Dear Customer

Please find enclosed Amendment 12, effective 14 February 2014, to the Acceptable Solutions and Verification Methods for Clause B1 Structure of the New Zealand Building Code. The previous amendment to B1 was Amendment 11, August 2011.

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Acceptable Solutions and Verification Methods

For New Zealand Building Code Clause

B1 Structure
Status of Verification Methods and Acceptable Solutions

Verification Methods and Acceptable Solutions are prepared by the Ministry of Business, Innovation and Employment in accordance with section 22 of the Building Act 2004. Verification Methods and Acceptable Solutions are for use in establishing compliance with the New Zealand Building Code.

A person who complies with a Verification Method or Acceptable Solution will be treated as having complied with the provisions of the Building Code to which the Verification Method or Acceptable Solution relates. However, using a Verification Method or Acceptable Solution is only one method of complying with the Building Code. There may be alternative ways to comply.

Users should make themselves familiar with the preface to the New Zealand Building Code Handbook, which describes the status of Verification Methods and Acceptable Solutions and explains alternative methods of achieving compliance. Defined words (italicised in the text) and classified uses are explained in Clauses A1 and A2 of the Building Code and in the Definitions at the start of this document.
**Document Status**

The most recent version of this document (Amendment 12), as detailed in the Document History, are approved by the Chief Executive of the Ministry of Business, Innovation and Employment. The previous version of this document (Amendment 11) will cease to have effect on 14 August 2014. People using this document should check for amendments on a regular basis. The Ministry of Business, Innovation and Employment may amend any part of any Verification Method or Acceptable Solution at any time. Up-to-date versions of Verification Methods and Acceptable Solutions are available from www.dbh.govt.nz

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References

For the purposes of New Zealand Building Code compliance, the acceptable New Zealand and other Standards, and other documents referred to in these Verification Methods and Acceptable Solutions (primary reference documents) shall be the editions, along with their specific amendments, listed below. Where the primary reference documents refer to other Standards or other documents (secondary reference documents), which in turn may refer to other Standards or other documents, and so on (lower order reference documents), then the applicable version of these secondary and lower order reference documents shall be the version in effect at the date these Verification Methods and Acceptable Solutions were published.

Standards New Zealand

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COMMENT

The above suite of Structural Design Action Standards, together with their amendments, are referred to collectively as “AS/NZS 1170”.

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Definitions

This is an abbreviated list of definitions for words or terms particularly relevant to these Acceptable Solutions and Verification Methods. The definitions for any other italicised words may be found in the New Zealand Building Code Handbook.

**Adequate** Adequate to achieve the objectives of the Building Code.

**Alter** in relation to a building, includes to rebuild, re-erect, repair, enlarge and extend the building.

**Baluster** A post providing the support for the top and bottom rails of a barrier.

**Boundary joist** A joist running along the outer ends of the floor joists.

**Building** has the meaning ascribed to it by sections 8 and 9 of the Building Act 2004.

**Building element** Any structural and non-structural component or assembly incorporated into or associated with a building. Included are fixtures, services, drains, permanent mechanical installations for access, glazing, partitions, ceilings and temporary supports.

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

**Chimney** A *non-combustible* structure which encloses one or more *flues*, *fireplaces* or other heating appliances.

**Chimney back** The *non-combustible* wall forming the back of a *fireplace*.

**Chimney base** That part of a *chimney* which houses the *fireplace*.

**Chimney jamb** The side walls of a *fireplace*.

**Combustible** See *non-combustible*.

**Construct** in relation to a building, includes to design, build, erect, prefabricate, and relocate the building.

**Drain** A pipe normally laid below ground level including fittings and equipment and intended to convey *foul water* or *surface water* to an *outfall*.

**Factor of safety** in relation to any building means the ratio of resisting forces to applied forces for a given loading condition. It is generally expressed to two significant figures.

**Fireplace** A space formed by the *chimney back*, the *chimney jamb*, and the *chimney breast* in which fuel is burned for the purpose of heating the room into which it opens.

**Fixture** An article intended to remain permanently attached to and form part of a building.

**Flue** The passage through which the products of combustion are conveyed to the outside.

**Gather** That part of a *chimney* where the transition from *fireplace* to stack occurs.

**Good ground** means any soil or rock capable of permanently withstanding an ultimate bearing pressure of 300 kPa (i.e. an allowable bearing pressure of 100 kPa using a factor of safety of 3.0), but excludes:

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

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

c) Any ground which could forseeably 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 shrinking, frost heave, changing ground water level, erosion, dissolution of soil in water, and effects of tree roots.
COMMENT:
Soils (excepting those described in a), b) and c) above) tested with a dynamic cone penetrometer in accordance with NZS 4402 Test 6.5.2, shall be acceptable as good ground for building foundations if penetration resistance is no less than:

a) 5 blows per 100 mm at depths down to twice the footing width.
b) 3 blows per 100 mm at depths greater than twice the footing width.

Depths shall be measured from the underside of the proposed footing.

Hearth The insulating floor under the fire and in front and at the sides of the fireplace.

Intended use, in relation to a building:

a) includes any or all of the following:
   i) any reasonably foreseeable occasional use that is not incompatible with the intended use;
   ii) normal maintenance;
   iii) activities undertaken in response to fire or any other reasonably foreseeable emergency; but
b) does not include any other maintenance and repairs or rebuilding.

Nominal pile width The least width of a pile in side view and is equal to the diameter in round piles.

Non-combustible Materials shall be classified as non-combustible or combustible when tested to: AS 1530 – Part 1.

Other property

a) means any land or buildings, or part of any land or buildings, that are—
   i) not held under the same allotment; or
   ii) not held under the same ownership; and
b) includes a road

Sitework means work on a building site, including earthworks, preparatory to or associated with the construction, alteration, demolition or removal of a building.

Specified intended life has the meaning given to it by section 113(3) of the Building Act 2004.

Section 113(3) states:
“(3) In subsection (2), specified intended life, in relation to a building, means the period of time, as stated in an application for a building consent or in the consent itself, for which the building is proposed to be used for its intended use.”

Strength reduction factor The factor by which the ultimate strength is multiplied to obtain the design strength.

COMMENT:
NZS 4203: 1992 uses the terms ideal strength in place of ultimate strength, and dependable strength in place of design strength.

Surface water All naturally occurring water, other than sub-surface water, which results from rainfall on the site or water flowing onto the site, including that flowing from a drain, stream, river, lake or sea.

Territorial authority (TA) means a city council or district council named in Part 2 of Schedule 2 of the Local Government Act 2002; and—

a) in relation to land within the district of a territorial authority, or a building on or proposed to be built on any such land, means that territorial authority; and
b) in relation to any part of a coastal marine area (within the meaning of the Resource Management Act 1991) that is not within the district of a territorial authority, or a building on or proposed to be built on any such part, means the territorial authority whose district is adjacent to that part.

Verification Method means a method by which compliance with the Building Code may be verified.
1.0 General

1.0.1 The Standards cited in this Verification Method provide a means for the design of structures to meet the performance requirements of New Zealand Building Code Clause B1 Structure. For any particular building or building design, the Verification Method shall consist of AS/NZS 1170 used in conjunction with the relevant cited material standards as modified by this Verification Method.

1.0.2 Modifications to the Standards, necessary for compliance with the New Zealand Building Code, are given against the relevant clause number of each Standard.

1.0.3 Citation of Standards in this Verification Method is subject to the following conditions.

a) The citation covers only the scope stated or implicit in each Standard. Aspects outside the scope, when applied to a particular building, are not part of the Verification Method.

b) Further limitations, modifications and/or constraints apply to each Standard as noted below.

c) Provisions in the cited Standards that are in non-specific or unquantified terms do not form part of the Verification Method. Non-specific or unquantified terms include, but are not limited to, special studies, manufacturer’s advice and references to methods that are appropriate, adequate, suitable, relevant, satisfactory, acceptable, applicable, or the like.

d) Where AS/NZS 1170 is used in combination with other Standards cited in this Verification Method and there are incompatibilities with these other Standards, then the underlying philosophy, general approach, currency of information and methods of AS/NZS 1170 are to take precedence.

e) An engineer with relevant experience and skills in structural engineering shall be responsible for interpretation of the requirements of the Standards cited when used for building structure design. A structural engineer who is chartered under the Chartered Professional Engineers of New Zealand Act 2002 would satisfy this requirement.

COMMENT

The Standards referenced in this Verification Method relating to building design require the application of specialist engineering knowledge, experience and judgement in their use.

2.0 Structural Design Actions Standards

2.1 The requirements of the AS/NZS 1170 suite of Standards are to be complied with. These comprise:

- AS/NZS 1170.0: 2002 including Amendments 1, 2, 3, 4 and 5
- AS/NZS 1170.1: 2002 including Amendments 1 and 2
- AS/NZS 1170.2: 2011 including Amendments 1, 2 and 3

COMMENT

This suite of Standards, together with their amendments, are referred to collectively in this Verification Method as “AS/NZS 1170”.

2.2 The requirements of AS/NZS 1170 are subject to the following modifications.

2.2.1 Material Standards Where AS/NZS 1170 calls for the use of appropriate material Standards, only those material Standards referenced in this Verification Method B1/VM1 are included. Use of other Standards with AS/NZS 1170 must be treated as an alternative means of verification.
2.2.2 Notes in AS/NZS 1170

“Notes” that relate to clauses, tables or figures of AS/NZS 1170 are part of the Verification Method.

**COMMENT**

AS/NZS 1170 makes a general statement that notes are not an integral part of the Standard. However, in many cases the content of the notes makes them an integral part of the interpretation of the Standard. In these cases, the notes have been specifically cited as being part of this Verification Method.

2.2.3 AS/NZS 1170 Part 0, Clause 4.1

General

Add the following to the end of the Clause:

“The combination factors for permanent actions (dead loads) are based on the assumption that they have a coefficient of variation of approximately 10%. Situations where this assumption is not valid are outside the scope of this Verification Method.”

2.2.4 AS/NZS 1170 Part 0, Clause 4.2.4

Replace the Clause with the following:

“The combination of actions for checking strength and stability for the ultimate limit state for fire shall be as follows:

(a) During the fire:
   (i) \[G, \text{thermal actions arising from fire, } \psi_l Q\]
   together with:
   (ii) a lateral force of 2.5% of \((G + \psi_C Q)\) applied as per Clause 6.2.2.

(b) After the fire until the building is either repaired or demolished:
   (i) \[G, \text{thermal actions arising from fire, } \psi_l Q\]
   together with the more critical of either:
   (ii) a lateral force of 2.5% of \((G + \psi_C Q)\) applied as per Clause 6.2.2.

   or

   (iii) a uniformly distributed horizontal face load of 0.5 kPa in any direction.

Account shall be taken of the effects of the fire on material properties and the geometry of the structure.”

2.2.5 AS/NZS 1170 Part 0, Clause 5.2

**Structural models**

Delete (a) to (d) in Clause 5.2 and replace with:

“(a) Static and/or dynamic response.
(b) Elastic and/or non-elastic (plastic) response.
(c) Geometrically linear and/or geometrically non-linear response.
(d) Time-independent and/or time-dependent behaviour.”

**COMMENT**

Each of the modelling approaches (a), (b), (c) and (d) allows only one method. This is unnecessarily restrictive since designers may decide to use both approaches for a particular building. Accordingly, “or” has been replaced with “and/or”.

2.2.6 AS/NZS 1170 Part 1, Table 3.2

Replace the entry for “R2, Other roofs (i) Structural elements” with:

“R2 Other roofs (i) Structural elements 0.25 1.1”

Delete Note 2
Delete Note 3

2.2.7 AS/NZS 1170 Part 1, Clause 3.6 Barriers

In the first paragraph, second sentence, delete “… top edge or handrail…” and substitute “… top edge and rail…”

Delete the second paragraph and substitute:

“Apply as detailed below the uniformly distributed line loads (kN/m), uniformly distributed loads (kPa) and concentrated loads (kN) given in Table 3.3.

For the purposes of applying loads, a rail shall be any handrail or any top rail having a width in plan of greater than 30 mm.

The following are separate load cases, and one load at a time, either vertical or horizontal, is to be applied.

(a) Line loads (kN/m). Regardless of barrier height, line loads need not be applied more than 1200 mm above the floor (or stair pitch line):
   (i) For domestic and residential activities, other residential (Row 2 of Table 3.3)
      - For barriers with a rail or rails:
        - apply the horizontal load to the top rail
where the top of the barrier is not a rail and where it is less than 200 mm above the top rail, the horizontal load to the top of the barrier may be reduced by 50%, otherwise apply the full horizontal load

• apply the vertical load to the top of the barrier.

• For barriers without a rail, apply:
  – the horizontal load at 900 mm above the floor (or stair pitch line)
  – 50% of the horizontal load to the top of the barrier
  – the vertical load to the top of the barrier.

(ii) For all types of occupancy other than Row 2 of Table 3.3:
• apply the loads to the top edge of the barrier and to the top rail
• where the top of the barrier is not a rail and where it is less than 200 mm above the top rail, the horizontal load to the top of the barrier may be reduced by 50%, otherwise apply the full horizontal load.

(b) Distributed loads (kPa):
For all types of occupancy:
• consider the load as acting over the whole area bounded by the top of the barrier and the floor line for the full length of the barrier
• distribute this load to the appropriate solid portions of the barrier.

(c) Concentrated loads (kN):
For all types of occupancy:
• consider each concentrated load to be distributed over a circular or square area of 2000 mm²
• apply concentrated loads so as to produce the most severe effect on the structural element being considered

• concentrated loads applied more than 1200 mm above the floor (or stair pitch line) may be reduced by 50%
• where the barrier infill or balustrade consists of parallel vertical members, less than 100 mm wide and with spaces between them of less than 100 mm, 50% of the concentrated load may be applied to each vertical member.”

COMMENT
In Table 3.3, “external balconies” for domestic and residential activities applies to decks, balconies, verandahs and the like of individual houses as well as multi household unit buildings. Such barriers may be required by Clause F4 of the Building Code.

2.2.8 AS/NZS 1170 Part 1, Clause 3.8
Car park Add to the last paragraph of Clause 3.8:
“The basis for determining the horizontal impact actions on barriers quoted in the Clause, including the assumed deceleration distances, is given in Clause C 3.8 of the Commentary to AS/NZS 1170 Part 1. Different design actions may be derived using Equation C3.8, provided that:
(i) The deceleration length applied is based on analysis or tests.
(ii) The vehicle mass and associated velocity are not reduced from those quoted in Commentary Clause C3.8.”

2.2.9 AS/NZS 1170 Part 1, Appendix B
Replace the last paragraph with the following:
“For the design of outdoor visitor structures as defined in SNZ HB 8630: 2004, the imposed actions must be as given by that publication with references to NZS 4203 replaced by equivalent references to AS/NZS 1170.”

2.2.10 AS/NZS 1170 Part 2, Clauses 3.2 and 4.4.3
Add the following at the end of Clauses 3.2 and 4.4.3:
“Where local wind design information is more onerous than determined by this Standard and is published and required to be used by any territorial authority for its area, this local wind design information shall take precedence over the equivalent information in this Standard for the determination of wind actions on buildings.”
Where such local wind design information is less onerous than that of this Standard, the use of such information is not part of this Verification Method.”

2.2.12 AS/NZS 1170 Part 3, Clause 2.1
Add the following at the end of Clause 2.1:

“Where local snow and ice design information is more onerous than determined by this Standard and is published by any territorial authority for its area, this local snow and ice design information shall take precedence over the equivalent information in this Standard for the determination of snow and ice actions on buildings.

Where such local snow and ice design information is less onerous than that of this Standard, the use of such information is not part of this Verification Method.”

2.2.13 AS/NZS 1170 Part 3, Clause 5.4.3
Add the following to the end of Clause 5.4.3:

“For Regions N4 and N5 the minimum value of \( s_g \) for the ultimate limit state only must be taken as 0.9 kPa.”

2.2.14 NZS 1170 Part 5, Clause 1.4
Add the following to the end of the Clause 1.4:

“Where a special study yields a site-specific uniform risk design spectrum for 500 year return period equivalent to a hazard factor, \( Z \), of less than 0.08, a design spectrum equivalent to at least \( Z = 0.10 \) may be adopted and the minimum magnitude 6.5 earthquake need not be considered.

COMMENT:
In areas where the uniform risk hazard factor is less than 0.08, the use of a minimum hazard factor \( Z = 0.13 \) implies design for earthquakes with extremely low probabilities of occurrence. For some projects in these areas this may involve considerable cost consequences and a reduction in requirements is acceptable when site-specific hazard studies are undertaken.”

Consequential changes due to 2010/11 Canterbury earthquakes

COMMENT:
1. As a result of the 2010/11 sequence of earthquakes in Canterbury, there is a heightened risk of seismic activity over the next few decades above that currently factored into structural design requirements. B1/VM1 is amended to reflect an increased seismic hazard factor for the Canterbury earthquake region.

2. The seismic hazard factor \( Z \) defined in NZS 1170 Part 5 (Table 3.3) has been raised for the Canterbury earthquake region. This is reflected in the following amendments to B1/VM1.

2.2.14a NZS 1170 Part 5, Clause 3.1.4
Add (to the end of Clause 3.1.4):

“The minimum hazard factor \( Z \) (defined in Table 3.3) for the Canterbury earthquake region shall be 0.3. Where factors within this region are greater than 0.3 as provided by NZS 1170 Part 5, then the higher value shall apply.

The hazard factor for Christchurch City, Selwyn District and Waimakariri District shall apply to all structure periods less than 1.5 seconds.”

COMMENT:
The revised \( Z \) factor is intended only for use for the design and assessment of buildings and structures, pending further research. All structures with periods in excess of 1.5 seconds should be subject to specific investigation, pending further research.

2.2.14e NZS 1170 Part 5, Table 3.3
Delete row: 102 Christchurch 0.22 -
Replace with: 102 Christchurch 0.3 -
Delete row: 101 Akaroa 0.16 -
Replace with: 101 Akaroa 0.3 -

2.2.14c NZS 1170 Part 5, Clause 3.1.5
Add (as another paragraph after the last sentence in Clause 3.15):

“In the Canterbury earthquake region, the risk factor for the serviceability limit state shall not be taken less than \( R_s = 0.33 \).”

2.2.14o NZS 1170 Part 5, Figure 3.4
Figure 3.4 Hazard factor \( Z \) for the South Island is amended as per Paragraph 2.2.14a above.
2.2.15 NZS 1170 Part 5, Clause 4.2 Seismic weight and seismic mass
After: “0.3 is the earthquake imposed action (live load) combination factor for all other applications” add the following:

“except roofs.
ψ_E = 0.0 is the earthquake imposed action (live load) combination factor for roofs.”

2.2.16 NZS 1170 Part 5, Sections 5 and 6
Time history analysis
Time history analysis is not part of this Verification Method.

COMMENT:
Time history analysis is a highly specialised method of assessing structural response to earthquakes. It requires many detailed and interdependent assumptions to be made in relation to the nature of earthquake shaking and its propagation from the source, the properties of the building site and the detailed characteristics of the building and its structural elements.

AS/NZS 1170 outlines the steps for time history analysis in some detail, but the applicability of each step needs to be evaluated on a building-by-building basis. More importantly, the output of the analysis needs to be examined carefully in each particular context.

Time history analysis can be an acceptable aid to verifying compliance with structural requirements provided that:

- It is carried out by specialists with in-depth experience in applying the technique.
- The output of the analysis and the viability of the resulting structural design are reviewed by an independent team experienced in both analysis and design.

2.2.17 NZS 1170 Part 5, Clause 5.2.2.3, equation 5.2(4)
Delete equation 5.2(4) and replace with:

\[ C_d(T) = \frac{C(T) S_p}{k \mu} \] … 5.2(4)

2.2.18 NZS 1170 Part 5, Clause 6.1.4.1
Requirement for modelling
Delete the last sentence of the first paragraph and replace with:

“The model shall include representation of the diaphragm’s flexibility.”

Delete the third (last) paragraph.

3.0 Concrete

3.1 NZS 3101: Part 1 subject to the following modifications:

a) Replace clause 4.8 External walls that could collapse outward in fire with:

4.8 External walls that could collapse inwards or outwards in fire

4.8.1 Application
This clause applies to external walls which could collapse inwards or outwards from a building as a result of internal fire exposure.

All such walls shall:

- (a) Be attached to the building structure by steel connections;
- (b) Be restrained by these connections, when subject to fire, from inwards or outward movement of the wall relative to the building structure; and
- (c) Comply with the appropriate provisions of this Standard for walls.

4.8.2 Forces on connections
The connections between each wall and the supporting structure shall be designed to resist all anticipated forces. In the absence of a detailed analysis, the connections shall be designed to resist the largest of:

- (a) The force resulting from applying Clause 2.2.4 of Verification Method B1/VM1;
- (b) for walls fixed to a flexible structure of unprotected steel, the force required to develop the nominal flexural strength of the wall at its base;
- (c) for walls fixed to a rigid structure such as reinforced concrete columns or protected steel columns or another wall at right angles, the force required to develop the nominal flexural strength of the wall at mid-height.

b) Amend Clause 9.3.9.4.13 Minimum area of shear reinforcement
In Clause 9.3.9.4.13 c) delete the words after “750 mm” and substitute “and the depth of the precast unit is equal to or less than 300 mm.”
c) Amend Clause 18.7.4 Floor or roof members supported by bearing on a seating

Add to the end of Clause 18.7.4 (g)(ii) add an additional sentence:
“The details given by C18.6.7(e) may be applied to hollow-core units where the depth of the precast unit is equal to or less than 300 mm.”

3.2 NZS 3106

4.0 Concrete Masonry

4.1 NZS 4230

5.0 Steel

5.1 NZS 3404: Part 1

5.2 AS/NZS 4600 subject to the following modifications:

a) Actions must be determined in accordance with AS/NZS 1170. All references to NZS 4203 are replaced by equivalent references to AS/NZS 1170.

b) The term “normative” identifies a mandatory requirement for compliance with this Standard.

c) The term “informative” identifies information provided for guidance or background which may be of interest to the Standard’s users. Informative provisions do not form part of the mandatory requirements of the Standard.

d) Where this Standard has provisions that are in non-specific or unquantified terms then these do not form part of the Verification Method and the proposed details must be submitted to the territorial authority for approval as part of the building consent application. This includes, but is not limited to, special studies and manufacturer’s advice.

e) All stages of construction of a structure or part of a structure to which this Standard is applied shall be adequately reviewed by a person who, on the basis of experience or qualifications, is competent to undertake the review.

f) The extent of the review to be undertaken shall be nominated by the design engineer, taking into account those materials and workmanship factors which are likely to influence the ability of the finished construction to perform in the predicted manner.

g) At the end of the first paragraph of Appendix A add the words “Unless noted otherwise a document referred to below shall be the version of that document current at the date of issue of this Standard or if amendments are cited to this Standard in the “References” pages of this document at the latest date of those amendments.”

h) Appendix B shall be read as normative with “shoulds” changed to “shalls”.

5.3 NASH Standard – Residential and Low-rise Steel Framing Part 1: Design Criteria.

6.0 Timber

6.1 NZS 3603 subject to the following modifications:

a) Actions must be determined in accordance with AS/NZS 1170. All references to NZS 4203 are replaced by equivalent references to AS/NZS 1170.

b) Delete Clause 2.2.1.2 and replace with:
“Machine stress-grading shall be in accordance with AS/NZS 1748 as modified by NZS 3622. Machine stress-graded timber shall have its properties verified, and be identified, in accordance with the requirements of NZS 3622.”

7.0 Aluminium

7.1 AS/NZS 1664.1 subject to the following modifications:

a) Actions must be determined in accordance with AS/NZS 1170. All references to NZS 4203 are replaced by equivalent references to AS/NZS 1170.

b) The terms “capacity factor” and “strength limit state” are to be read as “strength reduction factor” and “ultimate limit state” respectively.
c) Where this Standard has provisions that are in non-specific or unquantified terms then these do not form part of the Verification Method and the proposed details must be submitted to the territorial authority for approval as part of the building consent application. This includes, but is not limited to, special studies and manufacturer’s advice.

d) All stages of construction of a structure or part of a structure to which this Standard is applied shall be adequately reviewed by a person who, on the basis of experience or qualifications, is competent to undertake the review.

e) The extent of the review to be undertaken shall be nominated by the design engineer, taking into account those materials and workmanship factors which are likely to influence the ability of the finished construction to perform in the predicted manner.

f) Clause 1.2 to read “MATERIALS This Standard applies to aluminium alloys listed in Table 3.3(A) that comply with AS 1734, AS 1865, AS 1866, AS 1867 and AS 2748.1.”

g) At the end of the first paragraph of Clause 1.4 add the words “Unless noted otherwise a document referred to below shall be the version of that document current at the date of issue of this Standard or if amendments are cited to this Standard in the “References” pages of the Acceptable Solutions and Verification Methods at the latest date of those amendments.”

8.0 Earth Buildings

8.1 NZS 4297 subject to the following modifications:

Actions must be determined in accordance with AS/NZS 1170. All references to NZS 4203 are replaced by equivalent references to AS/NZS 1170.

9.0 Foundations

See B1/VM4.
Clause 10.3 After the words “the test load” add “or proof load”.

Appendix A Delete “Normative” and replace with “Informative”

Appendix B Delete “Normative” and replace with “Informative”

12.0 Windows

12.1 NZS 4211 subject to the following modification:

References to air leakage, water leakage and operational effectiveness of opening sashes in NZS 4211, are non-structural considerations and do not apply to this document.

13.0 Seismic Performance of Engineering Systems in Buildings

13.1 NZS 4219 subject to the following modifications in the Canterbury earthquake region:

Where the building structure period is less than 1.5 seconds, the zone factor Z shall be determined from the Standard but shall not be less than 0.3.

COMMENT:

All building structure periods in excess of 1.5 seconds should be subject to specific investigation, pending further research.

The component risk factor $R_c$ shall be determined from the Standard but shall not be less than 0.33.
Acceptable Solution B1/AS1

General

1.0  Explanatory Note

1.1  B1/AS1 contains Acceptable Solutions for Masonry (Paragraph 2.0), Timber (Paragraph 3.0), Earth Buildings (Paragraph 4.0) and Stucco (Paragraph 5.0), Drains (Paragraph 6.0) and Glazing (Paragraph 7.0).

1.2  B1/AS gives an Acceptable Solution for small chimneys (referred to in Paragraph 8.0).

1.3  Modifications to the Standards, necessary for compliance with the New Zealand Building Code, are given against the relevant clause number of each Standard.

1.4  Consequential changes due to 2010/11 Canterbury earthquakes

COMMENT:

Raising the seismic hazard factor $Z$ in NZS 1170 Part 5 (Table 3.3) for the Canterbury earthquake region through amendments to B1/VM1 requires consequential amendments to NZS 4229, NZS 3604 and NZS 4299 referenced in B1/AS1.

2.0  Masonry

2.1  NZS 4229 subject to the following modifications:

2.1.1  NZS 4229 Clause 7.8.3

Delete clause 7.8.3.

Replace with:

“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 2.27kg/m$^2$ welded Grade 500E reinforcing mesh sheets (1.14 kg/m$^2$ in each direction), which shall be lapped at sheet joints such that the overlap measurement between the outermost cross wires of each fabric sheet is equal to the greater of one of the following:

- the spacing of cross wires plus 50 mm;
- 150 mm; or
- the manufacturer’s requirements.

Slabs shall have a maximum dimension of 18 m between free joints.”

2.1.2  NZS 4229

Foundations in the Canterbury earthquake region only where good ground has not been established.

COMMENT:

Foundations for houses built on ground that has the potential for liquefaction or lateral spread are outside the scope of B1/AS1.

Foundation designs for houses built in areas that have the potential for liquefaction, as defined by the Christchurch City Council, the Selwyn District Council and the Waimakariri District Council, may be in accordance with the MBIE Guidance Document “Repairing and rebuilding houses affected by the Canterbury earthquakes” (refer to www.mbie.govt.nz).

The foundation options in the MBIE Guidance Document apply to properties in the Canterbury earthquake region that have been categorised as Technical Category 1 to 3 (TC1, TC2 and TC3).

For TC1 properties, provided the conditions for good ground in Section 3 of NZS 3604 are met, house foundations following B1/AS1 can be used.

For TC2 and TC3 properties the MBIE Guidance Document provides a range of foundation solutions depending on expected ground movement and available bearing capacity. These parameters also determine the degree of involvement of structural and geotechnical engineers and the extent of specific engineering design.

Further guidance is being developed for other New Zealand regions and it is expected that this will inform the wider building and construction sector in due course. In the meantime for properties outside the Canterbury earthquake region that have the potential for liquefaction, MBIE recommends that further engineering advice is sought. For these properties a foundation solution following those provided for TC2 in the MBIE Guidance Document may be appropriate.
3.0 Timber

3.1 NZS 3604 subject to the following modifications:

3.1.1 NZS 3604 Paragraph 1.3 Definitions
Add (in the definition for Good Ground):
“liquefaction, lateral spread – for the Canterbury earthquake region only)” after “subsidence” in subparagraph (c).

3.1.2 NZS 3604 Section 5 Bracing Design

Make the following amendments:
Amend Figure 5.4, Earthquake zones, so that all the area within the Christchurch City Council boundary is within Zone 2.
Amend Figure 5.4 Earthquake zones, so that the lowest zone within the Selwyn or Waimakariri District Council boundaries is within Zone 2. Areas within Selwyn District that are designated as Zone 1 in NZS 3604 shall become Zone 2.

3.1.3 NZS 3604 Clause 7.5.2.3
Delete: Clause 7.5.2.3
Replace with: “Clause 7.5.2.3 The combined foundation and edge details shall be constructed as shown in Figures 7.13(B), 7.14(B) or (C) (and Figures 7.15(B) and 7.16(B) or (C) for foundations supporting a masonry veneer).”

3.1.4 NZS 3604 Figure 7.13
Delete: Figure 7.13(A) – Foundation edge details – In situ concrete – Dimensions & reinforcing for single storey.
Amend title of Figure 7.13(B) to “Dimensions & reinforcing for 1 or 2 storeys”, and add a note: “for a single storey foundation, 15 Series masonry may be used and the minimum footing width may be 190 mm”.

3.1.5 NZS 3604 Figure 7.14
Delete: Figure 7.14(A) – Foundation edge details – Concrete masonry – Single storey
Amend title of Figure 7.14(B) to “1 or 2 storeys”, and add a note: “for a single storey foundation, 15 Series masonry may be used and the minimum footing width may be 190 mm”.

COMMENT:
Unreinforced and untied slab to footing single storey option removed.
3.1.6 NZS 3604 Figure 7.15
Delete: Figure 7.15(A) – Masonry veneer foundation edge details – Dimensions and reinforcement for single storeys.

COMMENT:
Unreinforced and untied slab to footing single storey options removed.

3.1.7 NZS 3604 Figure 7.16
Delete: Figure 7.16 (A) – Masonry veneer foundation edge details – Concrete masonry – Single storey.

COMMENT:
Unreinforced and untied slab to footing single storey option removed.

3.1.8 NZS 3604 Clause 7.5.8.1
Delete: Clause 7.5.8.1
Replace with: “Clause 7.5.8.1 All slab-on-ground floors shall be reinforced concrete in accordance with Clauses 7.5.8.3, 7.5.8.4 and 7.5.8.6.4. All reinforcing steel, including welded mesh, shall be Ductility Class E in accordance with NZS 4671.”

3.1.9 NZS 3604 Clause 7.5.8.3
Delete: Clause 7.5.8.3
Replace with: “Clause 7.5.8.3 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/m² welded reinforcing mesh sheets (1.14 kg/m² in each direction), which shall be lapped at sheet joints such that the overlap measurement between the outmost cross wires of each fabric sheet is equal to the greater of one of the following:
- the spacing of cross wires plus 50 mm,
- 150 mm or
- the manufacturer’s requirements.
Slabs shall have a maximum dimension of 24 m between free joints.”

3.1.10 NZS 3604 Clause 7.5.8.6.2
Delete: Clause 7.5.8.6.2

3.1.11 NZS 3604 Figure 7.18
Delete title: Figure 7.18 – Irregular slab (plan view) (see 7.5.8.6.2)
Replace with: “Figure 7.18 – Irregular slab (plan view) (see 7.5.8.6.4)”.

3.1.12 NZS 3604 Clause 7.5.8.6.3
Delete: Clause 7.5.8.6.3.

3.1.13 NZS 3604 New Clause
Add new: “Clause 7.5.8.8 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, e.g. by wrapping dowel bars for 300 mm with petrolatum tape. Joint dowel bars must be installed in a single plane, in true alignment and parallel.”

3.1.14 NZS 3604 Foundations in the Canterbury earthquake region only where good ground has not been established

COMMENT:
Foundations for houses built on ground that has the potential for liquefaction or lateral spread are outside the scope of B1/AS1.

Foundation designs for houses built in areas that have the potential for liquefaction, as defined by the Christchurch City Council, the Selwyn District Council and the Waimakariri District Council, may be in accordance with the MBIE Guidance Document “Repairing and rebuilding houses affected by the Canterbury earthquakes” (refer to www.mbie.govt.nz). The foundation options in the MBIE Guidance Document apply to properties in the Canterbury earthquake region that have been categorised as Technical Category 1 to 3 (TC1, TC2 and TC3).

For TC1 properties, provided the conditions for good ground in Section 3 of NZS 3604 are met, house foundations following B1/AS1 can be used.

For TC2 and TC3 properties the MBIE Guidance Document provides a range of foundation solutions depending on expected ground movement and available bearing capacity. These parameters also determine the degree of involvement of structural and geotechnical engineers and the extent of specific engineering design.

Further guidance is being developed for other New Zealand regions and it is expected that this will inform the wider building and construction sector in due course. In the meantime for properties outside the Canterbury earthquake region that have the potential for...
liquefaction, MBIE recommends that further engineering advice is sought. For these properties a foundation solution following those provided for TC2 in the MBIE Guidance Document may be appropriate.

4.0 Earth Buildings

4.1 NZS 4299 subject to the following modifications:

4.1.1 NZS 4299, Paragraph 1.3 Definitions
Add (in the definition for Good Ground):
“(liquefaction, lateral spread – for the Canterbury earthquake region only)” after “subidence” in subparagraph (c).

4.1.2 NZS 4299, Clause 2.3 Earthquake zones
Add to the end of Clause 2.3:
“The earthquake zone factor > 0.6 shall apply to the Canterbury earthquake region.”

4.1.3 NZS 4299, Figure 2.1 Earthquake zones
On the map shown in NZS 4299 Figure 2.1 Earthquake zones, the Canterbury earthquake region shall be interpreted as having an earthquake zone factor of > 0.6.

4.1.4 NZS 4299, Clause 4.8.6.
Delete: Clause 4.8.6
Replace with: “Clause 4.8.6 The thickness and reinforcement and detail of concrete slabs shall comply with the requirements of NZS 3604 as modified in B1/AS1 Paragraph 3.1.”

4.1.5 NZS 4299 Foundations in the Canterbury earthquake region only where good ground has not been established

COMMENT:
Foundations for houses built on ground that has the potential for liquefaction or lateral spread are outside the scope of B1/AS1.

Foundation designs for houses built in areas that have the potential for liquefaction, as defined by the Christchurch City Council, the Selwyn District Council and the Waimakariri District Council, may be in accordance with the MBIE Guidance Document “Repairing and rebuilding houses affected by the Canterbury earthquakes” (refer to www.mbie.govt.nz).

The foundation options in the MBIE Guidance Document apply to properties in the Canterbury earthquake region that have been categorised as Technical Category 1 to 3 (TC1, TC2 and TC3).

For TC1 properties, provided the conditions for good ground in Section 3 of NZS 3604 are met, house foundations following B1/AS1 can be used.

For TC2 and TC3 properties the MBIE Guidance Document provides a range of foundation solutions depending on expected ground movement and available bearing capacity. These parameters also determine the degree of involvement of structural and geotechnical engineers and the extent of specific engineering design.

Further guidance is being developed for other New Zealand regions and it is expected that this will inform the wider building and construction sector in due course. In the meantime for properties outside the Canterbury earthquake region that have the potential for liquefaction, MBIE recommends that further engineering advice is sought. For these properties a foundation solution following those provided for TC2 in the MBIE Guidance Document may be appropriate.

5.0 Stucco

5.1 NZS 4251
6.0 Drains

6.1 AS/NZS 2566.1

6.2 AS/NZS 2566.2

6.3 AS/NZS 2032

6.4 AS/NZS 2033
7.0 Glazing

7.1 NZS 4223.1 subject to the following modifications:

Clause 1.2(e) Reword to read:

“For framed, unframed, and partly framed glass assemblies in buildings up to 10 m high, glass shall be selected in accordance with section 5.”

7.2 NZS 4223.2

7.2.1 201 Selection and installation of sash and frames

Delete Clause 201.1 (b)

Replace with: “Clause 201.1(b). They must allow for contraction and expansion of the building and comply with relevant clauses of AS/NZS 1170 and NZS 4223.1 section 3.5.”

7.3 NZS 4223.3

7.3.1 Related documents, New Zealand Standards

Delete NZS 4203: 1992 General structural design and design loadings for buildings

Replace with: “AS/NZS 1170 Structural Design Actions.”

7.3.2 Clause 310.1

Delete Clause 310.1

Replace with: “Glazing used in any building in situations that require protection for occupants from falling 1000 mm or more from the floor level shall meet the barrier requirements of AS/NZS 1170 as modified by B1/VM1.”

7.3.3 NZS 4223: Part 3 Clause 312.2

Unframed or partly framed balustrades and fences

Delete Clause 312.2 (a) and (b)

Replace with: “Unframed and partly framed balustrade systems shall be designed in accordance with AS/NZS 1170 as modified by B1/VM1.”

7.3.4 NZS 4223: Part 3 Clause 312.3

Structural balustrades and fences

Delete Clause 312.3

Replace with: “Clause 312.3. Where glass is used as a structural member, toughened safety glass shall be used. The thickness used shall be determined in accordance with AS/NZS 1170 as modified by B1/VM1.”

7.3.5 NZS 4223: Part 3 Section 313

Stairwells and Porches

Delete Clause 313.1

Replace with: “Glazing in stairways within 2000 mm horizontally or vertically, from any part of a stairway or landing shall be Grade A safety glass in accordance with Table 3.1. Stairways include stairwells, landings and porches and comprise at least two risers. All glazing in stairways protecting a fall of 1000 mm or more shall also meet the barrier requirements of AS/NZS 1170 as modified by B1/VM1.”

7.3.6 Table 3.7 Glazing protecting a difference in level in any building.

Delete Table 3.7

7.3.7 Table 3.8 Unframed or partly framed balustrades and fences.

Delete Table 3.8

Appendix 3.E

Delete Appendix 3.E

Replace with: “Refer to NZS 4223 Part 1 Section 5.4”

7.4 NZS 4223.4

8.0 Small Chimneys

See Acceptable Solution B1/AS3.
In addition there is a small positive water pressure acting on the underside of the wall which reduces the vertical load applied to the foundation.

\[ u = 0.4 \times 9.81 = 3.92 \] \[ V_{drained} = 154.87 - 3.92 \times 2.65 = 144.48 \]

This has the effect of changing slightly \( X \) and \( e \), hence \( B^i \) and \( q_d \). We have from the first ultimate limit state the moment about the heel of the wall of the vertical forces = 131.29 kNm per metre length of the wall, so:

\[ X = (131.29 - 3.92 \times 2.65 \times 2.65/2)/144.48 = 0.813 \]

Eccentricity of load:

\[ e = 70.47 \times 1.44/144.48 = 0.703 \]

Design bearing pressure:

\[ q_d = V_{drained}/B^i = 144.5/2.27 = 63.7 \text{ kPa} \]

For \( \phi \) equal to 25\(^\circ\) the bearing capacity factors are: \( N_c = 21 \), \( N_q = 11 \) and \( N_g = 9 \).

Determine ultimate bearing strength:

\[ q_{u,drained} = cB^iN_c\lambda_{cg\lambda_{qg}} + q^f\lambda_{cq}\lambda_{qg}\lambda_{qg}N_q + 0.5B^i\gamma'\lambda_{cq}\lambda_{qg}\lambda_{qg}N_g \]

Shape factors \( \lambda_{cq}, \lambda_{qg} \) and \( \lambda_{qg} \) shall be taken as 1.0 as foundation is assumed to be long compared to its width. Also ground inclination factors \( \lambda_{cq}, \lambda_{qg} \) and \( \lambda_{qg} = 1.0 \) as the foundation is horizontal. Thus we need only to evaluate depth and load inclination factors.

Depth factors:

\[ \lambda_{cd} = 1 + 2\tan\phi(1 - \sin\phi) = 1 + 2\tan(25) = 1.05 \]

\[ \lambda_{qd} = (1 - \lambda_{cd})/(N_q - 1) = 0.05 - (1 - 1.05)/11\tan(25) = 1.06 \]

Load inclination factors:

\[ \lambda_{cI} = (1 - 0.7H/\lambda_{qg})/N_q = 0.46 \]

\[ \lambda_{cI} = (1 - H/(\lambda_{qg} + 3.5\cot(25))) = 0.28 \]

\[ q_{u,drained} = cN_c\lambda_{cg\lambda_{qg}} + q^fN_q\lambda_{qg}\lambda_{qg} + 0.5B^i\gamma'N_q\lambda_{cq}\lambda_{qg} \]

\[ = 12.5 \times 21 \times 1.06 \times 0.40 + 3.3 \times 11 \times 1.05 \times 0.46 + 0.5 \times 9 \times 2.27 \times 8.2 \times 1 \times 0.28 = 152.29 \]

\[ q_{ds,drained} = q_{u,drained}\Phi_{bc} = 152.29 \times 0.45 = 68.5 \]

Thus OK as \( q_{ds,drained} > q_d \)

### C12.0 Sixth Ultimate Limit State (long term foundation sliding failure)

The design sliding strength is derived from the sliding resistance on the base and the passive resistance from the clay in front of the embedded part.

Sliding resistance: \( S_{drained} = cB^i + \lambda_{qg}\tan\phi = 12.5 \times 2.27 + 144.48 \times \tan(25) = 95.75 \)

Passive resistance:

\[ P_{p,drained} = 0.5K_p\gamma'\lambda_{qg}^2 + 2c\lambda_{cq}\lambda_{qg} \]

\[ = 0.5 \times 3.5 \times 8.2 \times 0.4^2 + 2 \times 12.5 \times 0.4 \times \sqrt{3.5} = 21.00 \]

Design sliding strength:

\[ S\Phi_{sl} + P_{p}\Phi_{pp} = 95.75 \times 0.8 + 21.00 \times 0.45 = 86.05 \]

\[ H = 70.5 \]

Thus OK as \( S\Phi_{sl} + P_{p}\Phi_{pp} > H \)
C13.0 Comments

The above calculations reveal that, for static loading, it is the long term case that is critical. Also for the short term cases the sliding strength derived from passive earth pressure in front of the embedded foundation is significant.

If the horizontal earthquake acceleration is increased much above 0.2g the third ultimate limit state becomes the limiting case as bearing failure is initiated. However, as explained in clauses 4.11.2.4 and C4.11.2.4 of NZS 4402: 1992, controlled sliding and tilting of the foundation during the passage of an earthquake is possible if the resulting post-earthquake permanent displacements are acceptable. The procedures and criteria for this approach are beyond the scope of this document.