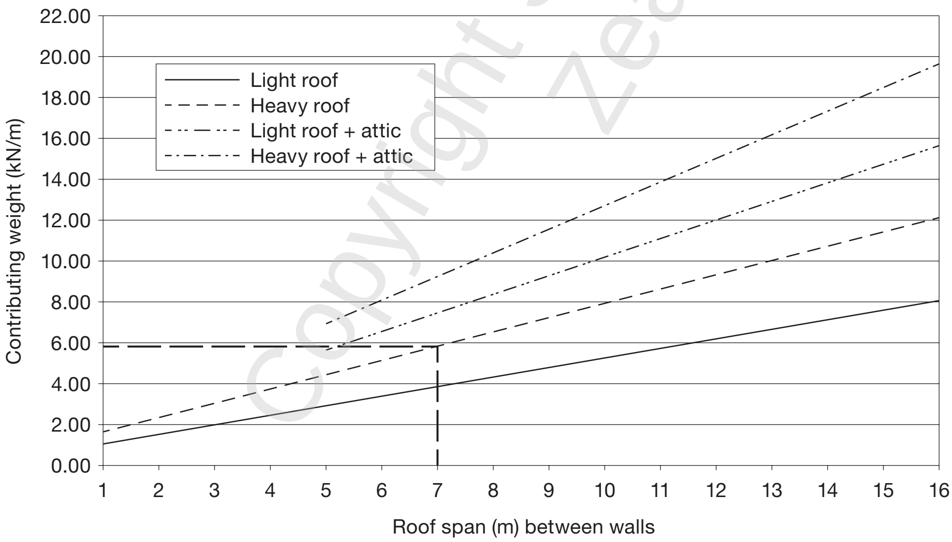
Longest lintel span is 3.2 m.
From Table 11.5, required steel is 2/D12, R6 @ 100.

Load at wall support = $\frac{3.2 \times 5.88}{2} = 9.4$ kN

From 11.4 and Table 11.7, max. load 19 kN for solid fill 190 width, that is, O.K.

Note that lintel is at the same level of bond beam.

Therefore, use bond beam steel for lintel.



NOTE –

(1) Roof weight values include a maximum ceiling weight of 0.1 kPa.

(2) A 0.75 m eaves overhang is included.

Figure D1 – Example calculation of roof weight contribution (see D3.4)

D3.5 Footing design

Roof weight =	5.88 kN/m	**Reference to NZS 4229** From Figure 6.1
Wall weight =	2.2 kN/m, 20 series partial fill	From Table 6.1
Wall height =	2.4 m	
Wall load =	2.2 kN/m x 2.4 m = 6.5 kN/m	
Total load =	6.5 + 5.88 = 12.38 kN/m	

From Table 6.2, the solution is 300 mm wide x 200 mm deep footing with 2/D12, R6 @ 600 mm.

D3.6 Bracing capacity

Calculations are given for the building example in Figure D2.

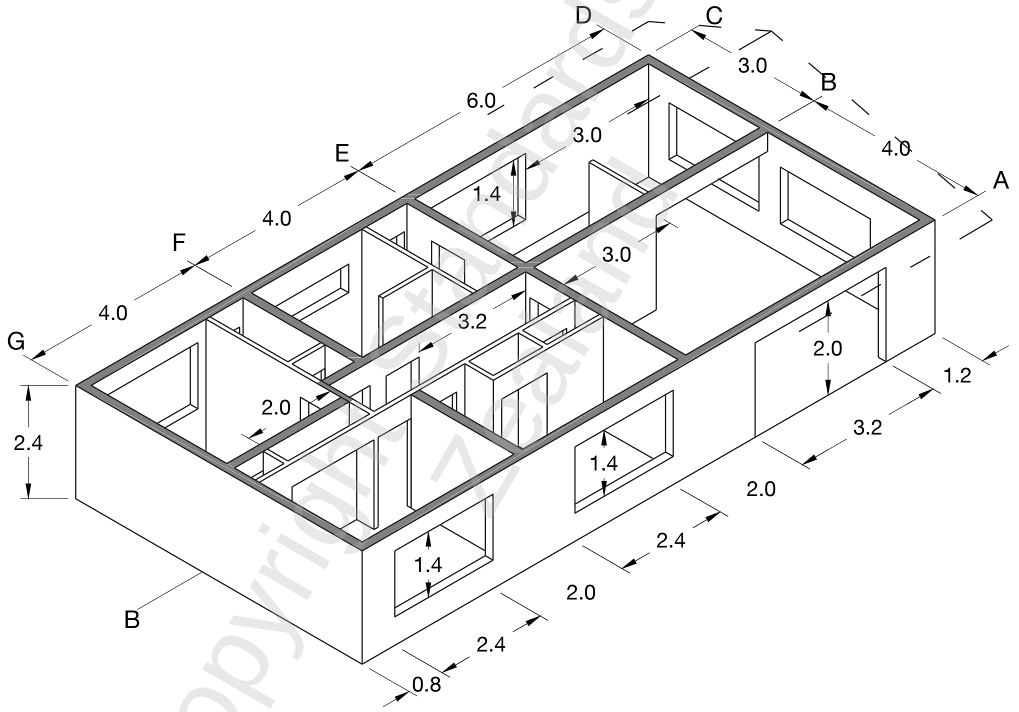


Figure D2 – Bracing capacity example (see D3.6)

D3.6.1 Line A

Reference to NZS 4229

Distance to line B = 4 m

Tributary width minimum for external wall 2 m

Bracing units required for Bracing Line A
= 2 m (Tributary width) x 14 m (Length) x 26.0 (BUs/m^2)
= 728 BUs required.

Clause 8.6.1

Bracing capacity – Line A

BUs from Table 5.1

Panel		Block	Fill	BUs	BU
Height	**Length**	**Series**		**capacity**	**Demand**
1.4	0.8	20	Partial	250	728
1.4	2.0	20	Partial	940	
1.4	2.0	20	Partial	940	
2.0	1.2	20	Partial	310	
				2440	

D3.6.2 Line B

Tributary width = 3/2 (To C) + 4/2 (To A) = 3.5 m

Clause 8.7.4

Tributary minimum width = 4 m

Bracing demand for line B = 4 x 14 x 26.0 = 1456 BUs

Bracing capacity – Line B

Panel		Block	Fill	BUs	BU
Height	**Length**	**Series**		**capacity**	**Demand**
2.0	2.0	20	Partial	695	1456
2.0	3.0	20	Partial	1395	
2.0	3.2	20	Partial	1245	
				3335	

D3.6.3 Line C

Distance to line B = 3 m

Reference to NZS 4229

Tributary width minimum for external wall 3/2 m but minimum of 2 m required.

Clause 8.6.1

Bracing units required for Bracing Line C
= 2 m (Tributary width) x 14 m (length) x 26.0 (BUs/m^2)
= 728 BUs required

Bracing capacity – Line C

Panel		Block	Fill	BUs	BU
Height	**Length**	**Series**		**capacity**	**Demand**
1.4	3.0	20	Partial	1670	728

No need to consider other panels.

D3.6.4 Line D

Tributary width = 3 m

Bracing demand for line D = 3 x 7 x 26.0 = 546

Bracing capacity – Line D

Panel		Block	Fill	BUs	BU
Height	**Length**	**Series**		**capacity**	**Demand**
1.4	1.2	20	Partial	425	546
1.4	1.2	20	Partial	425	
				850	

D3.6.5 Lines E and F

BU demand for E = 5 x 7 x 26.0 = 910

BU demand for F is similar but lower than E.

Both walls have panels 3 m long x 2 m high, each providing a bracing capacity of 1240 BU.

Hence O.K.

D3.6.6 Line G

BU demand similar to D. Capacity for panel 2.4 (height) and 7.0 (length) = 3395 which exceeds 672 demand.

D3.6.7 Calculation notes

When using bracing line approach and having calculated the bracing demand for each line, it may be quicker to identify whether a principal single panel in the line can provide the total bracing capacity to meet the demand on the line.

D3.6.8 Diaphragm method

When using a diaphragm approach, there will be fewer support lines resulting in increased bracing demands on these walls probably requiring more detailed evaluation of a series of panels.

The building example in Figure D2 is considered with no internal bracing walls and stability would need to be provided by a ceiling diaphragm.

Bracing demand will be as before, that is 2458 BUs for earthquake forces and 672 BUs for wind forces.

Clause 8.8.2 requires each external wall to carry 60% of the bracing demand. Hence each wall line A, C, D, and G shall carry 2458 x 60% = 1475 BUs.

From previous calculations:

Line A has BU capacity of 2440 BUs

Line C has BU capacity of 1670 BUs

Line D has BU capacity of 850 BUs

Line G has BU capacity of 3395 BUs

Bracing demand exceeds the capacity for line D and hence alterations to openings would need to be made to increase capacity to 1475 BUs.

Where it is impossible to amend the bracing capacity, the solution may be:

(a) Introduce additional bracing line to reduce the bracing demands on the walls but retain diaphragm method using more than one diaphragm; or

(b) Revert fully to the bracing line method.

Select the ceiling diaphragm nailing requirements from Table 9.1.

Wall type is 20 series, partially filled.

Length to width ratio is 2.0.

Wall height is 2.4 m.

Minimum nailing around ceiling diaphragm sheets is 2.5 mm dia. nails at 150 mm centres.

Interior fixing of sheets is at 300 mm centres.

D4 Derivation of tables

D4.1 General

D4.1.1

The following Standards have been used in the preparation of this Standard.

AS/NZS 1170 series

NZS 4230

NZS 3604

The following research papers were used to develop alternative wall design strategies for building types covered by this Standard from those used in NZS 4230:

Brammer, D R. 'The lateral force-deflection behaviour of nominally reinforced concrete masonry walls.' ME Thesis, Department of Civil and Resource Engineering, University of Auckland, April 1995.

Davidson, B J. 'In-plane cycling loading of nominally reinforced masonry walls with openings.' Auckland UniServices Ltd. Report, January 1995.

Kelly, T E. Holmes Consulting Group. 'Face load testing of masonry walls, analysis of response.' Report prepared for the Cement and Concrete Association of New Zealand, June 1997.

Kelly, T E. Holmes Consulting Group. 'Face load testing of masonry walls, supplementary analysis of wall with central opening.' Report prepared for the Cement and Concrete Association of New Zealand, June 1997.

Kelly, T E. Holmes Consulting Group. 'Face load testing of masonry walls, supplementary analysis of 9.0 m x 6.4 m high wall.'

Singh, Shivas S. 'The performance of a partially grouted reinforced concrete masonry wall and ribraft floor under simulated seismic loading.' ME Thesis, Department of Civil Engineering, University of Canterbury, September 1996.

Zhang, Xudong. 'Out-of-plane performance of partially grouted reinforced concrete masonry walls under simulated seismic loading.' ME Thesis, Department of Civil Engineering, University of Canterbury, September 1996.

D4.1.2

Because wind generally is not a dominant load feature for most small masonry buildings, a simplified approach has been used assuming a maximum ultimate limit state wind speed of 55 m/s corresponding to the Extra High Wind zone of NZS 3604.

D4.1.3

This Standard does not seek to fully detail timber component requirements necessary in some of the structural systems used. The Standard has identified any special provisions which are different to NZS 3604, but for installation information, reference is required to NZS 3604.

D4.1.4

The lateral load provisions of this Standard have been prepared on the assumption that partially filled heavyweight 20 Series concrete masonry units are used. Correction factors for other masonry units are provided. Total horizontal force has been calculated from AS/NZS 1170.5 assuming:

$\mu = 2$

Period of vibration < 0.4 seconds

Site Subsoil Class D (deep or soft soil sites)

$S_p = 0.7$

$k_\mu = 1.57$

$R = 1.0$

Z = As appropriate for Zones 1 (0.2), 2 (0.3), 3 (0.46), 4 (0.6)

$L_u = 1.0$

D4.1.5

A summary of design parameters used is shown in Tables D1 and D2.

Table D1 – Design parameters (see D4.1.5)

Design strengths used	
Compression $f'm$	8.0 MPa
Maximum shear provided by masonry	0.24 MPa
Strength reduction factor	
Flexure, with or without axial tension	0.80
Axial tension	0.80
Bearing on masonry	0.60
Shear and shear friction	0.70

Table D2 – Basic load data (see D4.1.5)

Heavy roof	Concrete tiles, timber roof truss, and ceiling	0.84 kPa
Light roof	Steel sheeting/tiles, timber truss, and ceiling	0.46 kPa
Timber floor	Sheeting, joists, and ceilings	0.40 kPa
Concrete floor	–	4.50 kPa
Timber partitions	Non-loadbearing	0.20 kPa (on building plan area)
All live loads as per AS/NZS 1170.1	–	–

D4.2 Bracing tables

D4.2.1 Bracing demand

The bracing unit (BU) demand Table 4.3 which expresses the BU demand in units per m^2 was developed from considering a 7 m square box building. The weights (see Table D2) of walls, suspended floors, and roofs were calculated and expressed in a square metre of building plan format.

The wall weights were based on partial grout filling using heavyweight masonry (2200 kg/m^3). No allowance has been included for using 1600 – 1800 kg/m^3 masonry.

A roof pitch of 45° was used to calculate the roof weight and also an allowance for using up to 40% of the roof plan area as a habitable attic with 1.5 kPa live load was included.

Where masonry walls are to be solid filled, a multiplication factor has been included with Table 4.3.

D4.2.2 Bracing capacity

The bracing capacity Table 5.1 was primarily developed from the research test programme listed in D4.1.1 (particularly Brammer), considering the masonry performance once the nominal shear strength of the masonry had been exceeded.

An example of developing the wall capacity calculations is shown below:

Calculation of Yield Force F_y

L	=	2600 mm
H	=	2400 mm
d_1	=	2500 mm
d_2	=	1700 mm
d_3	=	900 mm
b_w	=	140 mm
A_s	=	113 mm^2
E_s	=	200 GPa
ε_y	=	0.0015
f'_m	=	8 MPa
f_y	=	300 MPa
Self-weight	=	22 kN

Taking 1 reinforcing bar only:

$T_1 = A_s.f_y = 33.9$ kN

$C = T_1 + \text{self-weight} = 55.9 \text{ kN} = 0.85.f'_m.a.b_w$

Solve for a

a	=			58.7 mm
c	=	58.7/0.85	=	69.1 mm
ε_{s2}	=			0.0010
ε_{s3}	=			0.0005
f_{s2}	=			200 MPa
f_{s3}	=			102.5 MPa

Including second rebar

First iteration:

T_2	=	$A_s.f_y + A_{sn}.f_{sn}$	=	68.1 kN
C	=	T_2 + self-weight	=	90.1 kN
a	=			94.6 mm
c	=			111.3 mm
ε_{s2}	=			0.0010
ε_{s3}	=			0.0005
f_{s2}	=			199.5 MPa
f_{s3}	=			99.1 MPa

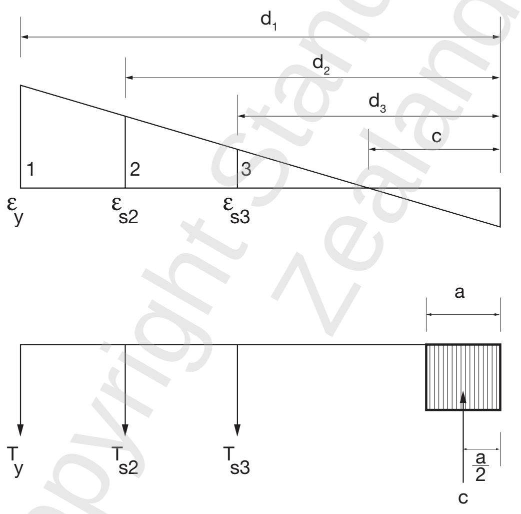


Figure D3 – Strain and force diagram (see D4.2.2)

Second iteration:

T_2	=	$A_s.f_y + A_{sn}.f_{sn}$	=	67.7 kN	
C	=	T_2 + self-weight	=	89.7 kN	
a	=			94.2 mm	
c	=			110.8 mm	
ε_{s2}	=			0.0010	
ε_{s3}	=			0.0005	
f_{s2}	=			199.5 MPa	= previous calculation
f_{s3}	=	99.1 MPa			
M_i	=	$T_y\,[d_1 - ½\,a] + T_{s2}\,[d_2 - ½\,a] + T_{s3}[d_3 - ½\,a]$			
	=	130.1 kN.m			

Calculate lateral yield force:

$F_y.(H + 200\text{ mm}) - 0.8\ [\text{self-weight}\ (½\ L - ½\ a) + M_i\ ] = 0$

Therefore $F_y = 48$ kN

The Brammer research paper recommended that for wall lengths over 3000 mm, the ideal strengths obtained from the calculation process, demonstrated in this case for 2600 mm, should be rated at 80% of the ideal strength. This factor has been applied to the bracing values in Table 5.1.

In this example the term (H + 200 mm) is used in place of the actual H of the wall. This is to account for the fact that the load will be applied to the bracing panel from the centre of the bond beam, effectively increasing the height of the bracing panel by 200 mm. The flexural strength reduction factor of 0.8 is included in the final equation for clarity and not in the main calculation.

D4.3 Bond beams and lintels

D4.3.1 Bond beams

For the evaluation in the bracing line support method it was decided to use a full scale testing programme to measure actual performance of the bond beam, see D4.1.1. A 9 m span 400 mm deep bond beam with 2/D16 bars vertically above one another was tested at Canterbury University which deflected 0.8 mm at the ultimate limit state code loading. Further testing at 0.76 g lateral load caused the deflection to extend to 7.5 mm. These results were comparable with the computer model analysis carried out by Holmes Consulting Group.

The ultimate limit state performance of the bond beams tested was approximately 3 times that predicted by conventional section analysis. Tables 8.4 and 10.1 were developed principally from the test results by using a factor of 2 on conventional section analysis with adjustments for horizontal loading conditions arising from veneer for example and in two-storey construction from the intermediate floor. Such development of the values in the tables is only permissible within the limited building parameters set by this Standard. Such span values should not be applied to other masonry structures outside the jurisdiction of the Standard without specific engineering design considering the applicability of the test data to the particular project.

D4.3.2 Lintels

The design of lintels was based on NZS 4230 using Table D1 to generate the lintel tables. Arching effects for lintels with masonry above was not included.

Lintels have been designed assuming fixed ends, that is, $wL^2/12$ for moments and $wL^4/384EI$ for deflections have been used. Creep has been accounted for by doubling ultimate limit state deflections. Deflections have been limited to the lesser of span/250 or 12 mm. Span/250 is NZS 1170.5's recommendation for deflection limits for beams with line of sight across the soffit. 12 mm has been recommended as the largest acceptable deflection before problems would be encountered on opening wide span doors and windows.

D4.3.3 Columns

The design of columns was based on NZS 4230 except that a minimum dimension of 190 mm x 190 mm was considered acceptable for the range of buildings covered by this Standard. Additional load restrictions were imposed on the Type 1 column which utilises a single D16 bar. The permitted load of 25 kN is less than half the theoretical calculated value.

D4.4 Diaphragms

D4.4.1

The design of structural diaphragms, both timber and concrete, has been based on the maximum dimensions permitted by this Standard.

D4.4.2 Concrete

The structural design of the concrete floor is not covered by this Standard. It requires specific design.

D4.4.3 Timber

The structural design of the timber floor using sheet materials such as particle board and plywood are based on the loading conditions of this Standard but require construction to be carried out as required by NZS 3604, incorporating any additional requirements such as nailing centres from this Standard. Connection details between the diaphragm and the supporting bracing walls have been specifically designed for this Standard in consultation with proprietary suppliers.

D4.5 Foundations

For simplicity of design, the foundation selection section contains conservative approximations of contributing weight. Figures 6.1 and 6.2 include the ultimate limit state load factors from AS/NZS 1170.0 in the determination of contributing floor and roof weight to the foundation. The dead load factor of 1.2 has been similarly included in Table 6.1. The footing dimensions in Table 6.2 are based on a maximum foundation pressure of 100 kPa.

D4.6 Cantilevered walls

D4.6.1

For lateral loads see D4.1.4.

D4.6.2

For design parameters see D4.1.5 and Tables D1 and D2.

D4.7 Masonry retaining walls

Generic retaining wall parameters used are contained in Part 6.1 of the *New Zealand concrete masonry manual.*

APPENDIX E – MASONRY VENEER WALL COVERING

(Informative)

CE

Users of this Standard should check E2/AS3 and the latest amendments to ensure they are referring to the latest requirements for masonry veneer wall covering.

At the time of publication of this Standard it is intended that E2/AS3 will be amended to contain all requirements for masonry veneer wall covering. Appendix E is included for guidance during the transition period between publication of NZS 4229:2013 and amendment of E2/AS3.

E1 Scope

This appendix covers requirements for masonry veneer wall covering.

(a) The maximum height of veneer is 6 m measured from the top of a supporting concrete masonry or reinforced concrete foundation or a slab edge foundation except that, if at a gable end, the overall height can be increased to 10 m.

(b) All masonry veneers are constructed in running (or stretcher) bond pattern.

(c) Where construction adjoins a public place or egress and the veneer is in excess of 6 m in height specific engineering design is required for the veneer construction.

(d) Where a timber-framed upper storey has been used then the maximum height above the masonry substructure is covered by the provisions of NZS 3604.

(e) The maximum mass of veneer is 220 kg/m^2.

E2 General

E2.1

Requirements for the materials and workmanship of masonry veneer are contained in NZS 4210.

E2.2

The maximum length of a veneer wall or return is 230 mm, measured from the external face of the veneer.

E2.3

The minimum nominal work width of masonry units is 70 mm as determined by AS/NZS 4455.1.

E3 Foundation

The maximum overhang of the veneer over the supporting foundation is 20 mm.

E4 Cavities

E4.1

The minimum width of the cavity between masonry veneer and the exterior face of the masonry structure is 40 mm and the maximum width is 75 mm.

CE4.1

It is important to maintain the minimum cavity width of 40 mm as cumulative construction tolerances could reduce the cavity width below 40 mm, which is unacceptable.

E4.2

Pipes and services may not be placed in the cavity other than passing directly through the cavity to the exterior.

E4.3

Refer to E2/AS3 for drainage, ventilation, and weathertightness details.

CE4.3

Acceptable Solution E2/AS3 refers to the CCANZ publication CP 01:2011 Code of practice for weathertight concrete and concrete masonry construction for requirements for moisture control.

E5 Wall ties

E5.1

Attach masonry veneer to a structural backing by wall ties. The ties may be dry bedded and of such a length that:

(a) They have an embedment length of at least half the width of the veneer;

(b) They have an end cover in the bed joint of not less than 15 mm.

Ensure that mortar less than 24 hours old is not subject to vibration.

E5.2

Use stiff ties which have been tested to the provisions of AS/NZS 2699.1 for the specific cavity width and comply with the durability provisions of Table E1.

CE5.2

The exposure zones are as defined in section 4 of NZS 3604.

Table E1 – Protection for masonry veneer ties supporting masonry veneer using AS/NZS 2699.1 (see E5.2)

Location (NZS 3604 Exposure Zones)	Grades 316, 316L or 304 stainless steel	470 g/m^2 galvanising on mild steel
Zone B	Yes	Yes
Zone C	Yes	Yes
Zone D	Yes	No

Table E2 – Protection for masonry veneer lintels supporting masonry veneer using AS/NZS 2699.3 (see E6.1)

Location (NZS 3604 Exposure Zones)	Grades 316, 316L or 304 stainless steel or 600 g/m^2 galvanising on mild steel plus duplex coating	600 g/m^2 galvanising on mild steel or 300 g/m^2 galvanising on mild steel plus duplex coating
Zone B	Yes	Yes
Zone C	Yes	Yes
Zone D	Yes	No

E5.3

Masonry veneer ties are spaced horizontally and vertically so that the area of masonry veneer attached to each tie does not exceed the area in m^2 specified in Table E3 for the tie duty, the earthquake zone, and the veneer mass.

E5.4

Alternatively masonry veneer ties may be selected directly from Table E4.

Table E3 – Masonry veneer area/tie (see E5.3)

Earthquake zone	Area of masonry veneer attached to each Type B veneer tie of the duty specified (m^2)					
	Veneer less than 180 kg/m^2			Veneer 180 kg/m^2 – 220 kg/m^2		
	EL	EM	EH	EL	EM	EH
1	0.24	0.24	0.24	0.20	0.24	0.24
2	0.16	0.24	0.24	0.13	0.20	0.24
3	0.11	0.16	0.24	0.09	0.13	0.24
4	0.08*	0.12	0.23	0.07*	0.11	0.22

* Some small veneer areas may be impracticable.

NOTE –

(1) The horizontal tie spacing multiplied by the vertical tie spacing selected is equal or less than the area of masonry veneer given for the earthquake zone and the veneer mass. The maximum spacing of ties is 600 mm horizontal and 400 mm vertical.

(2) Type B and prefix E indicate ties are manufactured to meet the testing conditions set out in AS/NZS 2699.1.

(3) L (light), M (medium), and H (high) indicate strength capabilities of ties to meet the testing conditions set out in AS/NZS 2699.1.

(4) Using higher strength ties does not permit the maximum spacing of ties to be increased.

(5) Ties may be face fixed to blockwork or fully embedded in the structural masonry wall joint.

(6) Minimum strengths for tie fixings to blockwork are: 0.5 kN (EL), 0.75 kN (EM), and 1.5 kN (EH).

Table E4 – Tie duty schedule (see E5.4)

Earthquake zone	Masonry veneer attached by Type B veneer ties of the duty and spacings specified	
	Veneer less than 180 kg/m^2	Veneer 180 kg/m^2 – 220 kg/m^2
	Spacing 600 mm x 400 mm	Spacing 500 mm x 400 mm
1	EL	EL
2	EM	EM
3	EH*	EH*
4	SED*	EH

* The veneer area/tie table (Table E3) will provide a more judicious tie spacing.

NOTE –

(1) Maximum spacing of ties with veneer less than 180 kg/m^2 and for SED is 600 mm by 400 mm. SED means actual spacing of ties is to be determined by specific engineering design.

(2) Maximum spacing of ties with veneer between 180 kg/m^2 and 220 kg/m^2 is 500 mm by 400 mm.

(3) Type B and prefix E indicate ties are manufactured to meet the testing conditions set out in AS/NZS 2699.1.

(4) L (light), M (medium), and H (high) indicate strength capabilities of ties to meet the testing conditions set out in AS/NZS 2699.1.

(5) Using higher strength ties does not permit the maximum spacing of ties to be increased.

(6) Ties may be face fixed to blockwork or fully embedded in the structural masonry wall joint.

(7) Minimum strengths for tie fixings to blockwork are: 0.5 kN (EL), 0.75 kN (EM), and 1.5 kN (EH).

E6 Openings

E6.1

Openings with masonry veneer above are spanned by steel lintel angles protected against corrosion to the provisions of Table E2 and for the structural sizes required by Table E5.

E6.2

Steel lintel angles have a minimum seating of 100 mm for spans up to and including 2 m and 200 mm for spans over 2 m.

Table E5 – Veneer lintel table – Steel angles (see E6.1)

Maximum lintel span (mm)	**Thickness of veneer** (mm)					
	70 mm			**90 mm**		
	Maximum height of veneer supported (mm)					
	350	**700**	**2000**	**350**	**700**	**2000**
2000	60 x 60 x 6	60 x 60 x 6	60 x 60 x 6	60 x 80 x 6	60 x 80 x 6	80 x 80 x 6
2500	60 x 60 x 6	80 x 80 x 6	80 x 80 x 6	80 x 80 x 6	80 x 80 x 6	80 x 80 x 8
3000	60 x 60 x 6	80 x 80 x 6	125 x 75 x 6	80 x 80 x 6	80 x 80 x 8	90 x 90 x 10
3500	80 x 80 x 6	80 x 80 x 6	125 x 75 x 6	80 x 80 x 8	90 x 90 x 10	125 x 75 x 10
4000	80 x 80 x 8	125 x 75 x 6	125 x 75 x 10	80 x 80 x 10	125 x 75 x 6	150 x 90 x 10
4500	125 x 75 x 6	125 x 75 x 10	–	125 x 75 x 6	125 x 75 x 10	–
4800	125 x 75 x 6	125 x 75 x 10	–	125 x 75 x 6	125 x 75 x 10	–

NOTE –

(1) All sections are steel angles.

(2) Stainless steel sections of equivalent section modulus are a permitted alternative.

Approved by the Minister for Building and Construction on 6 March 2013.

Approved by the Standards Council on 11 March 2013 to be a New Zealand Standard pursuant to the provisions of section 10 of the Standards Act 1988.

First published: 27 March 2013.

The following references relate to this Standard:

Project No. P 4229

Draft for comment No. DZ 4229

Typeset by: Standards New Zealand

STANDARDS
NEW ZEALAND
PAEREWA AOTEAROA