



RIBRAFT® TECHNICAL MANUAL

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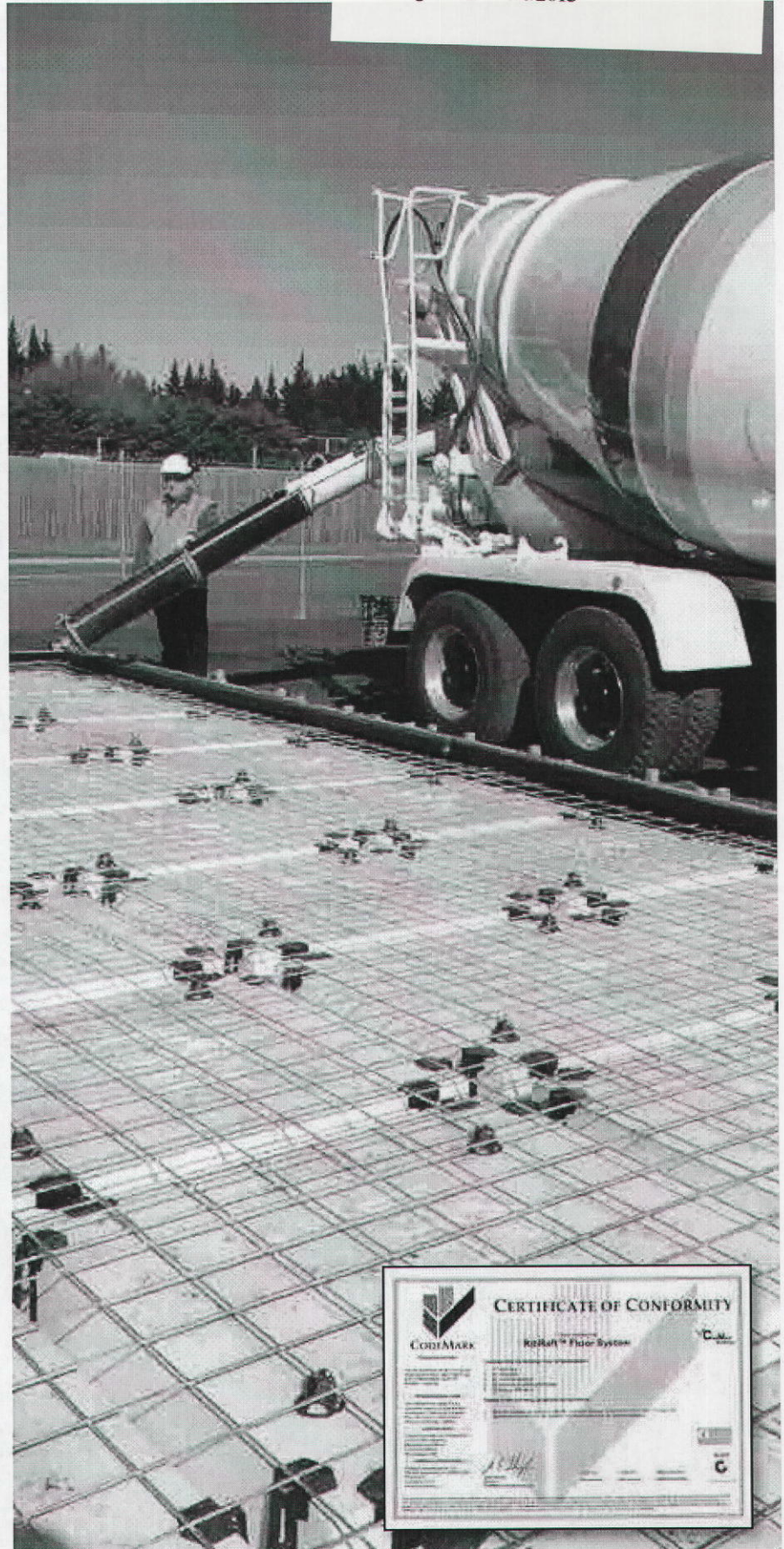
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INSTRUCTIONS ON THE USE OF THIS MANUAL

This Manual consists of three Sections:

Section 1: Firth RibRaft Floor System Design Information

Section 2: Firth RibRaft Floor System Installation Information

Section 3: Firth RibRaft Floor System Verification

Section 1 contains information principally useful for the specifier or building designer. Section 2 is primarily aimed at the person on site installing the Firth RibRaft Floor system. While Section 3 describes the required verification checks.

This document contains design and installation information. A variation to any of the information given requires specific engineering design and is hence beyond the scope of this document.

Firth RibRaft Floor System can be constructed for all slab-on-ground concrete floors for domestic or residential buildings that fall within the scope of NZS 3604:2011 "Timber Framed Buildings" and Clause 3 "Scope" of Section 1 of this Manual. The design and installation details in this Manual shall be used to design and construct such a floor.

The Firth RibRaft Floor System is covered by the DBH Codemark®. This is conditional on the system being used as described in CertMark Australasia certification decision, which in turn requires design in accordance with Section 1 and installation in accordance with Section 2 of this Manual and on site Verification in accordance with Section 3.

Note that a DBH Codemark means that if this manual is rigidly followed the relevant Building Control Authority will automatically provide a building permit without the need for producer statements. To comply with the manual does mean that Firth Concrete must be used.

CONTENTS

SECTION 1

1	GENERAL.....	4
2	TECHNICAL DESCRIPTION	4
2.1	Overview	4
2.2	Pods.....	4
2.3	Steel.....	4
2.4	Concrete.....	4
3	SCOPE	5
3.1	Structure Limitations	5
3.2	Live Loading	6
3.3	Dead Loading	6
3.4	Building Types	6
3.5	Foundation Soils	6
3.6	Flow Diagrams.....	6
4	CONSTRUCTION DETAILS.....	8
4.1	Pod Layout.....	8
4.2	Edge Beam Width and Reinforcement..	9
4.3	Internal Ribs (non load bearing) Width and Reinforcement	9
4.4	Internal Ribs (load bearing) Width and Reinforcement.....	9
4.5	Mesh Reinforcement	9
4.6	Re-entrant Corners	9
5	LATERAL RESISTANCE	10
5.1	Earthquake Resistance.....	10
5.2	Wind Resistance	10
5.3	Shear Keys	11
6	OTHER DESIGN DETAILS.....	11
6.1	R-Values.....	11
6.2	Shrinkage Control	12
6.3	Services Detailing	12

SECTION 2

1	GENERAL	15
2	SITE REQUIREMENTS.....	15
2.1	General	15
2.2	Temporary Excavations.....	15
2.3	Surface Water	15
3	INSTALLATION PROCEDURE	16
3.1	Site Preparation	16
3.2	Earthworks.....	16
3.3	Shear Keys	16
3.4	Plumbing and Services	16
3.5	Sand Blinding	17
3.6	Damp Proof Membrane	17
3.7	Edge Formwork	17
3.8	Laying the Pods and Spacers	17
3.9	Reinforcing Steel.....	18
3.9.1	Edge Beam Steel	18
3.9.2	Rib Steel.....	18
3.9.3	Mesh Reinforcing	19
3.9.4	Re-entrant Corner Steel	19
3.10	Concrete Installation.....	19
3.10.1	Placing.....	19
3.10.2	Finishing	19
3.10.3	Curing.....	20
3.11	Shrinkage Control Joints.....	20
3.12	Removal of Formwork	20
3.13	Brick Veneer.....	20
3.14	Landscaping/Paving.....	20
3.15	Ongoing Maintenance	20
4	SHEAR KEYS	20

SECTION 3

1	DESIGN	22
2	CONSTRUCTION	22

FIRTH RIBRAFT FLOOR SYSTEM

SECTION 1: DESIGN INFORMATION

1 GENERAL

This Section of this Manual contains design information not requiring specific engineering input for the Firth RibRaft Floor System (the system). Full information on the installation procedures is described in Section 2 of this Manual (Installation Information). Where Standards are referenced in this manual, these shall include the latest amendments.

2 TECHNICAL DESCRIPTION

2.1 Overview

The Firth RibRaft Floor System is a reinforced concrete waffle raft floor slab-on-ground. It consists of an 85mm thick slab supported by a grid of ribs normally 100mm wide at 1200mm x 1200mm centres. The overall depth is 305mm. Edge beams and ribs under load bearing walls are 300mm wide to provide for the extra load carried by these members. Where heating coils of less than 25mm diameter are embedded in the topping, the slab concrete thickness shall be 110mm meaning the overall thickness is 330mm.

2.2 Pods

Firth RibRaft polystyrene pods 1100mm square and 220mm thick are placed directly on levelled ground and are arranged in such a way as to form a reinforced concrete floor slab with a grid of reinforced concrete ribs and edge beams when concrete is placed onto them. Pods may be cut to suit specific architecture layout and also to accommodate services. [300mm thick pods are available if needed for deeper edge beams and internal ribs for construction following specific engineering design. Such uses are outside the scope of this document.]

2.3 Steel

Reinforcing steel in the slab shall consist of Welded Reinforcing Mesh complying with AS/NZS 4671:2001 with a minimum weight of 2.27kg/m², a lower

characteristic stress of 500MPa, square configuration of orthogonal bars between 150 to 300mm centres, and ductility class L or E, hereafter referred to as "665 mesh, or mesh". The reinforcing bars in the ribs and edge beams shall conform to AS/NZS 4671:2001 "Steel Reinforcing Materials". Specifically designed spacers are used to position the polystyrene pods and the rib and edge beam reinforcing steel bars in a secure manner until the concrete is placed. The reinforcing mesh is held in place by mesh chairs. Conventional timber or steel formwork is used to form the edge of the slab.

2.4 Concrete

One of the following Firth concrete products shall be used in the system:

- 1) Raftmix – a 20MPa 100mm slump structural mix available in either a 13mm or more usually a 19mm nominal aggregate size. This mix is normally placed in the floor straight from the concrete truck chute and if necessary by wheelbarrow over planks set up over the pods.
- 2) Raftmix Pump – a 20MPa 100mm slump pump mix available in either a 13mm or more commonly a 19mm nominal aggregate size. The selection of aggregate size may be determined either by the capability of the available concrete pump or by the concrete placer's preference.

The exception being for buildings constructed in the 'sea spray zone' (i.e. within 500m of the sea including harbours, within 100m of tidal estuaries or inlets, on offshore islands and elsewhere as defined as exposure zone D in 4.2.3.3 of NZS3604) in which case one of the following Firth concrete products shall be used in the system:

- 1) Raftmix25 – a 25MPa 100mm slump structural mix available in either a 13mm or more usually a 19mm nominal aggregate size. This mix is normally placed in the floor straight from the concrete truck chute

and if necessary by wheelbarrow over planks set up over the ____s.

- 2) Raftmix Pump25 – a 25MPa 100mm slump pump mix available in either a 13mm or more commonly a 19mm nominal aggregate size. The selection of aggregate size may be determined either by the capability of the available concrete pump or by the concrete placer's preference.

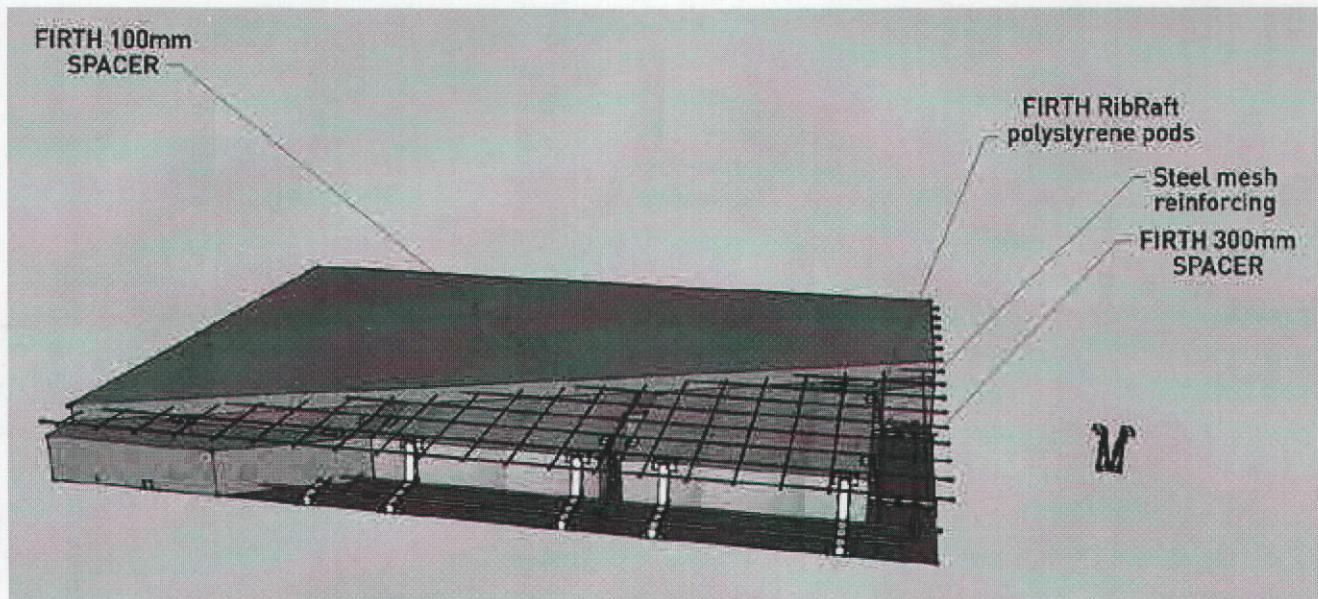


Figure 1 *The RibRaft System*

3 SCOPE

This Clause sets out the limitations that apply to the use of the system to ensure that specific engineering input is not required. The concrete floor slab for buildings or ground conditions that do not meet this scope must be subjected to specific engineering design to comply with the requirements of the New Zealand Building Code.

3.1 Structure Limitations

Specific engineering input shall not be required only where the structure supported by the system complies with the following criteria:

- The structure supported by the system is constructed in a location where the Seismic Hazard Factor Z (defined in NZ1170.5) is less than or equal to 0.45 (refer to figure 6).
- The system is laid level, and is not stepped.
- The structure supported by the system has no basement, part basement or foundation walls.
- The total height from the lowest ground level to the highest point of the roof shall not exceed 10m.
- The structure supported by the system has a roof

pitch limited to 60 degrees maximum from the horizontal.

- The maximum height of each storey of the structure supported by the system is 3m.
- Only ground floor walls of the structure supported by the system are permitted to be "heavy external walls" (as defined in Clause 3.3).
- The roof truss span shall be less than or equal to 12m when the roof and ceiling loads are supported entirely by the external walls.
- Where internal load bearing walls are used to support the roof or floors, the loaded dimensions stated in Tables 8.2 and 14.10 of NZS3604:2011 shall apply, and the load bearing wall shall be supported on a 300mm wide load bearing rib as detailed in this manual.
- Floors may be of unlimited size provided that the maximum dimension between free joints shall not exceed 30m. Where free joints are required they should be detailed in accordance with NZS3604:2011.

3.2 Live Loading

The live loading cases of structures covered by these designs are:

- 1.5kPa and 3.0kPa as per NZS 3604:2011 "Timber Framed Buildings".
- 13kN concentrated load in garage over area of 0.3 x 0.3m (vehicle limited to 2500kg gross).

3.3 Dead Loading For Use With This Manual

The dead load cases of structures covered by these designs are:

- Light external walls with total mass not exceeding 60kg/m² – e.g. timber framing with weather boards and interior wall linings.
- Heavy external walls with total mass greater than 60kg/m² but not exceeding 290kg/m² – e.g. timber framing with masonry veneer or partially filled 20 series masonry blocks.
- Internal walls with total mass not exceeding 45kg/m² – e.g. timber framing and linings.
- Light roofs with total mass not exceeding 45kg/m² – e.g. ceiling linings and metal roof, including framing.
- Heavy roofs with total mass greater than 45kg/m² but not exceeding 85kg/m² – e.g. ceiling lining and concrete tiles or slates, including framing.
- Mid-floors with total mass not exceeding 60kg/m² – e.g. timber framing and flooring, including ceiling linings.
- Heavy internal walls and/or load bearing internal walls supported on a load bearing rib.

3.4 Building Types

The designs given in this Manual are limited to where the system supports Building Types A to D as described in Table 1. The classification of wall weights is as detailed in Clause 3.3 of this Section. Single and two storey shall be as defined in NZS 3604:2011.

Table 1 Building Identifier

Building Type	Description	Ground Floor External Walls	Second Storey External Walls
A	Single Storey	Light	
B	Single Storey	Heavy	
C	Two Storey	Light	Light
D	Two Storey	Heavy	Light

3.5 Foundation Soils

The system may be used when the supporting ground meets the definitions of "good ground" given in Section 3 of NZS 3604:2011: (as modified by B1 of the Building Compliance Documents). In addition, the system shall not be used for damp sites i.e. where it can be reasonably expected that the ground water level could come within 600mm of the underside of the system. The acceptability of the ground shall be verified in accordance with Clause 3.1.3 of NZS 3604:2011.

Where the ultimate bearing capacity required of the supporting ground is verified by Scala Penetrometer testing in accordance with Clause 3.3 of NZS 3604:2011. The bearing capacity shall be considered adequate when the number of blows per 300mm depth of penetration below the underside of the system at each test site, exceeds the values given in Table 2 below. For RibRaft foundations compliance with Table 2 allows ultimate bearing capacities of less than 300kPa. However, with the exception of bearing capacity all other requirements in NZS3604:2011 for "good ground" shall be complied with.

Table 2 Scala Penetrometer Blows Required For Determining Ultimate Bearing Capacity

Building Type	Min. blows per 300mm depth
A	6
B	7
C	8
D	9

3.6 Flow Diagrams

The flow diagrams on the following pages (adapted from NZS 3604:2011) will help in determining whether the non-specific details for the system can be used for the purposes of the concrete floor slab construction. There are two checks in the process. The first is to determine whether the proposed building complies with the requirements set out in this Manual (Building Check), and the second is to determine whether the site complies with the requirements set out in this Manual (Site Check).

[Note: NZS 3604:2011 provides for parts of buildings

to be considered as individual buildings. These flow diagrams apply to those parts of the building where slab-on-ground is being considered and where the part of the building can be considered as an individual building under NZS 3604:2011).

Figure 2 Building Check Flow Diagram

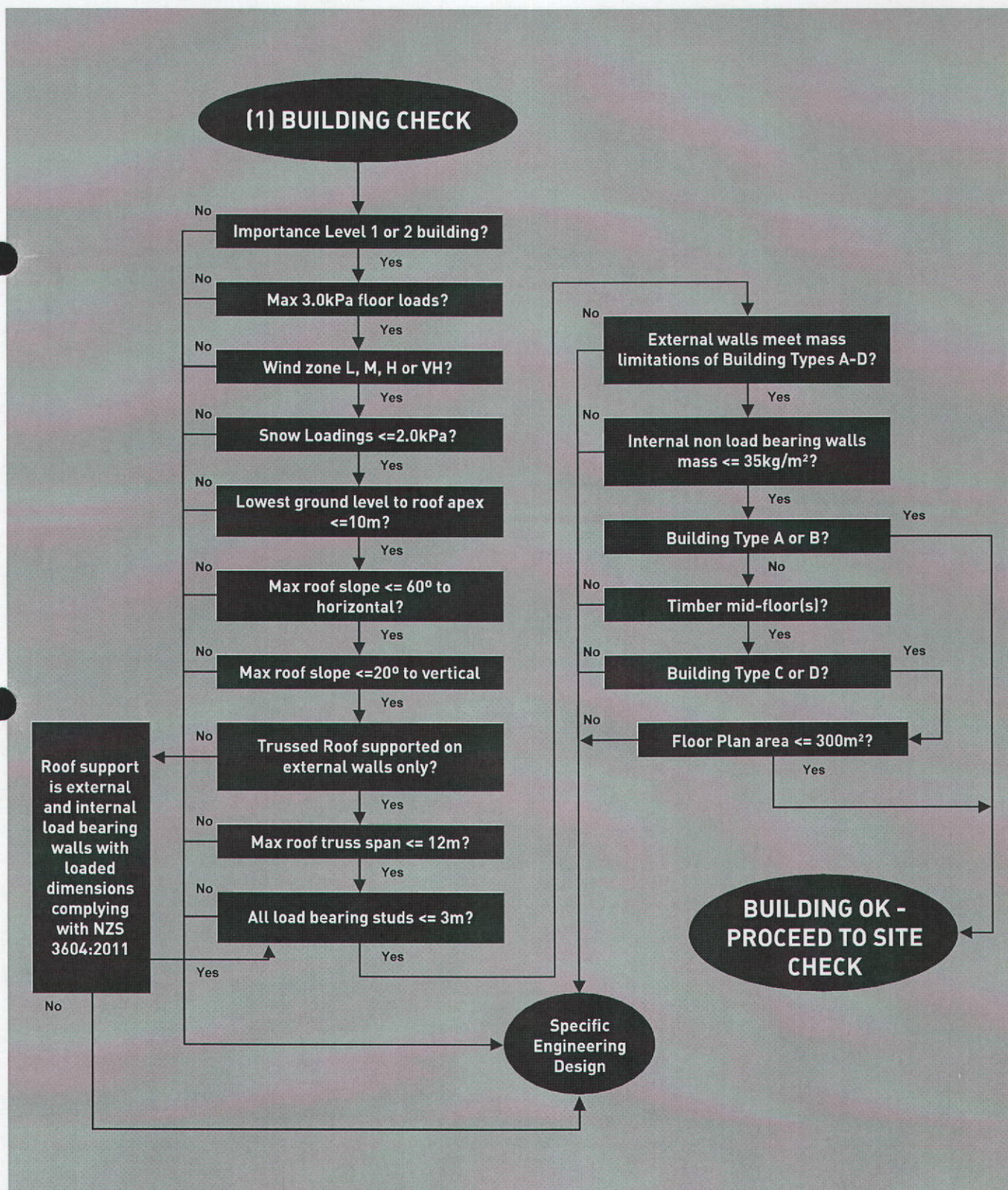
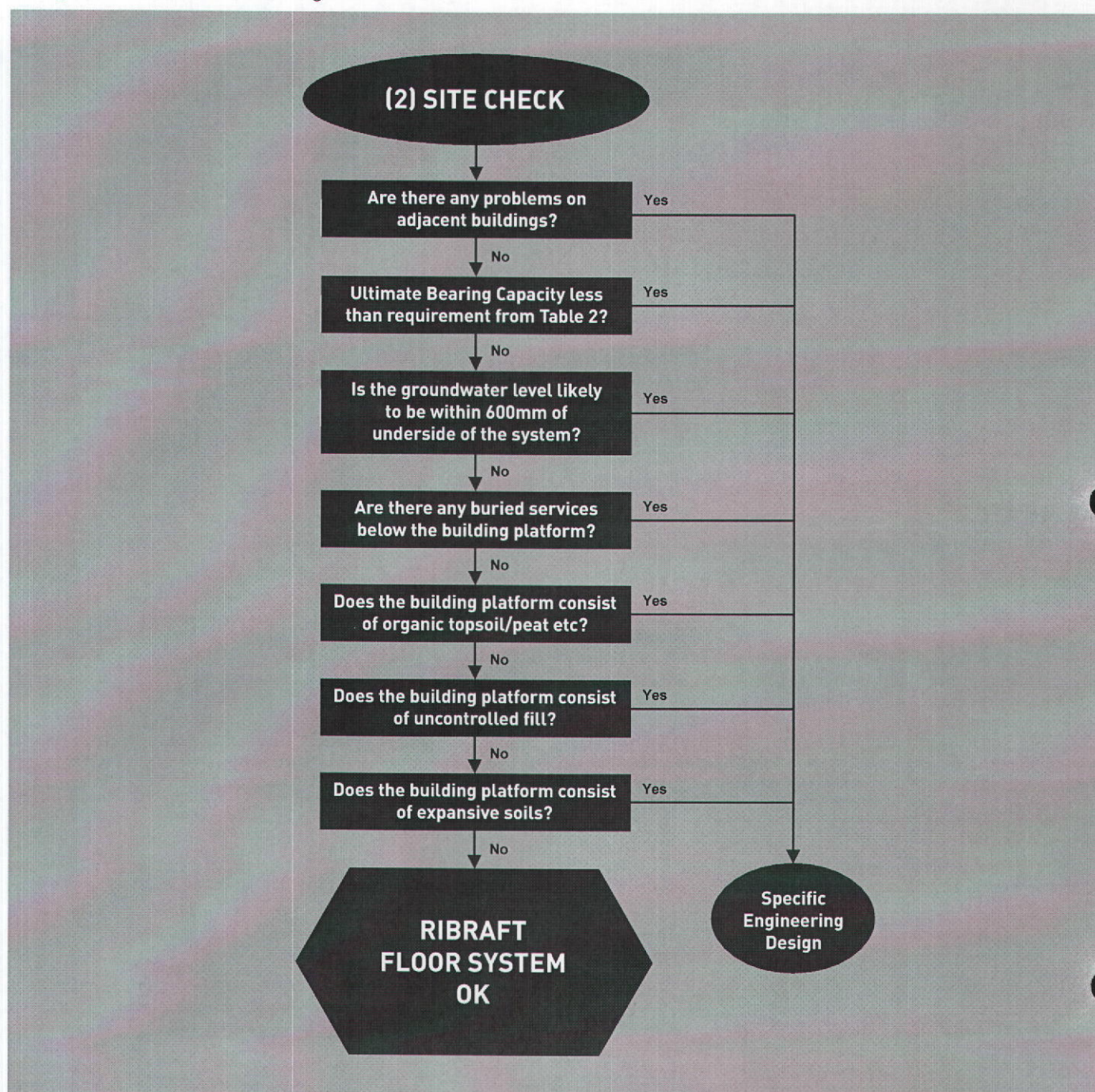


Figure 3 Site Check Flow Diagram



4 CONSTRUCTION DETAILS

Standard construction details for the system are provided here for buildings that fall within the above scope.

4.1 Pod Layout

RibRaft polystyrene pods supplied by Firth (1100 x 1100 x 220mm thick) shall be placed on levelled ground and arranged in a waffle pattern. The pods are used as void formers while the concrete is curing. These pods are an integral component of the system and shall not be substituted.

Pods shall be placed so as to provide the necessary spacing between the edge beams and ribs as described below. The first rib out from the edge beam shall have a maximum clear separation of 1100mm however in all other cases the centre to centre distance between the ribs, whether they are 100mm or 300mm wide, shall be 1200mm. In the case of 100mm ribs this centre to centre spacing is achieved by the 1100mm square pods however between 100mm and 300mm ribs, or between two 300mm ribs, the pods shall be cut down to suit. Pods may be cut down to size but shall not be added to, where this is necessary to suit the building layout,

penetrations or orientation of beams and ribs.

Figure 4 below shows a typical layout of the pods and ribs. Note the part pods around the edge, where the building shape dictates, and adjacent to the 300mm rib.

Firth suggests that when drawing the building plan, a generic RibRaft grid (100mm wide ribs at 1200mm centres) is set out using the corner of the building as a starting point. The location of any load bearing ribs are identified and pods cut to establish 300mm wide ribs. The most cost effective solution being a simple grid layout which requires minimum cutting of the pods. Ribs can be used at less than 1200mm centres, however it is more cost effective to use the 1200mm centres wherever practicable.

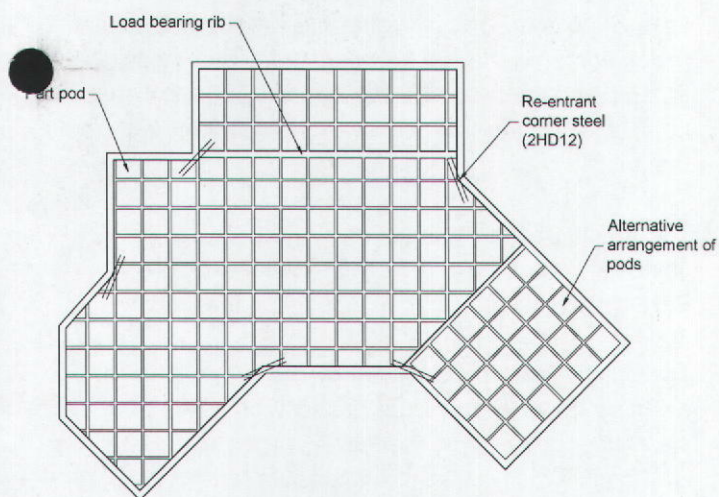


Figure 4 Typical RibRaft Plan

4.2 Edge Beam Width and Reinforcement

Edge beams around the perimeter of the floor slab shall be 300mm to provide bearing capacity for external load bearing walls, and contain 2-HD12 bars (Grade 500E) as bottom steel and 1-HD12 bar (Grade 500E) in the top. This top bar shall be tied to the underside of the reinforcement mesh. Refer Figure 5, below for construction details. The edge beam shall be rebated for brick veneers where necessary as shown in Figure 5[C].

4.3 Internal Ribs (non load bearing) Width and Reinforcement

Each standard internal rib shall be 100mm wide and shall contain 1-HD12 steel bar (Grade 500E) held in place at the bottom of the rib by a Firth spacer. Refer Figure 5E for construction details.

4.4 Internal Ribs (load bearing) Width and Reinforcement

For all load bearing walls and heavy internal walls, the pods shall be cut to create a 300mm wide rib directly under the load bearing wall, with 2-HD12 (Grade 500E) steel bars as bottom steel. Refer Figure 5(D) for construction details under load bearing walls.

Where the load bearing ribs meet and terminate at an edge beam or internal rib the bottom reinforcement from the load bearing rib shall be bent into the adjacent rib and tied together. The reinforcement shall lap for at least 720mm.

4.5 Mesh Reinforcement

The entire floor slab shall be reinforced with 665 Mesh supported on 40mm mesh chairs sitting on the polystyrene pods.

4.6 Re-entrant Corners

In order to limit cracking at the re-entrant, or internal corners, extra steel shall be placed on top of the mesh. These shall be 2-HD12 bars (Grade 500E), 1200mm long tied to the top of the mesh at 200mm centres, with 50mm cover from the internal corner – refer Figure 4.

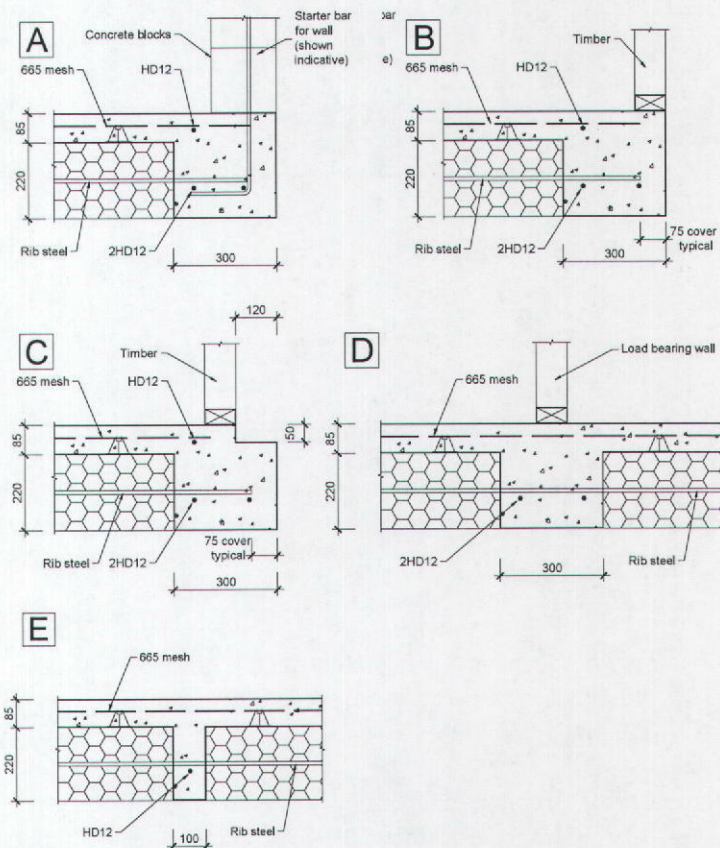


Figure 5 Standard RibRaft Construction Details

5 LATERAL RESISTANCE

5.1 Earthquake Resistance

Unlike conventional foundation systems, the Firth RibRaft system is not embedded into the ground.

Sliding resistance to horizontal seismic loads is provided by frictional contact with the soil.

In locations where the Seismic Hazard Factor, Z is greater than 0.45, shear keys may be required to resist seismic loads. Such buildings require specific engineering design and are outside the scope of this document. Refer to figure 6.

Depending on the wind zone and the weight of the building elements this frictional resistance may not be sufficient to provide sliding resistance to wind loads, and specific shear keys may be required, as detailed in clause 5.2.

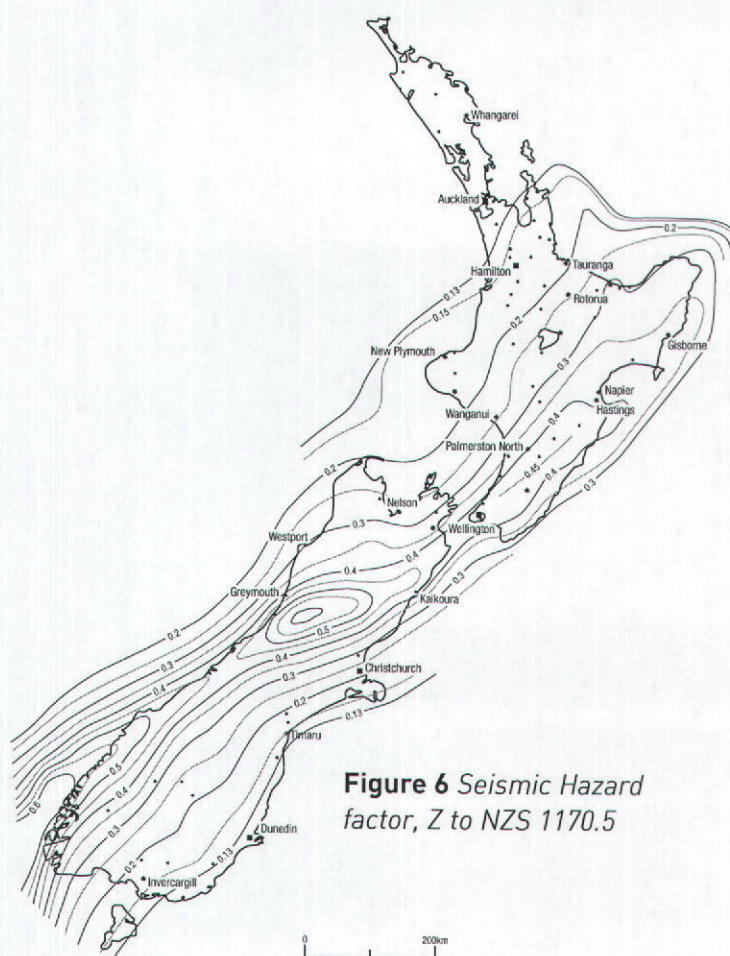


Figure 6 Seismic Hazard factor, Z to NZS 1170.5

For the purposes of this Manual, the ground shall be classified as clay or sand according to the following descriptions:

Clay: retains shape when moulded under hand pressure; may stick to boots and hands; cracks and becomes hard, but retains shape, when dried in direct sunlight; and when dug with a spade the cut vertical surface stands.

Sand: Individual particles visible to the unaided eye; when dry will run through the fingers and forms a conical mound if poured; when moist quickly dries out under direct sunlight; and when dug with a spade the vertical surface does not stand for long.

5.2 Wind Resistance

The building's bracing demand from wind loading shall be assessed from Section 5 of NZS 3604:2011 for both directions (i.e. along and across the building). The bracing capacity of the system must exceed the greater of the bracing demands determined.

The bracing capacity of the system shall be determined as the sum of the bracing capacity provided by frictional resistance (i.e. friction between the system and the ground) and the bracing capacity provided by the shear keys (if any) necessary to meet the requirements of Clause 5.2.

The bracing capacity provided by frictional resistance shall be determined from Table 6 depending on the building type, roof weight, and floor live loading.

The bracing capacity provided by the shear keys shall be the sum of the bracing capacity of the individual shear keys determined as follows. If the shear key is in clay, each shear key shall be considered to contribute 170 BU's. If the shear key is in sand, each shear key shall be considered to contribute 200 BU's.

If the bracing capacity of the system, determined from the frictional resistance and the shear keys as described above, is less than the bracing demand further shear keys shall be added until the bracing demand is met.

Building Type	Roof Type	BUs provided per 100m ² for live loading of:	
		1.5kPa	3.0kPa
A	Light	1150	1267
A	Heavy	1267	1383
B	Light	1800	1917
B	Heavy	1917	2033
C	Light	1617	1833
C	Heavy	1717	1950
D	Light	2267	2483
D	Heavy	2367	2600

Table 6 Bracing Capacity provided by Frictional Resistance per 100m² of ground floor area.

5.3 Shear Keys

Shear key piles required by Clause 5.2 must be uniformly distributed around the perimeter of the building, and be located at the edge beam/internal rib junction. Where a shear key is required, the minimum number of shear keys shall be two per floor plan. Where two shear keys are used they shall be placed at diagonally opposite ends of the floor plan.

Construction details of the shear keys shall be as shown on Figure 7 below. Shear keys shall be a minimum of 900mm long. The holes shall be over-drilled at least 100mm and a polystyrene RibRaft Shear Key Support placed into the bottom of each hole. This will support only the plastic (wet) concrete and then allow movement of the shear key if settlement of the supporting ground occurs. The effective end bearing of the shear keys is therefore eliminated.

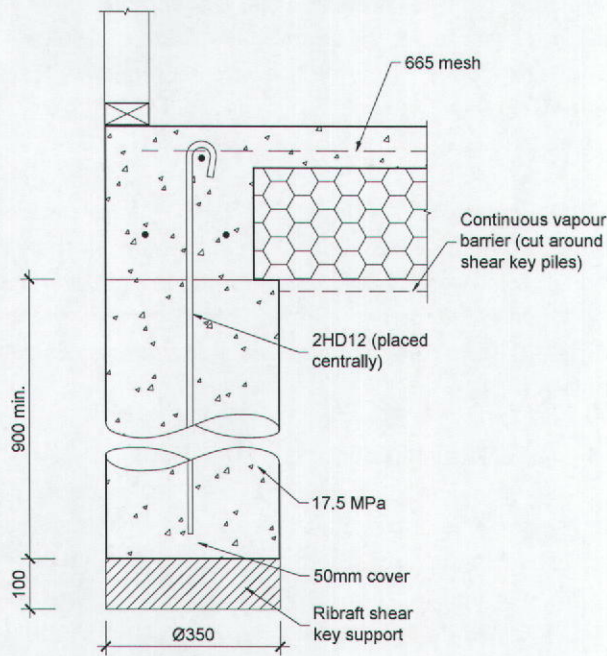


Figure 7 RibRaft Shear Key

6 OTHER DESIGN DETAILS

6.1 R-Values

The insulation performance of a building element is measured by the "R-Value". The schedule method is the simplest method to achieve compliance with Clause H1 of the Building Code. Using this method the minimum R-Values required for floors are R1.3 for light timber frame construction, and typically R1.5 for masonry construction. R values of R1.3 can be used for masonry construction if glazing with greater insulation is used [refer NZBC, Clause H1]. If in-floor heating is used the

minimum required R-Value is increased to R1.9, and the resistance to thermal movement into the room must be one tenth of that to the outside environment.

The R-Value of a RibRaft floor is dependent on the floor area to perimeter ratio, and the details of the floor perimeter. The R-Value for various solutions are illustrated below. The R-Values have been independently calculated using NZS4214:2006 "Methods of Determining the Total Thermal Resistance of Parts of Buildings," though modified for perimeter heat loss using recommendations from the Building Research Establishment.

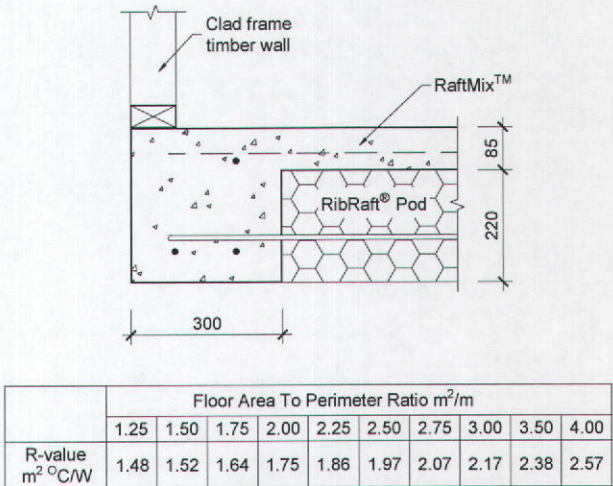


Figure 8 RibRaft R-Values for 90mm thick walls on the floor edge.

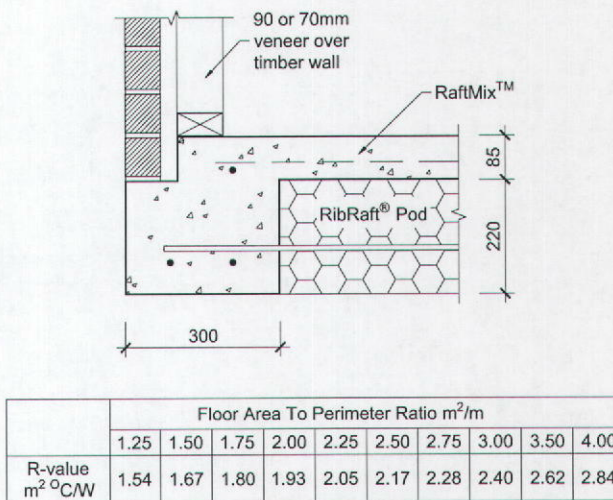
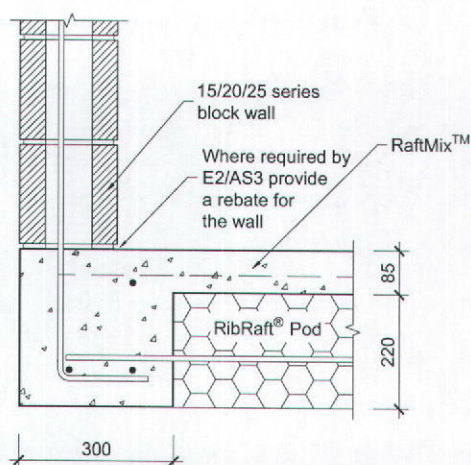
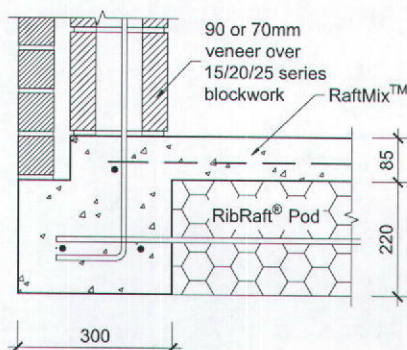


Figure 9 RibRaft R-Values for 70-90mm thick veneer, cavity, and 90mm walls.



	Block	Floor Area To Perimeter Ratio m ² /m									
		1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.50	4.00
R-value m ² °C/W	15 series	1.48	1.60	1.73	1.85	1.96	2.08	2.19	2.30	2.51	2.72
	20 series	1.54	1.67	1.80	1.93	2.05	2.17	2.28	2.40	2.62	2.84
	25 series	1.59	1.73	1.86	1.99	2.12	2.24	2.37	2.49	2.72	2.95

Figure 10 RibRaft R-Values for various thicknesses of masonry walls.



	Block	Floor Area To Perimeter Ratio m ² /m									
		1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.50	4.00
R-value m ² °C/W	15 series	1.59	1.73	1.86	1.99	2.12	2.24	2.37	2.49	2.72	2.95
	20 series	1.64	1.78	1.92	2.06	2.19	2.32	2.44	2.56	2.81	3.04
	25 series	1.69	1.83	1.98	2.11	2.25	2.38	2.51	2.64	2.88	3.12

Figure 11 RibRaft R-Values for 70-90mm thick veneer, cavity, and various thicknesses of masonry walls.

6.2 Shrinkage Control

Shrinkage control joints reduce the risk of unwanted cracks, and their placement needs to be carefully considered where cracking could be unacceptable. Factors to consider are the type of floor finish, the location of ribs and ground beams, underfloor heating and the effect of piles restraining shrinkage. Shrinkage control joints shall be saw cut after hardening. The saw cuts shall be cut to a depth of 25mm and shall be cut no later than 24 hours. The shrinkage control joints shall be positioned to coincide with major changes in floor plan. Where the concrete is to be exposed, or brittle covering placed over, the maximum intermediate bay sizes shall be limited to 6m.

Bay dimensions formed by shrinkage control joints shall be limited to a maximum ratio of length:width of 2:1.

Shrinkage control joints shall be placed over 100mm wide internal ribs wherever possible. Where a shrinkage control joint runs along the line of a 300mm wide load bearing rib then the joint shall be located directly above one edge of the 300mm rib.

Supplementary reinforcing using 2-HD12 bars (Grade 500E) shall be used at all re-entrant corners as shown on Figure 4. These bars shall be 1200mm long, 200mm apart, tied to the top of the mesh, with 50mm side cover and shall not be placed across any shrinkage control joints.

6.3 Services Detailing

Ideally, services ducts shall be conveyed underground to their plan location then brought up through the polystyrene pod and the concrete floor slab, but this may not always be possible. Services shall not be placed within any concrete except to cross that section of concrete i.e. services shall not run along ribs or edge beams.

The maximum diameter of the services shall be as outlined in Table 7.

Table 7 Maximum Diameter of Pipe Services

Element	Vertical Services	Horizontal Services
300mm wide edge beam	50mm in a duct 50mm larger diameter than pipe	50mm in a duct 50mm larger diameter than pipe unless detailed as per note 2
500mm localised wide edge beam (1)	100mm in a duct 50mm larger diameter than pipe	50mm in a duct 50mm larger diameter than pipe, see note 2
300mm wide internal load bearing rib	50mm in a duct 50mm larger diameter than pipe	50mm in a duct 50mm larger diameter than pipe, see note 2
100mm wide internal rib	Nil	50mm in a duct 50mm larger diameter than pipe, see note 2
Slab	110mm in a duct 50mm larger diameter than pipe or for large services 450mm square ⁽⁴⁾ see also note 2.	Nil

Notes

(1) For situations where a 100mm diameter pipe is required to pass through the edge beam, the edge beam shall be locally increased in width to a minimum of 500mm wide. This shall be achieved by keeping flush the outside face of the edge beam and removing 200mm from the pod. The width shall remain at 500mm for a distance of 600mm beyond the service pipe. Refer to figure 12 for details.

(2) The need for a duct 50mm larger than the service diameter can be deleted when the pipe work does not cross the interface between the bottom of the RibRaft system and the ground at any point along its length. An example would be services laid within the plane of the pods and passing through the edge beam and discharging to a gully trap or similar. In these cases the diameter of the service can be increased to a maximum of 100mm and a service duct is not required. The pipe work shall be wrapped in denso tape where it crosses concrete elements to prevent adhesion between the concrete and pipe work.

(3) Where a gas pipe line runs through the RibRaft floor system, in addition to the requirements above, the pipeline shall enter the building through the outside face of the perimeter foundation beam and be located in the plane of the pods. The aim being to ensure that damage to the gas pipe will most likely occur outside the building envelope should movement occur between the ground and RibRaft in a large earthquake.

(4) Larger penetrations or voids up to 450mm square (e.g. for shower waste/traps) are permitted through the slab provided all the conditions of this paragraph are met. These openings shall be trimmed with 1 HD12 (Grade 500E) bar 1500mm long placed along each side of the opening, tied to the mesh. One set of parallel bars shall be placed on top of the mesh and the other set placed under

the mesh. These openings shall not be placed over a rib or edge beam. If necessary, the rib spacing shall be reduced or the pod layout altered to ensure that the opening occurs solely in the slab above a polystyrene pod. Penetrations such as these shall not be installed in garages or other areas where large (>3kN) point loads could be present. Only one penetration greater than 110mm is permitted in the slab above any single pod or part pod. Where two large openings are required to be in close proximity, an internal rib shall separate them. For these large penetrations/voids in the slab, the services shall not be within 25mm of the edges of the void through which they pass, and the opening shall be sealed to prevent materials entering the subfloor cavities. (This type of opening is normally only required for a shower waste/trap and the installation of the shower will ensure that the void is sealed/covered).

Any services crossing ribs or the edge beam horizontally shall be placed only within the middle third of the member. Except as noted in figure 12, services crossing the ribs vertically shall also be constrained to the middle third of the width of the edge or internal load bearing rib. Except as noted in figure 12 at no stage shall any of the reinforcement bars be relocated or cut to allow for the services (it is acceptable, however to cut the mesh). In some instances this will dictate the location of the ribs. The pods shall be cut to allow for this and if necessary, the spacing of the ribs shall be decreased locally. There shall be 600mm minimum clear spacing in each direction between penetrations through the system.

Except as noted in table 7, all services shall be placed centrally within an opening 50mm greater in diameter than the service duct/pipe, where they pass through the system. This is to allow seismic tolerances to reduce the probability of shearing of the services during a seismic event. Where the services pass through the slab, the opening shall be sealed to prevent materials entering the subfloor cavities. (This can be achieved with Denso tape

and a type of easily compressible foam). A pictorial of some of the above requirements is illustrated in figure 12:

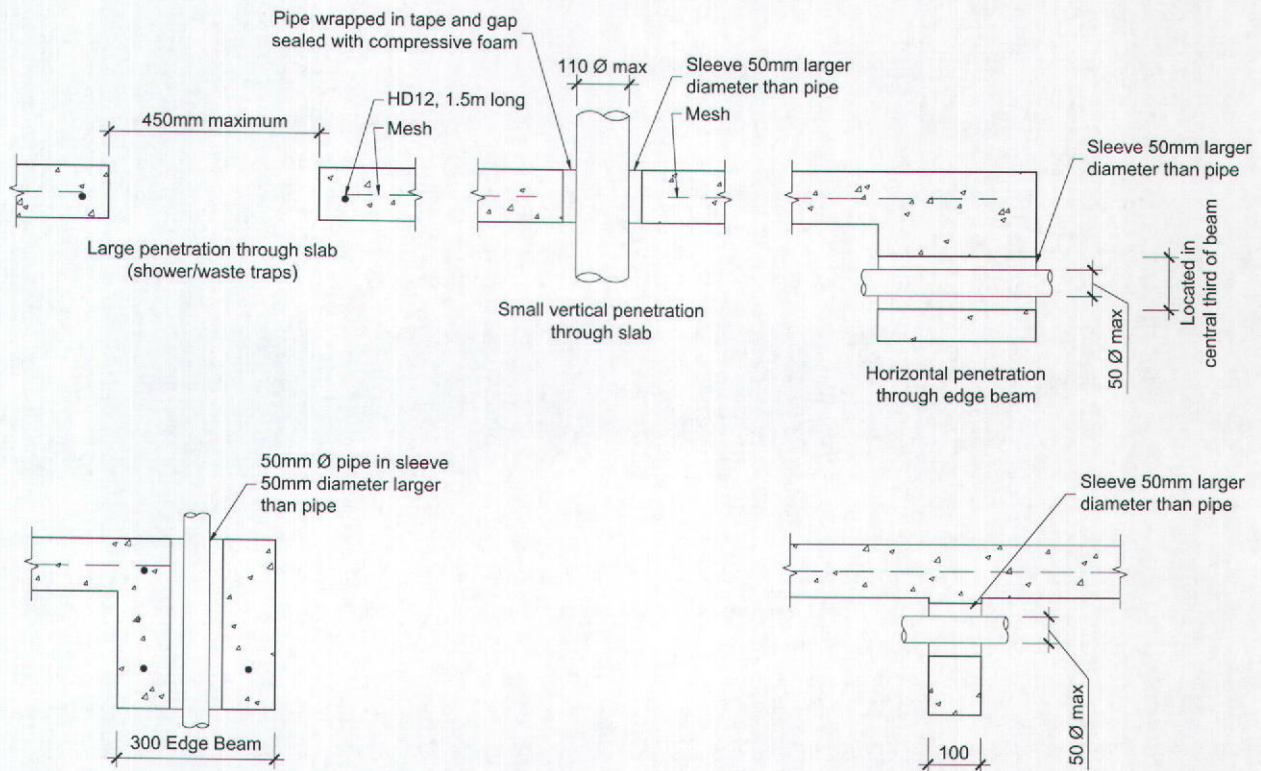


Figure 12 Example of detailing requirements for services

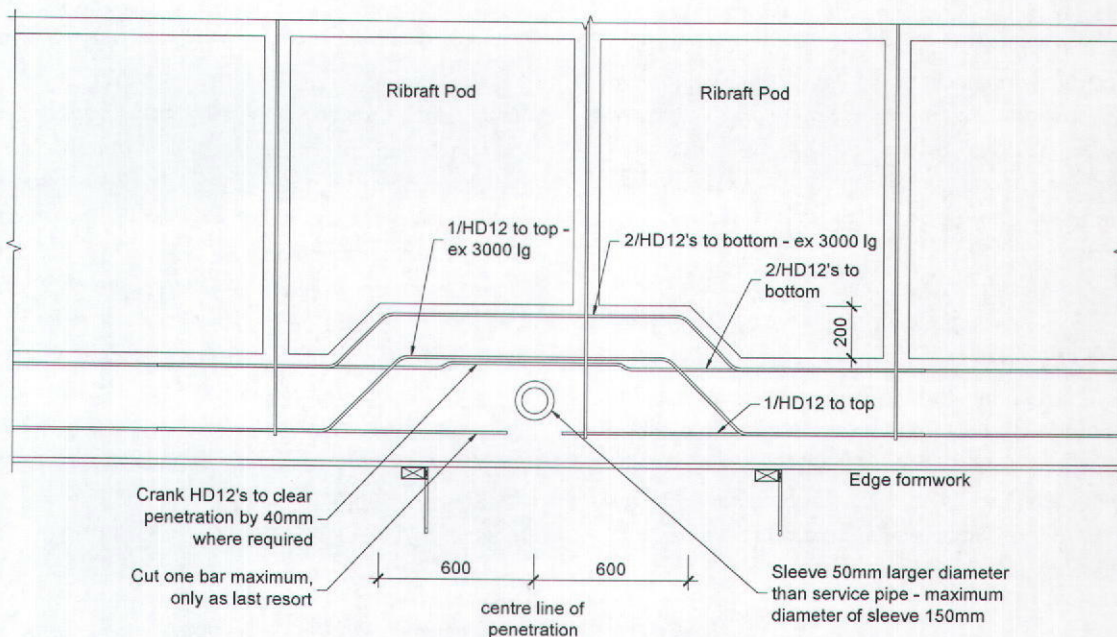


Figure 13 Localised increase in width at edge beam where vertical services up to 100mm diameter are required

FIRTH RIBRAFT FLOOR SYSTEM

SECTION 2: INSTALLATION INFORMATION

1 GENERAL

This Section details the installation information required for the Firth RibRaft Floor System (the system). Full information on the design procedures not requiring specific engineering input, and requirements for the site assessment are described in Section 1 of this Manual (Design Information). Where standards are referenced in this manual these shall include the latest amendments.

2 SITE REQUIREMENTS

2.1 General

The site requirements of this Manual are concerned solely with the soil conditions under or immediately adjacent to the system. If a site does not comply with this Manual, the system shall be subject to specific engineering design.

This Section shall only apply for building sites such that:

- The ground is as specified in Section 1 of this Manual;
- Any system erected at the top of a slope (whether fill compacted in accordance with NZS4431, or natural ground) shall be located as shown in Figure

1 so that the finished ground is always outside the dashed line shown. (The vertical distance, V, shall be measured to 50mm below the underside of the slab).

Where the finished ground does not comply with Figure 1, the slope shall be retained by a specifically designed retaining wall.

2.2 Temporary Excavations

No excavation shall take place at a location or in a manner where the stability of the foundation material is likely to be compromised. The backfilled material shall match the compaction and strength of, and have similar properties to, the surrounding material. The sides of the excavation shall be propped as necessary.

Temporary excavations shall be open for no longer than 48 hours and shall take place only above the critical depth line as shown on Figure 2. Should temporary excavations be required below this line, specific engineering design is required.

2.3 Surface Water

Surface water from the site shall not flow across the slab platform. For example, on cut and fill sites the

ground uphill from the system shall be graded to direct

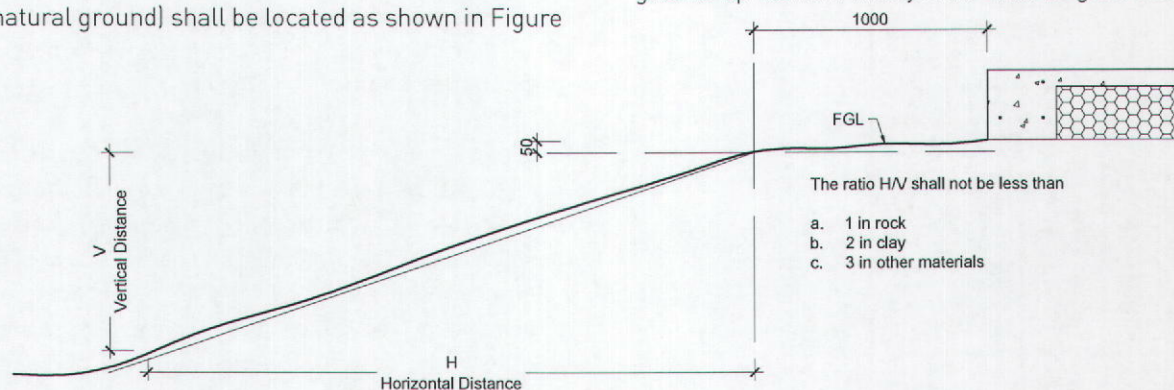


Figure 1 Relationship of RibRaft to Sloping Ground Surface

any surface run-off away from the system as shown in Figure 3.

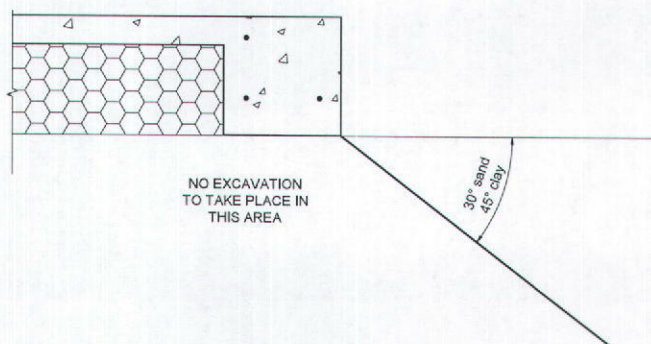


Figure 2 Temporary Excavation Limited

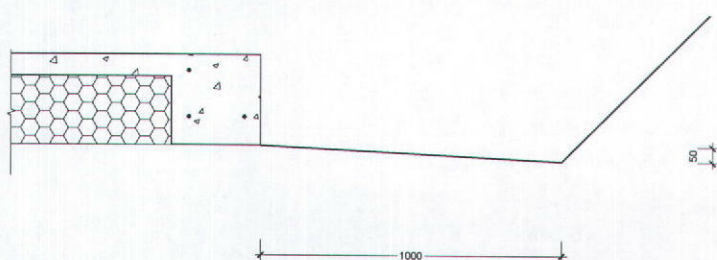


Figure 3 Site Grading

5 INSTALLATION PROCEDURE

3.1 Site Preparation

All vegetation, topsoil and other organic or deleterious material shall be removed from the area to be covered by the building (formation area) prior to commencing construction of the system.

3.2 Earthworks

The formation area shall be cut or filled to a level approximately 330mm below finished floor level. Where fill is required to achieve this level, the fill shall be certified by a geotechnical engineer (outside the scope of this Manual) or shall be granular fill in accordance

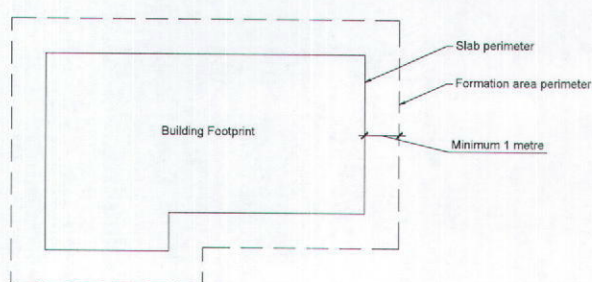


Figure 4 Plan of Formation Area (With Clause 7.5.3 of NZS 3604:2011 "Timber Framed

Buildings". The formation area shall also extend a minimum of 1000mm beyond the slab perimeter as shown in Figure 4 below. The installer shall confirm the acceptability of the ground over the entire building platform before proceeding with the construction. Refer to Clause 3.5 of Section 1 (Design Information) for requirements.

3.3 Shear Keys

Where shear keys are required, the holes shall be drilled following the site clearing and earthworks, in accordance with Clause 4 below, and prior to the construction of the system commencing.

3.4 Plumbing and Services

Plumbing and services required beneath the system should preferably be conveyed underground to their plan location then brought up through the system. The trenching, placing, and bedding of the pipes/ducts and the backfilling of the trenches shall conform to the requirements of the consent documentation. Services shall not be placed within any concrete except to cross that section of concrete i.e. services shall not run along ribs or edge beams. The maximum diameters of the services/ducts shall be as dictated in clause 6.3 of Section 1.

Where required, the services can be installed by removing unnecessary polystyrene and placing pipes within the pod depth. All pipes shall be held firmly in place and have temporary end covers. Any services crossing ribs or the edge beam horizontally shall be placed only within the middle third of the member. Except as noted in figure 12 (section 1) services crossing the ribs vertically shall also be constrained to the middle third of the width of the edge or internal load bearing rib. Except as noted in figure 12 (section 1) at no stage shall any of the reinforcement bars be relocated or cut to allow for the services (it is acceptable, however to cut the mesh). In some instances this will dictate the location of the ribs. The pods shall be cut to allow for this and if necessary, the spacing of the ribs shall be decreased locally. There shall be 600mm minimum clear spacing in each direction between penetrations through the system.

Except as noted in 6.3 of section 1, services shall be placed centrally within an opening 50mm greater in diameter than the service duct/pipe, where they pass through the system. This is to allow seismic tolerances to prevent shearing of the services during a seismic event. Where the services pass through the top of the system, the opening shall be sealed to prevent materials entering the subfloor cavities. (This can be achieved with Denso tape and a type of easily

compressible foam].

Larger penetrations or voids that are required, up to 450mm square (e.g. for shower waste/traps), shall be installed in accordance with all the conditions of this paragraph. These openings shall be trimmed with 1 HD12 bar (Grade 500E) 1500mm long placed along each side of the opening, tied to the mesh. One set of parallel bars shall be placed on top of the mesh and the other set placed under the mesh. These openings shall not be placed over a rib or edge beam. If necessary, the rib spacing shall be reduced or the pod layout altered to ensure that the opening occurs solely in the slab above a polystyrene pod. Penetrations such as these shall not be installed in garages or other areas where large (>3kN) point loads could be present. Only one penetration greater than 110mm is permitted in the slab above any single pod or part pod. Where two large openings are required to be in close proximity, an internal rib shall separate them. For these large penetrations/voids in the slab, the services shall not be within 25mm of the edges of the void through which they pass, and the opening shall be sealed to prevent materials entering the subfloor cavities. [This type of opening is normally only required for a shower waste/trap and the installation of the shower will ensure that the void is sealed/covered].

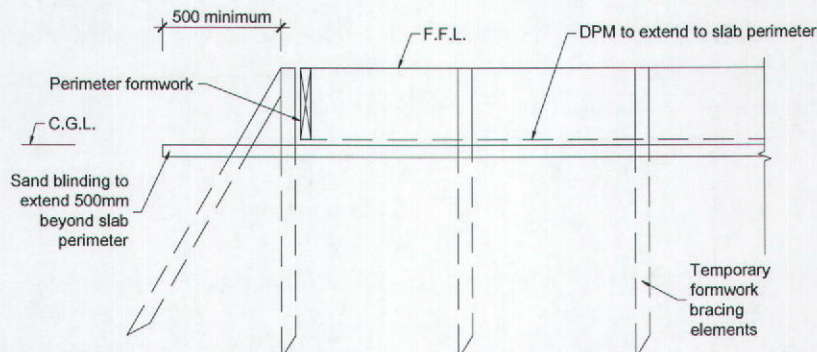


Figure 5 Sand Blinding/DPM/Formwork Details

3.5 Sand Blinding

A layer of sand shall be placed, screeded and compacted over the building platform, extending to at least 500mm beyond the system perimeter – refer Figure 5. The maximum thickness of this blinding layer shall be 50mm. The surface shall be level and a minimum of 305mm below finished floor level. A small plate compactor, vibrating roller or similar, should be used to compact the sand blinding layer. When the building platform is clay, it is essential that the blinding sand is compacted onto a clay surface that has not been softened by construction activities. If the clay has been softened (i.e. has a muddy surface layer due to construction activities), remove the softened material from under the RibRaft ribs before placing the sand. If excavation lowers the clay surface to more than 50mm

below the underside of the RibRaft, fill shall be placed in accordance with Clause 7.5.3 of NZS 3604:2011 "Timber Framed Buildings". *The sand is required to be level to ensure that pods remain stable throughout the installation of the system.*

3.6 Damp Proof Membrane

The damp proof membrane (DPM) material shall be polyethylene sheet in accordance with NZS 3604:2011. The DPM shall be laid over the entire building platform directly on top of the sand blinding layer, extending to the outside of the edge beam – refer Figure 5 below. The joints shall be lapped not less than 150mm and sealed with pressure sensitive tape not less than 50mm wide. All penetrations of the DPM by plumbing and services or punctures during construction shall also be sealed with pressure sensitive tape. The DPM may extend beyond the edge of the slab i.e. underneath the formwork, or may be folded and stapled up the inside of the formwork. The minimum requirement is that the DPM extends to the outside of the edge beam. It is very important that the DPM is not bunched up at the formwork. The installer shall ensure a square and tidy finish at the underside and at all corners of the edge beam.

3.7 Edge Formwork

The edge formwork shall be constructed ensuring that the requirements of NZS 3109:1997 "Concrete Construction" are adhered to. The formwork shall be adequately supported and braced to prevent any buckling or warping. If the wall is to be constructed in masonry veneer, formwork for a masonry veneer rebate should be adequately fixed to the perimeter formwork.

Thorough cleaning of re-useable formwork and the use of release agents enhances the life and performance of formwork and maintains a quality surface finish.

3.8 Laying the Pods and Spacers

The Firth RibRaft polystyrene pods shall be laid out over the DPM in a regular waffle pattern ensuring direct contact with the ground across the entire pod. The edge beam shall be formed using the Firth approved 300mm spacers (refer figure 9). These shall be placed at a maximum of 1200mm centres along the perimeter of the slab and one per pod or part pod. Ribs supporting a load bearing wall shall be formed using a minimum of one Firth approved 300mm spacer along the edge of each pod or part pod.

Except where a 300mm wide rib is required, each pod or part pod shall always be separated by 100mm using a minimum of one Firth approved 100mm spacer along each edge of each pod or part pod. The ribs in both directions shall form a waffle pattern throughout the slab. It is essential that the ribs and edge beams are straight when the concrete is poured, i.e. the pods need to be lined up. Figure 6 shows a detailed layout of the pods and spacers.

Where the shape of the house plan dictates, it may be more practical to consider the floor to be made up of different segments. The pods in each segment shall be in a regular waffle pattern – refer right hand side of Figure 7. Where these segments meet, the pods shall be cut to suit and the ribs made to join. The non right-angle rib junctions created by this approach are acceptable.

Alternatively, it is also acceptable to keep the orientation of the pods constant throughout the plan and have non right-angle junctions between the ribs and edge beam – refer left hand side of Figure 7.

As can be seen from Figure 7, it is not necessary for the pods to line up perfectly with the edge beam. It is acceptable to cut the pods (i.e. use part pods).

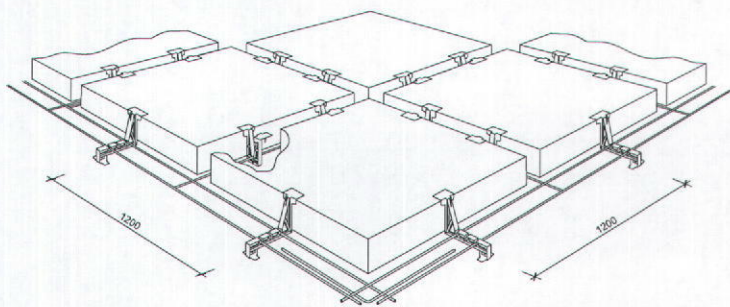


Figure 6 Detailed Layout of Pods and Spacers
(mesh and top steel omitted for clarity)

3.9 Reinforcing Steel

Reinforcing bars shall conform to NZS 4671:2001 "Steel Reinforcing Materials". All bars shall be of deformed type (Grade 500E). All bends shall be made cold without fracture and in accordance with the bend diameters given in NZS 3109 "Concrete Construction". Welded lap joints are not permitted.

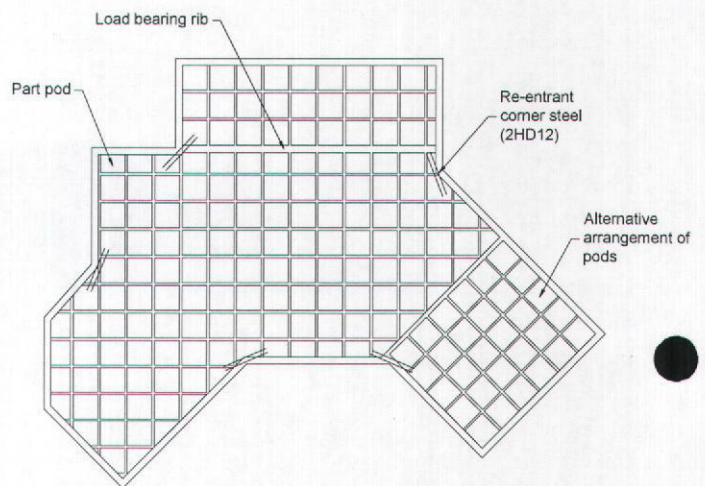


Figure 7 Typical Pod and Rib Layout

Reinforcing steel in the slab shall consist of Welded Reinforcing Mesh complying with AS/NZS 4671:2001 with a minimum weight of 2.27kg/m², a lower characteristic stress of 500MPa, square configuration of orthogonal bars between 150 to 300mm centres, and ductility class L or E, hereafter referred to as "665 mesh, or mesh".

Figure 10 shows the detailed layout of the spacers and the steel in the edge beam and the standard ribs.

3.9.1 Edge Beam Steel

Two edge beam reinforcing bars shall be placed in the bottom of the edge beam and supported in the correct position by the Firth spacers, as shown in Figure 10. One edge beam bar shall be tied below the mesh at the perimeter of the area covered by the polystyrene pods as shown in Figure 10.

All steel shall be lapped a minimum of 60 bar diameters (720mm for 12mm steel). Tying of the edge beam steel is only required at corners. Figure 8 shows the layout for the edge beam bottom steel bars at the corner. The inner bottom bars and the top bars shall cross each other and extend to 75mm from the outside face of the edge beam as shown. These bars shall be tied together where they cross.

3.9.2 Rib Steel

Rib reinforcing steel shall be placed in the bottom of the internal ribs and supported in the correct position by the Firth or Wilton Joubert spacers (WJ). Figure 9 shows the detail of the Firth and WJ spacers, and Figure 10 shows a detailed section identifying how the steel is located in the spacers. The 300mm spacer shall be used for the 300mm wide internal ribs. These spacers ensure that cover to DPM below the base is greater than 45mm and cover to the exterior perimeter is 75mm.

All steel shall be lapped a minimum of 60 bar diameters (720mm for 12mm steel). At the junction with the edge beam, each rib steel bar shall sit on top of the edge beam bars, and extend to the outermost bar. The 75mm cover to the edge of the beam shall still be allowed for. One HD12 bar (Grade 500E) shall be placed in each 100mm wide rib and two HD12 bars (Grade 500E) shall be placed in the bottom of each 300mm wide rib. For perimeter 300mm Ribs a HD12 bar is also required in the top at the beam.

3.9.3 Mesh Reinforcing

665 Mesh reinforcing shall be placed over the pods and supported on 40mm mesh chairs spaced at a minimum of 1200mm centres, with at least two mesh chairs placed per pod and at least one per part pod. The mesh shall be lapped 225mm minimum and tied at all laps.

3.9.4 Re-entrant Corner Steel

Two HD12 bars (Grade 500E), 1200mm long shall be placed across the corner, tied to the top of the mesh at re-entrant corners at 200mm centres, with 50mm cover from the internal corner as detailed in Figure 7 (this steel is to control cracking at this potential weak point).

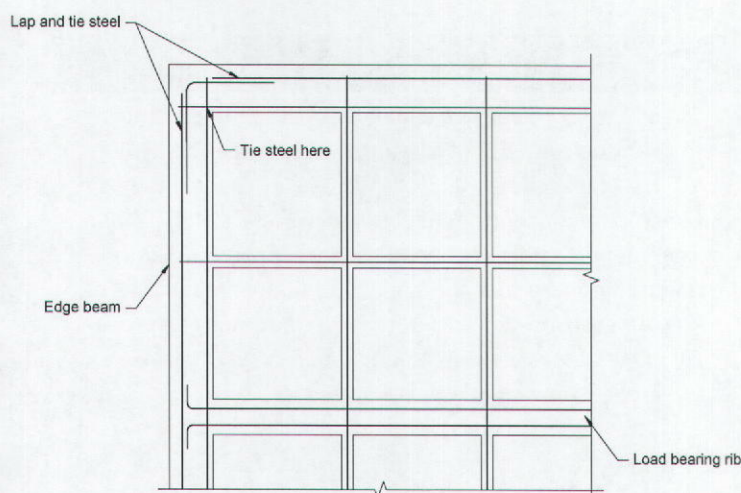


Figure 8 Corner Steel Layout
3.10 Concrete Installation

Concrete placing, finishing and curing shall be in accordance with NZS 3109:1997, Clause 7.

3.10.1 Placing

Only Firth Raftmix, Raftmix Pump, Raftmix25 or Raftmix Pump25 concrete shall be used in the floor.

These two different concrete mixes shall be used in the following instances:

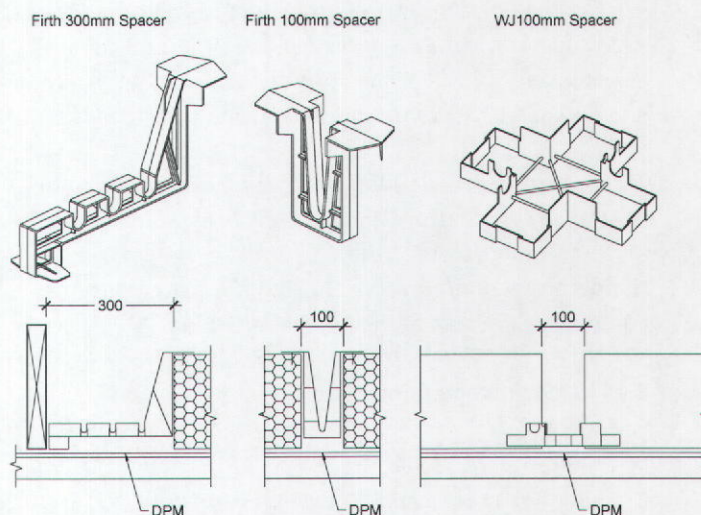


Figure 9 Spacer Details

- Raftmix – For placement in the floor directly from the concrete truck chute.
- Raftmix Pump – For placement in the floor by concrete pump.

Refer 2.4 of Section 1 for locations where RaftMix 25/ Raftmix 25 Pump is required.

The concrete supplied by Firth shall be poured in such a way to ensure that the pods remain in position during placing (Firth recommends that small amounts of concrete be placed on top of the pods prior to the ribs being filled). The concrete shall be compacted with the use of an immersion vibrator around all steel and into all corners of the formwork.

3.10.2 Finishing

Screeding with the aid of a level shall commence immediately after compaction. Unless specifically installed as a screeding datum, the top of the formwork shall not be assumed as level and thus shall not be used for screeding purposes. Final finishing with a trowel shall take place after all the bleed water has evaporated. The edge of the slab and rebates shall be tooled to prevent chipping of the top of the slab.

Early age care of the slab shall be in accordance with good trade practice appropriate for the weather conditions. The surface shall be a blemish free surface to class U3 finish (refer NZS 3114:1987 "Specification for Concrete Finishes").

3.10.3 Curing

Proper curing of the concrete must take place immediately after finishing the concrete. One of the following methods of curing is recommended:

- Ponding or continuous sprinkling of water.
- Placing a wet covering or plastic membrane over the slab.
- The use of liquid membrane curing compounds.

When warm sunny days are followed by cool nights, the change in temperature can cause cracking. Immediate and continuous wet curing to reduce the maximum temperature and/or raise the minimum temperature can reduce the risk of this type of cracking.

3.11 Shrinkage Control Joints

Shrinkage control joints shall be saw cut after hardening. The saw cut shall be cut to a depth of 25mm and shall be cut no later than 24 hours in summer, or 48 hours in winter. The shrinkage control joints shall be positioned to coincide with major changes in floor plan. Where the concrete is to be exposed or brittle covering placed over, the maximum intermediate bay sizes shall be limited to 6m. Bay dimensions formed by shrinkage control joints shall be limited to a maximum ratio of length:width of 2:1.

Shrinkage control joint shall be placed over 100mm wide internal ribs wherever possible. Where a shrinkage control joint runs along the line of a 300mm wide load bearing rib then the joint shall be located directly above one edge of the 300mm rib. Supplementary reinforcing bars shall not be placed across any shrinkage control joints.

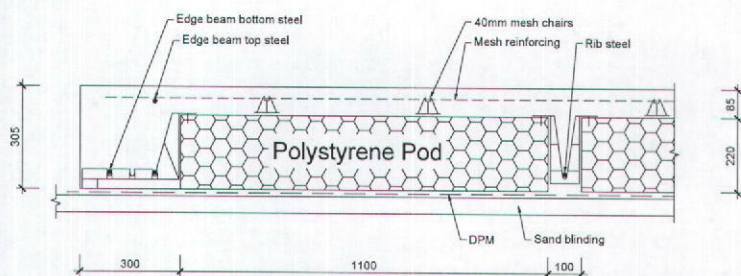


Figure 10 Detailed Section
5.12 Removal of Formwork

The formwork shall not be removed prior to 12 hours after the slab has been finished. No installation loads are to be placed on the system before adequate curing has taken place.

3.13 Masonry Veneer

Where the building is to be clad with masonry veneer, the rebate in the edge beam shall be waterproofed with a bituminous sealer due to the possibility of ponding of water. Firth recommends a Flintcote® or equivalent coating on both the vertical and horizontal faces of the rebate.

3.14 Landscaping/Paving

Landscaping and/or paving adjacent to the slab shall be kept as a minimum the specified distance below finished floor level as required by NZS 3604:2011. The landscaping shall allow for large trees to be kept sufficiently away from the edge of the slab. This is to prevent the tree roots from disturbing the soil moisture conditions under the slab. As a guide, trees should be as far away from the edge of the slab as they are tall when fully grown.

3.15 Ongoing Maintenance

The building owner shall ensure that the ground surrounding the system be maintained so that the integrity of the system is not jeopardised. In other words, at no time shall the ground immediately adjacent to the system be allowed to settle away to expose the underside of the slab.

This can also be ensured by maintaining the landscaping or providing a paved surface or similar around the edge of the building.

Shear keys, if required, shall be provided to conform to the requirements of Section 1 of this Manual. Holes for the shear keys shall be drilled at least 1000mm deep. Into the bottom of each hole a RibRaft Shear Key Support shall be placed. Every precaution shall be taken to ensure that the shear key support is laid level and at the base of the hole. The minimum depth of concrete placed on the support shall be 900mm. Refer to Figure 11 for construction details.

The connection steel (2HD12 Grade 500E) shall be secured in place and held during pouring to ensure the bars are correctly located. The concrete for the shear keys shall be placed separately to the rest of the

floor and shall be finished level to the top of the sand blinding layer. The top surface of the shear key shall be finished rough to ensure a good join to the Raftmix concrete in the system and the DPM shall be neatly cut around the shear keys.

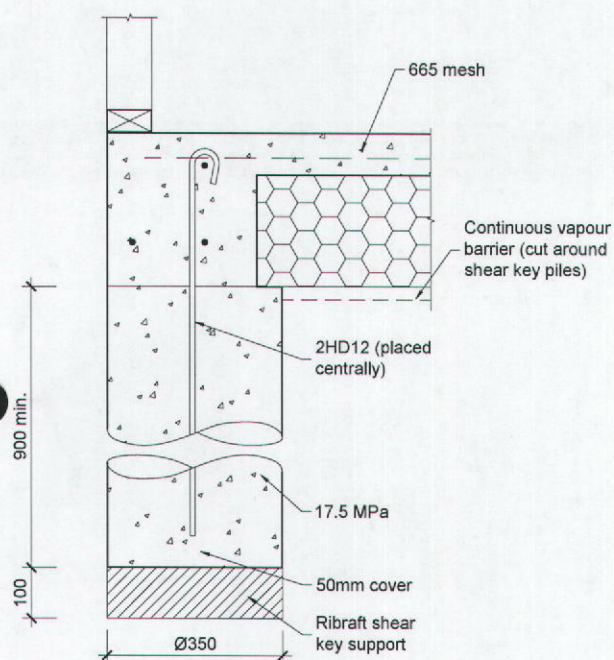


Figure 11 *Shear Pile Construction Detail*

FIRTH RIBRAFT FLOOR SYSTEM

SECTION 3: VERIFICATION

1 DESIGN

Verification that the design complies with the structural limitation outlined in this Manual is the responsibility of the designer, and shall be confirmed by the Building Control Authority issuing the Building Consent. Solutions outside the limitations outlined in this Manual will require specific engineering design.

2 CONSTRUCTION

The RibRaft foundation system has been designed to accommodate structures complying with the non specific design standards NZS3604 or NZS4229. With these types of structures the Building Control Authority specifies the inspections required and often conducts these. A similar construction verification process shall be applied to the RibRaft system.

To assist inspection the following checklist has been prepared for structures complying with the limitation:

Pre-pour Inspection Check list

	Confirmed
Good Ground confirmed as per NZS3604, clause 3.1.3.	
Vegetation, topsoil, organic or deleterious material removed.	
Proximity to slope-ground surface is always above dash line shown in figure 1.	
Shear piles (where required) in place and reinforcement protruding.	
Formation area extends at least 1m beyond building footprint.	
No steps in the formation.	

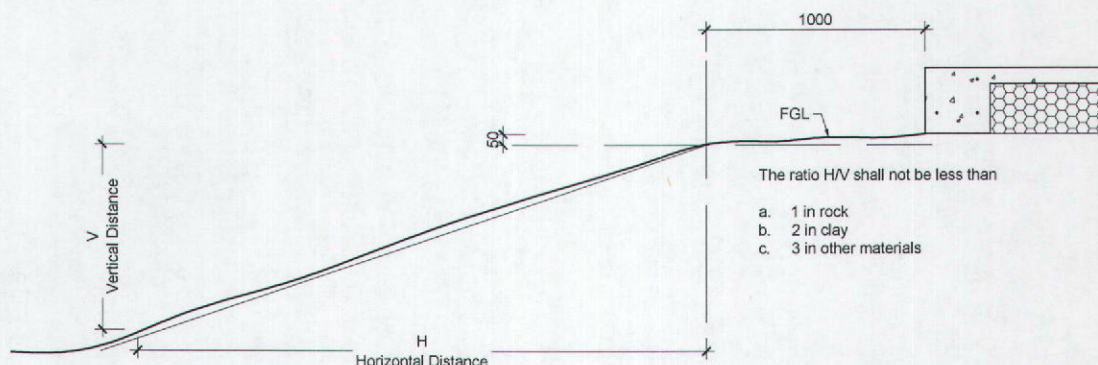
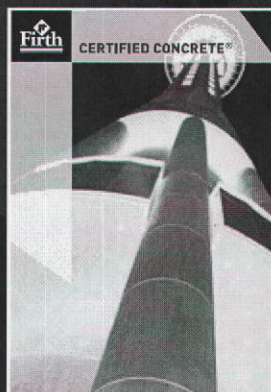
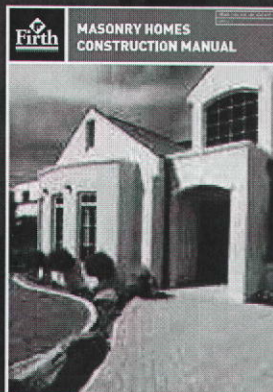


Figure 1 Relationship of RibRaft to Sloping Ground Surface

Pre-layout Inspection Check list

	Confirmed
Damp proof membrane in place.	
Perimeter foundation	Width 300mm ⁽¹⁾ .
	Reinforcement 2 x HD12 bottom, 1 x HD12 top.
	Firth supplied spacer used at 1.2m maximum centres.
Internal Ribs	Width 100mm.
	Reinforcement 1 x HD12.
	Firth supplied spacer, max spacing of one per pod or part pod.
Load Bearing ribs	Width 300mm.
	Reinforcement 2 x HD12 bottom.
	Firth supplied spacer, max spacing of one per pod or part pod.
Pods	Firth supplied RibRaft pod.
Mesh	40mm chairs, 1.2m max centres, min two per pod or one per part pod.
	Mesh in place and 665 or equivalent area.
	Mesh laps minimum of 225mm.
Reinforcement	2 x HD12 bars 1.2m long provided at re-entrant corners.
	Laps for 12mm reinforcement minimum of 720mm.
Concrete	Cover to pods minimum of 85mm or 110mm if infloor heating used.
	Firth Raftmix ordered.
Service penetrations	No reinforcement (with exception of mesh) cut to allow passage of service pipes. Refer clause 6.3 of Section 1 for exceptions.
	Diameter of opening for services 50mm greater that service pipe. Refer clause 6.3 of Section 1 for exceptions.
	Diameter/size of penetrations as per Table 7, Section 1 of this manual.

(1) At locations of service penetrations the width of the perimeter foundation maybe locally increased. Refer figure 12 section 1 for details.



SUSTAINABILITY: THE FIRTH CONCRETE & CONCRETE MASONRY SUSTAINABILITY LIFECYCLE

- | | |
|---|---|
| <input checked="" type="checkbox"/> Environmentally compliant manufacturing plants | <input checked="" type="checkbox"/> Most wash water returned from construction sites |
| <input checked="" type="checkbox"/> Surplus water and some aggregates recycled | <input checked="" type="checkbox"/> Highly durable, low maintenance buildings and no rot |
| <input checked="" type="checkbox"/> Low transport impacts | <input checked="" type="checkbox"/> High degree of noise control |
| <input checked="" type="checkbox"/> Leftover concrete returned from construction sites | <input checked="" type="checkbox"/> Inherent fire resistance |
| <input checked="" type="checkbox"/> Passive solar heated thermal mass makes completed buildings more energy-efficient | <input checked="" type="checkbox"/> Overall longer effective building life |
| | <input checked="" type="checkbox"/> Demolished concrete can be recycled as hard fill or aggregate |

For more on Firth's contribution to building a sustainable tomorrow today, visit www.firth.co.nz or call us on 0800 800 576 for our free brochure.

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AUSTRAL BRICKS™

01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

The technical information in this manual is aimed to provide guidance on the properties of bricks and on the selection of bricks for specific applications.

Austral Bricks™ manufactures all products to Australian and New Zealand Standard AS/NZS 4455 (Masonry units and segmental pavers), unless otherwise specified in the technical data sheet made available for each product.

Australian and New Zealand Standard AS/NZS 4456 (Masonry units and segmental pavers - methods of test) outlines the test methods required for the determination of the brick properties discussed. General information about bricklaying practices has also been provided to briefly explain some aspects of masonry construction.

BRICK PROPERTIES

Dimensions

Austral Bricks™ declares a working size and a dimensional deviation category for each product, in accordance with NZS 4210. Generally, the cumulative method of determining dimensions is used, as described in AS/NZS 4456.3. In this method 20 bricks are stacked and their length is measured. This measurement is compared with 20 times the standard work size.

This is done separately for length, width and height. The deviation of this measurement from the standard is used to determine the dimensional deviation category of the bricks. The different categories of dimensional deviation and their requirements are given in the table below.

Dimensional Category	Work size dimensions		
	Under 150mm (for example, width and height).	150 – 250mm (for example, length).	Over 250mm (for example, length of blocks).
DW0	No Requirement		
DW1*	±50mm	±90mm	±100mm
DW2*	±40mm	±60mm	±70mm
DW3	By agreement between supplier and purchaser.		
DW4**	Standard deviation of not more than 2mm and the difference between the mean and the work size of not more than 3mm.		

*As determined by the cumulative method over 20 units (Method A of AS/NZS 4456.3).

**As determined from the individual dimensions of 20 units (Method B of AS/NZS 4456.3).

All masonry units are expected to comply with the DW1 category. No tolerances apply (DW0) when bricks are intended to have a irregular or rough surface finish (e.g. rumbled or sandstock bricks). Supply of units to higher tolerances such as DW2, DW3 and DW4 requires a specific request to Austral Bricks™.

AUSTRAL BRICKS™

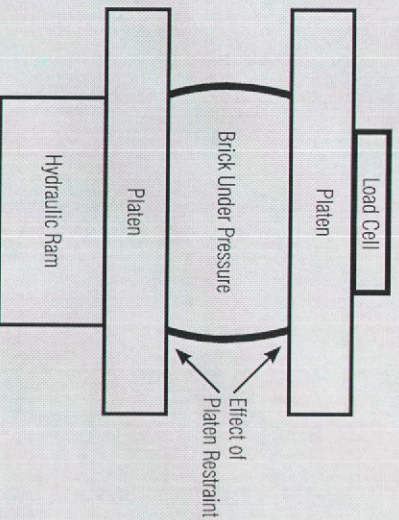
01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

Strength

Characteristic Unconfined Compressive Strength

Austral Bricks™ makes available the characteristic unconfined compressive strength (f'_{uc}) of their products as required by Australian and New Zealand Standard AS/NZS 4455. The f'_{uc} values are determined using the test method detailed in AS/NZS 4456.4. The test method involves subjecting the masonry unit to increasing load by compressing it between two metal platens. The friction between the platens and the masonry unit acts to restrain the sideways spread of the unit, as shown in the diagram below.



Compressive Testing of Masonry Units

The effect of this restraint is more pronounced in shorter specimens than in taller specimens of the same width. The incorporation of an aspect ratio (height to thickness ratio) factor, allows the results to be converted to an equivalent unconfined compressive strength value (f'_{uc}). That is, a correction factor, directly related to the dimensions of the unit, is used to compensate for the restraining effects of the platens during testing. The f'_{uc} allows direct comparison of all masonry units, regardless of the size.

The characteristic unconfined compressive strength (f'_{uc}) values now supplied for a traditional sized brick are approximately 60% of the previously used characteristic confined compressive strength values. It is important to note that this difference is due to the altered approach used when determining the values and not a reduction in strength.

For further information on compressive strength measurements refer to Think Brick Manual 2: The Properties of Clay Masonry Units (available at www.thinkbrick.com.au).

BRICK DURABILITY

Definition

All products manufactured by Austral Bricks™ are classified by their durability. The durability of a brick is a measure of its resistance to attack by soluble salts.

The test method used to determine the durability of bricks is given in AS/NZS 4456.10. The suitability of the units for use in a given environment determines their salt attack resistance category.

Salt Attack Resistance Categories

- 1. Exposure Grade:** Suitable for use in external walls exposed to aggressive environments, such as:
 - in areas where walls are subjected to salts in the soil, adjacent material or ground water
 - in coastal areas where walls are exposed to attack from windborne salt spray
 - retaining walls that may be subjected to fertilisers and ground salts.
- 2. General Purpose:** Suitable for use in an external wall under ordinary exposure conditions.
- 3. Protected:** Suitable for use in internal and external walls only when above a sheet or membrane damp-proof course and protected by an adequate coping, eaves, roof or similar top covering. These units should not be directly exposed to saline environments.

Durability Required

The severity of the environmental conditions, such as the amount of moisture and the availability of soluble salts, determines the durability grade required. New Zealand Standard NZS 4210 (Masonry Construction: Materials and Workmanship) states that masonry units must be classified according to their durability and used in the exposure conditions appropriate to their classification.

AUSTRAL BRICKS™

01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

The durability requirements set out in NZS 4210 are summarised in the following table:

Exposure Category*	Minimum Salt Attack Resistance Grade of Masonry Units	Minimum Mortar Classification	Minimum Durability Classification of Built-in Components
Sea spray	Exposure Grade	M4	R4
1 & 4	General Purpose	M4	R3
2 & 3	Protected	M3	R3
Closed interior	Protected	M2	R1
Geothermal hotspot	Exposure Grade	M4	R5

*NZS 3604 classification of exposure zones is shown on the exposure zone maps in Appendix 1.

It is important to take into consideration the given environment during the design and construction of brickwork buildings, to minimise the potential for salt attack. The most suitable mortar joints for aggressive environments are ironed or weather struck joints. The mortar classifications given in the table and the types of mortar joints possible are discussed in more detail in the mortar section of this manual. It should also be noted that raked mortar joints should not be used in severe marine environments.

The minimum durability classification of built-in components is particularly relevant to the use of wall ties in masonry constructions. AS/NZS 2699.1 classifies the durability of masonry wall ties as:

- R3 - galvanised to a coating weight of at least 470g/m² on both sides, in accordance with AS/NZS 4680
- R4 - stainless steel grade 316 or 316L.

Think Brick Manual 2: The Properties of Clay Masonry Units provides further information on the durability of bricks.

FRETTING OF BRICKWORK (SALT ATTACK)

Fretting of brickwork is linked to the durability of bricks and is directly related to the exposure environment in which they are placed. The fretting (flaking or crumbling) of bricks can be prevented by the adequate maintenance of your wall structure. An extreme case of fretting is shown in the image on this page.

Fretting is caused by the action of salt migration in the walling system. Water which has salt dissolved in it migrates through

the brickwork to the brick surface. As the water evaporates and the brick dries, the salt is left behind.

The salt crystals grow in the voids within the brick. The strength of the growing salt crystal can be stronger than the elements that hold the brick together. If this occurs, the brick face begins to crumble and fall away. This is also true for mortar joints.



Image: An extreme case of brickwork fretting.

For salt attack to occur the following three conditions are required:

- There must be salts present.
- There must be water entering the wall.
- The water must evaporate from the wall.

The absence of any one of these conditions will prevent salt attack. The fretting of bricks can be exacerbated at specific locations around a house which undergo increased wetting and drying cycles. The brickwork will continue to deteriorate unless moisture movement through the masonry is prevented. When treating fretting, "prevention is the best cure". The source of the salt may be airborne salt from sea spray or salts that are naturally present in the soil, or introduced by fertilizers and salt-water swimming pools. The use of bore water may also provide the source of the salt.

The first step in treating fretting is to identify the source of the salt and where the salt might be coming from. The best method of preventing fretting is to prevent the salt from being absorbed into the wall. This may be a physical barrier such as plastic sheeting, digging the soil away from the wall or rearranging the sprinklers so that they do not spray directly onto the wall. Once fretting has begun it will not stop until the salt source is identified and removed. It could then take another 12-24 months before the fretting process comes to a complete halt. Once the fretting process has stopped the brickwork can then be repaired. Any repairs made to the brickwork while the fretting action is still occurring will generally fail.

AUSTRAL BRICKS™

01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

Fretting brickwork may be treated using breathable sealers that penetrate the brickwork and consolidate loose particles. However, depending on the degree of fretting it may be necessary to render or replace the affected brickwork. For further information contact Austral's Technical Department.

EXPANSION

Brick Growth

Bricks undergo long-term permanent expansion over time. This expansion continues for the life of the brick, but the majority of the growth occurs early in its life. Moisture expansion, or brick growth, of fired clay units begins as soon as they have cooled after leaving the kiln. All fired-clay products, including pavers, are subject to chemical reactions between water and some of their constituent minerals that cause them to expand. Moisture expansion reduces at an exponential rate after leaving the kiln with the majority of expansion occurring in the first six months.

Most general purpose bricks have a coefficient of expansion in the range of 0.5-1.5mm/m (millimetres per metre) over fifteen years. Designers can use the values of the coefficient of expansion to accommodate for the growth of bricks by the size and spacing of the control joints. The coefficient of expansion, or 'e' value, of clay bricks is tested in accordance with AS/NZS 4456.11 and is an estimate of the amount of growth expected in the first fifteen years after the brick leaves the kiln.

Typical values are given only as a guide as there is no pattern in the coefficient of expansion based on brick colour or manufacturing methods, and the coefficient of expansion can vary considerably between batches even within a single brick type, due to variations in the manufacturing process and raw materials used. For these reasons, Austral Bricks™ regularly tests its products to determine the coefficient of expansion in accordance with AS/NZS 4456.11. Recent test data is available from our NATA accredited laboratories.

Expansion Gaps

The provision of expansion gaps (also known as control or articulation joints) between parts of the structure during construction will accommodate movements within the structure over time. Numerous sources of movement exist and include:

- change in size of building materials with temperature, loading conditions and moisture content
- differential change in size of building materials (for example, cement products shrink over time, whilst clay bricks expand slowly over time)

- foundation and footings movement
- frame movement
- frame shortening
- temperature movement
- internal horizontal and vertical movement.

Design of Control Gaps

Typical control gaps should initially be approximately 20mm wide and allow 10mm closing movement. The joints need to be clear of mortar dags or bridges, tied at appropriate intervals with flexible ties and sealed with a polyethylene rod or suitable compressible filler. The filler material should be positioned well back from the masonry surface to avoid the filler material becoming visible if the joint contracts. It is recommended, for brickwork greater than 10m in length or height, that control joints be typically installed at 8m centres.

Common Problems

The typical problems arising with expansion gaps include:

- inadequate sealing
- failure to ensure that the gaps are clean and that no hard materials such as mortar droppings are left before sealing
- use of joint fillers that are too rigid, which have compressive strengths high enough to transfer forces across the joint.

However, these problems can be avoided by good workmanship during construction. Further information on expansion gaps is available in Think Brick Manual 10: Construction Guidelines for Clay Masonry.

INITIAL RATE OF ABSORPTION

The initial rate of absorption (IRA) is a function of the size and extent of the porosity of the bricks. The IRA is a measure of how quickly a brick will absorb water. The test method to determine the initial rate of absorption is given in AS/NZS 4456.17.

The ability of bricks to absorb water affects the bond formed between brick and mortar. A tug-of-war occurs between the bricks ability to absorb water and the capacity of the mortar to retain water. If either the brick or the mortar wins, a poor bond will result. Therefore, the water retentivity of the mortar needs to be matched to the IRA of the bricks to ensure that a strong bond forms.

AUSTRAL BRICKS™

01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

High Suction Bricks

If the brick wins the tug-of-war and the water is absorbed too quickly from the mortar, the cement will not undergo proper hydration. Therefore, if the bricks have high suction the mortar will stiffen in the bed joint before the next course can be properly bedded. To accommodate high suction bricks, a high water retention mortar is required. It may also be necessary to shorten the bed joint or to wet the bricks prior to laying, in order to reduce their suction.

However, wetting the bricks may lead to efflorescence in the brickwork (refer to Austral Bricks™ Manual 2: Brick Cleaning and Maintenance for an explanation of efflorescence).

Dry press bricks often have high suction. Dry press bricks can be lightly sprayed with a hose and left until the water has spread throughout the brick before laying.

Low Suction Bricks

If the mortar wins the tug-of-war and retains too much water, the bricks will tend to float on the mortar bed. Low suction bricks may, therefore, make it difficult to lay plumb walls at a reasonable rate. To accommodate for low suction bricks a leaner mortar is required. A lean mortar can usually be obtained by increasing the proportion of washed sand to unwashed sand used in the mix. For further information on the absorption of water by bricks refer to the Think Brick Manual 2: The Properties of Clay Masonry.

LIME PITTING

Lime pitting is an imperfection occurring in the surface of a brick due to the expansion of large lime particles just below the surface. The lime originates from the raw materials used in the manufacture of the bricks. Lime pitting is observed when the lime particles are present just below or on the surface of the brick. The volume expansion of the lime particle, resulting from the presence of moisture, can cause it to pop out of the brick or break the brick surface, generating a defect. An example of a large lime pit is shown below.



Image: An example of a large lime pit on brickwork.

Lime pitting is defined in AS/NZS 4456 and the degree of lime pitting can be determined in accordance with AS/NZS 4456.13. Lime pitting is classified by the number and size of lime pits on the face or ends of the brick, as described below:

Nil	No Visible lime pits.
Slight	Not more than 5 lime pits, none exceeding 8mm in diameter.
Moderate	No pits exceeding 10mm diameter.
Severe	One or more pits exceeding 10mm diameter.

AUSTRAL BRICKS™

01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

BRICKLAYING

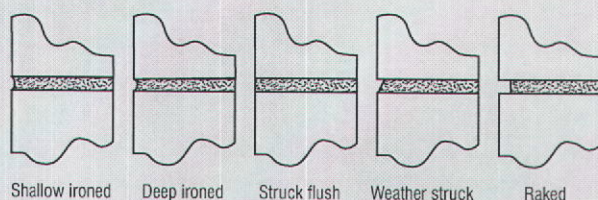
All buildings must be constructed in accordance with the New Zealand Building Code (NZBC). Timber framed brick veneer buildings are to be constructed according to NZS 3604 (Timber Framed Buildings), and all masonry work is to be constructed to NZS 4210 (Masonry Construction: Materials and Workmanship).

Mortar - Colour and Style

Mortar is used to bond bricks together so that the masonry can act as a structural element. The choice of mortar colour and style is just as important as the choice of brick. Mortar generally represents about 15% of the total visible area of brickwork and can dramatically change the look of a building.

For example, mortar coloured to match the brick wall will give the impression of a large area of one colour. Whereas, contrasting mortar colour will highlight the shape of individual bricks. Mortar joint style also plays a major part in determining the overall appearance of a building. The different styles possible are shown below.

Mortar Joint Styles



Properly filled and tooled joints improve the durability, weather resistance and sound performance of brickwork. Raked and ironed joints are used to achieve the 'character' look in new brickwork. Flush joints will increase the impact of the mortar colour when a contrasting colour is chosen.

For bricks with a bevelled edge, it is recommended that a raked joint be used.

It should be noted that raked or recessed joints should not be used in severe marine environments and should be avoided in applications where durability is critical. Examples of the effect of the choice of mortar colour and style are given above.

Effects of Mortar Colours on the Same Brick Blend

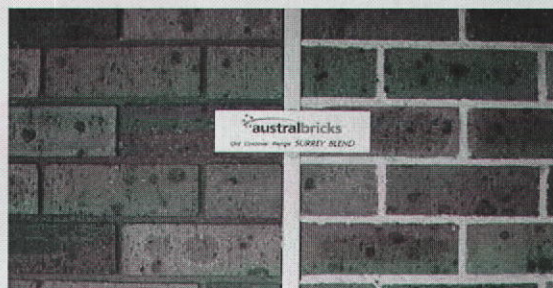


Image: Grey mortar

Image: White mortar

Effects of Mortar Joint Style on the Same Brick Blend

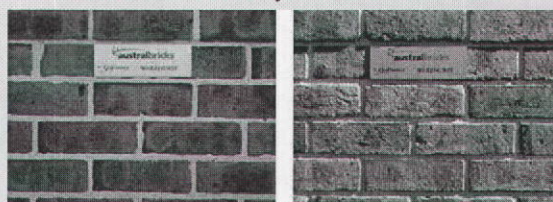


Image: - Flush joint

Image: - Raked joint.

Wet sponging of the mortar joints is a common practice with smooth face bricks. Although this creates a smoother joint finish it smears a cement rich mortar film over the brick face, which often develops into staining and can be extremely hard to remove.

With the variety of mortar colours, brick colours and joints available, the combinations are almost limitless, which means that owners can proudly stamp their style and individuality onto their home.

Batching Mortar

Unless the proportions of sand, lime and cement that go into a mortar mix are measured with care, it is impossible to be sure if the correct mix has been achieved. In order to ensure that the correct proportion of materials has been used it is suggested that batching be carried out using buckets. A shovel should not be used as the measure during batching, as a shovel is able to hold more sand than cement (as shown in the images below).

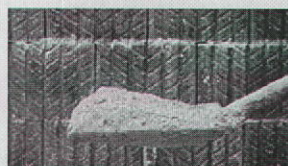


Image: Cement



Image: Sand

AUSTRAL BRICKS™

01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

Mortar Mixes

Mortar mixes are always specified as the proportion of cement to lime to sand. For example, a common mortar made from Portland cement has one part cement, to one part lime and 6 parts of sand is abbreviated C1:L1:S6 or 1:1:6 (the chief cementing agent will always be expressed as one).

The type of mortar mix is classified according to the New Zealand Standard NZS 4210 as either M2, M3 or M4. The grade chosen by the masonry designer should match the requirements of the design. NZS 4210 lists the deemed -to-satisfy proportions for the various grades, as given below:

Grade	Mix
M4	1 : 0.25 : 3
M3	1 : 0.5 : 4.5
M2	1 : 1 : 6

For a more detailed description of the masonry mixes, grades and their applications refer to NZS 4210 or to the Think Brick Manual 10: Construction Guidelines for Clay Masonry.

Coloured Mortar

Weathering and cleaning can adversely affect the colour of the mortar. Pigmented mortars must be strong enough to retain the pigment particles on the face of the joint. In weak mortars, the pigment particles may be rapidly eroded from the face of the joint by wind and rain.

Acid cleaning of brickwork may also degrade pigment colour, leading to faded, patchy and unattractive mortar joints. For durable pigmented mortar always finish the joint by tooling even when a raked joint is required.

Other Mortar Components

The Importance of Lime

The addition of lime to mortar has the advantage of making the mortar workable in the wet state and may eliminate the need for plasticiser admixtures. Mortar containing lime will be less pervious, more durable and more 'forgiving' than a mortar without lime. There is no substitute for the benefits of lime.

Admixtures

The additives permitted by New Zealand Standard (NZS 4210) include:

- plasticisers or workability agents, including air entraining agents complying with NZS 3113 or AS 1478
- cellulose type chemical water thickeners
- colouring mineral oxide pigments complying with NZS 3117
- set-retarding chemical agents complying with NZS 3113 or AS 1478.

Other admixtures cannot be used unless they have demonstrated compliance with NZS 4210.

BRICKLAYING PRACTICES

Wall Ties

Wall ties are used to connect the leaves of a cavity wall or to connect a masonry wall to a timber frame or steel stud. The failure of wall ties may result in the masonry falling during an earthquake or in high winds. It is essential that the wall ties are chosen for the design requirements, as specified in AS/NZS 2699.

The durability requirements of NZS4210 (as previously discussed in the durability section) should also be met when selecting the wall ties. For example, the classification R4 needs to be met by the wall ties in severe marine environments. In addition, the installation of the wall ties is critical to the integrity of the system.

The wall ties should be:

- installed that they are contained within the mortar bed, with a layer of mortar both above and below the tie
- installed so that they have an embedment length in the mortar joint of at least half the width of the veneer and that they have an end cover of not less than 15mm
- aligned correctly to prevent water transfer into the building
- placed at the required spacings.

Generally, spacing of wall ties should not exceed 600mm horizontally and 400mm vertically, whilst features such as openings, control joints and wall edges generally require spacings of less than 300mm. The spacing of the wall ties relies on the individual design. If located within a seismic area, wall ties need to meet design and minimum strength criteria set out in NZS 4210.

AUSTRAL BRICKS™

01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

New Zealand Standard NZS 4210 and Australian and New Zealand Standard AS/NZS 2699 should be referred to for more details on the design and installation of wall ties. A more detailed description of placement of wall ties is available in Think Brick Manual 10: Construction Guidelines for Clay Masonry.

Damp-Proof Courses (DPC)

Section E2 of the New Zealand Building Code (NZBC) requires damp-proof courses and flashing be used to prevent the movement of moisture vertically in the masonry and from the exterior of the building to the interior. In addition, the moisture from a cavity should be shed to the outer course by the damp-proof course. A good description of damp-proof courses is available in Think Brick Manual 10: Construction Guidelines for Clay Masonry.

It is important that the damp-proof course should not be bridged, thereby allowing moisture to travel above the DPC level. The DPC should be exposed out of the face of the brickwork to prevent any moisture paths up the brickwork.

Care should also be taken during the application of a render coating, to prevent the formation of a bridge. The DPC should also be considered during exterior landscaping.

Weep holes

A weep hole acts as a drain hole through the brick wall. Weep holes are created during the construction of the brick wall. Weep holes are normally in the first or second brick course above ground level. NZS 3604 states that weep holes need to be provided at 800mm maximum centers.

Weep holes are required at the head and sill flashing of windows over 800mm wide and are commonly used for smaller windows also. Think Brick Manual 10: Construction Guidelines for Clay Masonry provides descriptions of the different types of weep holes possible.

Prevention of Brickwork Stains

Good workmanship and correct storage of bricks during construction will ensure that a number of potential stains are avoided. In addition, the use of the correct cleaning methods will prevent further problems arising. It is also important that garden beds, paved, concrete or tiled areas should be below the level of the installed damp proof course and that they do not cover the weep holes in your brickwork.

Building any form of structure over your weepholes can restrict the drainage of moisture that penetrates your brickwork. Allowing moisture to enter the brickwork may result in efflorescence, as is discussed in Brick Manual 2: Brick Cleaning and Maintenance.

Two Storey Brick Veneer Construction

Austral Bricks™, in conjunction with other NZ brick manufacturers, have developed a BRANZ appraised two storey brick veneer system (Branz Appraisal Certificate No. 521). This system allows brick veneer cladding to be erected to a height greater than the maximum height specified by NZS 3604 of 4 meters.

This is achieved by incorporating a slip joint at an intermediate height in the wall. The slip joint effectively structurally separates the wall, allowing the top and bottom panels to move independently in the event of a major earthquake, thereby reducing the chance of structural damage of the veneer.

The Two Storey Brick Veneer System is a 70, 76, 80 or 90mm clay brick veneer external wall cladding system for two storey residential and light commercial type buildings where domestic construction techniques are used.

To view the appraisal online at the Austral Bricks™ website please visit this address:

<http://www.australbricks.com.au/nz/Technical-Information/Construction-Resources>

AUSTRAL BRICKS™

01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

FIRE RESISTANCE

Fire resistance levels (FRL) are specified in the New Zealand Building Code (NZBC). The FRL specifies the fire resistance periods (FRP) for structural adequacy, integrity and insulation. These components can be defined as:

- **Structural Adequacy** - The ability of a wall to continue to perform its structural function.
- **Integrity** - The ability of a wall to maintain its continuity and prevent the passage of flames and hot gases through cracks in the wall.
- **Insulation** - The ability of a wall to provide sufficient insulation, such that the side of the wall away from the fire does not exceed a predefined rise in temperature.

The fire resistance level is expressed in minutes and lists the three components in the same order as they are given above. For example, an FRL of 90/90/90 means a minimum fire resistance period of 90 minutes each for structural adequacy, integrity and insulation. FRLs are determined by testing in accordance with AS 1530.4.

The fire resistance level of a wall depends not only on the thickness of the wall but also on its height, length and boundary conditions (i.e. how it is connected to other building elements). For this reason, an FRL is given on a particular system - it is impossible to give a FRL for a particular brick.

Fire Test Results

Austral Bricks™, in association with BRANZ, has conducted two official tests on brick wall systems for fire resistance levels. These results can be referred to when fulfilling the requirements of the NZBC.

BRANZ test number: FP 3332

System: Non-load bearing 70mm clay brick wall	
Structural Adequacy:	241 minutes (no failure)
Integrity	241 minutes (no failure)
Insulation (with 5mm thick render):	79 minutes
Insulation (unrendered):	57 minutes

To view the full test report on the Austral Bricks™ website please visit this address:

http://www.australbricks.com.au/Products-Documents/Design-Manuals/fp3332_20071220100731

BRANZ test number: FR 3456

System: Load bearing, timber framed, plasterboard lined wall with 70mm slick brick veneer and 5mm render	
Structural Adequacy:	41 minutes
Integrity	41 minutes
Insulation	41 minutes (no failure)

System: Load bearing, timber framed, plasterboard lined wall with 70mm face brick veneer

Structural Adequacy:	41 minutes
Integrity	41 minutes
Insulation	41 minutes (no failure)

To view the full test report on the Austral Bricks™ website please visit this address:

http://www.australbricks.com.au/Products-Documents/Design-Manuals/fr3456_20071220100628

AUSTRAL BRICKS™

01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

APPENDIX 1: EXPOSURE ZONES

Exposure zones according to NZS 3604 are shown in the exposure zone maps below (Which can be found in NZS 3604 and NZS 4210). In addition to these it must be noted that:

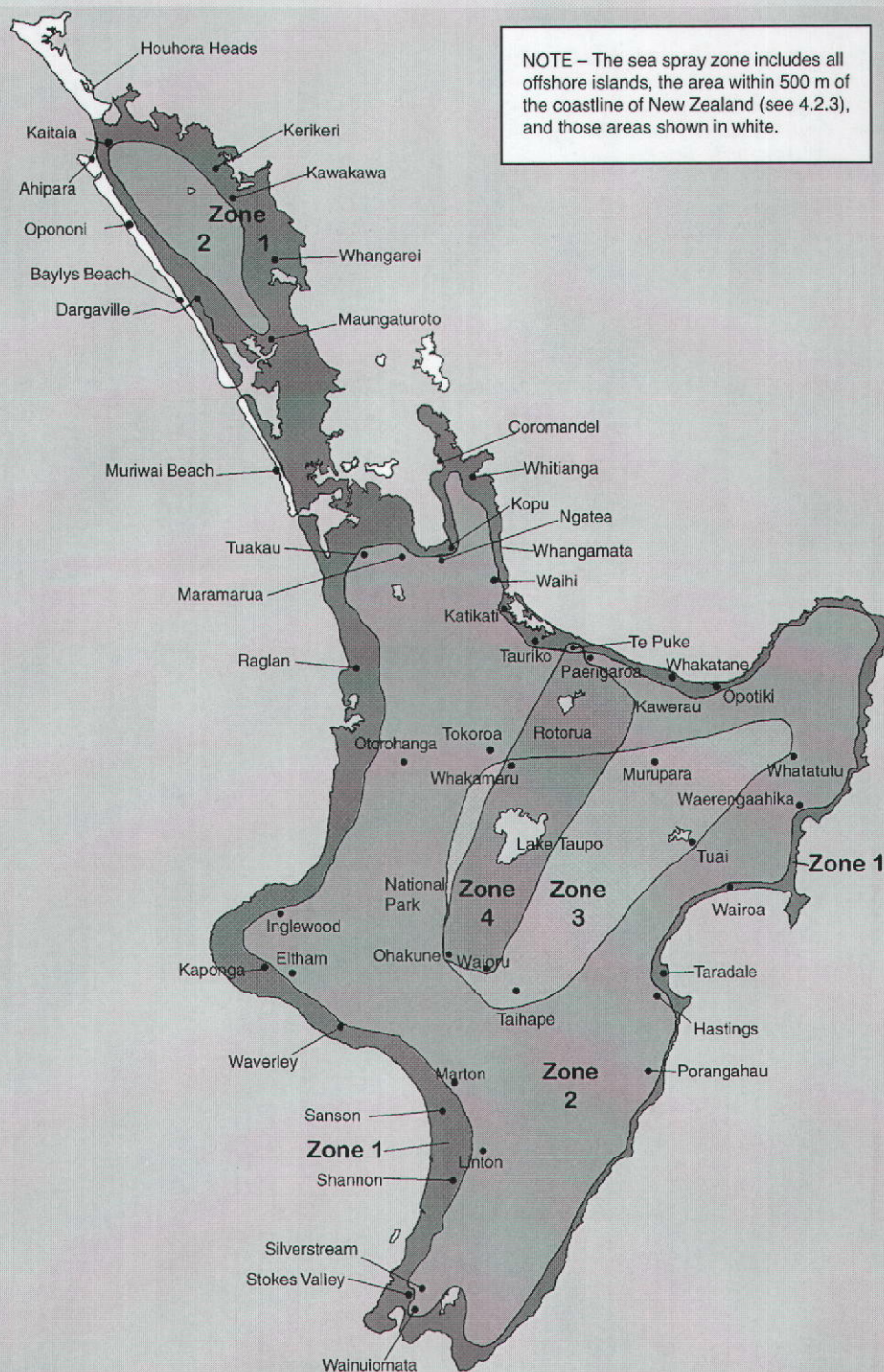
- Sea Spray zone is defined as areas within 500m from the sea including harbours, or 100m from tidal estuaries and sheltered inlets as well as the areas coloured white in the maps below. The sea spray zone also includes all offshore islands including Waiheke, Great Barrier, Stewart Island and the Chatham Islands.
- Geothermal Hotspots are mainly found in Zone 4, but may occur elsewhere.

AUSTRAL BRICKS™

01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

CORROSION ZONE MAP 1



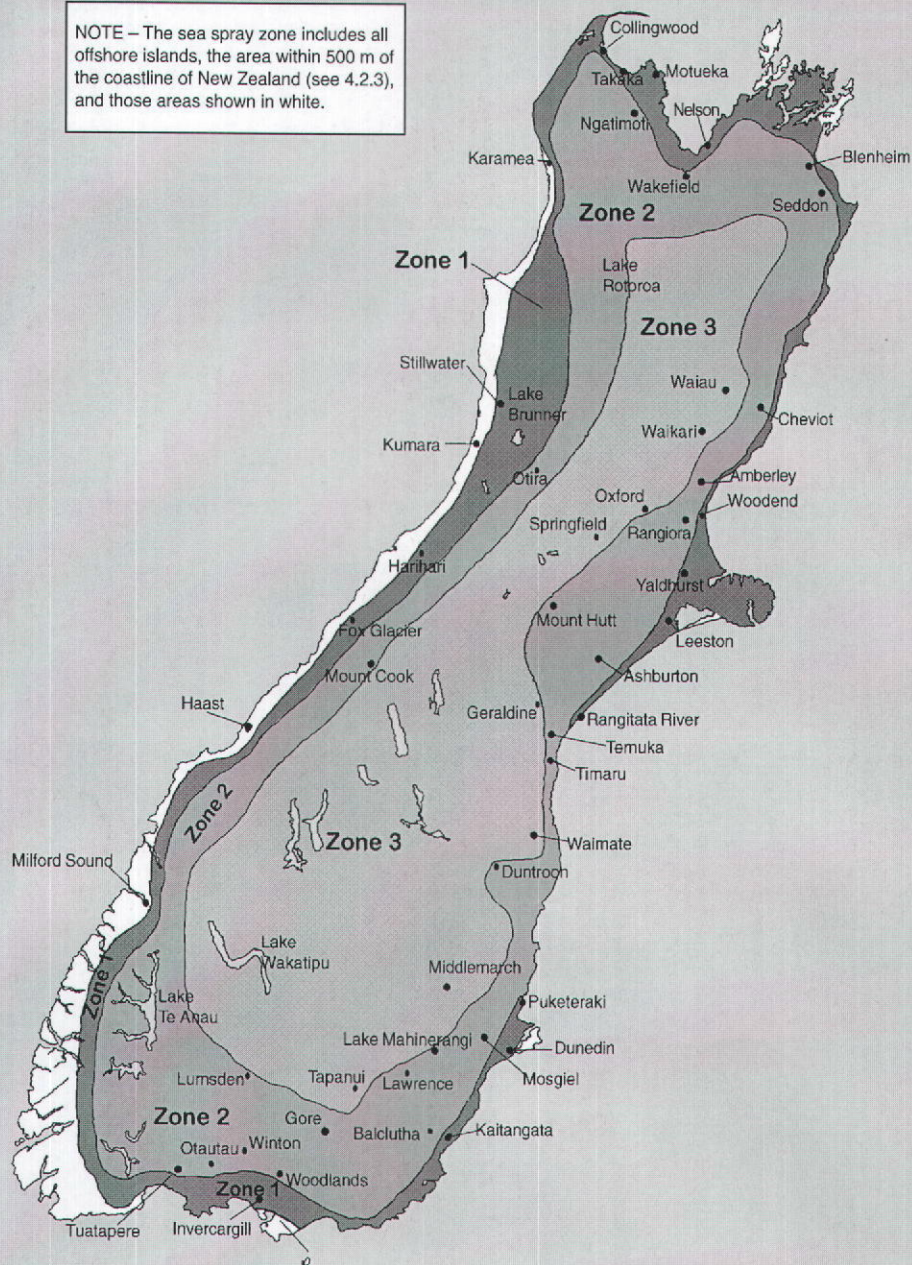
AUSTRAL BRICKS™

01. BRICK PROPERTIES AND BRICKLAYING PRACTICES

NEW ZEALAND EDITION

CORROSION ZONE MAP 2

NOTE – The sea spray zone includes all offshore islands, the area within 500 m of the coastline of New Zealand (see 4.2.3), and those areas shown in white.



Linea™
WEATHERBOARD

Technical Specification

December 2010 / New Zealand



James Hardie
a smarter way™

Contents

1	Application and scope	3	6	Jointing	8
1.1	Application	3	7	Finishing	8
1.2	Scope	3	7.1	Preparation and Priming	8
1.3	Details	3	7.2	Sealants	8
1.4	Specific Design	3	7.3	Painting	8
2	Design	3	8	Storage and handling	8
2.1	Compliance	3	9	Maintenance	8
2.2	Responsibility	3	10	Product information	9
2.3	Site and foundation	3	10.1	Manufacturing and Classification	9
2.4	Ground clearances	3	10.2	Trim	9
2.5	Moisture management	4	10.3	Durability	9
2.6	Structure	4	10.3.1	Resistance to Moisture/Rotting	9
2.7	Wind Loading	4	10.3.2	Resistance to Fire	9
2.8	Structural Bracing	4	10.3.3	Alpine Regions	9
2.9	Fire Rated Walls	4	10.4	Product Sizes and Mass	9
2.10	Energy Efficiency	4	10.5	Size and Weight	9
3	Framing	5	11	Safe working practices	10
3.1	General	5	12	Product sizes	11
3.2	Dimensions	5	13	Accessories	12
3.3	Timber Grade	5	14	Details	14
3.4	Durability	5	15	Warranty	42
3.5	Frame Construction	5			
3.5.1	Direct Fixed Construction Method	5			
3.5.2	Cavity Construction Method	5			
3.6	Tolerances	5			
4	Preparation	6			
4.1	Building Wrap	6			
4.2	Rigid Air Barrier	6			
4.3	Flashing	6			
4.4	Vent Strip	6			
4.5	Cavity Battens	6			
4.6	Intermediate Support	6			
4.7	Corners	6			
4.8	Junctions and Penetrations	6			
5	Fixing Linea™ Weatherboard	7			
5.1	General	7			
5.2	Fastener Durability	7			
5.3	Nail Sizes and Fixing Method	7			
5.4	Gun Nailing	8			

WE VALUE YOUR FEEDBACK

To continue with the development of our products and systems, we value your input. Please send any suggestions, including your name, contact details, and relevant sketches to:

Ask James Hardie™

Fax 0800 808 988

literaturefeedback@jameshardie.co.nz

1 Application and scope

1.1 APPLICATION

Linea™ Weatherboard is a 16mm thick, pre-primed bevel back fibre cement weatherboard and is classified as lightweight wall cladding suitable for residential and light commercial construction using timber framed external walls. Linea Weatherboard is available in 135mm, 150mm and 180mm widths.

James Hardie also has available:

- CLD® Fascia in two widths. CLD Fascia is a 16mm thick, pre-primed fibre cement product designed to accommodate James Hardie soffit linings.
- CLD® Trim comes in a variety of widths for use as decorative trims around openings and external corners. CLD Trim is a 16mm thick, pre-primed fibre cement product.

If you are a specifier

Or other responsible party for a project ensure that the information in this document is appropriate for the application you are planning and that you undertake specific design and detailing for areas which fall outside the scope of these specifications.

If you are an installer

Ensure that you follow the design, moisture management and associated figures and material selection provided by the designer and this James Hardie Technical Specification.

All the details provided in this document must be read in conjunction with the specifiers specification.

Make sure your information is up to date

When specifying or installing James Hardie products, ensure you have the current manual. If you're not sure you do, or, if you need more information, visit www.jameshardie.co.nz or Ask James Hardie on 0800 808 868.

1.2 SCOPE

This specification covers the use of Linea Weatherboard on buildings that fall within the scope limitations of New Zealand Building Code (NZBC) Acceptable Solution E2/AS1, Paragraph 1.1.

This specification includes the use of Linea Weatherboard in both direct to stud and cavity construction method and must be read in conjunction with the current BRANZ Appraisals for Linea Weatherboard.

This specification also covers the use of Linea Weatherboard in cavity construction for specific design projects (SED) subject to a wind pressure of 2.5kPa (ULS) maximum. This document is intended for use by architects, designers, specifiers or builders who are involved in specifying Linea Weatherboard. The document also serves the purpose of an installation manual for this product.

1.3 DETAILS

Various Linea Weatherboard details are provided in the Details section of this document. This specification and details in CAD file are also available to download from our website at www.jameshardie.co.nz.

1.4 SPECIFIC DESIGN

For use of Linea Weatherboard outside this published scope, the architect, designer or engineer must undertake specific design.

For advice on designs outside the scope of this specification, Ask James Hardie on 0800 808 868.

2 Design

2.1 COMPLIANCE

Linea Weatherboard direct fixed and cavity cladding has been issued a CodeMark certificate number GM-10-30018 which confirms Linea Weatherboard is deemed to comply with the requirements of NZBC. Please refer to our website www.jameshardie.co.nz for a copy of the CodeMark certificate.

Linea Weatherboard also has a BRANZ Appraisal number 446 (2010) and 447 (2010) at www.branz.co.nz or www.jameshardie.co.nz



2.2 RESPONSIBILITY

The specifier or other party responsible for the project must ensure that the information and details in this specification are appropriate for the intended application and that additional detailing is performed for specific design or any areas that fall outside the scope of this technical specification. For applications outside the scope of this literature and figures which are not provided herein, the architect, designer or engineer must undertake specific design and it should be ensured that the intent of their design meets the requirements of the NZBC.

All dimensions shown are in millimetres unless noted otherwise. All New Zealand Standards referenced in this manual are current edition and must be complied with.

James Hardie conducts stringent quality checks to ensure that any product manufactured falls within our quality spectrum. It is the responsibility of the builder to ensure that the product meets aesthetic requirements before installation. James Hardie will not be responsible for rectifying obvious aesthetic surface variations following installation.

2.3 SITE AND FOUNDATION

The site on which the building is situated must comply with the NZBC Acceptable Solution E1/AS1 'Surface Water'. Foundation design must comply with the requirements of NZS 3604 'Timber Framed Buildings' or be as per specific engineering design. The grade of adjacent finished ground must slope away from the building to avoid any possibility of water accumulation in accordance with NZBC requirements.

2.4 GROUND CLEARANCES

The floor and bottom edge of cladding must have a minimum clearance to paved or unprotected ground as required by NZBC Acceptable Solution E2/AS1 Table 18 and section 9.1.3.

Linea Weatherboards must overhang the bottom plate on a concrete slab by a minimum of 50mm as required by NZBC Acceptable Solution, E2/AS1 Table 18.

On the roofs and decks the minimum clearance must be 50mm.

Do not install external cladding such that it may remain in contact with water or ground.

2.5 MOISTURE MANAGEMENT

It is the responsibility of the specifier to identify moisture related risks associated with any particular building design.

Wall construction design must effectively manage moisture, considering both the interior and exterior environments of the building, particularly in buildings that have a higher risk of wind driven rain penetration or that are artificially heated or cooled. Walls shall include those provisions as required by NZBC Acceptable Solution E2/AS1 'External Moisture'. In addition, all wall openings, penetrations, junctions, connections, window sills, heads and jambs must incorporate appropriate flashings for waterproofing. The other materials, components and installation methods used to manage moisture in the walls, must comply with the requirements of relevant standards and the NZBC. For information in relation to designing for weathertightness, refer to BRANZ and the Department of Building and Housing (DBH) updates on the following websites, respectively www.branz.co.nz and www.dbh.govt.nz.

2.6 STRUCTURE

Timber framing must comply with NZS 3604 for buildings or parts of buildings within the scope limitations of NZS 3604. Buildings or parts of buildings outside the scope of NZS 3604 must be to a specific engineering design in accordance with NZS 3603 and AS/NZS 1170. Where specific engineering design is required, the framing stiffness must be equivalent to or more than the framing provisions of NZS 3604. In all cases stud spacing must not exceed 600mm centres maximum for buildings designed to NZS 3604 and 400mm centres maximum for specific engineering design buildings subject to design wind pressures higher than 1.5kPa.

2.7 WIND LOADING

Linea Weatherboard cladding is suitable for use in all wind zones as defined in NZS 3604 and is also suitable for use in SED wind pressures up to 2.5kPa (uls).

For wind pressures higher than those mentioned above, contact James Hardie at 0800 808 868 for assistance.

2.8 STRUCTURAL BRACING

Linea Weatherboard installed as per Linea Weatherboard specific bracing details will provide bracing for buildings designed and constructed in accordance with NZS 3604. The Linea Weatherboard bracing systems have been independently tested by BRANZ using both construction methods i.e. direct fixed and cavity construction. The following range of bracings can be achieved

- Wind 68 – 120BU'S
- Earthquake 60 – 105 BU'S

Refer to the James Hardie Bracing Design Manual for details.

2.9 FIRE RATED WALLS

Walls clad with Linea Weatherboard using a direct fix or cavity construction method can achieve fire ratings of up to 90/90/90 when constructed in accordance with the James Hardie 'Fire and Acoustic' Design Manual. Linea Weatherboard must be face fixed for Fire Rated applications.

Refer to Fire and Acoustic Design Manual for further information about fire rated systems.

2.10 ENERGY EFFICIENCY

External walls constructed using Linea Weatherboard, and bulk insulation, where the area of glazing is 30% or less of the total wall area and constructed as per this technical specification complies with the requirements for walls in NZBC Acceptable Solution H1/AS1 (NZBC Clause H1 Energy Efficiency), Replacement Table 1. To meet the minimum thermal insulation requirements for the construction, the bulk insulation as specified in Table 1 must be used. This insulation may be substituted with insulation material having higher R-values. The thermal insulation of a wall is affected when the depth of the timber framing is increased or decreased or stud spacing is decreased. The calculation used in Table 1 is based on a timber framing size 90 x 45mm and an internal lining material such as James Hardie Villaboard® Lining or a 10mm plasterboard.

Table 1

Insulation capability		
CLIMATE ZONE	CONSTRUCTION R-VALUE REQUIREMENT	MINIMUM R-VALUE OF INSULATION REQUIRED
1 and 2	1.9 m ² °C/W	#R2.0
3	2.0 m ² °C/W	#R2.2

Total construction R-Value depends on the insulation material used and the framing ratio. The insulation material R-Values specified in this table are for studs spaced at 600mm c/c and nogs spaced at 800mm c/c.

To achieve higher construction R-Values the wall insulation material must be replaced with an insulation material having higher R-Values to suit the requirements.

For further guidance on insulation requirement refer to current edition of 'House Insulation Guide' published by BRANZ.

3 Framing

3.1 GENERAL

This Linea Weatherboard technical specification is only suitable for timber-framed buildings. Other framing materials are outside the scope of this specification.

3.2 DIMENSIONS

A 35mm minimum stud width is required unless noted otherwise in this specification.

3.3 TIMBER GRADE

Timber must be graded in accordance with NZS 3631 'New Zealand Timber Grading Rules'. The timber grade to be used must be in accordance with NZS 3604 requirements.

3.4 DURABILITY

To comply with NZBC requirements the external framing must be treated to a minimum H1.2 treatment. Refer to NZBC Acceptable Solution B2/AS1 Durability for further information about the durability requirements. For timber treatment information refer to NZS 3602 (Timber and Wood-Based Products for use in Buildings) and NZS 3640 (Chemical Preservation of Round and Sawn Timber) for minimum timber treatment selection and treatment requirements. Also refer to framing manufacturer's literature for further guidance on timber selection.

Framing must be protected from moisture at sites in accordance with the recommendations of framing manufacturers.

Note: refer to NZS 3602 for information about the allowable moisture content in timber.

3.5 FRAME CONSTRUCTION

For buildings within the scope of NZS 3604 the framing sizes and set-out must comply with NZS 3604 with stud, nog / dwang centres as required by this specification.

3.5.1 DIRECT FIXED CONSTRUCTION METHOD

The following framing must be provided for direct fixed construction method:

- Studs must be provided at 600mm centres maximum.
- Nogs must be provided at 1200mm centres maximum.

- Double studs are required at internal corners.
- Extra packers may be required at external corners.
- Extra studs are required for aluminium internal corner sections.

3.5.2 CAVITY CONSTRUCTION METHOD

The following framing must be provided for cavity construction method:

- When studs are at 600mm centres the nogs must be provided at 800mm centres maximum.
- When studs are at 400mm centres the nogs may be provided at 1200mm centres maximum.
- Double studs are required at internal corners.
- Extra packers may be required at external corners.
- Extra studs are required for aluminium internal corner sections.

3.5.3 SPECIFIC ENGINEERING DESIGN (SED)

For specific engineering design projects the timber framing is required to be designed in accordance with NZS 3603 and AS/NZS 1170. The minimum framing sizes and layout must comply with this specification.

- Study spacing 400mm centres maximum
- Nog spacing 1200mm centres maximum
- Other requirements as per 3.5.2 above

3.6 TOLERANCES

In order to achieve an acceptable wall finish, it is imperative that framing is straight and true. Framing tolerances must comply with the requirements of NZS 3604. All framing must be made flush.

4 Preparation

4.1 BUILDING WRAP OR HOMERAB PRECLAD LINING

Building wrap must be provided as per the requirements of NZBC Acceptable Solution E2/AS1 'External Moisture' Table 23. The building wrap must be fixed in accordance with E2/AS1 and the wrap manufacturer's recommendations. Walls which are not lined on the inside face e.g. garage walls or gable ends must include a rigid sheathing or an air barrier behind the cladding which complies with the requirements of NZBC Acceptable Solution E2/AS1 Table 23. HomeRAB PreClad Lining is suitable for use in these applications. It must be installed in accordance with James Hardie Rigid Air Barriers installation manual.

4.2 RIGID AIR BARRIER

For specific engineering design (SED) projects where the design wind pressures are between 1.5kPa (uls) and 2.5kPa (uls), RAB Board (6mm) must be used. Refer to James Hardie Rigid Air Barriers installation manual for information regarding its installation.

4.3 FLASHING

All wall openings, penetrations, intersections, connections, window sills, heads and jambs must be flashed prior to weatherboard installation. Please refer to moisture management requirements in Clause 2.5. The building wrap must be appropriately incorporated with penetration and junction flashings. Materials must be lapped in such a way that water tracks down to the exterior on the face of building wrap. James Hardie will assume no responsibility for water infiltration within the wall due to poor installation of flashings or building wraps. The selected flashing materials must comply with the durability requirements of Table 20 of NZBC Acceptable Solution E2/AS1.

4.4 VENT STRIP

The James Hardie uPVC cavity vent strip must be installed at the bottom of all walls constructed using the drained and ventilated cavity construction method. James Hardie uPVC vent strip has an opening area of 1000mm²/m length. It is important that the openings in the vent strip are kept clear and unobstructed to allow free drainage and ventilation of cavities.

4.5 CAVITY BATTENS

Buildings with a risk score of 13-20 calculated in accordance with NZBC Acceptable Solution E2/AS1 Table 2 require Linea Weatherboards to be installed on a cavity.

The cavity battens provide airspace between the frame and cladding and are considered a "packer" only in this specification. The timber battens must be minimum H3.1 treated in accordance with NZS 3640 (Chemical preservation of Round and sawn timber) to comply with the durability requirements of B2/AS1.

Cavity battens must comply with E2/AS1 and:

- be minimum 18mm thick.

- be minimum as wide as the width of studs.
- be fixed by the cladding fixings to the main framing through the building wrap.
- until claddings are fixed the battens need only to be tacked to framing.

(Batten fixing is required temporarily to keep them straight on the wall during construction.)

The cavity battens are installed as described below:

- Fix cavity battens to studs at maximum 600mm centres.
- Battens should be fixed with 40 x 2.8mm nails at 800mm centres maximum.

4.6 INTERMEDIATE SUPPORT

Where studs are at 600mm centres an intermediate means of restraining the building wrap and insulation from bulging into the cavity shall be installed. An acceptable method to achieve this is using one of the following:

- intermediate cavity batten between the studs.
- 75 mm galvanized mesh.
- polypropylene tape.

No intermediate supports are required:

- where studs are at 400mm centres; or,
- when rigid sheathings instead of building wraps are used.

4.7 CORNERS

Anticipated joist shrinkage must be allowed for in the design process. Do not run trims or aluminium extrusions continuously across solid floor joists. There are a number of options to select from when detailing external corners:

- 90° corner soaker in aluminium, copper or stainless steel. Refer to Figures 7 and 32.
- Box corners using CLD® Trim. Refer to Figures 3, 4 and 29.
- Mitred corners to weatherboards. Refer to Figures 5 and 30.
- Aluminium boxed corners. Refer to Figures 6 and 31.

There are a number of options to select from when detailing internal corners:

- Scribed corner. Refer to Figures 8 and 33.
- 90° or 135° Aluminium W-mould. Refer to Figures 9, 10, 34 and 35.

4.8 JUNCTIONS AND PENETRATIONS

Refer to Clause 2.5 of this specification for moisture management requirements. All windows and doors must be detailed as per the requirements of this specification. James Hardie has developed the window details for Linea Weatherboards which meet the requirements of E2 'External Moisture', an approved document of the NZBC. Refer to Figures 11 to 24 and 36 to 53.

5 Fixing Linea Weatherboard

5.1 GENERAL

The horizontal lap of Linea Weatherboards must be 30mm minimum. Linea Weatherboards must be kept dry whilst in storage prior to and during fixing. Cut ends which are exposed after installation or where sealant is applied to the boards such as slimline box corners, internal corners, mitred external corners etc, must be primed prior to installation. Dust and loose material must be removed before priming.

An H3.1 treated timber cant strip must be provided to support the bottom board on the wall. Refer to Figure 1 and Figure 26.

5.2 FASTENER DURABILITY

Fasteners must meet the minimum durability requirements of the NZBC. NZS 3604 specifies the requirements for fixings material to be used in relation to the exposure conditions and are summarised in Table 2.

Table 2

Exposure conditions and nail selection prescribed by NZS 3604

NAIL MATERIAL		
Sea Spray Zones *	Zone 1 outside sea spray zone and Zones 2 – 4 and Geothermal hot spots	Bracing — All zones
Grade 316 Stainless	Hot-dipped galvanised or 316 stainless	Grade 316 stainless

**(Zone 1 areas where local knowledge dictates that increased durability is required, appropriate selection shall be made)*

Also refer to NZBC Acceptable Solution 'E2/AS1' Table 20 and 21 for information regarding the selection of suitable fixing materials and their compatibility with other materials.

5.3 NAIL SIZE AND FIXING METHOD

Linea Weatherboards and CLD Trim must be fixed to timber with the types of nails specified in Tables 3 and 4, in accordance with the following requirements:

- Linea Weatherboard can either be face/exposed fixed or concealed fixed.
- Linea Weatherboard must be fixed into studs at maximum 600mm centres. Fixing centres to coincide with stud spacing. Refer to Figure 2 and 28.
- All concealed nails must be driven flush with the board surface.
- When concealed fixing Linea Weatherboards, nails must be driven under the lap of boards, except at all corners and vertical edges of openings where Linea Weatherboards must be face fixed. Refer to Figure 2 and Figure 28.
- Nails must be fixed 25mm from the end of the board when hand nailing. For gun nailing refer to Section 5.4.

- When using concealed fixing method, any gaps that may appear under the lap due to site conditions can be minimised by fixing a jolt head nail as per the face fixing method in the affected area.
- When using concealed fixing method, Linea Weatherboard can also be tied together by face fixing through the lap using 32mm brad nails if desired.

Table 3

Nail requirements for Linea Weatherboards

DIRECT TO STUD FIXING	
Concealed Nailing	
40 x 2.8mm HardieFlex™ nails	Finish flush with the board surface
Face Nailing	
60 x 3.15mm jolt head nails	Hot-dipped galvanised may require pre-drilling through the top weatherboard Stainless steel jolt heads will require pre-drilling* of the top weatherboard.
CAVITY FIXING	
Concealed Nailing	
60 x 3.15mm HardieFlex™ nails	Finish flush with the board surface
Face Nailing	
75 x 3.15mm jolt head nails	Hot-dipped galvanised may require pre-drilling through the top weatherboard Stainless steel jolt heads will require pre-drilling* of the top weatherboard.
SED Projects (1.5kPa - 2.5kPa Wind Pressure)	
90 x 4.0mm jolt head nail	Hot-dipped galvanised. Pre-drill before fixing. Stainless steel ring shank nail. Pre-drill before fixing.

Table 4

Nail requirements for trim

Single Thickness	60mm jolt head nails. If fixing over Linea Weatherboard use predrilled* 75 x 3.15mm jolt head nails.
Double Thickness	60mm jolt head nails.
Single plus packer	If fixing over Linea Weatherboard use 75 x 3.15mm jolt head nails through a pre-drilled* hole. When fixing to timber support use 60mm jolt head nails.

* Use a 3.0mm drill bit

Note: Special fixing arrangements are required for bracing and fire-resistance rated wall systems. For more information Ask James Hardie on 0800 808 868.

5.4 GUN NAILING

Linea Weatherboard can also be gun-nailed when concealed fixing method is used.

- Gun-nailing must not be used when Linea Weatherboard is used for bracing.
- Nails must be no closer than 50mm from the ends of boards when gun nailing is used — double studs will be required.
- Be minimum length and gauge as per Table 3.

6 Jointing

The ends of Linea Weatherboards are jointed off-stud by means of a tongue and groove joint. Tongue and groove joints may be located centrally between studs but no closer than 100mm from the edge of a stud. The joints must be staggered by 600mm minimum. Sealant must be provided in the tongue and groove joint.

7 Finishing

Note: Protective coating of Linea Weatherboard and CLD Trim is required in order to meet the durability requirements of the NZBC.

7.1 PREPARATION AND PRIMING

The Linea Weatherboard and CLD Trim must be dry before painting. Punch and fill all exposed nails a maximum of 2mm below the surface. Fill the hole with an exterior grade builders fill, allow to cure and sand smooth ready for priming. Prime the filled holes in accordance with paint manufacturer's specifications.

7.2 SEALANTS

All sealants must demonstrate the ability to meet the relevant requirements of the NZBC and hold a current BRANZ Appraisal. Application and use of sealants must comply with manufacturer's instructions. Sealants, if coated, must be compatible with the paint system.

7.3 PAINTING

All Linea Weatherboards are pre-primed on their face and bottom edge with a factory applied acrylic base coat.

Linea Weatherboard must be painted within 90 days of installation. There is no restriction on the LRV of paint to be applied on the Linea Weatherboard. All exposed faces, including the top edges under the sills and bottom edges of Linea Weatherboard, Trim and accessories must be finished with latex exterior paint system complying with any of parts 7, 8, 9, and 10 of AS 3730.

Dark coloured paints can be used on Linea Weatherboard and Trim. The dark colours in certain environments may fade over a period of time. Special paints/coatings are required in certain harsh environments.

8 Storage and handling

Paint selection and the preparation required is dependant on paint chosen. Refer to the paint manufacturer for information before starting painting.

Linea Weatherboards and CLD Trim must be laid flat on a smooth level surface. To ensure optimum performance, store weatherboards under cover and keep dry prior to fixing. If the weatherboards should become wet, allow to dry thoroughly before fixing. Do not carry weatherboards on the flat, carry in the vertical position to avoid excessive bending.

9 Maintenance

It is the responsibility of the specifier to determine normal maintenance requirements to comply with NZBC Acceptable Solution B2/AS1. The extent and nature of maintenance will depend on the geographical location and exposure of the building. As a guide, it is recommended that basic normal maintenance tasks shall include but not be limited to:

- Washing down exterior surfaces every 6-12 months*,
- Re-applying exterior protective finishes**,
- Maintaining the exterior envelope and connections including joints, penetrations, flashings and sealants,
- Cleaning out gutters, blocked pipes and overflows as required,
- Pruning back vegetation close to or touching the building,
- The clearances between the bottom edge of Linea Weatherboard and the finished/unfinished ground must always be maintained.

**Do not use a water blaster to wash down the cladding.*

***Refer to your paint manufacturer for washing down and recoating requirements related to paint performance.*

10 Product information

10.1 MANUFACTURING AND CLASSIFICATION

James Hardie New Zealand is an ISO 9001 Telarc certified manufacturer. Linea Weatherboard and CLD Trim are manufactured to meet the requirements of AS/NZS 2908.2: 2000 'Cellulose-Cement Products'. Linea Weatherboard has a classification of Type A Category 3 in accordance with this Standard. Linea Weatherboard is a reduced density cellulose cement formulation incorporating James Hardie patented CLD® (Ceramic Low Density) technology.

Linea Weatherboard has a bevel back and tongue and groove at the ends for jointing. The bottom front edge of Linea Weatherboard is chamfered. The weatherboards are supplied pre-primed on their face and bottom edge with an acrylic primer.

Linea Weatherboards and CLD Trim are identified by the printing at regular intervals of the name LINEA on the back face.

10.2 JAMES HARDIE TRIM

The CLD Trim, used for box corners, around windows and doors as well as special architectural features, is also made with the CLD technology and is supplied pre-primed with an acrylic primer.

10.3 DURABILITY

Linea Weatherboard and Trim, when installed and maintained as per the technical specification, will meet the durability requirements for claddings as required in the NZBC Approved Document B2 'Durability'.

10.3.1 RESISTANCE TO MOISTURE/ROTTING

Linea Weatherboard and CLD Trim have demonstrated resistance to permanent moisture-induced deterioration (rotting) and has passed the following tests in accordance with AS/NZS 2908.2:

- Water Permeability (Clause 8.2.2)
- Warm Water (Clause 8.2.4)
- Heat Rain (Clause 6.5)
- Soak Dry (Clause 8.2.5).

10.3.2 RESISTANCE TO FIRE

Linea Weatherboard and CLD Trim has the following Early Fire Hazard Indices (tested to AS 1530 Part 3).

Table 5

Early fire hazard indices	
Flammability (FI)	0
Spread of Flame Index (SFD)	0
Heat evolved index	0
Smoke developed index (SDI)	0 - 1

10.3.3 ALPINE REGIONS

In regions subject to freeze/thaw conditions, Linea Weatherboard must not be in direct contact with snow or ice build up for extended periods, e.g. external walls in alpine regions subject to snow drifts over winter.

The Linea Weatherboard has been tested in accordance with AS/NZS 2908.2 Clause 8.2.3.

10.4 PRODUCT SIZES AND MASS

Available sizes of Linea Weatherboard and CLD Trim and its weight are given in Table 6.

10.5 SIZE AND WEIGHT

Linea Weatherboard is categorised as a Light Weight Wall Cladding as described in NZS 3604. Physical properties of Linea Weatherboard and CLD Trim are provided in Table 6.

11 Safe working practices

WARNING — DO NOT BREATHE DUST AND CUT ONLY IN WELL VENTILATED AREA

James Hardie products contain respirable crystalline silica which is considered by some international authorities to be a cause of cancer from some occupational sources. Breathing excessive amounts of respirable silica dust can also cause a disabling and potentially fatal lung disease called silicosis, and has been linked with other diseases. Some studies suggest smoking may increase these risks. During installation or handling: (1) work in outdoor areas with ample ventilation; (2) minimise dust when cutting by using either 'Score and Snap' knife, fibre cement shears or, where not feasible, use a HardieBlade™ Saw Blade and dust-reducing circular saw attached to a HEPA vacuum; (3) warn others in the immediate area to avoid breathing dust; (4) wear a properly-fitted, approved dust mask or respirator (e.g. P1 or P2) in accordance with applicable government regulations and manufacturer instructions to further limit respirable silica exposures. During clean-up, use HEPA vacuums or wet cleanup methods — never dry sweep. For further information, refer to our installation instructions and Material Safety Data Sheets available at www.jameshardie.co.nz.

Failure to adhere to our warnings, material safety data sheets, and installation instructions may lead to serious personal injury or death.

James Hardie recommended safe working practices

CUTTING OUTDOORS

- Position cutting station so that wind will blow dust away from user or others in working area.
- Use a dust reducing circular saw equipped with HardieBlade™ Saw Blade and HEPA vacuum extraction.

DRILLING/OTHER MACHINING

When drilling or machining you should always wear a P1 or P2 dust mask and warn others in the immediate area.

IMPORTANT NOTES

1. NEVER use a power saw indoors
3. NEVER use a circular saw blade that does not carry the HardieBlade™ logo
4. NEVER dry sweep — Use wet suppression or HEPA Vacuum
5. NEVER use grinders
6. ALWAYS follow tool manufacturer's safety recommendations

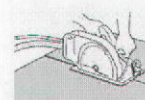
P1 or P2 respirators can be used in conjunction with above cutting practices to further reduce dust exposures. Additional exposure information is available at www.jameshardie.co.nz to help you determine the most appropriate cutting method for your job requirements. If concern still exists about exposure levels or you do not comply with the above practices, you should always consult a qualified industrial hygienist or contact James Hardie for further information.

WORKING INSTRUCTIONS

Refer to Recommended Safe Working Practices before starting any cutting or machining of product.

HARDIEBLADE™ SAW BLADE

The HardieBlade™ Saw Blade used with a dust-reducing saw connected to a HEPA vacuum is ideal for fast, clean cutting of James Hardie fibre cement products. A dust-reducing saw uses a dust deflector or a dust collector connected to a vacuum system. When sawing, clamp a straight-edge to the sheet as a guide and run the saw base plate along the straight edge when making the cut.



HOLE-FORMING

For smooth clean cut circular holes:

Mark the centre of the hole on the sheet.
Pre-drill a 'pilot' hole.

Using the pilot hole as a guide, cut the hole to the appropriate diameter with a hole saw fitted to a heavy duty electric drill.

For irregular holes:

Small rectangular or circular holes can be cut by drilling a series of small holes around the perimeter of the hole then tapping out the waste piece from the sheet face.



Tap carefully to avoid damage to sheets, ensuring that the sheet edges are properly supported.

STORAGE AND HANDLING

All James Hardie building products should be stored to avoid damage, with edges and corners of the sheets protected from chipping.

James Hardie building products must be installed in a dry state and be protected from rain during transport and storage. The product must be laid flat under cover on a smooth level surface clear of the ground to avoid exposure to water or moisture, etc.

QUALITY

James Hardie conducts stringent quality checks to ensure that any product manufactured falls within our quality spectrum. It is the responsibility of the builder to ensure that the product meets aesthetic requirements before installation. James Hardie will not be responsible for rectifying obvious aesthetic surface variations following installation.

12 Product sizes

Table 6

Linea Weatherboard and trim sizes

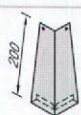
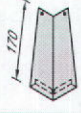
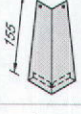
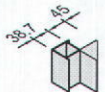
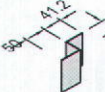
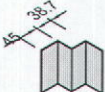
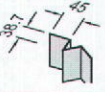


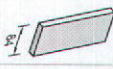
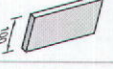



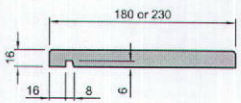
Product	Length (mm)	Width (mm)	Thickness (mm)	End Details	Effective Cover (mm)	COVERAGE INFORMATION			
						No. of planks/ metre height (approx.)	Mass kg/lineal m (approx. at EMC)	Mass kg/m ² (approx. at EMC)	Weight/ packs (60 units/ pack)
135 Linea Weatherboard	4200*	135	16	T & G	105	9.5	2.62	24.93	660.00
150 Linea Weatherboard	4200*	150	16	T & G	120	8.3	3.1	25.70	781.00
180 Linea Weatherboard	4200*	180	16	T & G	150	6.7	3.57	23.92	899.00
84mm CLD Trim	2600	84	16	Square	N/A	N/A	1.6	N/A	N/A
100mm CLD Trim	2600	100	16	Square	N/A	N/A	1.9	N/A	N/A

*Length is 4200mm plus 5mm for the tongue and groove making overall length 4205mm

*The effective thickness of finished Linea Weatherboard on the wall at the lap is approximately 33 to 35mm

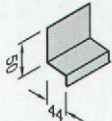
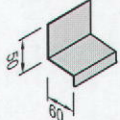















13 Accessories

Accessories/Tools supplied by James Hardie

	ACCESSORY AND MATERIAL NUMBER	SIZE (MM)	MATERIAL / APPEARANCE
	External corner soaker 90° for 180mm weatherboards <ul style="list-style-type: none"> Aluminium 301186 Copper 301188 Stainless Steel 301197 	200 long	Self colour
	External corner soaker 135° for 180mm Linea weatherboards <ul style="list-style-type: none"> Aluminium 301178 	200 long	Self colour
	External corner soaker 90° for 150mm weatherboards <ul style="list-style-type: none"> Aluminium 302820 Stainless Steel 302821 	170 long	Self colour
	External corner soaker 90° for 135mm weatherboards <ul style="list-style-type: none"> Aluminium 301185 Stainless Steel 301196 	155 long	Self colour
	External Slimline Box Corner Mould 301195	2700 long	Etch Primed Aluminium
	Box Corner 'Z' Flashing 301203	2700 long	uPVC Grey
	Internal 'W' Mould 90° 301184	2700 long	Etch Primed Aluminium
	Internal 'W' Mould 135° 301183	2700 long	Etch Primed Aluminium
	Vent Strip 302490	3000 long	uPVC White
	JH Corner Under Flashing 50 x 50 303745	3000 long	uPVC White
	CLD Trim 16mm 401943	84 x 2600 long	Fibre Cement primed
	CLD Trim 16mm 401930	100 x 2600 long	Fibre Cement primed
	HardieFlex™ nail - 5kg 302782	60 x 3.15mm	316 Stainless Steel
	HardieFlex™ nail - 5kg 302784	60 x 3.15mm	Hot Dip Galvanised
	HardieBlade™ Saw Blade 300660	4 tooth - 184mm	Diamond Tipped
	CLD Fascia - 180mm - 230mm 401843 402230	4200 long	Fibre cement Primed

Accessories not supplied by James Hardie

James Hardie recommends the following products for use in conjunction with its Linea Weatherboard and CLD Trim. James Hardie does not supply these products. There may also be some other accessories required depending upon the application. Please contact component manufacturer for information on their warranties and further information on their products.

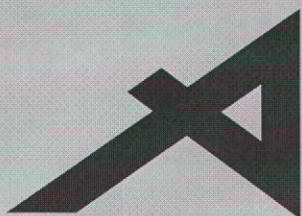
	ACCESSORY AND MATERIAL NUMBER	SIZE (MM)	MATERIAL/APPEARANCE
	Head Flashing for Direct Fixed without CLD Trim facings	To suit	Etch Primed Aluminium/ Powder Coated
	Head Flashing for Direct Fixed with CLD Trim facings	To suit	Etch Primed Aluminium/ Powder Coated
	HardieFlex™ nail	40 x 2.8mm	316 Stainless Steel
	HardieFlex™ nail	40 x 2.8mm	Hot Dip Galvanised
	Flexible Sealant or Expandable foam	Tube	Fosroc, Holdfast
	PEF Rod	Polyethylene foam	Fosroc or similar
	Flashing Tape	Proprietary tape to adhere to building wrap	Tyvek, Protecto wrap or similar
	Flashing material as per Table 20, 'E2/AS1'		Flashing Fabricator
	Jolt Head Nail - Hot Dip Galvanised or 316 Stainless Steel	50 x 2.8mm 60 x 3.15mm 75 x 3.15mm 90 x 4.0mm	Self colour
	Planted Sill	As shown	H3.1 Treated Timber Timber Merchant or cut on site
	Titanium Coated High Speed Drill Bit	3.0mm	
	Timber Scriber	As required	H3.1 Treated Timber Timber Merchant or cut on site
	Fibre Cement Cutting Blade	254mm	Diamond Tipped
	Fibre Cement Cutting Blade	305mm	Diamond Tipped
	Electra Meter Box Refer Electrical Suppliers		
	Cant Strip Redway Developments 03 358 5775 Predrill the weatherboards when fixing using Redway Development Cant/Vent Strips	To suit	uPVC
	Inseal 3109 Sealing Strip	5 x 3mm x 25mm	Black compressible foam

14 Details

Various details outlined in the following table are available on Pages 15 to 40.

Table 7

Details				
DESCRIPTION	DIRECT FIXED		CAVITY CONSTRUCTION	
	FIGURE	PAGE	FIGURE	PAGE
Foundation Detail and Soffit Detail	Figure 1	15		
Weatherboard Fixing	Figure 2	15	Figure 30	27
Boxed Corner	Figure 3 and 4	16	Figure 31	28
Mitre Corner	Figure 5	17	Figure 32	28
Aluminium Box Corner	Figure 6	17	Figure 33	28
External Corner Soaker	Figure 7	18	Figure 34	29
Internal Corner	Figure 8	18	Figure 35	29
Internal 135° Aluminium 'W' Mould Corner	Figure 9	19	Figure 36	30
Internal 90° Aluminium 'W' Mould Corner	Figure 10	19	Figure 37	30
Window Sill with Facings	Figure 11	19	Figure 39	31
Window Sill with Support Bar and Facings	Figure 12	20		
Window Head with Facings	Figure 13	20	Figure 40	32
Window Jamb with Facings	Figure 14	20	Figure 41	32
Window Sill without Facings	Figure 15	21	Figure 42	32
Window Sill with Support Bar and without Facings	Figure 16	21		
Window Head without Facings	Figure 17	21	Figure 43	33
Window Jamb without Facings	Figure 18	22	Figure 44	33
Head Flashing Termination	Figure 19	22	Figure 45	34
One Piece Apron Flashing Joint	Figure 20	23	Figure 46	35
Pipe Penetration	Figure 21	23	Figure 48	36
Meter Box at Head	Figure 22	24	Figure 49	37
Meter Box at Sill	Figure 23	24	Figure 50	37
Meter Box at Jamb	Figure 24	24	Figure 51	37
Timber Cavity Fix Meter Box			Figure 52	38
Parapet Flashing	Figure 25	25		
Deck Junction	Figure 26	25		
Timber Cavity Batten Fixing			Figure 27	26
Foundation Detail			Figure 28	26
Soffit Detail			Figure 29	27
Batten Layout at Window Opening			Figure 38	31
One Piece Gutter/Wall Junction			Figure 47	36
Drainage Joint			Figure 53	39
Enclosed Deck Balustrade to Wall			Figure 54	40
Enclosed Balustrade to Wall			Figure 55	40
Enclosed Deck	Figure 56	41	Figure 56	41



BRANZ Appraised

Appraisal No.446 [2005]

BRANZ Appraisals

Technical Assessments of products
for building and construction

BRANZ APPRAISAL CERTIFICATE

No. 446 (2005)

This Certificate replaces BRANZ
Appraisal Certificate No. 446 (2004)
issued 23 February 2004.

Amended 6 March 2007.

LINEA® WEATHERBOARD

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Product

1.1 Linea® Weatherboard is a bevel-backed fibre cement weatherboard, which is designed to be used as part of an external wall cladding system for residential and light commercial type buildings where domestic construction techniques are used.

1.2 The weatherboards are applied direct to the external wall framing over a building wrap and incorporate secondary seals behind all internal and external corners, head and sill flashings for window and door penetrations as well as air seals to wall penetrations. The cladding is finished with a latex paint system.



Scope

2.1 Linea® Weatherboard has been appraised as an external wall cladding for buildings within the following scope:

- the scope limitations of NZBC Acceptable Solution E2/AS1, Paragraph 1.1; and,
- constructed with timber framing complying with the NZBC; and,
- with a risk score of 0-12, calculated in accordance with NZBC Acceptable Solution E2/AS1, Table 2; and,
- situated in NZS 3604 Building Wind Zones up to, and including 'Very High'.

2.2 Linea® Weatherboard must only be installed horizontally on vertical surfaces.

2.3 Linea® Weatherboard is appraised for use with aluminium window and door joinery that is installed with vertical jambs and horizontal heads and sills. (The Appraisal of Linea® Weatherboard relies on the joinery meeting the requirements of NZS 4211 for the relevant Building Wind Zone.)

(Note: Linea® Weatherboard can be used to provide structural bracing and fire resistance rated construction, but these aspects have not been assessed by this Certificate and are outside its scope.)

Building Regulations

New Zealand Building Code (NZBC)

3.1 In the opinion of BRANZ, Linea® Weatherboard if designed, used, installed and maintained in accordance with the statements and conditions of this Certificate, will meet the following provisions of the NZBC:

Clause B1 STRUCTURE: Performance B1.3.1, B1.3.2 and B1.3.4. Linea® Weatherboard meets the requirements for loads arising from self-weight, earthquake, wind, human impact and creep [i.e. B1.3.3 (a), (f), (h), (j) and (q)]. See Paragraphs 9.1 - 9.3.

Readers are advised to check the validity of this Certificate by referring to the Valid Certificates listing on the BRANZ website, or by contacting BRANZ.

Clause B2 DURABILITY: Performance B2.3.1 (b), 15 years. Linea® Weatherboard meets this requirement. See Paragraphs 10.1 and 10.2.

Clause C3 SPREAD OF FIRE: Performance C3.3.5. Linea® Weatherboard meets this requirement. See Paragraph 12.1.

Clause E2 EXTERNAL MOISTURE: Performance E2.3.2. Linea® Weatherboard meets this requirement. See Paragraphs 14.1 - 14.3.

Clause F2 HAZARDOUS BUILDING MATERIALS: Performance F2.3.1. Linea® Weatherboard meets this requirement and will not present a health hazard to people.

3.2 This Certificate appraises an **Alternative Solution** in terms of New Zealand Building Code compliance.

Technical Specification

4.1 Linea® Weatherboards are produced with a smooth face and are pre-primed with an acrylic primer on the front face and both edges. The weatherboards are 16 mm thick and are available 135 mm, 150 mm and 180 mm wide. All boards are supplied 4200 mm long.

4.2 Linea® Weatherboards are manufactured from a reduced density cellulose fibre cement formulation. The boards are formed, cut to length and then cured by high-pressure autoclaving. After autoclaving, a bevel is cut on the back face of the weatherboards, the front corner at the bottom of the board is chamfered and the ends are tongue and grooved for jointing. Linea® Weatherboards are manufactured to meet the requirements of AS/NZS 2908.2.

Accessories

4.3 Accessories used with Linea® Weatherboard which are supplied by James Hardie New Zealand Ltd are:

- Linea® Trim - a 16 mm thick fibre cement trim manufactured from a reduced density cellulose fibre cement formulation. Linea® Trim is pre-primed with an acrylic primer on the front face and both edges, and is available in sizes of 135 mm and 180 mm wide by 4200 mm long, and 84 mm and 100 mm wide by 2600 mm long.
- Z-flashings - boxed corner Z-flashing for use with Linea® Trim boxed corners. The Z-flashing is available in grey uPVC in 2700 mm lengths.
- External and internal corner mouldings - chromate treated aluminium external box corner, 90° internal corner 'W' mould and 135° internal corner 'W' mould. The mouldings are available in 2700 mm lengths.
- Corner soakers - 90° soakers are available for 135 mm, 150 mm and 180 mm Linea® Weatherboards. The soakers are available in chromate treated aluminium, copper and stainless steel.

4.4 Accessories used with Linea® Weatherboard which are supplied by the building contractor are:

- Building wrap - paper or wrap complying with NZBC Acceptable Solution E2/AS1, Table 23, or breather-type membranes covered by a valid BRANZ Appraisal Certificate for use as wall wraps.
- Flexible sill, head and jamb flashing tape - flexible flashing tapes complying with NZBC Acceptable Solution E2/AS1, Paragraph 4.3.11, or flexible flashing tapes covered by a valid BRANZ Appraisal Certificate for use around window and door joinery openings.
- Joinery sill and head flashings - folded from aluminium or galvanised steel to suit the window or door trim opening. Refer to NZS 3604, Section 4 and NZBC Acceptable Solution E2/AS1, Table 20 for durability requirements.

- Planted sill and scribes - timber treated to Hazard Class H3.1, pre-primed before installation.
- Window and door trim cavity air seal - air seals complying with NZBC Acceptable Solution E2/AS1, Paragraph 9.1.6, or self-expanding, moisture cure polyurethane foam air seals covered by a valid BRANZ Appraisal Certificate suitable for use around window, door and other wall penetration openings.
- Flexible sealant - sealant complying with NZBC Acceptable Solution E2/AS1, or sealant covered by a valid BRANZ Appraisal Certificate for use as a weather sealing sealant for exterior use.
- Linea® Weatherboard fixings - 40 x 2.8 mm flat head hot-dip galvanised Hardiflex nails or stainless steel ring shank Hardiflex nails (for concealed nailing), and 60 x 3.15 mm jolt head hot-dip galvanised nails or stainless steel ring shank nails (for face nailing).
- Linea® Trim fixings - 60 x 3.15 mm or 75 x 3.15 mm hot-dip galvanised jolt head nails and stainless steel ring shank jolt head nails.

(Note: Stainless steel fixings must be Grade 316 and hot-dip galvanising must comply with AS/NZS 4680).

Paint System Specification

4.5 Paint systems are not supplied by James Hardie Building Products and have not been assessed, therefore are outside the scope of this Certificate.

4.6 All exposed faces, including top edges at sills and all bottom edges of Linea® Weatherboard, Linea® Trim and accessories must be finished with a latex exterior paint system complying with any of Parts 7, 8, 9, or 10 of AS 3730.

Handling and Storage

5.1 Handling and storage of all materials supplied by James Hardie Building Products or the building contractor, whether on site or off site, is under the control of the building contractor. Linea® Weatherboards must be stacked flat, off the ground and supported on a level platform. They must be kept dry at all times either by storing under cover or providing waterproof covers to the stack. Care must be taken to avoid damage to edges, ends and surfaces. Weatherboards must always be carried on edge.

5.2 Accessories must be stored so they are kept clean, dry and undamaged. All accessories must be used within the maximum storage period recommended by the manufacturer.

Technical Literature

6.1 Refer to the Appraisals listing on the BRANZ website for details of the current Technical Literature for Linea® Weatherboard. The Technical Literature must be read in conjunction with this Certificate. All aspects of design, use, installation and maintenance contained in the Technical Literature and within the scope of this Certificate must be followed.

Design Information

Framing

Timber Treatment

7.1 Timber wall framing behind Linea® Weatherboards must be treated as required by NZS 3602.

Timber Framing

7.2 Studs must be provided at maximum 600 mm centres. Nogs must be fitted flush between the studs at maximum 1200 mm centres.

7.3 Timber framing must comply with NZS 3604 or be to a specific design using NZS 3603 and NZS 4203. Where specific design is required, the framing must be of at least equivalent stiffness to the framing provisions of NZS 3604.

7.4 Timber framing must have a maximum moisture content of 24% at the time of the cladding application. *(If weatherboards are fixed to framing with a moisture content of greater than 24% problems may occur at a later date due to excessive timber shrinkage.)*

7.5 Timber wall framing must have a maximum moisture content of 18% before the weatherboards are painted.

General

8.1 At ground level the bottom edge of Linea® Weatherboards must be kept clear of paved surfaces, such as footpaths, by a minimum of 100 mm and unpaved surfaces by 175 mm in accordance with NZBC Acceptable Solution E2/AS1, Table 18. The ground clearances to finished floor levels as set out in NZS 3604 must be adhered to.

8.2 At deck or low pitch roof/wall junctions, the bottom edge of Linea® Weatherboards must be kept clear of any adjacent surface, or above the top surface of any adjacent roof flashing by a minimum of 35 mm in accordance with NZBC Acceptable Solution E2/AS1, Paragraph 9.1.3.6.

8.3 All buildings must have barriers to airflow in the form of interior linings with all joints stopped, or alternatively, unlined gables and walls must incorporate a rigid sheathing or an air barrier which meets the requirements of NZBC Acceptable Solution E2/AS1, Table 23. Where rigid sheathings are used, the fixing length must be increased by a minimum of the thickness of the sheathing.

8.4 Where Linea® Weatherboards abut other cladding systems, designers must detail the junction to meet their own requirements and the performance requirements of the NZBC. Details not included within the Technical Literature have not been assessed and are outside the scope of this Certificate.

Structure

Mass

9.1 The mass of the 135 mm wide Linea® Weatherboard when installed on the wall is 24.9 kg/m² at equilibrium moisture content (EMC). The mass of the 150 mm wide board is 25.7 kg/m² at EMC and the mass of the 180 mm wide board is 23.9 kg/m² at EMC. Linea® Weatherboard is therefore considered a light wall cladding in terms of NZS 3604.

Impact Resistance

9.2 Linea® Weatherboards will resist human impacts likely to be encountered in normal residential use. The likelihood of impact damage to the cladding when used in light commercial situations should be considered at

the design stage, and appropriate protection such as the installation of bollards and barriers provided for vulnerable areas.

Wind Zones

9.3 Linea® Weatherboard is suitable for use on buildings situated in all Building Wind Zones of NZS 3604, up to, and including Very High. *(For the scope limitations of buildings covered by this Certificate, refer to Paragraph 2.1.)*

Durability

Serviceable Life

10.1 Linea® Weatherboard installations are expected to have a serviceable life of at least 50 years provided the paint coating system is maintained in accordance with this Certificate to ensure the Linea® Weatherboards and fixings remain dry in service. Linea® Weatherboards must be painted within 3 months of fixing.

10.2 Areas of geothermal activity and coastal locations can be very corrosive to fasteners, especially coastal locations within distances of up to 500 metres of the sea including harbours, or 100 metres from tidal estuaries and sheltered inlets in some instances. These coastal locations are defined in NZS 3604 as Sea Spray Zone and Zone 1. To achieve a 50 year serviceable life in Sea Spray Zones and areas of geothermal activity, Linea® Weatherboard must be fixed with stainless steel fasteners. To achieve a 50 year serviceable life in Zone 1, Linea® Weatherboard must be fixed with stainless steel or protected hot-dip galvanised steel fasteners. Fasteners outside the Sea Spray Zone, Zone 1 and areas of geothermal activity may be hot-dip galvanised steel.

Maintenance

11.1 Regular maintenance is essential for the Linea® Weatherboards to continue to meet the NZBC durability performance provision and to maximise their serviceable life.

11.2 Annual inspections must be made to ensure that all aspects of the cladding system, including the paint coating system, flashings and any sealed joints remain in a weatherproof condition. Any damaged areas or areas showing signs of deterioration which would allow water ingress must be repaired immediately. Sealant and paint coatings must be repaired in accordance with the sealant or paint coating manufacturer's instructions.

11.3 Regular cleaning (at least annually) of the paint coating surface is recommended to remove grime, dirt and organic growth and to maximise the life and appearance of the coating. Paint systems must be recoated at approximately 5-10 yearly intervals in accordance with the paint manufacturer's instructions.

11.4 Minimum ground clearances as set out in this Certificate must be maintained at all times during the life of the cladding. *(Failure to adhere to the minimum ground clearances given in this Certificate and the Technical Literature will adversely affect the long term durability of Linea® Weatherboards.)*

Control of External Fire Spread

12.1 Linea® Weatherboard is suitable for use where a non-combustible material is specified. When Linea® Weatherboard is finished with a paint coating of not more than 1.0 mm in thickness, it is suitable for use as an external wall cladding in all building Purpose Groups in accordance

with NZBC Acceptable Solution C/AS1 Part 7, Paragraph 7.11.2(a).

Outbreak of Fire

13.1 When Linea® Weatherboards are finished with a paint coating of not more than 1.0 mm in thickness, clearance separations from chimneys and flues are not required. However, when used in conjunction with, or attached to heat sensitive materials, the heat sensitive material must be separated from chimneys and flues in accordance with the requirements of NZBC Acceptable Solution C/AS1 Part 9 for the protection of combustible materials.

External Moisture

14.1 Linea® Weatherboards, when installed in accordance with this Certificate and the Technical Literature will prevent the penetration of moisture that could cause undue dampness or damage to building elements.

14.2 Linea® Weatherboards allow excess moisture present at the completion of construction to be dissipated without permanent damage to building elements to meet code compliance with Clause E2.3.6.

14.3 The details given in the Technical Literature for weather sealing are based on the design principle of having a first and second line of defence against moisture entry for all joints, penetrations and junctions. The ingress of moisture must be excluded by detailing joinery and wall interfaces as shown in the Technical Literature. Weathertightness details that are developed by the designer are outside the scope of this Certificate and are the responsibility of the designer for compliance with the NZBC.

Internal Moisture

15.1 NZBC Acceptable Solution E3/AS1 Paragraph 1.1.1(a) requires a minimum wall R-value of 1.5 for framed cavity wall construction and therefore the wall frame cavity must be insulated.

Water Vapour

15.2 Linea® Weatherboard is not a barrier to the passage of water vapour, and when installed in accordance with this Certificate will not create or increase the risk of moisture damage resulting from condensation.

Installation Information

Installation Skill Level Requirements

16.1 Installation of Linea® Weatherboard and accessories supplied by James Hardie New Zealand Ltd and the building contractor must be completed by tradespersons with an understanding of bevel-back weatherboard installation, in accordance with instructions given within the Linea® Weatherboard Technical Literature and this Certificate.

System Installation

Building Wrap and Flexible Sill and Jamb Tape Installation

17.1 The selected building wrap and flexible sill and jamb tape system must be installed by the building contractor in accordance with the wrap and tape manufacturer's instructions prior to the installation of the Linea® Weatherboards. Particular attention must be paid to the installation of the building wrap and sill and jamb flashing tapes around window and door openings to ensure a continuous seal is achieved and all exposed timber in the opening is protected.

Linea® Weatherboard Installation

17.2 Linea® Weatherboards may be cut on site by power saw. Holes and cut-outs may be formed by drilling a number of holes around the perimeter of the opening required and tapping out the centre with a hammer, or by using a hole saw.

17.3 Weatherboards must be dry prior to installation. Before the weatherboards are installed, cut ends and the back face of the bottom course must be sealed with an acrylic sealer to reduce the absorbency of the fibre cement.

17.4 Linea® Weatherboards must be installed starting at the bottom of the wall. A cant strip (H3.1 treated timber or fibre cement) must be fixed behind the bottom course of weatherboards to ensure the weatherboards are set at the correct angle. The cant strip must be continuous around the perimeter of the building. The bottom course of weatherboards must overhang the bottom plate by a minimum of 50 mm.

17.5 Before the weatherboards are installed, the corner detail must be prepared to suit the selected option, e.g. external box corner, corner soaker. The necessary flashings must be installed before commencing weatherboard fixing.

17.6 The first course of weatherboards must be full length, i.e. 4200 mm and commence from an external corner. Jointing of Linea® Weatherboards is made off the stud using the pre-cut tongue and groove joint. Tongue and groove joints may be located centrally between the studs, but must be no closer than 100 mm to the edge of a stud. A bead of sealant must be applied to the front side of the tongue before the corresponding board is inserted. Subsequent courses of weatherboards must be installed so that the tongue and groove joints are staggered by 600 mm minimum from joints in the previous course.

17.7 Linea® Weatherboards must have a minimum lap of 30 mm, and should be set out so as near to a full board as possible will finish under and over windows and doors and at the top of the wall. A storey rod can be used to accurately position weatherboard courses.

17.8 Linea® Weatherboards must be fixed to each stud using concealed fixings behind the lap of the boards or face nailing, except that face nailing must be provided at all corners and vertical edges of openings.

17.9 Concealed fixing must be carried out using 40 x 2.8 mm hot-dip galvanised or stainless steel Hardiflex nails depending on the location - see Paragraph 10.2. Nails must be fixed 25 mm from the top edge of the board and must be driven flush with the board surface.

17.10 Face nailing must be carried out using 60 x 3.15 mm hot-dip galvanised or stainless steel jolt-head nails depending on the location - see Paragraph 10.2. Nails must be fixed 15 mm up from the bottom of the board and punched a maximum of 2 mm below the surface of

the board. When stainless steel nails are used, the top board at each lap must be pre-drilled.

17.11 Linea® Weatherboards can be hand or gun nailed. Nails must not be closer than 25 mm to the end of the board when hand nailing, or closer than 50 mm when gun nailing.

(Note: Gun nailing must only be used for concealed nailing.)

Aluminium Joinery Installation

17.12 Aluminium joinery and associated head and sill flashings must be installed by the building contractor in accordance with the Technical Literature. A 7.5 mm nominal gap must be left between the joinery reveal and the wall framing so a PEF rod and air seal can be installed after the joinery has been secured in place.

17.13 After installing the window and door joinery; Linea® Trim, planted sills and scribes may be installed in accordance with the Technical Literature to provide additional weatherproofing for the joinery/weatherboard junction.

Inspections

17.14 The Technical Literature must be referred to during the inspection of Linea® Weatherboard installations by building consent authorities and territorial authorities.

Finishing

17.15 The paint coating manufacturer's instructions must be followed at all times for application of the paint finish. Linea® Weatherboards and trim must be clean and dry before commencing painting.

Health and Safety

18.1 Cutting of Linea® Weatherboard must be carried out in well ventilated areas, and a dust mask and eye protection must be worn.

18.2 When power tools are used for cutting, grinding or forming holes, health and safety measures as set out in the Technical Literature must be observed because of the amount of dust generated.

18.3 Safe use and handling procedures for Linea® Weatherboard and the components that make up the cladding system are provided in the relevant manufacturer's Technical Literature.

Basis of Appraisal

The following is a summary of the technical investigations carried out:

Tests

19.1 The following testing has been completed by BRANZ:

- BRANZ expert opinion on NZBC E2 code compliance for Linea® Weatherboard was based on testing and evaluation of all details within the scope and as stated within this Certificate. Linea® Weatherboard was tested to AS/NZS 4284 with a BRANZ-designed extension. The testing was completed in three stages; the first being the standard AS/NZS 4284 test, the second being the modified AS/NZS 4284 test with defects introduced in the test panel, and the third being the modified AS/NZS 4284 test with the internal linings and building wrap removed. The testing assessed the performance of the foundation detail, window head,

jamb and sill details, internal and external corners. In addition to the weathertightness test, the details contained within the Technical Literature have been reviewed, and an opinion has been given by BRANZ technical experts that the system will meet the performance levels of NZBC Acceptable Solution E2/AS1 for direct fixed weatherboard claddings.

- Uniform wind face load tests to simulate wind pressures on 12 mm thick Linea® Weatherboards were carried out by BRANZ, and the results were used in assessing 16 mm thick Linea® Weatherboard.
- Cone Calorimeter testing to determine the peak rate of heat release and total heat release of Linea® Weatherboard was completed by BRANZ. The testing was carried out in accordance with AS/NZS 3837.

19.2 Linea® Weatherboards have been tested by a James Hardie NATA accredited laboratory in accordance with AS/NZS 2908.2. The testing covered: soak-dry, bending strength, warm water soaking, heat/rain, freeze/thaw and apparent density. The test methods and results have been reviewed by BRANZ and found to be satisfactory.

19.3 Testing has been carried out by James Hardie Building Products to determine the modulus of rupture and inter-laminar bond strength of carbonated and non-carbonated Linea® Weatherboard. The test methods and results have been reviewed by BRANZ and found to be satisfactory.

Other Investigations

20.1 Weathertightness, structural, fire and durability opinions have been provided by BRANZ technical experts.

20.2 Site visits have been carried out by BRANZ to assess the practicability of installation, and to examine completed installations.

20.3 The manufacturer's Technical Literature has been examined by BRANZ and found to be satisfactory.

Quality

21.1 The manufacture of Linea® Weatherboard has been examined by BRANZ, and details regarding the quality and composition of the materials used were obtained by BRANZ and found to be satisfactory.

21.2 The quality of materials, components and accessories supplied by James Hardie New Zealand Ltd is the responsibility of James Hardie New Zealand Ltd. The quality control system of James Hardie New Zealand Ltd has been assessed and registered as meeting the requirements of ISO 9001: 2000 by Telarc Limited, Registration Number 409.

21.3 Quality on site is the responsibility of the installer.

21.4 Designers are responsible for the building design, and building contractors are responsible for the quality of installation of Linea® Weatherboard and accessories in accordance with the instructions of James Hardie New Zealand Ltd.

21.5 Building owners are responsible for the maintenance of Linea® Weatherboard in accordance with the instructions of James Hardie New Zealand Ltd.

Sources of Information

- AS 3730 Guide to the properties of paints for buildings.
- AS/NZS 2908.2: 2000 Cellulose-cement products - Flat sheet.
- AS/NZS 3837: 1998 Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter.
- AS/NZS 4284: 1995 Testing of building facades.
- AS/NZS 4534: 1998 Zinc and zinc/aluminium-alloy coatings on steel wire.
- AS/NZS 4680: 1999 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.
- NZS 3602: 2003 Timber and wood-based products for use in building.
- NZS 3603: 1993 Timber Structures Standard
- NZS 3604: 1999 Timber framed buildings.
- NZS 4203: 1992 General structural design and design loadings for buildings.
- NZS 4211: 1985 Specification for performance of windows.
- Compliance Document for New Zealand Building Code External Moisture Clause E2, Department of Building and Housing, Third Edition July 2005.
- New Zealand Building Code Handbook and Approved Documents, Building Industry Authority, 1992.
- The Building Regulations 1992, up to, and including October 2004 amendment

Amendment No. 1, dated 6 March 2007.

The Appraisal Certificate has been amended to update the Certificate holders name; to remove reference to E2/AS1 Third Edition June 2004; to update the Technical Literature reference, and to amend Paragraphs 8.3, 8.4 and 14.1.



In the opinion of BRANZ, Linea® Weatherboard is fit for purpose and will comply with the Building Code to the extent specified in this Certificate provided it is used, designed, installed and maintained as set out in this Certificate.

The Appraisal Certificate is issued only to the Certificate Holder, James Hardie New Zealand Ltd, and is valid until further notice, subject to the Conditions of Certification.

Conditions of Certification

1. This Certificate:
 - a) relates only to the product as described herein;
 - b) must be read, considered and used in full together with the technical literature;
 - c) does not address any Legislation, Regulations, Codes or Standards, not specifically named herein;
 - d) is copyright of BRANZ.
2. The Certificate Holder:
 - a) continues to have the product reviewed by BRANZ;
 - b) shall notify BRANZ of any changes in product specification or quality assurance measures prior to the product being marketed;
 - c) abides by the BRANZ Appraisals Services Terms and Conditions.
3. The product and the manufacture are maintained at or above the standards, levels and quality assessed and found satisfactory by BRANZ.
4. BRANZ makes no representation as to:
 - a) the nature of individual examples of, batches of, or individual installations of the product, including methods and workmanship;
 - b) the presence or absence of any patent or similar rights subsisting in the product or any other product;
 - c) any guarantee or warranty offered by the Certificate Holder.
5. Any reference in this Certificate to any other publication shall be read as a reference to the version of the publication specified in this Certificate.

For BRANZ

J B Wanden

M E Reed

Date of issue: 4 February 2005

CONSTRUCTION CHEMICALS

CERAMIC TILE
ADHESIVES
& GROUTS

Dribond

WATERPROOFING PRODUCTS
FOR CONCRETE AND MASONRY

WEB SITE

www.constructionchemicals.com.au

☐ Adelaide

135 Cormack Rd
Wingfield S.A. 5013
Ph: (08) 82437888
Fax: (08) 82437800
Email
conchem@ozemail.com.au

ABN 66 008 091 503

☐ Brisbane

45 Coulson Street
Wacol Qld 4076
Ph (07) 32712944
Fax (07) 32713892
Email
conchem.qld@bigpond.com.au

☐ Melbourne

11 Gabrielle Court
Bayswater North Vic 3153
Ph (03) 97614711
Fax (03) 97614748

☐ Perth

11 Collie Road
Welshpool W.A. 6106
Ph (08) 93569999
Fax (08) 93569955

☐ Sydney

2 / 31-33 Newton Road
Wetherill Park N.S.W. 2164
Ph (02) 97563533
Fax (02) 97563534

☐ Auckland

16 Carpenter Road
East Tamaki N.Z.
Ph (09) 2735444
Fax 0800266236

☐ Kuala Lumpur

Lot 2 Jalan Kecepi,
33/2 Elite Industrial Estate
Off Jalan Bukit Kemuning
40000 Shah Alam
Ph (603) 51222522
Fax (603) 51222526

Project Name: [REDACTED]

Contact: [REDACTED]

Construction Chemicals WATERPROOFING SPECIFICATION

2. WATERPROOF MEMBRANES STANDARDS.

Waterproofing material shall comply with the following standards.
AS 3740 and local regulations.

2.1.1 GUARANTEE

The waterproof membrane manufacturer to provide a written guarantee for the whole of the waterproofing work, against failure due to defective material for a period of ten (10) years after the date of final completion.

2.1.2 SURFACE PREPARATION

The surface to be waterproofed must be free of grease, oil, dust and other contaminants.

The surface to be waterproofed must be primed with

Primer & Grout Additive Internally and Primax externally
Made by **Construction Chemicals Pty Ltd.**

2.1.3 All waterproofing to be carried out shall be installed by only and applicator approved by the manufacturer to obtain a ten (10) year product guarantee,

2.1.4 Any deviation from the materials specified in this schedule must be approved by the Architect in writing only.

2.1.5 SCHEDULE INTERNALLY :

Provide and install in all areas to be waterproofed
waterproof membrane manufactured by Construction Chemicals, strictly
in accordance with the manufacturers written instructions.

All areas in which the waterproof membrane is installed shall be **water Tested 24 hours** prior to the laying of the bed over the finished membrane.
The membrane must be allowed to cure for 72 hours prior to water testing.

- [REDACTED]
- [REDACTED]

2.1.6 EXTERNALLY.

Provide and install in all external locations **LIQUID FLASH II**
waterproof membrane, manufactured by Construction Chemicals, strictly in
accordance with the manufacturers written instructions.

- [REDACTED]

2.1.7 Waterproof membrane must be allowed to cure for a minimum of 24 hours prior to fixing tiles or a screed bed over the finished membrane.

Memorandum from licensed building practitioner: Certificate of design work
Section 45 and Section 30C, Building Act 2004

Please fill in the form as fully and correctly as possible.

If there is insufficient room on the form for requested details, please continue on another sheet and attach the additional sheet(s) to this form.

THE BUILDING

Street address: 30 Hamon Place

Suburb: Pukehangi

Town/City Rotorua

Postcode:

THE OWNER

Name(s): D & F Wocke

Mailing address: 30 Hamon Place

Suburb: Pukehangi

PO Box/Private Bag:

Town/City: Rotorua

Postcode:

Phone number:

Email address:

BASIS FOR PROVIDING THIS MEMORANDUM

I am providing this memorandum in my role as the: Please tick the option that applies (✓)

<input type="checkbox"/>	sole designer of all of the RBW design outlined in this memorandum – I carried out all of the RBW design myself – no other person will be providing any additional memoranda for the project
<input type="checkbox"/>	lead designer who carried out some of the RBW design myself but also supervised other designers – this memorandum covers their RBW design work as well as mine, and no other person will be providing any additional memoranda for the project
<input type="checkbox"/>	lead designer for all but specific elements of RBW – this memorandum only covers the RBW design work that I carried out or supervised and the other designers will provide their own memoranda relating to their specific RBW design
<input checked="" type="checkbox"/>	specialist designer who carried out specific elements of RBW design work as outlined in this memorandum – other designers will be providing a memorandum covering the remaining RBW design work

IDENTIFICATION OF DESIGN WORK THAT IS RESTRICTED BUILDING WORK (RBW)

I Brett Christopher Walshe carried out / ~~supervised~~ the following design work that is restricted building work

PRIMARY STRUCTURE: B1

Design work that is restricted building work	Description	Carried out/ supervised	Reference to plans and specifications
Tick (✓) if included Cross (X) if excluded	[If appropriate, provide details of the restricted building work]	[Specify whether you carried out this design work or supervised someone else carrying]	[If appropriate, specify references]

		out this design work]	
Primary structure			
All RBW Design work relating to B1	(✓)	Refer Drawings	(✓) Carried out () Supervised Refer Drawings
Foundations and subfloor framing	(✓)	Ribraft Floor & 89x89x6SHS Foundation	(✓) Carried out () Supervised Refer Drawings
Walls	(X)		() Carried out () Supervised
Roof	(X)		() Carried out () Supervised
Columns and beams	(✓)	89x89x6SHS Posts	(✓) Carried out () Supervised Refer Drawings
Bracing	(X)		() Carried out () Supervised
Other	(X)		() Carried out () Supervised
EXTERNAL MOISTURE MANAGEMENT SYSTEMS: E2			
All RBW design work relating to E2	(X)		() Carried out () Supervised
Damp proofing	(X)		() Carried out () Supervised
Roof cladding or roof cladding system	(X)		() Carried out () Supervised
Ventilation system (for example, subfloor or cavity)	(X)		() Carried out () Supervised
Wall cladding or wall cladding system	(X)		() Carried out () Supervised
Waterproofing	(X)		() Carried out () Supervised
Other	(X)		() Carried out () Supervised
FIRE SAFETY SYSTEMS: C1 – C6			
Emergency warning systems, evacuation and fire service operation systems, suppression or control systems, or	(X)		() Carried out () Supervised

other

Note: The design of fire safety systems is only restricted building work when it involves small-to-medium apartment buildings as defined by the Building (Definition of Restricted Building Work) Order 2011.

Note: continue on another page if necessary.

WAIVERS AND MODIFICATIONS

Waivers or modifications of the building code are required () Yes (✓) No

If Yes, provide details of the waivers or modifications below:

Clause	Waiver/modification required
<i>[List relevant clause numbers of building code]</i>	<i>[Specify nature of waiver or modification of building code]</i>

Note: continue on another page if necessary.

ISSUED BY

Name: Brett Christopher Walshe

LBP or Registration number: 130859

The practitioner is a: () Design LBP () Registered architect (✓) Chartered professional engineer

Design Entity or Company (optional): BSK Consulting Engineers Ltd

Mailing address (if different from below):

Street address / Registered office: 1364 Hinemoa Street

Suburb:

Town/City: Rotorua

PO Box/Private Bag: 23

Postcode: 3040

Phone number: 07 3485394

Mobile: 021 2137567

After Hours:

Fax: 07 3482311

Email address: brett@bsk.co.nz

Website:

DECLARATION

I Brett Christopher Walshe [name of practitioner], LBP,

state that I have applied the skill and care reasonably required of a competent design professional in carrying out or supervising the Restricted Building Work (RBW) described in this form, and that based on this, I also state that the RBW:

- Complies with the building code; or
- Complies with the building code subject to any waiver or modification of the building code recorded on this form.

Signature: BCWalshe

Date: 19/12/2012



NEW ZEALAND INSTITUTE OF
ARCHITECTS
INCORPORATED



Building Code Clause(s) ...B1,B2.....

PRODUCER STATEMENT – PS1 – DESIGN

(Guidance notes on the use of this form are printed on the reverse side*)

ISSUED BY:

BSK CONSULTING ENGINEERS LTD Job 19109
(Design Firm)

TO:

D & F Wocke

(Owner/Developer)

TO BE SUPPLIED TO:

Rotorua District Council
(Building Consent Authority)

IN RESPECT OF:

Ribraft Floor, 89x89x6SHS Posts & Timber Pole Retaining Wall (2.5kPa Surcharge)
(Description of Building Work)

AT:

30 Hamon Place

(Address)

LOT:49

DP:399109

SO:

We have been engaged by the owner/developer referred to above to provide

STRUCTURAL DESIGN
(Extent of Engagement)

services in respect of the requirements of

Clause(s)

B1,B2

of the Building Code for

☐ All or ☒ Part only (as specified in the attachment to this statement), of the proposed building work.

The design carried out by us has been prepared in accordance with:

☒ Compliance Documents issued by Department of Building & Housing

B1/VM1

(verification method/acceptable solution)

☐ Alternative solution as per the attached schedule

The proposed building work covered by this producer statement is described on the drawings titled As Above
and numbered Generation Homes
Sheets 74474/101-106,201,301,401

Together with the specification, and other documents set out in the schedule attached to this statement.

On behalf of the Design Firm, and subject to:

- (i) Site verification of the following design assumptions 240kPa Ultimate Bearing Capacity (80kPa Allowable)
- (ii) All proprietary products meeting their performance specification requirements;

I believe on reasonable grounds the building, if constructed in accordance with the drawings, specifications, and other Documents provided or listed in the attached schedule, will comply with the relevant provisions of the Building Code.

I, Brett Christopher Walshe
(Name of Design Professional)

am: ☒ CPEng (Structural)
☐ Reg Arch

I am a Member of: ☒ IPENZ ☐ NZIA and hold the following qualifications BE Civil (Hons) CPEng 130859
The Design Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than \$200,000*.

The Design Firm is a member of ACENZ ☒

SIGNED BY B C Walshe

ON BEHALF OF BSK CONSULTING ENGINEERS LTD

(Design Firm)

Date 19/12/2012

(signature)

Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of \$200,000*.

This form is to accompany Form 2 of the Building (Forms) Regulations 2004 for the application of a Building Consent.

LOT 42, 30 HAMON PLACE	JOB REF: 19109
	DATE 18/12/12
	SHEET 1 OF

House AREA = 210m²

Rotorua, $Z=0.24$ (AS/NZS1170) < 0.46 O.K

Single Storey, Heavy Walls (Brick) \therefore Building Type B

Light Roof \therefore 1800 BU/100m² provided.

$$\frac{210}{100} \times 1800 = 3780 \text{ BU's}$$

Low Wind Area

Building Length = 22.5m

Building Width = 12.4m

2.4m Stud, 2.2m Roof, 25° Pitch

Apex Height = 5m

$$\begin{aligned} A_{\text{ROOF}} &= 75 \times 12.4 = 930 \text{ BU} < 3780 \text{ BU} \\ A_{\text{WALL}} &= 80 \times 22.5 = 1800 \text{ BU} < 3780 \text{ BU} \end{aligned} \quad \left. \vphantom{\begin{aligned} A_{\text{ROOF}} \\ A_{\text{WALL}} \end{aligned}} \right\} \text{No Shear Keys required.}$$

Foundations, Roof $G = 0.35 \times 10.7/2 = 1.87 \text{ kN/m}$

Wall $G = 0.19 \times 7 \times 2.4 = 3.21 \text{ kN/m}$

$$\Sigma G = 5.07 \text{ kN/m}$$

$$1.35 G = 6.84 \text{ kN/m}$$

$$6.84 / (0.3 \times 1) = 23 \text{ kPa ULS}$$

$$\text{or } 23 / 1.35 = 17 \text{ kPa Allowable OK}$$

11kN Pt Load

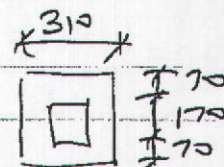
$$11 / (0.3 \times 1) = 37 \text{ kPa ULS}$$

$$\Rightarrow 27 \text{ kPa Allowable OK}$$

LOT 49, 30 HAMON PLACE	JOB REF: 19109
	DATE 18/12/12
	SHEET 2 OF

BRICK COLUMNS

H=2.3m, 310x310, 70 series brick.



$$G_{\text{roof}} = 0.35 \text{ kPa} \times 0.6 \text{ m} \times 2.4 \text{ m} = 0.5 \text{ kN}$$

$$G_{\text{col}} = 0.19 \times 7 \times 2.3 \times (0.31 \times 2 + 0.17 \times 2) = 3 \text{ kN}$$

$$C_h(T) = 3 \quad \text{for } T = 0.4 \text{ s}$$

$$Z = 0.24$$

$$R_u = 1$$

$$N(T, D) = 1$$

$$R_s = 0.25$$

$$C(T)_u = 3 \times 0.24 \times 1 \times 1 = 0.72$$

$$\text{Total } \mu = 1 \quad k_u = 1 \quad S_p = 0.9 \quad C_d(T)_u = 0.72 \times 0.9 = 0.65$$

$$M_{\text{Ed}}^* = 0.65 (0.5 \times 2.4 + 3 \times 1.2) = 3.11 \text{ kNm} \quad (\text{or } 2.58 \text{ kNm @ } 1.2 \text{ m})$$

or 1.29 kNm @ 2.4 m

$$89 \times 89 \times 6 \text{ SHS, } \Delta M_{\text{Ed}} = 0.9 \times 3550 \times 56.7 = 17.9 \text{ kNm} \quad \text{O.K for bending}$$

Check Foundation - Try 800x310x310

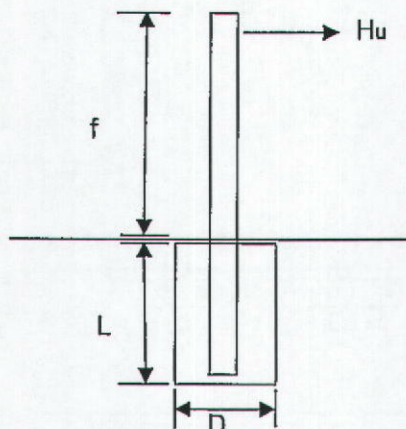
N.G. See P3,

U.R. 1100x310x310.

BSK CONSULTING ENGINEERS LIMITED

JOB TITLE	Wocke Post	JOB NO.	19109
ADDRESS	30 Hamon Place	DATE	18-Dec-12
			1

POLE EMBEDMENT CALCULATIONS



L-A METHOD

INPUTS

$H_u = 1.29 \text{ kN}$
 Distance from ground to $H_u = 2.4 \text{ m}$
 Moment $M = 3.096 \text{ (kNm)}$
 Passive earth pressure $K_p = 3 \text{ Kpa}$
 Density $\gamma = 18 \text{ (kN/m}^3\text{)}$
 Diameter of pile $D = 0.31 \text{ (m)}$
 Restraint at ground = n $Y=\text{yes}/N=\text{no}$
 $k = 0.68 \text{ (Dimensionless)}$

$$L = 0.2 + \sqrt{\frac{14.52 * M * k}{K_p * \gamma * D}}$$

WITH GROUND LEVEL RESTRAINT

$$L = 0.2 + \sqrt{\frac{4.68 * M * k}{K_p * \gamma * D}}$$

EMBEDMENT (L) = 1.4223

BROMS

EMBEDMENT (L) = 1.1 (m)

Coefficient of passive earth pressure $K_p = 3$
 Diameter of embedded pile shaft $D_s = 0.31 \text{ (m)}$
 Unit weight of soil $\gamma = 18 \text{ (kN/m}^3\text{)}$
 Distance from ground - to force H_u $f = 2.4 \text{ (m)}$
 Pole spacing $s = 4.8 \text{ (m)}$
 Strength reduction $\phi_{pp} = 0.5$

Depth to maximum moment $g_s = 0.356 \text{ (m)}$
 Maximum pile shaft moment $M_{max} = 4.1 \text{ (kNm)}$

Reduction factor for closely spaced piles $\phi = 1.00$
 Ultimate lateral resistance of pile $H_u = 3.2 \text{ (kN)}$
 Adjusted ultimate lateral resistance $\phi H_u = 1.6 \text{ (kN)}$

BSK CONSULTING ENGINEERS

JOB TITLE Generation Homes
ADDRESS 30 Hamon Place

JOB NO. 19109

DATE

19/12/2012

PAGE

TIMBER POLE RETAINING WALL (WITH SURCHARGE = 2.5 Kpa)

Pole Spacing = 1.2m

(a) DESIGN PARAMETERS

	Active	Passive
angle of backfill slope, $\omega =$	0	0
angle of wall backface, $\beta =$	-5	5
Internal angle of friction, $\phi =$	30	30
angle of wall friction, $\delta =$	30.00	-30.00
Earth Pressure coefficients :		

$$k_a = \frac{\cos^2(\phi - \beta)}{\cos^2 \beta \cos^2(\delta + \beta) \left[1 + \frac{(\sin(\phi + \delta) \sin(\phi - \omega))}{\cos(\delta + \beta) \cos(\omega - \beta)} \right]^2}$$

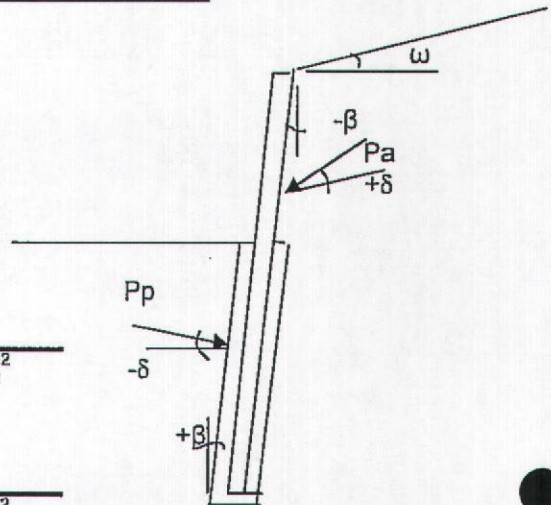
$$k_p = \frac{\cos^2(\phi + \beta)}{\cos^2 \beta \cos^2(\delta + \beta) \left[1 - \frac{(\sin(\phi - \delta) \sin(\phi + \omega))}{\cos(\delta + \beta) \cos(\omega - \beta)} \right]^2}$$

$$k_a = 0.26$$

$$k_p = 8.73$$

$$\text{soil density, } \gamma = 18$$

$$\text{surcharge, } q = 2.5 \text{ kPa}$$



LOAD COMBINATIONS

ULTIMATE - 1.5G

- 1.5G + 1.5Q

will be critical

(b) POLE SIZE

$$M^* = [1.5(K_a \gamma H_r^3)/6 + 1.5(K_a Q H_r^2)/2] S$$

where - H_r = height retained
- S = spacing

For timber poles :

$$\phi M_n = \phi k_1 k_{20} k_{21} f_b z$$

$$\text{where } \phi_{\text{POLE}} = 0.8$$

$$k_1 = 0.6$$

$$k_{20} = 0.90$$

$$k_{21} = 0.85$$

$$f_b = 38 \text{ MPa}$$

$$z = \pi D^3/32$$

$$\text{therefore } D > [32 \times M^*/(\phi k_1 k_{20} k_{21} f_b \pi)]^{1/3}$$

Ht Retained, H_r	Spacing, S	$M^*_{1.5G}$	$M^*_{1.5G+1.5Q}$	M^*_{DESIGN}	Pole Dia, D	SED
(m)	(m)	(kNm)	(kNm)	(kNm)	REQ (mm)	DIA(mm)
0.40	1.20	0.09	0.18	0.18	51	100
0.60	1.20	0.30	0.51	0.51	72	100
0.80	1.20	0.72	1.10	1.10	93	125
1.00	1.20	1.41	1.99	1.99	113	150
1.20	0.90	1.82	2.46	2.46	121	150
1.40	0.90	2.89	3.76	3.76	140	175
1.60	0.90	4.32	5.45	5.45	158	200
1.80	0.90	6.15	7.58	7.58	177	225
1.90	0.90	7.23	8.82	8.82	186	225

BSK CONSULTING ENGINEERS

JOB TITLE	Generation Homes	JOB NO.	19109
ADDRESS	30 Hamon Place	DATE	19/12/2012
		PAGE	

(C) EMBEDMENT

Use Brohms lateral resistance for short piles in granular soil

Note: Brohms uses ultimate strength (qult) which equates to limit state ideal strength (qi)

From MJ Pender:

$$P = (k_p D_s L^3 \gamma) / 2 (L + e)$$

Embedment:

$$L^3 - 2L\alpha - 2\alpha e = 0$$

$$\text{strength reduction, } \Phi_{bc} = 0.45$$

$$\text{Pole Spacing} = 1.20 \text{ m}$$

$$\text{Hole dia} = 0.45 \text{ m}$$

$$\text{Pole spacing reduction, } \Phi_{pile} = 0.6667$$

$$\Phi_{EMBED}, (\Phi_{bc} \times \Phi_{pile}) = 0.30$$

where

$$\alpha = P^* / (\phi K_p D \gamma)$$

$$P^* = [1.5 (K_a \gamma H_r^2) / 2 + 1.5 (K_a Q H_r)] S$$

$$K_p = 8.73$$

e = eccentricity of load (M*/P*)

L = trial depth

D = diameter of pole

$$\text{DEPTH} = 0.3 \text{ m} + L \text{ (to allow for surface effects)}$$

Ht Retained, Hr	Hole dia.	Spacing, S	P*	e	α	L	$L^3 - 2L\alpha - 2\alpha e$
(m)	(m)	(m)	(kN)	(m)		(m)	(SHOULD = 0)
0.40	0.45	1.20	1.14	0.16	0.05	0.40	0.00
0.60	0.45	1.20	2.22	0.23	0.10	0.55	0.00
0.80	0.45	1.20	3.64	0.30	0.17	0.70	0.00
1.00	0.45	1.20	5.39	0.37	0.25	0.90	0.08
1.20	0.45	0.90	5.61	0.44	0.26	0.90	0.02
1.40	0.45	0.90	7.43	0.51	0.35	1.10	0.21
1.60	0.45	0.90	9.51	0.57	0.45	1.20	0.14
1.80	0.45	0.90	11.83	0.64	0.56	1.30	0.03
1.90	0.45	0.90	13.09	0.67	0.62	1.40	0.18

(d) RAILS

Note:

- DESIGN RAILS FOR MAXIMUM FORCE AT THE BASE OF THE WALL

- ASSUME RAILS ARE SIMPLY SUPPORTED BETWEEN THE POLES

$$w^* = [1.5 (K_a \gamma h_r) + 1.5 (K_a Q)] h_{board}$$

$$M^* = w^* S^2 / 8$$

$$\phi M_l = \phi \times k_1 \times z \times f_b$$

TRY 200 x 50 RS TIMBER

where

$$b = 50 \text{ mm}$$

$$d = 200 \text{ mm}$$

$$f_b = 11.7 \text{ MPa}$$

$$Z = d b^2 / 6 = 83300 \text{ mm}^3$$

$$\phi M_l = 0.47 \text{ kNm}$$

Ht Retained, Hr	Spacing, S	w*	M*
(m)	(m)	(kN)	(kNm)
0.40	1.20	0.76	0.14
0.60	1.20	1.04	0.19
0.80	1.20	1.32	0.24
1.00	1.20	1.60	0.29
1.20	0.90	1.88	0.19
1.40	0.90	2.16	0.22
1.60	0.90	2.45	0.25
1.80	0.90	2.73	0.28
1.90	0.90	2.87	0.29

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use single rails or half round

use single rails or half round

use single rails or half round

use single rails or half round

use single rails or half round

use single rails or half round

use double rails or half round

use double rails or half round

use double rails or half round

OPTION TRY TIMBER HALF ROUNDS

SIZE (SED) = 150 mm

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JOB TITLE	Generation Homes			JOB NO.	19109	
ADDRESS	30 Hamon Place			DATE	19/12/2012	PAGE

$$Z = \pi r^3 / 11 = 80444 \text{ mm}^3$$

$$\phi M_l = 1.12 \text{ kNm}$$

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JOB TITLE Generation Homes

JOB NO. 19109

ADDRESS 30 Hamon Place

DATE

19/12/2012

PAGE

(e) **TIMBER POLE RETAINING WALL SUMMARY (WITH VEHICLE SURCHARGE)**

Ht Retained	TIMBER POLES			HOLE		Rails
	SED size	spacing	length	diameter	depth	
	mm	m	m	mm	m	
0.40	100	1.20	1.1	450	0.7	use single rails or half round
0.60	100	1.20	1.5	450	0.9	use single rails or half round
0.80	125	1.20	1.8	450	1.0	use single rails or half round
1.00	150	1.20	2.2	450	1.2	use single rails or half round
1.20	150	0.90	2.4	450	1.2	use single rails or half round
1.40	175	0.90	2.8	450	1.4	use single rails or half round
1.60	200	0.90	3.1	450	1.5	use double rails or half round
1.80	225	0.90	3.4	450	1.6	use double rails or half round
1.90	225	0.90	3.6	450	1.7	use double rails or half round

NOTES:

- 1 DRAINAGE LAYER BEHIND WALL SHALL BE 20-50mm CLEAN FREE DRAINING ROCK
- 2 ALL POLES TO BE H5 TREATED AND RAILS H4
- 3 RAILS SHALL BE EITHER 150 x 50 RS OR 150 DIAMETER HALF ROUNDS (IE. 75mm THICK)
- 4 SECURE RAILS TO POLES WITH GALV NAILS
- 5 GROUT POLES WITH 17.5MPa CONCRETE
- 6 ALL POLES TO BE PLACED LARGE END INTO FOOTING
- 7 ANY QUERIES OR DISCREPANCIES CONTACT THE ENGINEER
- 8 REFER DRAWING FOR OTHER DETAILS