SNZ HB 4236:2002

STANDARDS NEW ZEALAND
Paerewa Aotearoa

New Zealand Handbook

Masonry Veneer Wall Cladding

SNZ HB 4236:2002

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NZ Masonry Trades Registration Board

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CONTENTS **PAGE**

Copyright Standards New Zealand

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RELATED DOCUMENTS

Reference is made in this document to the following:

NEW ZEALAND STANDARDS

NZS 3101.1 and 2:1995	The Design of Concrete Structures
NZS 3603:1993	Timber Structures
NZS 3604:1999	Timber Framed Buildings
NZS 4203:1992	General Structural Design and Design Loadings for Buildings
NZS 4210:2001	Masonry Construction: Materials and Workmanship
NZS 4229:1999	Concrete Masonry Buildings not requiring Specific Engineering Design
NZS 4230.1 and 2:1990	Code of Practice for the design of Masonry Structures

JOINT AUSTRALIAN/NEW ZEALAND STANDARDS

AS/NZS 2699:2000 Part 1	Wall ties
AS/NZS 4455:1997	Masonry Units and Segmental Pavers
AS/NZS 4456.0:1997	General introduction and list of methods
AS/NZS 4456.3:1997	Determining dimensions
AS/NZS 4456.4:1997	Determining compressive strength of masonry units
AS/NZS 4456.10:1997	Determining resistance to salt attack

AUSTRALIAN STANDARDS

AS 3700-2001	Masonry structures

BRITISH STANDARDS

BS 5628 Part 3 – 2001	Code of Practice for use of Masonry Materials and Components, Design and Workmanship.

OTHER DOCUMENTS

Building Industry Authority – The New Zealand Building Code (NZBC)
The Brick Book, John Oliver

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FOREWORD

This Handbook is designed to assist tradespersons, in this case bricklayers and masons, in ensuring they are fully aware of the Standards documents relating to the area of their work.

The veneer handbook illustrates that in order to cover fully the aspects of the construction of veneer walls, reference to two and perhaps three New Zealand Standards are necessary.

In the case of NZS 3604 only part of section 11 relates to veneer construction. Similarly for NZS 4210 only some of section 2 applies and for NZS 4229 only Section 12. The extracts taken from NZS 3604, NZS 4229 and NZS 4210 are in their exact form from the full document including original clause numbering.

To focus on the need for compliant workmanship, two checklists have been included as a pre-construction list and a design/post-construction list. The design/post construction list has been developed, with kind permission from John Oliver, from a checklist printed in his publication “The Brick Book”.

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INTRODUCTION: SCOPE AND INTERPRETATION

Scope

This Standards New Zealand Handbook sets out guidelines and requirements for masonry veneer exterior cladding in New Zealand. All material in this Handbook is extracted from previously published New Zealand Standards - NZS 3604:1999, Section 11, NZS 4210:2001, Section 2; and NZS 4229:1999, Section 12. NZS 3604, NZS 4229 and NZS 4210 are Standards cited in the Building Industry Authority's Approved Documents and compliance with them is therefore an essential requirement.

This Standard does not specifically cover other forms of masonry nor the use of adhesives other than cement mortar between masonry units. Such forms of masonry construction are outside the scope of this Standard by reference to AS 3700.

Interpretation

This Handbook focuses on the elements of previously published New Zealand Standards which apply specifically to masonry veneer tradecraft. Consequently, ***only*** the abridged portions of the Parts from the previously published Standards, which are pertinent to masonry veneer tradecraft, appear here. For a complete version of the original Standards, please refer to the respective New Zealand Standards from which this Handbook was sourced. As this Handbook directly quotes extracted elements from existing New Zealand Standards, the word "shall" identifies a mandatory requirement for compliance with the Standard. The word "should" refers to practices which are advised or recommended. Clauses prefixed by "C" and printed in grey italic type are comments outlining recommendations and/or background information. The Standards can be complied with if the comments are ignored.

For a definition of terms please refer to the original Standards.

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CHECKING THE PROJECT: Pre-construction checklist

1) Is all the building paper in position, tears repaired, etc.?

2) Is there adequate framing behind the building paper for the type and pattern of cavity ties proposed? (e.g double studs adjacent to openings to allow the fixing of ties).

3) Are all the service outlet positions marked?

4) Are flashings installed where required?

5) Has a 50 mm step rebate been provided at the floor?

6) Is rebate width correct?

***Comment**: The rebate width requirements vary with brick selected ie 70 mm brick with nominal 5 mm foundation overhang requires a rebate width of a minimum of 105 mm.*

7) Can the wall be built to plumb and line while maintaining a minimum 40 mm cavity and maximum of 75 mm?

(a) Foundation straight?
(b) Framing in correct position and straight?
(c) Framing plumb and not bowed?

8) If control joints are required determine where they are to be located.

***Comment**: Control joints are not normally required for clay brick products.*

Building the wall without compliance with the above is a breach of the New Zealand Building Code.

Construction checklist
Colour/Appearance
Check that brick pallets have the same batch number.

***Comment**: Keep any open brick pallets covered and protected as far as practicable from rain or other contaminants such as mud, dust etc. Try to use the bricks from three pallets, wherever this is possible, to reduce any possible visual colour changes.*

Make sure that the mortar mixing volumes are consistent.

***Comment**: Changes in water and aggregate volumes can change the colour of the mortar.*

Check that cleaning down of the brick face is done once the mortar joints have set.

Checklist continued ➤

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Laying

Check the bond pattern to ensure that ideally 1/2 or full bricks adjoin every opening, but no less than 25 %.

Provide clean out openings in the first course.

***Comment**: Putting a thin scattering of sand behind the first course prevents mortar droppings adhering to the concrete, making cleaning out much easier.*

Provide weep holes in first course and above openings.

Check that the wall ties are correct for the job (i.e. length/durability rating) and you are aware of correct spacing.

Make sure mortar droppings on ties are knocked off and the debris cleaned out through the clean out opening.

***Comment**: Failure to do this can lead to water back tracking into the dwelling.*

BUILDING INSPECTOR CHECKLIST:
Building consent

1) Veneer thickness and cavity dimensions.

2) Foundation floor slab step depth minimum 50 mm and width suitable for the veneer specified.

3) Ties spacing and durability specified.

4) Flashing requirements shown for each opening or junction in materials.

5) Lintel specifications for span and durability.

6) Pipes and services not run along the cavity.

Construction checks

1) See pre-construction checklist for bricklayer.

2) Cavity width established.

***Comment**: Installation of insulation in the frame can result in significant reductions of the cavity width.*

3) Wall plumb, straight and not overhanging the foundation by more than 20 mm.

4) Weep holes and top venting of veneer installed.

5) Cavity ties installed.

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STANDARDS NEW ZEALAND HANDBOOK

MASONRY VENEER WALL CLADDING

Combined Standards referenced from NZS 3604, NZS 4210 and NZS 4229

APPLICATIONS OF MASONRY VENEER

NZS 3604

11.7 Masonry veneer wall cladding

11.7.1 Scope

Masonry veneer wall cladding (see figure 11.1) shall have:

(a) A maximum height of veneer above adjacent finished ground level of 7 m;

(b) A maximum mass of veneer of 220 kg/m2;

(c) A maximum height of veneer of 4.0 m, measured from the top of the concrete masonry wall, foundation wall or slab edge foundation. In the case of a veneer faced concrete block wall or foundation wall be measured from the top of that wall (see figure 11.1);

(d) A maximum height of veneer of 5.5 m on a gable end;

(e) The bracing demand for framing supporting masonry veneer determined from values listed in tables 5.8 to 5.10*;

(f) Where the veneer exceeds 3 m in height (excluding a gable) over more than 20 % of an exterior wall length, the minimum bracing demand of 10 bracing units given by 5.4.2.3*, shall be increased to 12.

* Reference to the full Standard shall apply.

C11.7.1 *All other veneer applications are required to be demonstrated by specific design that the veneer complies with the NZBC. Such design could be based on NZS 3603, NZS 4203, NZS 4210, NZS 4229 and NZS 4230 as appropriate.*

NZS 4229

12.1 Scope

This clause covers this Standard's requirements for masonry veneer exterior cladding.

(a) The maximum height of veneer shall be 6 metres measured from the top of a supporting concrete

Text continues on page 13 ➤

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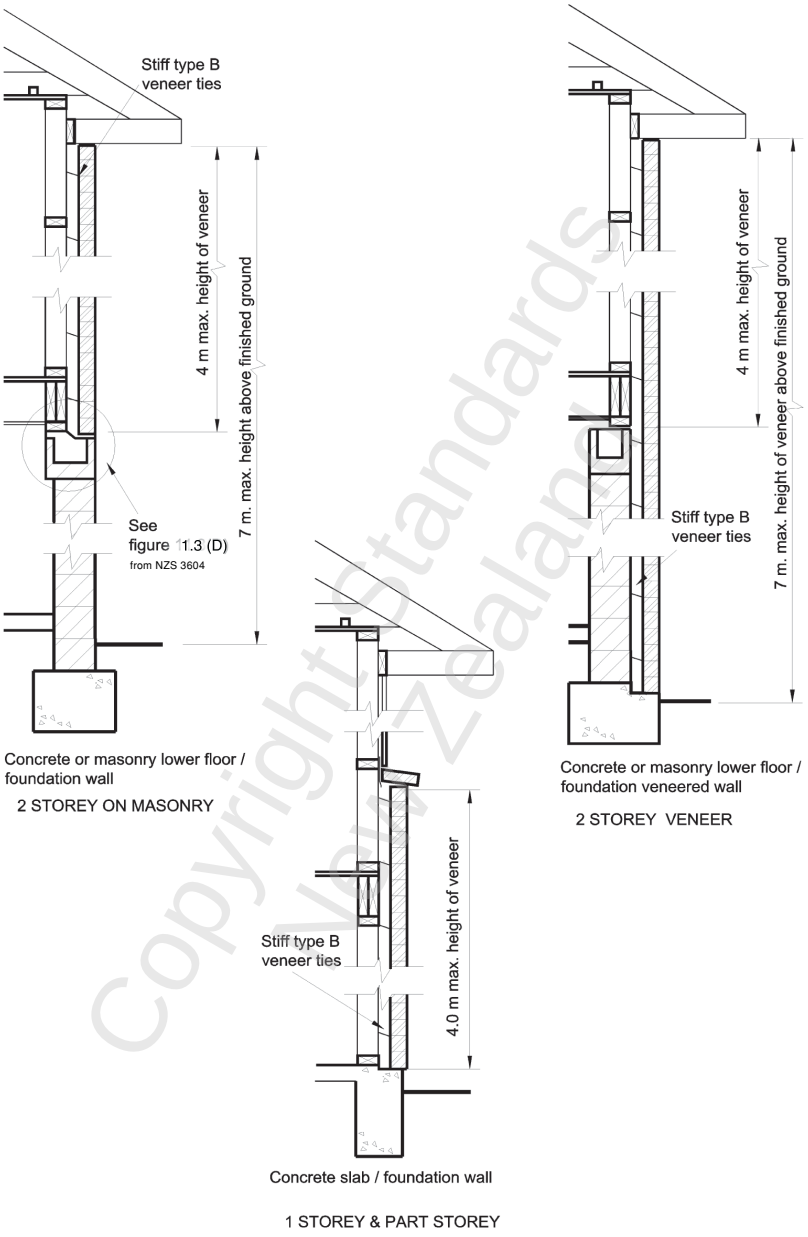

Figure 11.1 (a) – Heights of veneer construction
(continued on page 11 – see 11.7.1)
Extracted from NZS 3604

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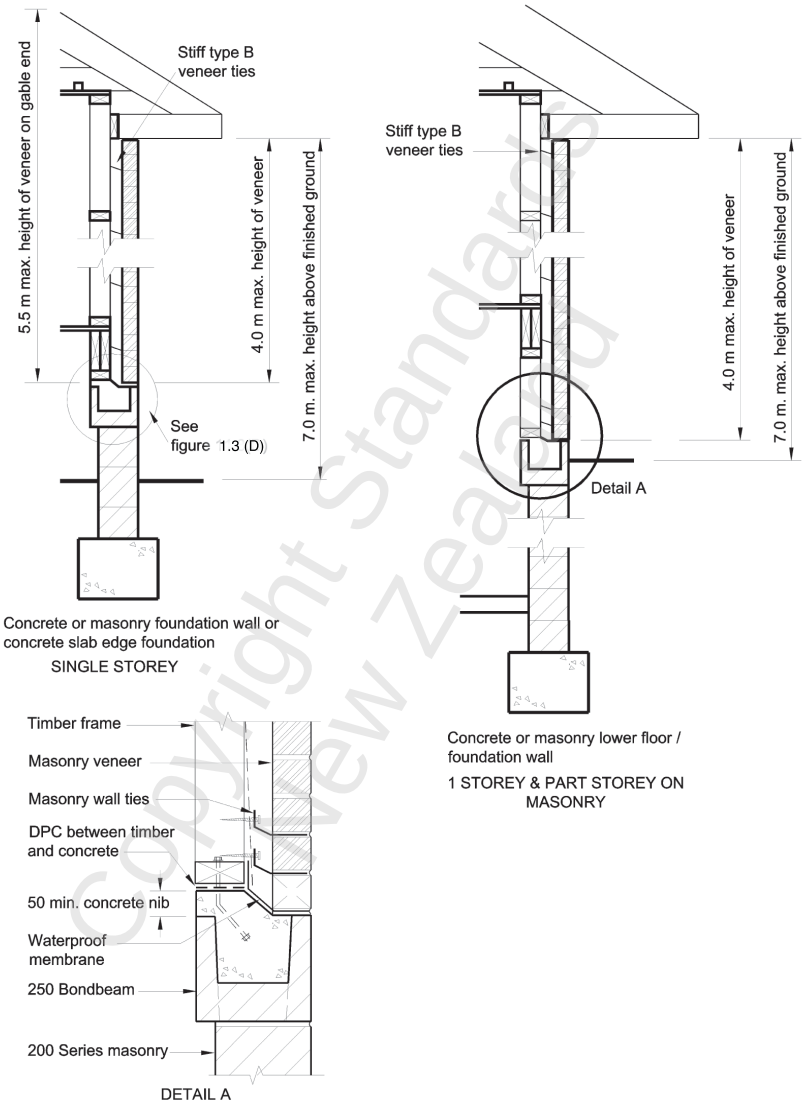

Figure 11.1 (b) – Heights of veneer construction
(continued from page 10 – see 11.7.1)
Extracted from NZS 3604

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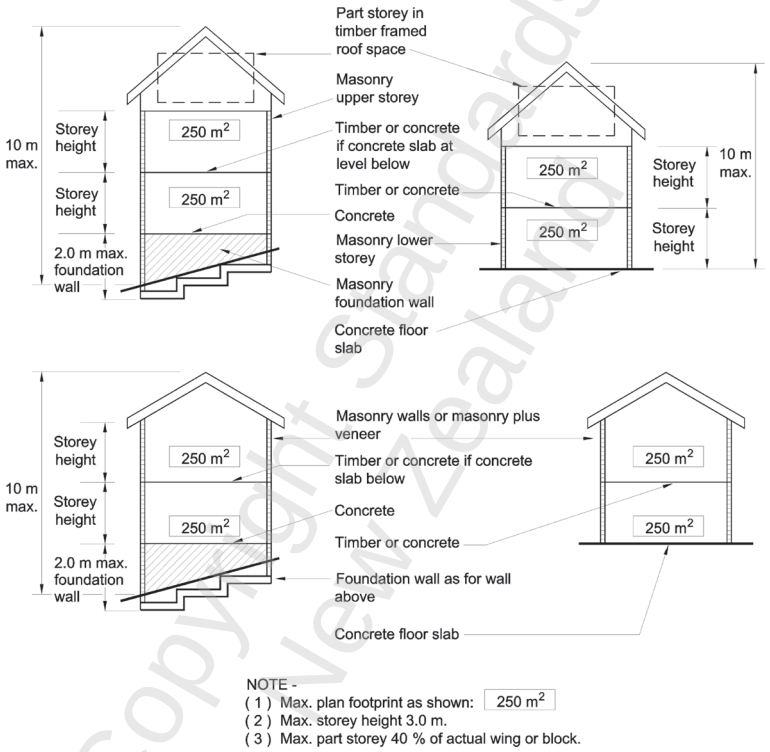

Figure 1.1 (b) – Building Types covered by this Standard
Extracted from NZS 4229:1999

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masonry or reinforced concrete foundation or a slab edge foundation except that, if at a gable end, the overall height can be increased to 10 metres;

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

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

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

NZS 4210

1.1 Scope

1.1.1

This Standard sets out requirements for the materials and workmanship of clay, concrete and natural stone masonry to be used in conjunction with NZS 3604, NZS 4229 and NZS 4230 for the construction of masonry buildings and masonry veneers.

C1.1.1 *This Standard does not specifically cover other forms of masonry nor the use of adhesives other than cement mortar between the masonry units. Such forms of masonry construction are outside the scope of this Standard but may be dealt with in terms of 2.1.3* or reference to AS 3700.*

* Reference to the full Standard shall apply.

1.1.2

NZS 3604, NZS 4229 and NZS 4210 are Standards cited in the Building Industry Authority's Approved Documents. Compliance with NZS 4210 is an essential requirement of all these Standards.

2.9.1 General

2.9.1.1

In a wall consisting of a veneer and a structural element complying with NZS 3604 and NZS 4229 which are separated by an ungrouted cavity or are in unbonded contact, the two components shall be connected together using wall ties meeting the type, placing and spacing requirements given in Appendix 2.E (of NZS 4210, page 45), 2.9.6 and 2.9.7, (on pages 19, 34 and 35 of this Handbook).

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2.9.1.2
Veneer construction, other than that deemed to comply with the limitations of NZS 3604 and NZS 4229, together with associated separation joints to allow the veneer to accommodate differential movements of the structural elements under seismic load, shall be subject to specific engineering design in accordance with NZS 4203 and NZS 4230: Part 1.

C2.9.1.2 *NZS 4230: Part 2 offers advice on separation joint details to accommodate differential movement between veneers, and veneers and their structural backing. Where the supporting structural element is significantly more flexible under racking load than the veneer, significant damage to the veneer can occur particularly at internal and external corners. The displacement can be either reduced by using a stiffer supporting wall or by providing appropriate separation details. The acceptable levels of seismic damage to a cladding such as veneer is not clearly defined. In Coalinga, USA, which experienced an earthquake of force 6.5 on the Richter scale, veneer with poor fixings collapsed but veneer with correctly installed ties survived undamaged despite the absence of special separation details. Veneer damage at Edgecumbe in 1987 revealed primarily a problem in inadequate tie provision and fixing. The adoption of full corner and window separation details is seen as a logical engineering step towards limiting damage in veneers. Veneer construction in these cases is likely to make use of the special flexible ties whose performance is set out in AS/NZS 2699:Part 1.*

VENEER UNITS

NZS 4210

2.1.4 Masonry units
2.1.4.1
Masonry units shall comply with AS/NZS 4455 and suppliers of such units shall provide the following information:

(a) Unconfined compressive strength as determined by AS/NZS 4456:Part 4;

(b) Work size tolerances as determined by AS/NZS 4456:Part 3.

C2.1.4.1 *The strength requirement is to ensure compatibility with the design requirements. Such values are normally expressed as minimum characteristic compressive strengths in MPa. Products would usually be arranged into groups of 5, 10, 15, 20 MPa etc.*

2.1.4.2
The salt attack resistance of clay and natural stone

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masonry units as determined in accordance with AS/NZS 4456:Part 10 shall comply with the requirements of table 2E1 on page 19 of this handbook.

C2.1.4.2 *Appropriate salt attack resistance is needed to ensure the durability of the masonry units. It is not necessary to determine the salt attack resistance for concrete masonry products.*

2.1.4.3
The suppliers of natural stone shall also comply with BS 5628, Part 3.

2.1.4.4
Where natural stone is used, the manufacturer shall supply instructions advising all necessary requirements of the installation (see C2.1.4.4).

C2.1.4.4 *The properties of a proposed natural stone material should be carefully assessed for the use to which the stone is to be put. Consideration should be given to compressive and tensile strength, splitting properties, mortar bonding characteristics and weathering aspects such as porosity and abrasive and chemical durability. While an established service record may exist, it is prudent to check that the quality of material being currently quarried meets a level of performance suitable for its intended use. Stone from sedimentary geological formations almost always needs to be laid with its natural bedding plane horizontal. The various considerations or limitations of use should form part of any approval issued in terms of this section. The producer's recommendations relating to bond patterns, tie spacing, tie embedment and placing methods should be followed.*

2.1.4.5
Masonry units supplied for use with NZS 3604 and NZS 4229 shall have the minimum required properties:

(a) Structural applications: unconfined compressive strength of 12.5 MPa;

(b) Non-structural veneer applications: unconfined compressive strength of 2.25 MPa for natural stone or 10 MPa for concrete products. The unconfined compressive strength of masonry units for designs to NZS 4230 is a matter of specific engineering design. However, for concrete units the strength shall not be less than 10 MPa.

C2.1.4.5 *Clay brick strengths are of the order of 15 MPa and above and historically have demonstrated durability to meet the NZBC – B2 requirements. Concrete bricks must have a*

physical strength in excess of 10 MPa to meet Clause B2 requirements of the NZBC.

2.1.4.6
Masonry units shall not be re-used nor deemed to satisfy the requirements of this and related Standards unless accompanied by evidence of selection of grading, and testing in respect of compressive strengths and 7-day masonry-to-mortar bond strengths (see *C2.2.3.2,* page 18 of this Handbook).

2.1.4.7
If samples of concrete masonry units are taken for testing after delivery from the manufacturer the sample size and storage shall comply with AS/NZS 4456. Tests shall be carried out in accordance with AS/NZS 4456 with compressive strength conforming to section 4 of that Standard.

2.9.1.3
Where a veneer and its supporting element are separated by an ungrouted cavity, the masonry units of the veneer shall have a minimum width of 70 mm.

NZS 4229

12.2.3
The masonry units shall have a minimum nominal work width of 70 mm as determined by AS/NZS 4455

MORTAR AND MORTAR JOINTS

NZS 4210

For information on cement, sand and admixtures reference must be made to the full Standard (NZS 4210)

2.2 Mortar

2.2.1 Measurement of materials

2.2.1.1
Materials for mortar shall be accurately measured by weight or volume in suitably calibrated devices.

Table 2.1 – Mortar mix composition using parts by volume using hydrated lime

Durability	Cement	Hydrated lime	Mortar sand
M4	1	0 – 0.25	3
M3	1	0.5	4.5
M2	1	1	6

This table is extracted from NZS 4210:2001

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2.2.2 Composition and mixing

2.2.2.1
Mortar shall be composed of Portland cement, sand and hydrated lime and water as required by table 2.1. The durability requirements shall be as given in table 2E1 of Appendix 2.E (See page 19 of this Handbook).

Hydrated lime may be omitted from the mix if it can be demonstrated that the performance requirements of 2.2.3.1 and 2.2.3.2 will still be achieved. Admixtures may be used in either case subject to the requirements of 2.1.8*.

* Reference to the full Standard shall apply.

C2.2.2.1 *The workability of mortars is significantly affected by sand grading and particle shape. For the majority of mortars it is likely that the use of an admixture or hydrated lime will be necessary to produce the desired workability. Admixture dosage should strictly follow the manufacturer's instructions since significant loss of strength and bond can occur through over dosage.*

2.2.2.2
The following provisions shall apply for mixing of mortars:

a) All materials shall be thoroughly mixed to an even consistency for a minimum time of 5 min in a mechanical batch mixer, provided that hand-mixing to an equivalent result is permitted for quantities of mortar not exceeding 0.03 m^3;

b) The volume of hydrated lime in a mix shall not exceed the volume of cement;

c) The mixing and proportions of any admixture shall be in accordance with the manufacturer's instructions;

d) If a batch of mortar which has been prepared for use has stiffened due to lapse of time, workability may be restored by the addition of water and thorough re-mixing, provided that the properties required by 2.2.3 shall not be impaired. Re-tempering water shall be added to a basin formed by the mortar and the mortar carefully worked into it. Re-tempering by dashing water over the mortar shall not be permitted;

e) Any mortar not used within 1.5 hours after the addition of cement to the mix shall be discarded, provided that in cold weather (below 5° C) this period may be

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extended to 2 hours, and provided that this requirement may be waived in the case of ready-mixed and retarded mortars if it can be established that such mortars meet the requirements of 2.2.3 (of NZS 4210);

f) Where mortar is to be coloured, this shall be achieved by the use of coloured cement or by the addition of mineral oxide pigment conforming to NZS 3117. Dosages of mineral oxide shall not exceed 3 % by weight of cement unless it can be shown that greater concentrations do not cause a reduction of mortar strength. In any case dosages in excess of 6 % by weight of cement shall not be used.

C2.2.2.2(f) *Dosages of some mineral oxide pigments in excess of 3 % may lead to unacceptable reductions in bond strength.*

2.2.1 Properties

2.2.1.1 Compressive strength

2.2.3.1.1

The 28-day compressive strength of mortar when tested in accordance with Appendix 2.A* shall not be less than 12.5 MPa for structural compliance with NZS 3604 and NZS 4229.

2.2.3.1.3

The minimum 28-day compressive strength of mortars used for veneer construction shall follow the requirements of the masonry suppliers.

2.2.1.2 Bond strength

The 7-day masonry-to-mortar bond strength when tested in accordance with Appendix 2.B* shall be not less than 200 kPa for structural compliance with NZS 3604 and NZS 4229.

For masonry to NZS 4230 the 7-day masonry-to-mortar bond strength is a matter for the designer to nominate as part of a specific engineering design.

* Reference to the full Standard shall apply.

C2.2.3.2*The relevance of bond strength in the seismic resistance of reinforced structural masonry construction is limited, due to the presence of tensile reinforcement.*

The bond strength value is more significant in the construction of unreinforced and lightly reinforced veneers. Apart from providing weather resistance and the structural connection mechanism to transfer the face loads of the veneer into the wall ties, mortar bond strength has an important effect on in-plane and out-of-plane flexural and shear strength of a brick veneer. Transverse strength tests of full scale walls indicate

that the bond between mortar and brick is the most important single factor affecting wall strength.

With the permitted use of unreinforced two storey veneers and multi-storey reinforced veneers, mortar bond strengths become a significant factor in the overall performances of veneers.

The typical mortar bond values for masonry construction laid to the requirement of this Standard are:

Clay brick masonry	*500-1000 kPa*
Concrete brick masonry	*400-900 kPa*

2.7.1.3
The thickness of mortar joints shall be 10 mm ± 3 mm except that a joint thickness up to 20 mm may be accepted on the bottom course in order to take up the permitted tolerances of the supporting concrete.

Table 2.E1 – Masonry durability requirements

Exposure categories		Durability requirements			
NZS 3604 zones	**NZS 3101 zones** (Note 1)	**Masonry units** (Note 2)	**Mortar** (Note 3)	**Classification built in components** (Note 4)	**Minimum cover to reinforcement** (Note 5)
Seaspray	B2	Exposed	M4	R4	30 (60)
1 & 4	B1	General purpose	M4	R3	20 (50)
2 & 3	A2	Protected	M3	R3	15 (45)
Closed interior	A1	Protected	M2	R1	5 (35)
Geothermal hotspot	U	Exposed	M4	R5	Specific engineering design consideration

NOTE –
(1) The NZS 3101 zones shall be as defined in section 5 of that Standard.
(2) These classifications are defined in AS/NZS 4456.10 for resistance to salt attack. The requirement is not needed for concrete masonry products.
(3) The requirements of the mortar to meet the classifications nominated in the table are given in 2.2.2.1 of this Standard.
(4) The classifications are defined in AS/NZ 2699:Part 1 Wall Ties, Part 2 Connectors and Accessories, Part 3 Lintel and shelf angles. A protection specification is given for the component which a manufacturer must meet and label the component to identify the level of corrosion protection.
(5) The cover is measured from the inside of the cell face of the unit. The figures in brackets are the approximate total cover to the outside face of the wall assuming a face shell thickness of 30 mm. Reinforcements shall be restrained so that the minimum covers are maintained during construction. Retaining walls shall be classed as B2 as specified in NZS 3101.
(6) When weatherproofed to the requirements of 2.21.2.2 – 2.21.2.5, Exposure Categories 1, 2, 3 & 4 (NZS 3604) or B1 & A2 (NZS 3101) can be reduced to "Closed Interior" or "A1".
When waterproofed to the requirements of 2.21.2.1 all exposure categories can be reduced to "Closed Interior" or "A1".

This table is extracted from NZS 4210, Appendix 2 – Durability.

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C2.7.1.3 *Where the in situ concrete surfaces on which masonry is to be laid vary such that the thickness of the mortar bed beneath the bottom course cannot be maintained within the tolerances given, remedial measures will be necessary. These may include cutting back the concrete surface (with possible reinstatement), or cutting the masonry units of the bottom course where necessary. Other options, including placing a high strength levelling screed (but not floor levelling compound), should be subject to specific engineering design.*

2.7.1.6
Precautions shall be taken to prevent mortar from falling down cells and cavities. (See 2.8 page 38 of this Handbook).

2.7.1.7
Any mortar protruding more than 5 mm into cells or cavities shall be removed. No mortar protrusions shall be closer than 5 mm to reinforcing steel.

2.7.4 Solid and cored units
2.7.4.1
Solid and cored units shall have all joints completely filled with mortar.

2.7.4.2
Furrowing of bed joints shall not exceed 25 % of the joint thickness.

2.7.7 Mortar joints
2.7.7.1
Mortar joints on external walls shall be:

(a) Concave tooled to a depth not exceeding 6 mm and burnished after the initial stiffening has occurred; or

(b) Raked out, pointed and tooled to a depth not exceeding 6 mm after the initial stiffening has occurred.

FOUNDATION AND LAYOUT

NZS 3604

11.7.2 General
11.7.2.1
The materials and workmanship of masonry veneer shall be in accordance with NZS 4210. Mortar less than 24 hours old shall not be subject to vibration, such as would result from the nailing of interior linings.

11.7.2.2
No length of a veneer wall or return shall be less than 230 mm, measured from the external face of the veneer.

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11.7.3 Foundation

11.7.3.1

Masonry veneer shall be supported by one, or a combination of the following:

(a) Foundation wall;

(b) Thickened slab edge footing.

The support shall be constructed to comply with figures 6.14*, 7.14*, 7.15* and 11.1.

*Reference to the full Standard shall apply.

11.7.3.2

The top of a foundation wall or concrete slab shall be stepped down, so that the surface supporting the veneer is 50 mm or more below the surface supporting the timber framing. The level of the concrete slab above ground shall comply with 7.5.2* of NZS 3604.

*Reference to the full Standard shall apply.

11.7.3.3

The veneer shall not overhang its supporting foundation by more than 20 mm.

NZS 4210

2.5 Initial preparation

2.5.1 Concrete base

2.5.1.1

Any discrepancies in the vertical alignment, other than those that can be corrected by a mortar bed not exceeding 20 mm thick at any point as provided by 2.7.1.3 (page 19 of this Handbook), and any discrepancies in the horizontal alignment of the supporting concrete base shall be corrected as specified in table 2.2 of 4210:2001/table 11.5 of 3604. (see page 23 of this handbook) before masonry units are laid.

2.5.1.2

The base shall be clean and free from laitance, loose aggregate, and anything that would prevent the mortar from bonding to the base, except where:

(a) A damp-proof course is permitted at the base of a veneer wall; or

(b) Allowance for non-bonding has been made by specific engineering design.

2.5.1.3

The units shall not overhang the supporting foundation by more than 20 mm.

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NZS 4229

12.2 General

12.2.1

The materials and workmanship of masonry veneer shall be in accordance with NZS 4210.

12.2.2

No length of a veneer wall or return shall be less than 230 mm, measured from the external face of the veneer.

12.3 Foundation

12.3.1

The veneer shall not overhang the supporting foundation by more than 20 mm.

LAYING

NZS 3604

11.7.8 Masonry veneer tolerances

Deviations from established lines, grades and dimensions shall be as listed in table 11.5 (refer page 23).

NZS 4210

2.6.3.3

In-joint reinforcement where required by specific engineering design shall be steel hot-dipped galvanized after fabrication of 316 stainless steel and shall be fully embedded within the mortar joint with a minimum side cover of 15 mm.

C2.6.3.3 *The minimum recommended joint thickness for using such a reinforcing system is 10 mm.*

2.7 Laying the units

2.7.1 General

2.7.1.1

All masonry units shall be laid in mortar in courses, true to line, plumb, and level to the tolerances specified in table 2.2 of 4210/table 11.5 of 3604 (see page 23 of this handbook).

C2.7.1.1 *The corners should be laid first, levelled and aligned. The first course should be laid with great care as it will assist the mason in laying succeeding courses.*

2.7.1.2

The units shall be set in soft plastic mortar to ensure proper embedment and bond.

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Table 2.2 – Maximum tolerances (see 2.7.1.1)

Item	Tolerances
Deviation from the position shown on plan for a building more than one storey in height	15 mm
Deviation from vertical within a storey	10 mm per 3 m of height
Deviation from vertical in total height of building	20 mm
Relative vertical displacement between masonry courses	2 mm on nominated fair face (one side only) 5 mm on structural face
Relative displacement between loadbearing walls in adjacent storeys intended to be in vertical alignment	5 mm
Deviation from line in plan: (a) In any length up to 10 m (b) In any length over 10 m	 5 mm 10 mm total
Deviation of bed joint from horizontal: (a) In any length up to 10 m (b) In any length over 10 m	 5 mm 10 mm total
Average thickness of bed joint, cross joint or perpend	±3 mm on thickness specified

This table is from NZS 4210, Section 2, Masonry Construction. It also appears in NZS 3604, Section 11 – The Building Envelope – Roof and wall Claddings.

2.7.1.4
For masonry constructions to NZS 3604 and NZS 4229 the tolerances shall be as given in table 2.2 (of NZS 4210/ table 11.5 of NZS 3604). Constructions to NZS 4230 shall comply with table 2.2 unless varied as part of the specific engineering design.

2.7.1.5
Should a unit need to be moved after it has been bedded in place, it shall be lifted, cleaned, and relaid in fresh mortar.

2.7.6 Bonding
2.7.6.1
Units shall be laid up in straight uniform courses with running bond, unless alternative patterns are specified.

Note – Stack bonding is not permitted in NZS 3604 and NZS 4229.

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C2.7.6.1 *Where stack bond is specified under NZS 4230, extra care with grouting is necessary to avoid shell failures of concrete masonry.*

NOTE – Bond (running or stretcher) in the context of this document means the bond where the units of each course overlap the units of the preceding course by between 25 % and 75 % of the length of the units.

2.7.2 Condition of units

2.7.2.1

The masonry units shall comply with the requirements of 2.1.4 and, when placed in the structure shall be clean, sound and free of defects which could impair the strength, weather resistance or performance of the construction. When cutting of a unit is necessary it shall be cut neatly and true to the shape required.

2.7.2.2

Masonry units shall be protected from the weather prior to laying to ensure they are not laid in a saturated state.

C2.7.2.2 *Masonry units should be in an air dry state i.e., not wet to the touch. Some surface damping may be required in hot dry weather to avoid significant amounts of water being drawn out of the mortar. The manufacturers' instructions on their products should be followed.*

CAVITIES

NZS 3604

11.7.4 Cavities

11.7.4.1

The cavity between the masonry veneer and the exterior face of the timber framing shall not be less than 40 mm or more than 75 mm wide.

C11.7.4.1 *It is important to maintain the minimum cavity width of 40 mm. The tolerances for erection of timber frames should be considered, because the cumulative tolerances from table 2.1 could reduce the cavity width to 20 mm, which is unacceptable. Variations in cavity width will require consideration of the length of tie used.*

11.7.4.2

Pipes and services shall not be placed in the cavity other than passing directly through the cavity to the exterior.

11.7.4.3

The cavity shall be drained from the bottom by providing weep holes, a minimum of 75 mm in height, by the width of the vertical mortar joint, at centres not exceeding 800 mm. Where the first course is less than 75 mm in height,

the spacing of weep holes shall be decreased to give a ventilation area of 1000 mm^2/m wall length.

11.7.4.4
The cavity shall be ventilated to the outside by the provision of weep holes at the bottom, as defined in 11.7.4.3, and either similar vents as defined in 11.7.4.3 at the top; or a continuous 10 mm gap between the top course and soffit board. The cavity shall be sealed off from the floor and roof space (see figure 11.2, page 26 of this Handbook).

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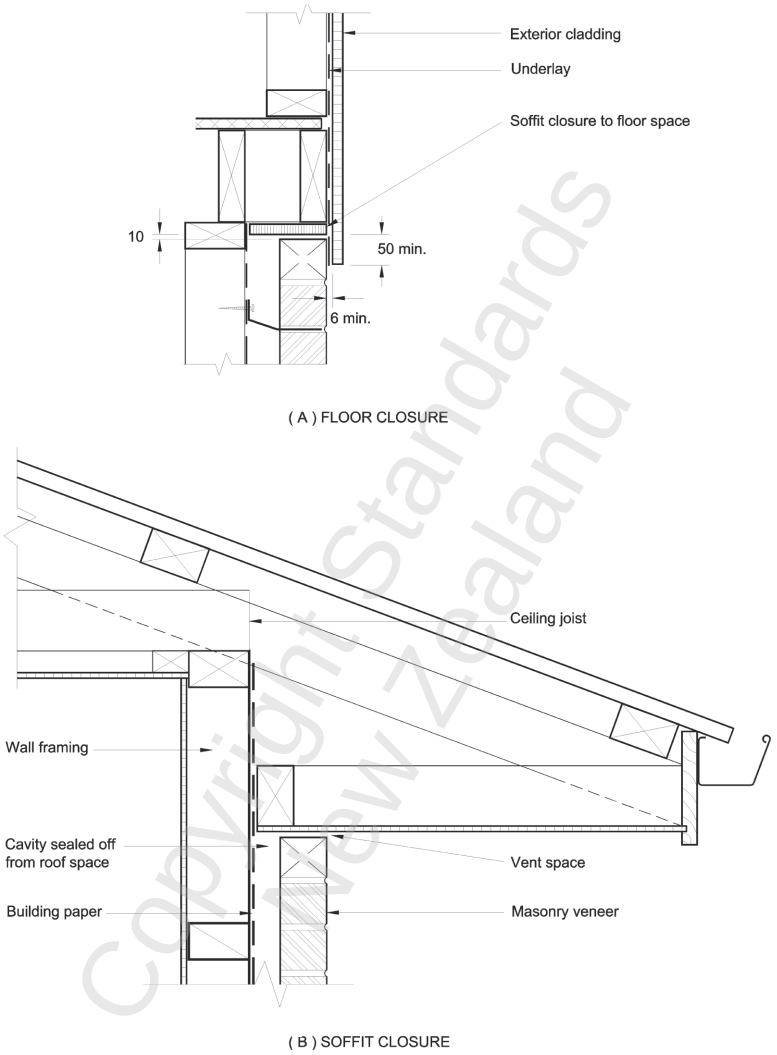

Figure 11.2 – Veneer cavity closures (see 11.7.4.4)
Extracted from NZS 3604:1999

11.7.4.5
Vermin proofing shall be fitted to the cavity where gaps greater than 13 mm exist.

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NZS 4210

2.9.2 Width of cavity

No ungrouted cavity, including any cavity between a veneer and its structural element, shall be less than 40 mm nor more that 75 mm wide unless subject to specific engineering design.

C2.9.2 *It is recommended that the minimum specified width is 50 mm to accommodate tolerances in timber construction of the supporting wall.*

2.9.3 Weep holes and ventilation of cavities

2.9.3.1

Weep holes in masonry veneers and in ungrouted hollow masonry walls shall be provided at the bottom of cavities and cells to drain moisture to the outside air. Weep holes in veneer to NZS 3604 and NZS 4229 shall be a minimum of 75 mm in height by the width of the vertical mortar joint at centres not exceeding 800 mm. If 75 mm height cannot be achieved the horizontal spacing shall be decreased to give a ventilation area of 1000 mm^2 per lineal metre.

C2.9.3.1 *Weep holes may be provided over flashings if the spacing dictates.*

2.9.3.2

The top of all cavities shall be ventilated to the outside air.

C2.9.3.2 *Veneer and cavity wall construction provides a rain shield with a drained and ventilated air gap between the veneer and the outside wall of the building. This provides an effective means of allowing water that enters the veneer and adjoining openings to drain to the outside of the building envelope. While this system has been in existence in New Zealand for over a hundred years it works well and is only now being recognized as a system for solving leakage problems in other cladding systems. NZS 3604 requires a 10 mm continuous gap to the top of veneer walls to ventilate the veneer cavity where there is an eaves protection. For other situations, follow the provisions for weep holes of 2.9.3.1. Wall ties to AS/NZS 2699 are provided with a mechanism to prevent water from being transferred across the cavity to the wall and to be effective must remain free of mortar.*

2.9.4 Pipes and services

Pipes and services shall not be placed in the cavity other than those passing directly through the cavity to the exterior.

NZS 4210

12.4 Cavities

12.4.1

The cavity between masonry veneer and the exterior face of the masonry structure shall not be less than 40 mm or more than 75 mm.

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C12.4.1 It is important to maintain the minimum cavity width of 40 mm as cumulative construction tolerances could reduce the cavity width below 40 mm, which is unacceptable.

12.4.2
Pipes and services shall not be placed in the cavity other than passing directly through the cavity to the exterior.

12.4.3
The cavity shall be drained from the bottom by providing weep holes, a minimum of 75 mm in height by the width of the vertical mortar joint at centres not exceeding 800 mm.

C12.4.3 *Where the first course is less than 75 mm in height, the spacing of weep holes should be decreased to give a ventilation area of 1000 mm^2/m wall length.*

12.4.4
The cavity shall be ventilated to the outside by the provision of weep holes at the bottom, as defined in 12.4.3 and either similar vents as defined in 12.4.3 at the top; or a continuous 10 mm gap between the top course and soffit board. The cavity shall be sealed off from the floor and roof space.

FLASHINGS

NZS 3604

11.7.7 Flashings
Flashings shall be protected against corrosion (see section 4 of 3604 – reference to the full Standard shall apply) and shall be provided:

(a) Across the top of openings;

(b) At window sills;

(c) Where different exterior cladding materials abut.

See figure 11.3 (opposite page) for flashing details.

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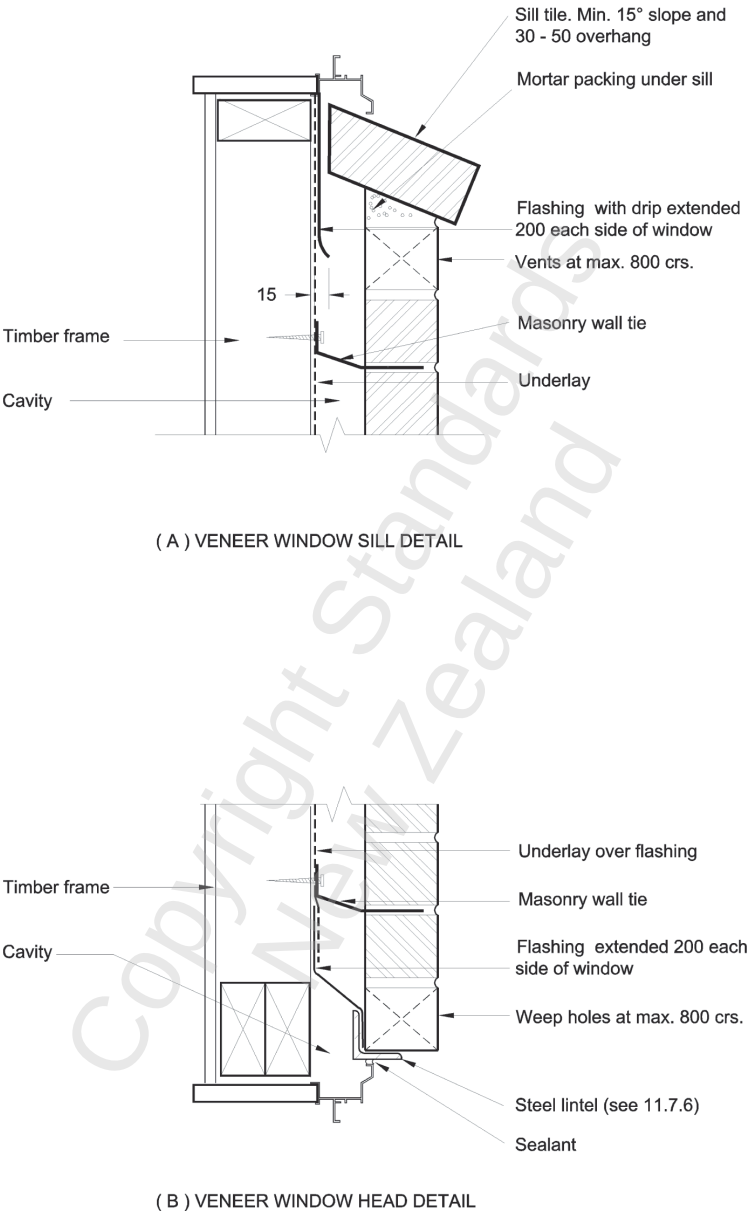

Figure 11.3 – Flashing details – Veneer (continued on page 30)
(see 11.7.7)
Extracted from NZS 3604

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11.7.4.6
Stepped joints on top of concrete or concrete masonry walls supporting veneers, which are adjacent to habitable spaces, shall be provided with moisture proof flashings over the full surface of the stepped joint, to prevent water from the veneer and cavity entering the building as illustrated in figure 11.3. Joints shall be sealed against moisture penetration. Flashings at openings shall be provided as required in 11.7.7.

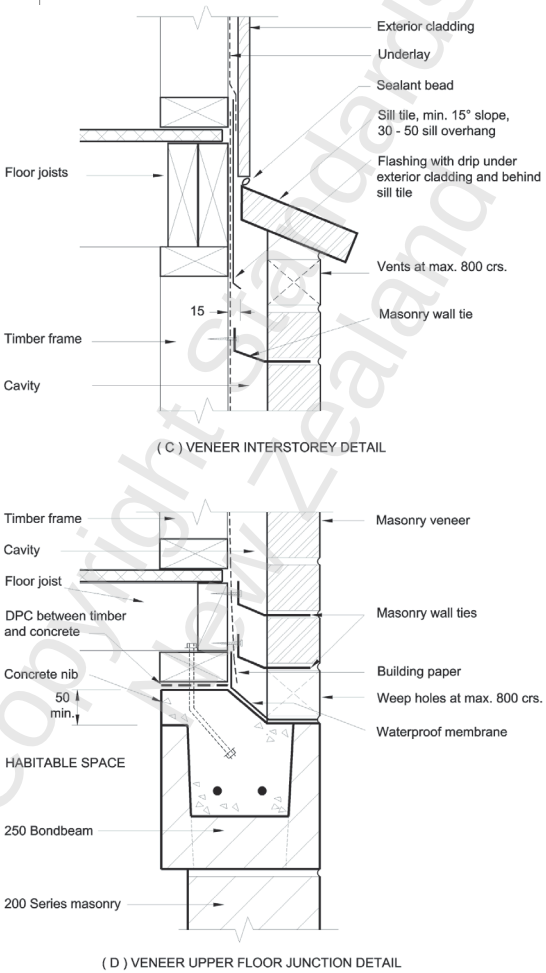

Figure 11.3 – Flashing details – Veneer (continued frompage 29)
(see 11.7.7)
Extracted from NZS 3604

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NZS 4210

2.7.7.2
Flashing or other means of weatherproofing shall be provided:

(a) Around openings in the wall;

(b) Where different exterior cladding materials abut.

NOTE – This Standard does not provide flashing or weatherproofing details and all proposals must be submitted to and approved by the territorial authority as part of the building consent process.

NZS 4229

12.4.5
Stepped joints on top of concrete block walls supporting veneers, which are adjacent to habitable spaces, shall be provided with moisture-proof flashings over the full surface of the stepped joint to prevent water from the veneer and cavity entering the building. Joints shall be sealed against moisture penetration.

12.4.6
Flashings at openings shall be provided as required in 12.7.

12.7 Flashings
Flashings shall be provided as follows:

(a) Across the top of openings;

(b) Where different exterior cladding materials abut.

C12.7 *This Standard does not provide flashing details and all proposals must be submitted to and approved by the territorial authority as part of a building consent application.*

WALL TIES

NZS 3604

11.7.5 Wall ties
11.7.5.1
Masonry veneer shall be attached to a structural backing (wall framing members or foundation walls) by wall ties.

11.7.5.2
Wall ties and their fixings, spacings and embedment shall be in accordance with the requirements of NZS 4210.

C11.7.5.2 *The spacing depends on the mass of the veneer, the earthquake zoning and type of tie. The ties are to be screw-fixed (i.e. non-impact method) using screw fixings supplied by the proprietary tie manufacturer. Reference to NZS 4210 is required.*

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11.7.5.3
Wall ties shall be installed so that they are contained within the mortar bed, with a layer of mortar both above and below the tie. Wall ties shall be of such a length that they have an embedment length of at least half the width of the veneer, and an end cover of 15 mm for galvanized steel ties. Wall ties shall be fixed to framing members with screws or other non-impact fasteners. Where rigid underlay has been used, the length of the fixing screw shall be increased by the thickness of the underlay.

C11.7.5.3 *The practice of dry placing onto the top of the veneer and placing the mortar bed across the top of the tie is not acceptable. The mortar bed must be prelaid and the tie placed on the wet mortar followed by flushing of mortar over the top surface of the tie. End covers for ties other than galvanized steel are available in NZS 4210. All fixings must be made through the sheeting to the primary frame, not just the sheeting material.*

4.5 Brick veneer ties and lintels
Table 4.4 (see page 33 of this Handbook) gives the protection required for brick veneer ties and lintels supporting brick veneer, to achieve a 50-year durability.

NZS 4210

2.1.2 Corrosion-resistant metal
Wall ties in ungrouted cavities, lintel bars, and any other metal components exposed to the weather or in any position where condensation or dampness will occur, shall be protected so as to have an acceptable resistance to corrosion. Materials shall comply with the requirements of table 2.E1 of Appendix 2.E. (See page 19 of this Handbook).

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Table 4.4 – Protection for masonry veneer ties and lintels supporting masonry veneer using AS/NZS 2699 (see 2.5.2, NZS 3604)

Location	Protection/material of ties	Protection/material of lintels
Sea spray zone R4*	316 or 316L stainless steel	316 or 316L stainless steel
Geothermal hot spots R5*	Specific engineering design(†)	Specific engineering design(†)
Elsewhere R3*	470 g/m^2 galvanized coating or 304 stainless steel	600 g/m^2 galvanized coating or 304 stainless steel

* The durability ratings (R) used in AS/NZS 2699 are as given in the "Location" column of the table.

† Cavities in veneer construction within 50 m of geothermal hot spots present an aggressive environment and ties and lintels therefore require special investigation and testing. AS/NZS 2699 provides a means of testing the material and protection of ties and lintels. However, such testing is outside the scope of this Standard and the proposed design needs to be submitted to and approved by the Territorial Authority. However, specific coating methods given by AS/NZS 2699 in zones R4 and R3 are considered to be acceptable alternative protection methods to those shown in the above table.

This table is extracted from 3604:1999, Section 4 – Durability.

2.1.9 Wall ties

2.1.9.1
All wall ties and their connections shall comply with masonry durability requirements given in table 2.E1 on page 19 of this Handbook, and testing provisions contained in AS/NZS 2699: Part 1. In addition manufacturers shall ensure all ties tested meet the requirements of 2.9.5.

2.1.9.2
Type, placing and spacing of ties shall be as given in 2.9.6 and 2.9.7.

2.9 Veneer and cavity wall construction

2.9.5 Tie anchorage, cover and fixing

2.9.5.1
Wall ties shall be installed so that they are contained within the mortar bed over the full contact length, with a layer of mortar both above and below the tie. Mortar less

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than 24 hours old shall not be subject to vibration.

2.9.5.2
Wall ties shall be of such a length that:

(a) They have an embedment length of at least half the width of the veneer;

(b) They have an end cover in the bed joint of not less than 15 mm.

2.9.5.3
For timber frame buildings wall ties shall be fixed to framing members with screws or other non-impact fasteners. When the studs are covered with a solid sheet material such as plywood, this shall also be face fixed providing the fixings pass through the plywood to provide full anchorage in the supporting stud.

2.9.5.4
The mortar bed shall completely fill the width of the masonry unit to secure the wall tie. This ensures that the length of the wall tie within the masonry unit is completely embedded in mortar.

C2.9.5.4 *The structural performance of a wall tie to resist axial and inplane loading as tested in accordance in AS/NZS 2699 is usually undertaken using solid or cored units where the mortar covers the full width of the masonry unit. The holes in cored units can vary from 10 mm to 20 mm in diameter in clay masonry that can be partially filled with mortar in the laying process and provide a continuous bed to place the wall ties.*

2.9.6 Placing of ties

2.9.6.1
Wall ties as specified herein shall be placed within 5° of a right angle to the plane of the masonry and shall slope down away from the framing, toward the masonry.

2.9.6.2
At unsupported edges and at all openings through veneered walls or non-grouted cavity walls, wall ties spaced as required by 2.9.7.1 shall be provided as follows:

(a) At the top and bottom of the opening:

Not more than 300 mm or 2 courses, whichever is smaller;

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(b) At the sides of the opening or at an unsupported edge: Not more than 300 mm.

2.9.6.3
Where the veneer wall continues above or is interrupted by a damp proof course or waterproof membrane, wall ties spaced as required by 2.9.7.1 shall be provided in each of the first two courses above the membrane.

2.9.7 Tie classification and spacing

2.9.7.1
For unreinforced veneers to the provisions of NZS 3604 for single storey veneers and their gable ends and those covered in NZS 4229, wall ties shall be selected for type and spacing from table 2.3.

Table 2.3 – Specification of Type B veneer ties for spacing of 600 mm (max.) horizontal x 400 mm (max.) vertical

Seismic zone	VENEER		
	Less than 180 kg/m^2	180 – 220 kg/m^2	More than 220 kg/m^2
	(Typically 70 – 90 mm thickness)	(Typically 91 – 110 mm thickness)	(Typically over 110 mm thickness)
A	EM	EH(1)	SED(2)
B	EM	EM	SED(2)
C	EL	EM	SED(2)

NOTE –
(1) EM may be used if the supported area does not exceed 0.20 m^2 e.g., 600 x 300 on a timber frame; 500 x 400 on a concrete masonry wall.
(2) Spacing of ties to be determined by specific engineering design (SED).
(3) Type B and prefix E indicate ties are manufactured to meet seismic testing conditions set out in AS/NZS 2699.
(4) L (light), M (medium) and H (high) indicate strength capacities of ties to meet the testing conditions set out in AS/NZS 2699.
(5) Using higher strength ties does not permit the maximum spacing of ties to be increased.

This table is extracted from NZS 4210:2001

C2.9.7.1 *Tie designations of type, size and application are required to be clearly labelled by the manufacturer using the terms set out in AS/NZS 2699.*

2.9.7.2
For reinforced veneers and grouted reinforced cavity walls which are outside the scope of NZS 3604 and NZS 4229, wall tie type and spacing shall be the subject of specific engineering design. Refer to NZS 4230.

C2.9.7.2 *In the case of the grouted reinforced cavity wall the ties may only be required to resist hydrostatic grout pressure.*

2.9.7.3
Two storey veneer construction to NZS 3604 is not permitted. In such cases veneer wall ties and spacing shall be subject to specific engineering design to the provisions of NZS 4203, NZS 4230 and selected for Classification for Seismic Veneer Tie from table 2 of AS/NZS 2699.1.

C2.9.7.3 *Some limited two storey construction is permitted by NZS 4229.*

NZS 4229

12.5 Wall ties

12.5.1
Masonry veneer shall be attached to a structural backing by wall ties.

12.5.2
Ties to be used for compliance with this Standard shall be stiff ties tested to the provisions of AS/NZS 2699: Part 1 for the specific cavity width and comply with the durability provisions of table 4.4 (refer to page 33).

C12.5.2 *Details of zones are set out in section 4 of NZS 3604.*

12.5.3
Wall ties and their fixings shall be spaced in accordance with the requirements of NZS 4210.

C12.5.3 *The spacing depends upon the mass of the veneer, the earthquake zoning and type of tie (medium or heavy duty).*

12.5.4
Wall ties shall be installed so that they are contained within the mortar bed with mortar above and below the tie. Mortar less than 24 hours old shall not be subject to vibration.

C12.5.4 *The previous practice of dry placing onto the top of the veneer and placing the mortar bed across the top of the tie is no longer acceptable. The mortar bed must be prelaid and the tie placed into the wet mortar followed by flushing of mortar over the top surface of the tie.*

12.5.5
Wall ties shall be of such length that:

(a) They have an embedment length of at least half the width of the veneer;

(b) They have an end cover in the bed joint of not less than 15 mm.

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OPENINGS

NZS 3604

11.7.6 Openings

11.7.6.1
Openings with masonry veneer above shall be spanned by mild steel angle or flat lintels, protected against corrosion in accordance with the provisions of 4.5 (see table 4.4, page 33 of this Handbook).

11.7.6.2
Lintels shall have a minimum seating of:

(a) 100 mm for spans up to, and including 2 m;

(b) 200 mm for spans over 2 m.

Sizes of veneer lintels are given in table 11.4.

Table 11.4 – Veneer lintels (see 11.7.6.2)

Maximum lintel span	Thickness of veneer (mm)					
	70			90		
	Maximum height of veneer supported (mm)					
	350	700	2000	350	700	2000
(mm)						
800	60 x 10	60 x 10	60 x 10	80 x 10	80 x 10	80 x 10
2000	60 x 60 x 6	60 x 60 x 6	60 x 60 x 6	60 x 60 x 6	60 x 60 x 6	80 x 80 x 6
2500	60 x 60 x 6	80 x 80 x 6	80 x 80 x 6	60 x 60 x 6	80 x 80 x 6	80 x 80 x 8
3000	80 x 80 x 6	80 x 80 x 6	125 x 75 x 6	80 x 80 x 6	80 x 80 x 8	90 x 90 x 10
3500	80 x 80 x 6	80 x 80 x 6	125 x 75 x 6	80 x 80 x 8	90 x 90 x 10	125 x 75 x 10
4000	80 x 80 x 8	125 x 75 x 6	125 x 75 x 10	80 x 80 x 10	125 x 75 x 6	150 x 90 x 10
4500	125 x 75 x 6	125 x 75 x 6	–	125 x 75 x 6	125 x 75 x 10	–
4800	125 x 75 x 6	125 x 75 x 10	–	125 x 75 x 6	125 x 75 x 10	–

NOTE –
60 x 10 = Mild steel flat
60 x 60 x 6 = Mild steel angle

This table is extracted from NZS 3604:1999

NZS 4210

2.9.8 Openings

2.9.8.1
Openings with masonry veneer above shall be spanned by steel lintel angles or flats protected against corrosion to the provisions of Table 2.E1, page 19 of this Handbook.

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2.9.8.2
For alternative materials or spans outside those permitted by NZS 3604 and NZS 4229, specific engineering design shall be required.

2.9.8.3
Steel lintel angles or flats shall have a minimum seating of 100 mm for spans up to and including 2 m and 200 mm for over 2 m unless covered by specific engineering design.

NZS 4229

12.6 Openings

12.6.1
Openings with masonry veneer above shall be spanned by steel lintel angles or flats protected against corrosion to the provisions of table 4.4 (page 33 of this Handbook) and for the structural sizes required to table 11.4 (page 37 of this Handbook).

12.6.2
Steel lintel angles or flats shall have a minimum seating of 100 mm for spans up to and including 2 m and 200 mm for spans over 2 m.

CLEANING OUT CAVITIES

NZS 4210

2.7.1.6
Precautions shall be taken to prevent mortar from falling down cells and cavities. (See 2.8)

2.7.1.7
Any mortar protruding more than 5 mm into cells or cavities shall be removed. No mortar protrusions shall be closer than 5 mm to reinforcing steel.

2.8 Cleaning out

2.8.1
Grout spaces shall be cleaned out before grout is poured (see 2.5.1.2). Any drained cavities between veneers and supporting structural walls shall also be cleaned out.

2.8.2
Cleaning out shall include the removal of any mortar from ties and reinforcing bars, the removal of any mortar protruding into cells or cavities at joints, and the removal of all mortar droppings and other loose material.

C2.8.2 *Loose material may be removed by hosing through the clean-out openings with a water jet at the end of each day's work, or alternatively a fine layer of sand can be provided at the bottom of the grout space and this sand together with other loose material removed by compressed air or other means through the clean-out openings.*

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METHODS OF CONTROLLING WALL MOVEMENTS

NZS 4210

2.10 Methods of controlling wall movements

2.10.1 General

2.10.1.1

Horizontal wall movements, along the length of the wall, shall be accommodated by using control joints or by the incorporation of specific engineering designed reinforcing steel to distribute the movement evenly along the wall.

This sub-clause is extracted from 2.10.1.2 of NZS 4210:2001, but is not the entire clause.

(d) Veneer construction to NZS 3604 and NZS 4229 control joint positions and details shall follow the manufacturer's requirements for the specific masonry product used, which shall include spacing between joints, requirements at windows, openings, intersections and corners.

C2.10.1.2 *All masonry materials undergo some movement changes and as each material has its own characteristic properties, it is appropriate that manufacturers stipulate requirements for their products. Generally there is no need to require shrinkage control joints for clay bricks, but natural stone and concrete products are more likely to need such control joints depending upon the nature of supply. Advice as per 2.10.1.2 (d) should be obtained from the manufacturer.*

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TESTING

NZS 4210

2.4.2 Building not requiring specific engineering design

For buildings not requiring specific engineering design built in accordance with NZS 4229 and NZS 3604, no testing is required but the mason shall ensure that the following records are kept:

(a) Proportions of mortar used, including admixtures;

(b) Supplier of grout and test certificates received or proportions of grout if site mixed;

(c) Supplier of mortar sand;

(d) Use or not of an expansive admixture.

NOTE – There is no requirement to deal with (b) and (d) for veneer construction.

C2.4.2 *It is recommended that the mason, as a competent tradesperson should have compressive strength tests of mortar carried out at regular intervals, particularly if the source of supply of sand is changed. In addition to being a check on the suitability of the mortar mix, such tests serve as a check on the cleanliness of the sand. The reactivity of the expansive admixture in the grout can be directly observed at the top of a grouted wall. Any adjustments in dosing rates for temperature conditions should be made in accordance with the manufacturer's instructions.*

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