

Dear Customer

Please find enclosed Amendment 16, effective 3 April 2018, to the Acceptable Solutions and Verification Methods for Clause B1 Structure of the New Zealand Building Code. The previous amendment to B1 was Amendment 15, 1 January 2017.

Section	Old B1	B1 Amendment 16
Title pages	Remove document history and status pages 1-4	Replace with new document history and status pages 1-4
Contents	Remove page 9/10	Replace with new page 9/10
References	Remove pages 11-14	Replace with new pages 11-14B
B1/VM1	Remove pages 17/18, 21–22F	Replace with new pages 17/18, 21–22F
B1/VM4	Remove pages 57/58, 65/66	Replace with new pages 57/58, 65/66



**MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT**
HĪKINA WHAKATUTUKI

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.

Enquiries about the content of this document should be directed to:



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**Verification Methods and Acceptable Solutions
are available from www.building.govt.nz**

New Zealand Government

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Document Status

The most recent version of this document (Amendment 16), as detailed in the Document History, is approved by the Chief Executive of the Ministry of Business, Innovation and Employment. It is effective from 3 April 2018 and supersedes all previous versions of this document.

The previous version of this document (Amendment 15) will cease to have effect on 30 June 2018.

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.building.govt.nz

B1: Document History			
	Date	Alterations	
First published	July 1992		
Amendment 1	September 1993	p. ix–xii, References p. 1, 1.3, 1.4.1–1.4.3, 2.1, 2.2, 3.1–3.3, 4.1, 5.1 p. 2, 6.1, 6.2, 8.1, 9.1 p. 4, 11.1, 12.1 p. 5, 1.2, 2.1, 2.2, 3.1, 3.2,s 4.1, 4.2, 6.1, 6.2, 7.1	p. 9, 1.0.1, 1.0.5 b) c) p. 10, 2.3.5 p. 13, Figure 4 p. 14, 2.3.6 p. 16, 2.3.8, 2.3.9 p. 34, Table 1 p. 47, 1.0.1 pp. 49–54, Index
Amendment 2	19 August 1994	pp. i and ii, Document History pp. vii and viii, Contents pp. x and xi, References p. xiv, Definitions p. 1, 1.4.2, 5.1 p. 2, 6.1 p. 5, 1.3, 3.1, 4.1 p. 6, 7.1 p. 10, 2.3.5 p. 12, Figure 3 p. 13, Figure 4 p. 14, 2.3.6, 2.3.7	p. 15, Tables 4 and 5 p.16, 2.4.1 p. 21, Figure 2 p. 22, Figure 3 p. 32, 2.2.4 p. 33, 1.0.2 p. 34, 3.2.1, Table 1 p. 35, 4.1, 4.1.2, 4.1.3, 4.2.1, 4.2.2, 4.3, 4.3.1, 5.0.1, Table 2 p. 36, 6.1.2, 7.1, 7.1.1 p. 37, 7.3.4 pp. 49, 50, 51, 54, Index
Reprinted incorporating Amendments 1 and 2	October 1994		
Amendment 3	1 December 1995	p. ii, Document History p. ix, References p. 1, 3.1	p. 5, 6.2 p. 50, Index
Reprinted incorporating Amendments 1, 2 and 3	July 1996		
Amendment 4	1 December 2000	p. ii, Document History pp. vii and viii, Contents pp. ix – xii, Revised References pp. xiii and xiv, Definitions	pp. 1–4A, Revised B1/VM1 pp. 5 and 6, Revised B1/AS1 pp. 33–63, Revised B1/VM4 p. 65, Revised B1/AS4 pp. 67–72, Revised Index
Erratum	9 February 2001	p. 46, 4.3.2 a) i)	
Amendment 5 incorporating Erratum	1 July 2001	p. 2, Document Status p. 3, Document History p. 7, References	p. 41, 1.7.2 Comment p. 49, 2.2.4 p. 48, 1.9.1 b) i)
Amendment 6	1 March 2005	p. 11, References	
Amendment 7	1 April 2007	pp. 11–12, 14, References pp. 15–16, Definitions	p. 18, 6.1

B1: Document History

Amendment 8	1 December 2008	p. 2, Document Status p. 3, Document History p. 9, Contents pp. 11–14, References pp. 15–16, Definitions	pp. 17–22B, B1/VM1 p. 51, B1/VM4 1.0.5, 2.0.1 p. 56, B1/VM4 Figure 2 p. 70, B1/VM4 B1.0.2 pp. 83–84, 86 Index
Amendment 9	30 September 2010	pp. 2–3, Document History, Status, pp. 11–14, References p. 20, B1/VM1 2.2.13 p. 21, B1/VM1 3.0, 5.1 pp. 22–22B, B1/VM1 11.0 pp. 23–24, B1/AS1 6.0, 6.1, 6.2, 6.3, 6.4, 7.1, 7.2, 7.3, 7.4	p. 27, B1/AS2 1.0.5 p. 44, B1/AS3 1.7.9 p. 47, B1/AS3 1.8.5, 1.8.6 p. 49, B1/AS3 2.1.1, 2.2.4 p. 63, B1/VM4 4.3.2 p. 67, B1/VM4 5.3.1
Reprinted incorporating Amendments 4–9	30 September 2010		
Erratum 1	30 September 2010	p. 21, B1/VM1 3.1	
Amendment 10 (Canterbury)	Effective from 19 May 2011 until 31 January 2012	p. 9, Contents p. 12–14, References p. 15, Definitions p. 17, B1/VM1	p. 20, B1/VM1 2.2.14A to 2.2.14D pp. 23–23C B1/AS1 1.4, 2.0, 3.0, 4.0 p. 48, B1/AS3 1.9.3 p. 84, Index
Amendment 11	Effective from 1 August 2011 until 14 August 2014	p. 9, Contents p. 11–14, References p. 17–22B, B1/VM1 1.0, 2.0, 2.2.9, 2.2.14c, 5.2, 6.1, 7.1, 8.1, 12.1, 13.0	pp. 23–24, B1/AS1 1.2, 2.0, 3.0, 4.0, 7.0, 8.0, 9.0 pp. 27–34, B1/AS2 pp. 83–87, Index
Amendment 12	Effective from 14 February 2014 until 31 May 2016	p. 9, Contents pp. 11–13, References pp. 15, 16, Definitions pp. 17, 18, 20, 22, 22A, 22B, B1/VM1 2.1, 2.2.6, 2.2.11, 5.2, 9.0, 12.1	pp. 23–23C, 24 B1/AS1 1.1, 1.2, 2.1.1–2.1.10, 3.1.9, 4.1.5, 8.0, 9.0 p. 79, B1/VM4 C11.0
Amendment 13	Effective from 1 June 2016 until 30 May 2017	p. 13, References	p. 24, B1/AS1 7.3.3, 7.3.4
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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 also 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.

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Feb 2014

Amend 7
Apr 2007

Amend 12
Feb 2014

Standards New Zealand

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Amend 12 Feb 2014	Part 0: 2002 General principles <i>Amends: 1, 2, 3, 4, 5</i>	AS1 7.2, 7.3
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	NZS 3603: 1993 Timber structures standard <i>Amend: 1, 2</i> (Applies to building work consented prior to 1 April 2007) <i>Amend: 1, 2, 4</i> (Applies to building work consented on or after 1 April 2007)	VM1 6.1, VM4 5.3.1
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Amends 13 & 15 Amend 15 Jan 2017 Amend 9 Sep 2010 Amend 15 Jan 2017	Part 3: 2016 Human impact safety requirements <i>Amend: 1</i>	AS1 7.3
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Amends 10 and 11	NZS 4229: 2013 Concrete masonry buildings not requiring specific engineering design	AS1 1.4, 2.1 AS3 1.1.1, 1.8.4, 1.9.2, 1.9.5, 2.2.1 b)
Amend 12 Feb 2014		
Amend 8 Dec 2008	NZS 4230: 2004 Design of reinforced concrete masonry structures <i>Amend: 1</i>	VM1 4.0
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	Test 2.2: 1986	Soil classification tests – Determination of liquid limit	Definitions
	Test 2.4: 1986	Soil classification tests – Determination of plasticity index	VM1 11.1
	Test 2.6: 1986	Soil classification tests – Determination of the linear shrinkage	Definitions
	Test 2.8.1: 1986	Soil classification tests – Standard method by wet sieving	VM1 11.1
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	Test 2.8.3: 1986	Soil classification tests – Standard method for fine soils (pipette method)	VM1 11.1
	Test 2.8.4: 1986	Soil classification tests – Subsidiary method for fine soils (hydrometer method)	VM1 11.1
	Test 4.1.1: 1986	Soil compaction tests – Determination of the dry density/water content relationship – New Zealand standard compaction test	VM1 11.1
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Amend 16 Apr 2018	NZS 4431: 1989	Code of practice for earth fill for residential development <i>Amend: 1</i>	VM1 10.1
	AS/NZS 4600: 2005	Cold-formed steel structures	VM1 5.2
Amends 10 and 11	AS/NZS 4671: 2001	Steel Reinforcing Materials <i>Amend: 1</i>	AS1 2.1.5, 3.1.8 AS3 1.8.5, VM1 14.0
	AS/NZS 4680: 2006	Hot-Dip Galvanised (zinc) Coating	AS3 1.8.6
Amend 9 Sep 2010			
Amend 16 Apr 2018	AS/NZS 5131: 2016	Structural steelwork – Fabrication and erection	VM1 5.1.3, 5.1.5-5.1.8, 5.1.10-5.1.12

Amend 14
Nov 2016

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Dec 2008

SNZ HB 8630: 2004 Tracks and outdoor visitor structures

Where quoted

VM1 2.2.9

The National Association of Steel Framed Housing Inc (NASH)

Amend 11
Aug 2011

NASH Standard: Residential and Low Rise Steel Framing Part 1 2010
Design Criteria

VM1 5.3

British Standards Institution

BS 8004: 1986 Code of practice for foundations

VM4 4.0.3

BS EN 14399 High-strength structural bolting assemblies for preloading

Part 1: 2015 General requirements

VM1 5.1.4

Part 2: 2015 Suitability for preloading

VM1 5.1.4

Part 3: 2015 System HR. Hexagon bolt and nut assemblies

VM1 5.1.2, 5.1.4

Part 5: 2015 Plain washers

VM1 5.1.2, 5.1.4

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Apr 2018

Standards Australia

Amend 14
Nov 2016

AS 1391: 2007 Metallic materials – Tensile testing at ambient temperature

VM1 14.1.1

Amend 9
Sep 2010

AS 1397: 2001 Steel sheet and strip – Hot-dipped zinc-coated or aluminium/zinc-coated

AS3 1.7.9

Amend 11
Aug 2011

AS 2159: 1995 Rules for the design and installation of piling (known as the SAA Piling Code)
Amend: 1

VM4 4.0.3

American Society of Testing and Materials

ASTM D1143: 1981 Test method for piles under static axial compressive load

VM4 4.0.3

New Zealand Geomechanics Society

Guidelines for the field descriptions of soils and rocks in engineering use. Nov 1988

VM1 11.1

New Zealand Legislation

Amend 8
Dec 2008

Chartered Professional Engineers of New Zealand Act 2002

VM1 1.0

International Organization for Standardization

ISO 15630-2 2010: Steel for the reinforcement and and prestressing of concrete – Test Methods – Part 2 Welded Fabric

VM1 14.1.1

ISO 17025: 2005 General requirements for the competence of testing and calibration laboratories

VM1 14.1.1

Amend 14
Nov 2016

Verification Method B1/VM1

General

Amend 10
May 2011Amend 8
Dec 2008

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.

Amend 11
Aug 2011Amend 11
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- 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

AS/NZS 1170.3: 2003 including Amendment 1, and NZS 1170.5: 2004.

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.

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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 , thermal actions arising from *fire*, $\Psi_f Q$]

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 , thermal actions arising from *fire*, $\Psi_f Q$]

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.”

2.2.6 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

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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.

$\Psi_E = 0.0$ 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:

$$C_d(T) = \frac{C(T) S_p}{k_\mu} \quad \dots \text{5.2(4)}$$

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:

3.1.1 Clause 18.7.4.4 Detailing requirements for support of hollow core floors

At the end of Clause 18.7.4.4 (b) 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.”

3.1.2 Cast iron anchors and couplers may be used for designs that otherwise comply with NZS 3101 until 1 November 2018.

COMMENT:

The continued use of cast iron couplers and anchors until 1 November 2018 is subject to the anchor or coupler complying with relevant performance requirements set out in NZS 3101.

COMMENT:

Welded wire fabric that is used in designs to NZS 3101 is subject to the requirements of Paragraph 14.0 Ductile Steel Mesh of this *Verification Method*.

3.2 NZS 3106

4.0 Concrete Masonry

4.1 NZS 4230

5.0 Steel

5.1 NZS 3404: Part 1 subject to the following modifications:

5.1.1 Clause 2.2.1 Specification

In Clause 2.2.1 a) replace:

“AS 1163 Structural steel hollow sections AS 1594 Hot-rolled steel flat products”,

with

“AS/NZS 1163 Cold-formed structural steel hollow sections

AS/NZS 1594 Hot-rolled steel flat products”

5.1.2 Clause 2.3.1 Steel bolts, nuts and washers

In Clause 2.3.1 add the following to the end of the Clause:

“BS EN 14399-3 High-strength structural bolting assemblies for preloading, System HR. Hexagon bolt and nut assemblies

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Amend 16 Apr 2018

Amend 9 Sep 2010

Amend 8 Dec 2008

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BS EN 14399-5: High-strength structural bolting assemblies for preloading, Plain washers”

5.1.3 new Clause 3.10 Documentation

Insert the following after clause 3.9:

“Clause 3.10 Documentation

The requirements in AS/NZS 5131 Section 4.1.1 General shall be applied.”

5.1.4 Clause 9.3.1 Bolts and bolting category

In Clause 9.3.1.2 replace:

“and AS 1559”

with

“, AS 1559, BS EN 14399.1, BS EN 14399.2, BS EN 14399.3 and BS EN 14399.5”.

5.1.5 Section 14 Fabrication

Replace Section 14 Fabrication with the following:

“14 Fabrication

The fabrication of steel structures shall be in accordance with AS/NZS 5131.

Construction categories for the purposes of this Standard shall be determined in accordance with Appendix C of AS/NZS 5131.”

5.1.6 Section 15 Erection

Replace Section 15 Erection with the following:

“15 Erection

The erection of steel structures shall be in accordance with AS/NZS 5131.

Construction categories for the purposes of this standard shall be determined in accordance with Appendix C of AS/NZS 5131.”

5.1.7 Section 16 Modification of Existing Structures

Replace Section 16 Modification of existing structures with the following:

“16 Site modifications during erection and modification and repair of existing structures

Site modifications during erection and modification and repair of existing structures shall be in accordance with AS/NZS 5131 Section 14 Site modifications during erection and modification and repair of existing structures.”

5.1.8 new Section 18 Architecturally Exposed Structural Steelwork

Insert the following after Section 17:

“18 Architecturally exposed structural steelwork

The requirements in AS/NZS 5131 Section 10 Architecturally exposed structural steelwork shall be applied.”

5.1.9 Appendix A

Replace references to AS/NZS 3678, AS/NZS 3769.1 and AS/NZS 3679.2 in NZS 3404 with the 2016 versions that are referenced in this Verification Method

5.1.10 Appendix D

Replace Appendix D Inspection of Welding to AS/NZS 1554.1 with the following:

“Appendix D Inspection of Welding

The recommendations in AS/NZS 5131 Appendix I Inspection of Welding and Bolting. (Informative) should be used.”

5.1.11 Appendix K

Replace Appendix K Standard test for evaluation of slip factor (normative) with the following:

“Appendix K Standard test for evaluation of slip factor (normative)

The requirements in AS/NZS 5131 Appendix G Standard test for evaluation of slip factor shall be used.”

5.1.12 Appendix L

Replace Appendix L Inspection of bolt tension using a torque wrench (informative) with the following”

“Appendix L Inspection of bolt tension using a torque wrench (informative)

The recommendations in AS/NZS 5131 Appendix H Inspection of bolt tension using a torque wrench should be used.”

5.1.13 new Appendix R

Insert the following after Appendix Q:

“Appendix R Selection of materials for the avoidance of lamellar tearing (informative)

The guidance in AS/NZS 1554.1 Appendix H Selection of materials for the avoidance of lamellar tearing should be used.”

5.2 AS/NZS 4600 subject to the following modifications:

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8 and 11

- 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”.

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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.”

Amend 11
Aug 2011

Amend 11
Aug 2011

Amend 7
Apr 2007

Amend 8
Dec 2008

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.

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Aug 2011

Amend 8
Dec 2008

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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."

Amend 8
Dec 2008

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."

Amend 12
Feb 2014

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.

Amend 11
Aug 2011

9.0 Foundations

See B1/VM4.

Amend 12
Feb 2014

10.0 Siteworks

10.1 NZS 4431

11.0 Drains

11.1 AS/NZS 3725 subject to the following modifications:

Clause 3 Add to the list of reference documents:

"NZS 3101 The design of concrete structures.

NZS 4402 Methods of testing soils for civil engineering purposes: Tests 2.4, 2.8, 4.1.1, 4.2.1, 4.2.2, 4.2.3 and 5.1.1.

New Zealand Geomechanics Society,
Guidelines for the field description of soils and rocks in engineering use."

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Sep 2010

Clause 4 In the paragraph headed "(c) Select fill", after the words "given in Table 1" add "or the New Zealand Geomechanics Society Guidelines".

Clause 5 In definition of Pt, replace "AS 4058" with "AS/NZS 4058"

Clause 6.4 Replace the word "may" with "shall". Delete the words "Superimposed concentrated dead loads should be avoided."

Clause 6.5.3.1 Delete the words "The appropriate road vehicle loading shall be specified by the relevant highway authority or owner".

Clause 6.5.3.2.2.2 Replace the word "may" with "shall".

Clause 6.5.4.3 Delete the words "unless otherwise specified by the Relevant Authority".

Clause 6.5.5 Delete the first words "For" and after the words "for aircraft types" add the words "is outside the scope of this Standard but..."

Clause 7 Replace the word "should" with "shall".

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"

Amend 9
Sep 2010

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.

- ISO 15630-2: 2010 Steel for the reinforcement and prestressing of concrete – Test methods – Part 2 Welded fabric.
- AS 1391: 2007: Metallic materials – Tensile testing at ambient temperature
- AS/NZS 4671: 2001 Steel Reinforcing Materials as modified by this Verification Method.

Accreditation must be by a signatory to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA).

COMMENT:

International Accreditation New Zealand (IANZ) in NZ and the National Association of Testing Authorities (NATA) in Australia are signatories to the ILAC MRA. Details of signatory accreditation bodies in other economies are available on request from IANZ or directly from the ILAC website at <http://ilac.org/signatory-search/?q=all>

Test certificates must be endorsed i.e. must carry the symbol of their accreditation body and/or a statement that they are accredited, by a named accreditation body, for the reported tests.

13.0 Seismic Performance of Engineering Systems in Buildings

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

The zone factor Z shall be determined from the Standard but shall not be less than 0.3.

14.1.2 Interpretation and Clarification of AS/NZS 4671

Where conflicting or contradictory information is found between AS/NZS 4671:2001 and Standards it references, AS/NZS 4671:2001 takes precedence.

14.1.3 AS/NZS 4671 Clause 3.1 Ageing

Delete Clause 3.1 and replace with:

“The test samples must be brought up to a surface temperature of 100±10°C (i.e. the surface of the steel is recorded at 100 ± 10°C) then held at 100±10°C for 60 minutes (+15, -0 minutes). The method used to generate the temperature increase can be a suitable calibrated oven (calibrated for both temperature and temperature spatial distribution) or boiling water.

“Once heating is completed as detailed above, the samples are to be cooled in still air to ambient room temperature.”

14.0 Ductile Steel Mesh

14.1 Grade 500E welded steel mesh

Where Grade 500E welded steel mesh is specified, it shall meet the requirements of AS/NZS 4671 subject to the following modifications.

14.1.1 Laboratory accreditation

COMMENT:

Amendment 14 to Verification Method B1/VM1 is effective from 4 November 2016, except for this Paragraph 14.1.1 which is effective from 1 January 2017.

Laboratories that provide testing and certification of Grade 500E welded steel mesh for use in New Zealand must be accredited for testing to ISO 17025: General requirements for the competence of testing and calibration laboratories, with a scope of accreditation that includes:

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Feb 2014

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Aug 2011

Amend 15
Jan 2017

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Nov 2016

Amend 14
Nov 2016

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Jan 2017

14.1.4 AS/NZS 4671 Clause 9.3 Labelling of reinforcing steel

Add a line:

"9.3 (a)(vii) that Grade 500E steel mesh complies with Paragraph 14 of B1/VM1."

Add a line:

"9.3 (b)(vi) that Grade 500E steel mesh complies with Paragraph 14 of B1/VM1."

14.1.5 AS/NZS 4671 Appendix A

Delete Appendix A.

14.1.6 AS/NZS 4671 Clause B1.1

Insert "through steel processing" after "steel melting".

14.1.7 AS/NZS 4671 Clause B1.3.1

Delete paragraph (b) and replace with:

"Unless specified differently in Clauses other than Clause B1.3.1 in AS/NZS 4671, a batch shall be:

For mesh products:

- (i) A quantity of mesh not exceeding 1000 sheets produced from steel of the same surface geometry and nominal diameter, of the same nominal strength grade and of the same ductility class and the mesh is manufactured in the same run under the same conditions using the same equipment; or
- (ii) Where sheets of mesh have steel wires that differ in any of surface geometry, diameter, nominal strength grade, or ductility class, a quantity of mesh not exceeding 1000 sheets considering each type of steel separately (e.g. if different types of steel wires are used in each direction then the wires in each direction will be considered a separate batch)."

COMMENT:

In (i) above, the term 'same run' allows for breaks in production (e.g. overnight or weekends etc. provided the other criteria remain constant).

14.1.8 AS/NZS 4671 Clause B1.3.5

Delete and replace with:

"The minimum length of specimen test piece will be determined by the requirement to obtain a test piece including at least one welded

intersection and a gauge length for the measurement of elongation remote at least 20 mm from the welded intersections.

Furthermore, additional length of the test piece will be required to keep both the welded intersection and gauge length of the elongation measurement remote at least 20 mm from the jaws of the testing machine.

"There is no maximum limitation imposed on the length of the test piece. The test piece must not be subject to any post-production treatment that will unduly affect the test result."

14.1.9 AS/NZS 4671 Clause B1 Scope and general

Add a Clause:

"B1.4 For grade 500E steel mesh, all test certificates produced in compliance with AS/NZS 4671 shall note that they are compliant with B1/VM1 Paragraph 14."

14.1.10 AS/NZS 4671 Clause B3 (c)

Delete Amendment No 1 June 2003 to Clause B3 (c)(i).

Delete Clause B3 (c) i and ii and replace with:

- "(i) Mechanical properties, one test per batch on each of three separate longitudinal bars and three separate transverse bars (i.e. 6 tensile tests). If different grade ductility class, surface geometry or nominal diameter edge bars are used on the mesh, one extra tensile test per batch is required on the differing edge bars per sheet.
- (ii) Weld-shear tests, one test per batch on each of three separate intersections from different wires. If different grade ductility class, surface geometry or nominal diameter edge bars are used on the mesh, one extra shear test per batch is required on the differing edge bars per sheet."

Add after (v):

"(vi) Where a manufacturer can demonstrate long-term quality compliance for mesh with respect to Re, Agt and Rm/Re in accordance with Clause B6, the testing frequencies required in Clause B3 (c)(i) may be reduced to one test on each of two separate longitudinal and two transverse

bars (i.e. 4 tensile tests). However, the testing requirement on edge wires will remain unchanged from Clause B3 (c)(i)."

14.1.11 AS/NZS 4671 Clause B4.1.1 Batch parameters

Add a Clause:

"The individual results for Agt shall be rounded to 0.1% and for Rm/Re to 0.01 and the average of these results shall be then rounded."

14.1.12 AS/NZS 4671 Clause B4.1.2

Delete the first sentence and replace with:

"A batch analysis shall be undertaken at the completion of all batch testing undertaken in accordance with Clause B3. The batch shall be deemed to conform with the tensile parameters specified in Table 2 if the following criteria are satisfied:"

Add a second line to Clause B4.1.2(b)

"For mesh manufactured from Grade 500E, all individual test sample results of Agt must be a minimum of 6%."

14.1.13 AS/NZS 4671 Clause B5

Add to the last sentence of paragraph 2:

"along with the original test results."

14.1.14 AS/NZS 4671 Clause B6

Add a comment:

"COMMENT:

Long-term conformance is shown by completing a statistical analysis in accordance with clause B6 on the collected batch results. Clause B6.3 requires all production and processing to be subject to continual control in accordance with Clause 8 and Clause B6. Clause B6.3 makes it mandatory to undertake batch testing."

14.1.15 AS/NZS 4671 Clause B6.1

Add the following to the end of the last sentence of paragraph 2:

"and including a minimum of four separate batches."

Add the following sentence:

"If different grade ductility class, surface geometry or nominal diameter edge bars are used on the mesh, then a separate analysis for long-term quality level shall be carried out on these bars."

Delete the Note to Clause B6.1 in Amendment No 1: June 2003.

Add the following paragraph:

"For New Zealand, the application of long-term quality compliance for mesh with respect to Agt and Rm/Re may be waived, at the choice of the manufacturer. However, all batch test results in the long-term compliance review must meet the requirements defined in Clause B4."

14.1.16 AS/NZS 4671 Clause B6.2.1

Add a comment:

"COMMENT:

The mean and standard deviation are to be calculated from the individual test values for each test sample from each batch as defined in Section B2."

14.1.17 AS/NZS 4671 Clause B6.3

Add a comment:

"COMMENT:

Clause 6.3 requires all production and processing to be subject to continued control in accordance with Clause 8 and Appendix B. Appendix B provides two pathways to compliance: using long-term conformance; and not using long-term conformance.

"When using long-term conformance:

- Individual batches (defined in B1.3.1) are subjected to testing in accordance with Clause B3 and evaluated to the requirement of Clause B4.
- A batch will fail the initial testing if it does not comply with all requirements of Clause B4.1.2 or Clause B4.2.
- If the additional testing on twice as many test samples (i.e. 12 tensile pieces or six weld shear pieces) for the specific parameter investigated, do not meet the requirements of Clause B4.1.2 or Clause B4.2, then the batch will have failed to comply with the Standard and needs to be downgraded and removed from the data for long-term quality analysis."

Add a sentence after the existing sentence as follows:

"Where the sample size of a batch falls between sample sizes given in Table B1, the value of the multiplier 'K' may be interpolated linearly between the next lowest and next highest number of samples given in Table B1 Statistical Multiplier 'K'."

Add a comment:

“COMMENT:

Clause B6.3 details the conformance criteria and makes reference to CvL (the lower characteristic value of a variable parameter) and CvU (the upper characteristic value of a variable parameter). For Re, these are detailed in Table 2 of the Standard as 500 MPa and 600 MPa respectively. One interpretation is that the 95% and 105% allowances can be applied to these having relied on the CvL: p=0.95, and CvU: p=0.05 figures in Table 2 to make this allowance. This is incorrect.

“The p-values are provided to indicate that this is a 90% confidence level and are used to determine the correct ‘K’ statistical multiplier from Table B1 that should be applied to the sample test results dataset, and to calculate the required confidence interval. These p-values are not to be used to expand the lower and upper limits of 500 MPa and 600 MPa within which the confidence interval is required to fall. The same issue exists for Agt and Rm/Re unless the manufacturer has waived the Long-term quality level (LTQL) for these parameters.”

14.1.18 AS/NZS 4671 B6.4

Add a Clause after B6.3:

“B6.4 Non-conformance to long-term quality levels

Where steel of welded mesh is sourced on the spot market from random different suppliers, then Clause B6 cannot be used and Clause B7 must be used to show conformance.

14.1.19 AS/NZS 4671 Clause B7.2

Add the following before the first paragraph:

“Individual batches must be subjected to testing in accordance with Clause B7.2 and Clause B7.3.

“The results shall be evaluated against the requirements of Clause B7.4.1 (a) and Clause B7.4.2.

“If the steel does not comply with the requirements of Clause B7.4.1 (a) then it shall be subjected to additional testing in accordance with Clause B7.4.1 (b).

“If the additional results fail to meet the specified values, the batches are deemed to be non-conforming and the manufacturer/ supplier must demonstrate ongoing compliance through B7 until a new LTQL can be established in accordance with B6.1 (for example 200 test results).”

Add a comment:

“COMMENT:

Test piece and specimen have the same meaning.”

14.1.20 AS/NZS 4671 Clause B7.3

Add a line in Clause B7.3(a) after (iv):

“(v) Shear strength of joints in mesh”

14.1.21 AS/NZS 4671 Clause B7.4.1(a)(iii)

Delete the two equations and replace them with:

$$\bar{x}_{15} - 2.33s_{15} \geq R_{ek,L}; \text{ and}$$

$$\bar{x}_{15} - 2.33s_{15} \leq R_{ek,U};$$

COMMENT:

The error in these equations only appears to affect downloaded copies of AS/NZS 4671.

14.1.22 AS/NZS 4671 Clause C2.2.2

Delete all but the last sentence and replace with:

“The uniform elongation Agt shall be determined in accordance with ISO 15630-2 with the following permitted amendments:

(a) a minimum extensometer gauge length of 50 mm may be used

(b) for measurements taken after failure gauge marks of up to 25 mm may be used.”

Amend the last sentence by deleting “unless otherwise agreed between the parties concerned.”

Add a sentence after the last sentence:

“Where possible when testing for Agt, the gauge length for the measurement of elongation shall exclude the welded intersection.”

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Nov 2016

- for $\phi > 0$:

$$\lambda_{qd} = \lambda_{qd} - \frac{(1 - \lambda_{qd})}{N_q \tan \phi}$$

$$\lambda_{\gamma i} = \left(1 - \frac{H_{uf}}{V_{uf} + A'c' \cot \phi'} \right)^3$$

- for $\frac{D_f}{B'} \leq 1$:

$$\lambda_{qd} = 1 + 2 \tan \phi (1 - \sin \phi)^2 \left(\frac{D_f}{B'} \right)$$

$$\lambda_{ci} = \frac{\lambda_{qi} N_q - 1}{N_q - 1}$$

- for $\frac{D_f}{B'} > 1$:

$$\lambda_{qd} = 1 + 2 \tan \phi (1 - \sin \phi)^2 \tan^{-1} \left(\frac{D_f}{B'} \right),$$

where \tan^{-1} is in radians

- for all cases

$$\lambda_{\gamma d} = 1$$

- c) Load inclination factors: λ_{ci} , λ_{qi} and $\lambda_{\gamma i}$

where:

- for $\phi = 0$

$$\lambda_{ci} = 0.5 \left(1 + \sqrt{1 - \frac{H}{A'S_u}} \right)$$

$$\lambda_{qi} = 1$$

- for $\phi > 0$

- for horizontal loading parallel to L^1

$$\lambda_{qi} = \lambda_{\gamma i} = 1 - \frac{H_{uf}}{(V_{uf} + A'c' \cot \phi')}$$

$$\lambda_{ci} = \frac{\lambda_{qi} N_q - 1}{N_q - 1}$$

- for horizontal loading parallel to B^1

$$\lambda_{qi} = \left(1 - \frac{0.7 H_{uf}}{V_{uf} + A'c' \cot \phi'} \right)^3$$

- d) Ground inclination factors: λ_{cg} , λ_{qg} and $\lambda_{\gamma g}$

For horizontal ground $\lambda_{cg} = \lambda_{qg} = \lambda_{\gamma g} = 1$

For inclined ground, the permitted slope (angle ω below the horizontal) depends on soil angle of shearing resistance ϕ and the distance D_e between the foundation and the slope face:

- where $\phi \geq 0$ (drained analysis)

v shall not be $> \phi$

- where $\phi = 0$ (undrained analysis)

ω shall not be $> 45^\circ$

The ground inclination factors shall be:

- for $D_e \geq 2B$

$$\lambda_{cg} = \lambda_{qg} = \lambda_{\gamma g} = 1$$

- for $D_e < 2B$

$$\lambda_{cg} = 1 - \omega(1 - D_e/2B)/150$$

$$\lambda_{qg} = \lambda_{\gamma g} = (1 - \tan(\omega(1 - D_e/2B)))^2$$

Amend 16
Apr 2018

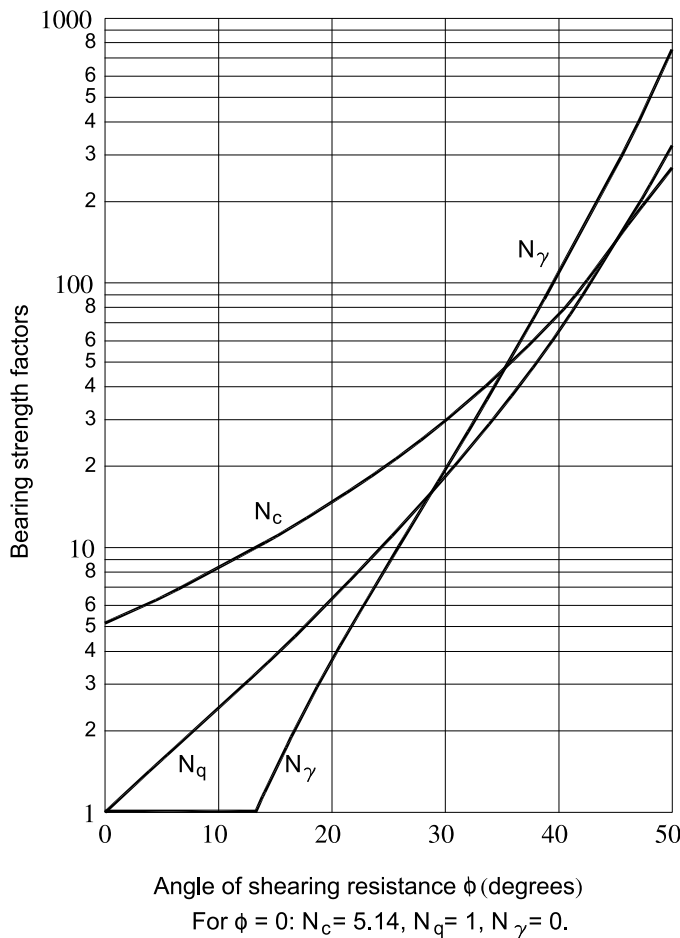
3.3.3 Local shear

For sands with relative densities less than 40% and clays having liquidity indices greater than 0.7, the bearing strength shall be evaluated using $0.67c$ for cohesion and $\tan^{-1}(0.67 \tan \phi)$ for the angle of shearing resistance.

COMMENT:

The formulae in Paragraph 3.3.2 assume a general shear failure of the soil but for the soils specified in this Paragraph a local shear failure is likely.

Figure 3: Bearing Strength Factors
Paragraphs 3.3.2 and 4.1.3



3.4 Ultimate limit state sliding resistance

3.4.1 When the loading is not normal to the foundation base, foundations shall be checked for failure by sliding.

3.4.2 The ultimate sliding resistance shall comprise the sum of the ultimate sliding strength between the base of the foundation and the ground, and any available passive earth pressure in the direction of sliding at the side of the foundation.

3.4.3 Passive earth pressure shall not be considered if:

- a) For foundations in clay soils, it is possible that the clay could shrink away from the vertical faces of the foundation, or

- b) The possibility exists that the soil in front of the foundation may be removed by erosion or by building or landscaping work in the future.

3.4.4 For drained conditions, the ultimate sliding strength shall be:

$$S = c'A' + V' \tan \delta'$$

The value of δ' shall be taken as the angle of shearing resistance (ϕ') of the foundation soil for cast-in-situ concrete foundations and $0.67\phi'$ for smooth precast foundations.

3.4.5 For undrained conditions, the ultimate sliding strength shall be:

$$S = A's_u$$

$$H_u \left[\frac{2}{3} \sqrt{\frac{2H_u}{9D_s \chi}} + f \right] - 2M_{ult} = 0$$

The location of the maximum pile shaft moment is obtained from the same equation as for the long free head pile.

4.3.4 Drained lateral strength of piles in cohesionless soil

a) Free head piles

i) short free head piles

The ultimate lateral strength of a short free head pile is:

$$H_u = \frac{K_p D_s L^3 \gamma}{2(f + L)}$$

The location, measured from the ground surface, of the maximum pile shaft moment is:

$$g_s = \sqrt{\frac{2H_u}{3K_p \gamma D_s}}$$

The maximum pile shaft moment is:

$$M_{max} = H_u \left[\frac{2}{3} \sqrt{\frac{2H_u}{3K_p D_s \gamma}} + f \right]$$

ii) long free head piles

The ultimate lateral strength of a long free head pile is obtained by solving the following equation:

$$H_u \left[\frac{2}{3} \sqrt{\frac{2H_u}{3K_p D_s \gamma}} + f \right] - M_{ult} = 0$$

The location of the maximum pile shaft moment (M_{ult}) is obtained from the same equation as for the short pile.

b) Restrained head piles

i) short restrained head piles

The ultimate lateral strength of a short restrained head pile is:

$$H_u = 1.5K_p D_s L^2 \gamma$$

The magnitude of the maximum pile head moment is:

$$M_{max} = H_u \left(\frac{2}{3}L + f \right)$$

If M_{max} is greater than M_{ult} then the intermediate length case, ii) below, is appropriate.

ii) intermediate restrained head piles

The ultimate lateral strength of an intermediate length restrained head pile is:

$$H_u = \frac{K_p D_s L^3 \gamma}{2(f + L)} + \frac{M_{ult}}{f + L}$$

The location, measured from the ground surface, of the maximum pile shaft moment is:

$$g_s = \sqrt{\frac{2H_u}{3K_p D_s \gamma}}$$

The pile shaft moment at this depth is:

$$M_{max} = H_u \left[\frac{2}{3} \sqrt{\frac{2H_u}{3K_p D_s \gamma}} + f \right] - M_{ult}$$

If M_{max} calculated from this equation is greater than M_{ult} then the long case, iii) below, is appropriate.

iii) long restrained head piles

The ultimate lateral strength of a long restrained head pile is obtained by solving:

$$H_u \left[\frac{2}{3} \sqrt{\frac{2H_u}{3K_p D_s \gamma}} + f \right] - 2M_{ult} = 0$$

The location of the maximum pile shaft moment is obtained from the same equation as is used for the intermediate length case.

4.4 Pile groups

4.4.1 Ultimate vertical strength of pile groups

The undrained vertical strength of a pile group considered as a single block in a cohesive soil is:

$$V_B = (9s_u + q) B_G L_G + 2 (B_G + L_G) L (c_a)_{average}$$

The drained strength of a pile group considered as a single block of soil is given by:

$$V_B = (c^i + q^i N_q + 0.6 B_G \Gamma N_\gamma) B_G L_G + 2 (B_G + L_G) L \{ (c_a^i)_{average} + (\sigma_v^i K_o \tan \delta^i)_{average} \}$$

The ultimate vertical strength of the group is determined from:

$$\frac{1}{V_G^2} = \frac{1}{n^2 V_1^2} + \frac{1}{V_B^2}$$

4.4.2 If only part of an embedded friction pile length is in satisfactory material, the surface area calculated as providing frictional resistance shall be limited to the surface areas in contact with that material.

4.5 Downdrag

4.5.1 Downdrag may be generated when a pile shaft passes through a compressible soil layer. Downdrag shall be considered as dead load applied to the parts of the pile below the compressible layer. It shall be added to the imposed loadings and factored accordingly.

4.6 Ultimate lateral strength of pile groups

4.6.1 If piles are spaced at centre to centre intervals of less than 4.0 times the *nominal pile width*, the ultimate lateral pile strength shall be reduced. The reduced value shall be calculated as a percentage of the ultimate lateral pile strength for an isolated pile by linear interpolation between the two values given in Table 3.

4.7 Strength reduction factors

4.7.1 *Strength reduction factors* for design of ultimate vertical and lateral strengths in pile foundations shall be within the range given in Table 4.

The designer shall nominate in the design the *strength reduction factors* chosen along with substantiation as to why the values chosen are considered appropriate. The values chosen shall be to the approval of the *territorial authority*.

COMMENT:

The value of the *strength reduction factor* used in design will depend on the designer's knowledge of the site and the investigations undertaken. As a guide the lower end of the range will generally be appropriate when a limited site investigation is undertaken, average geotechnical properties are used, published correlations are used to obtain design parameters or there will be minimal *construction* control. The upper end of the range will generally be appropriate when a comprehensive site investigation and laboratory testing is undertaken, geotechnical properties are chosen conservatively, site specific correlations are used for design parameters and there will be careful *construction* control.

5.0 Pile Types

5.1 Concrete piles

5.1.1 Precast concrete piles, including prestressed piles, shall withstand without damage or significant cracking, the stresses arising from manufacture, handling and transportation, in addition to those arising from driving and imposed loadings.