CBI 3100/3111/3112/4711

JAN 2012

RIBRAFT®
TECHNICAL MANUAL

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.

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SECTION 1

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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 pods.

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.

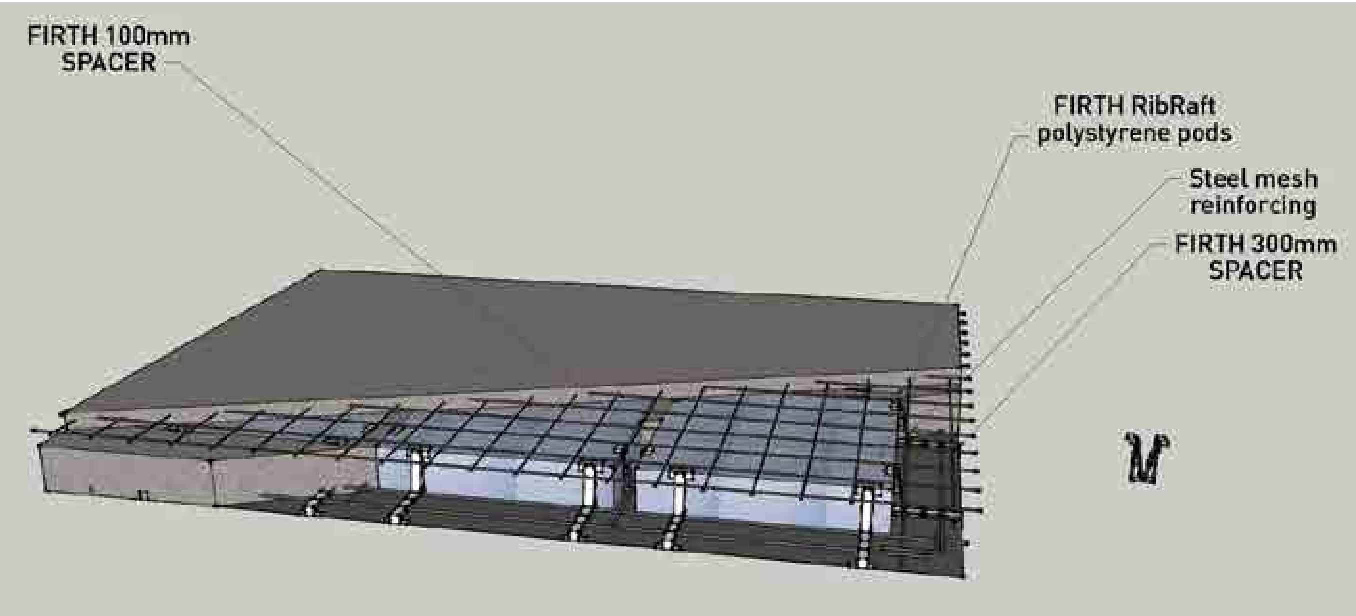


Figure 1 *The RibRaft System*

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*

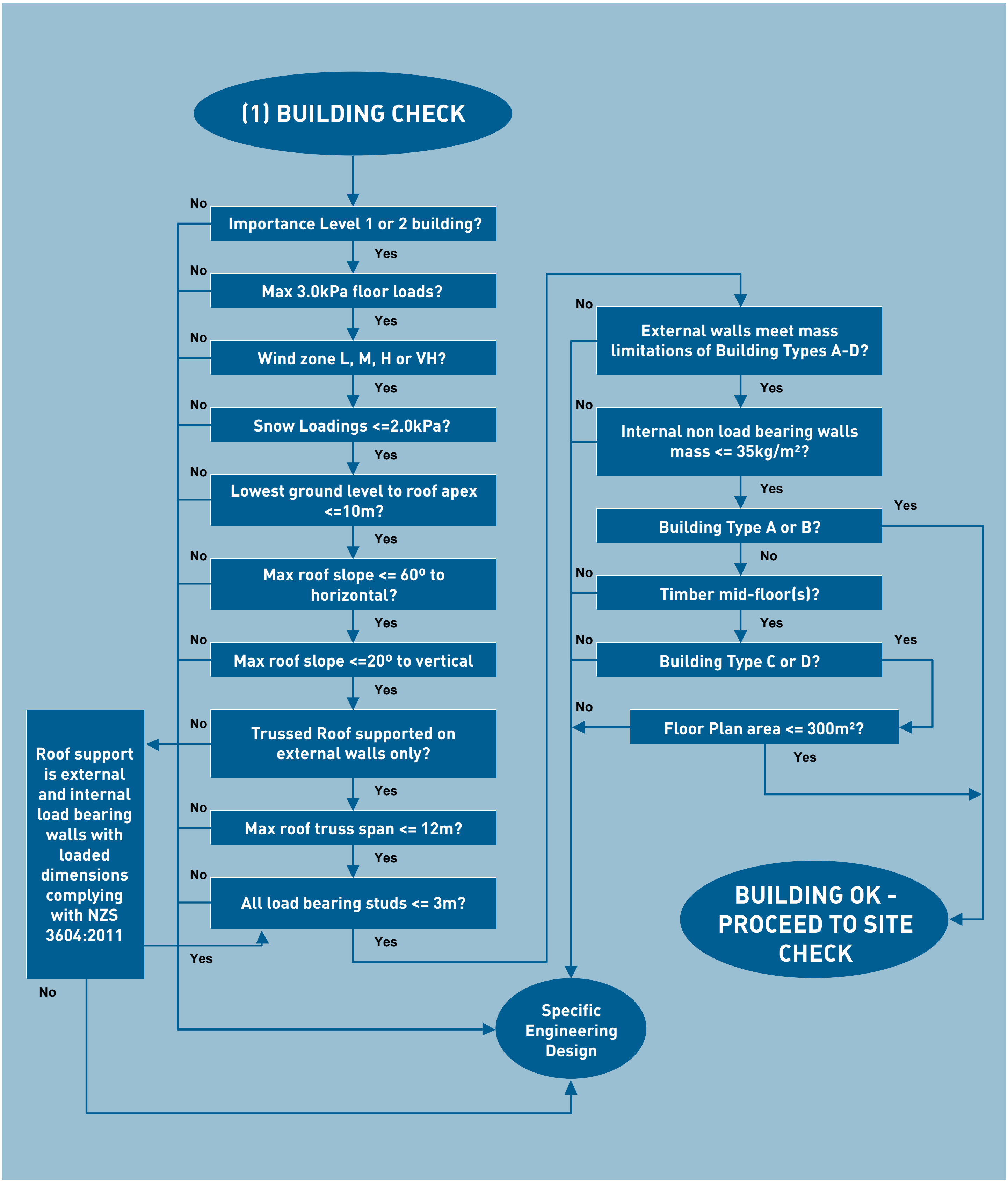
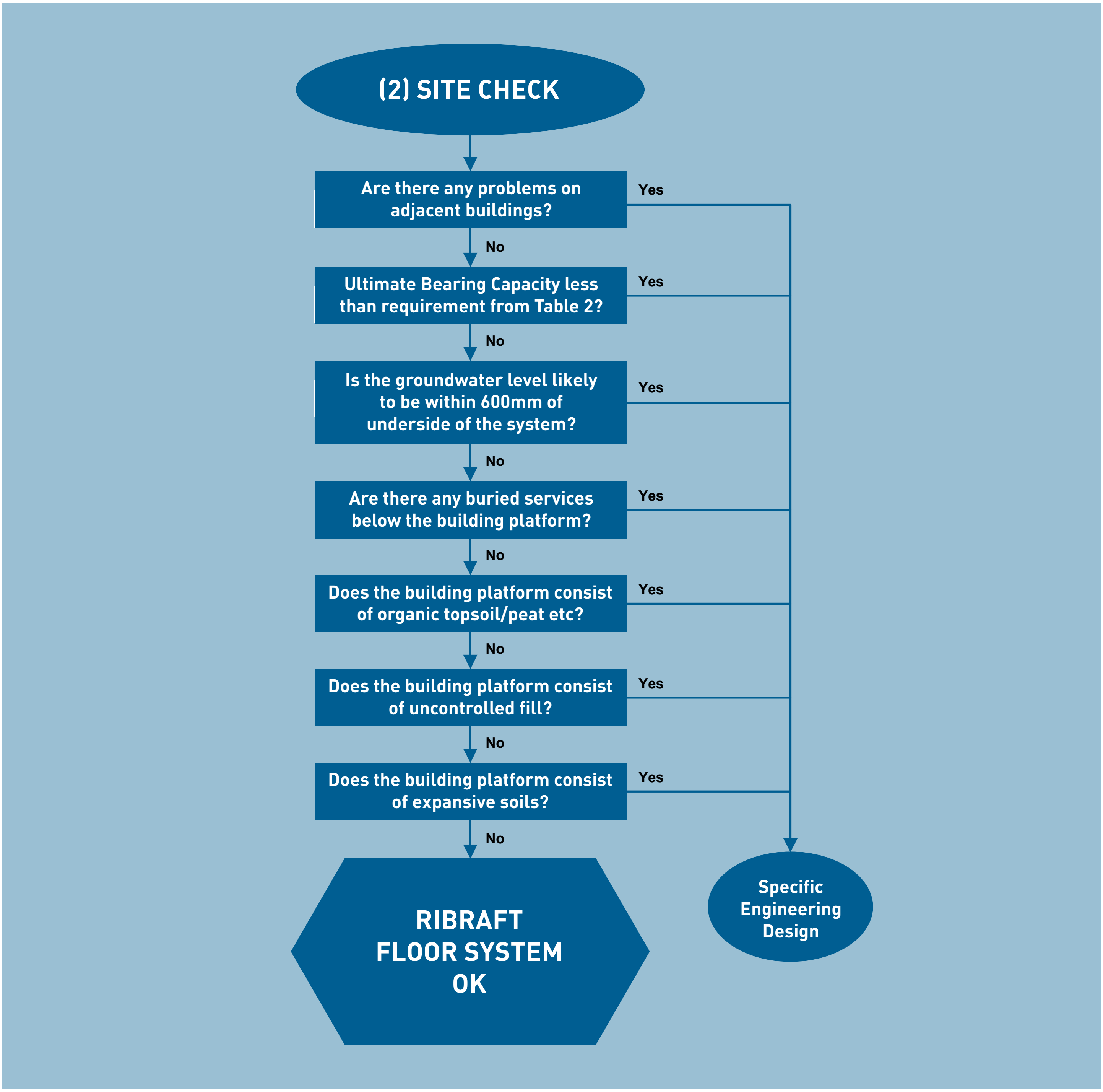


Figure 3 *Site Check Flow Diagram*



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.

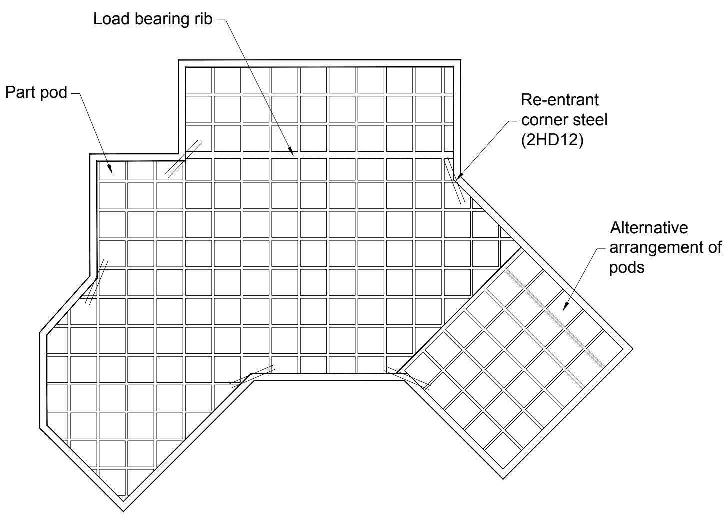


Figure 4 *Typical RibRaft Plan*

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.

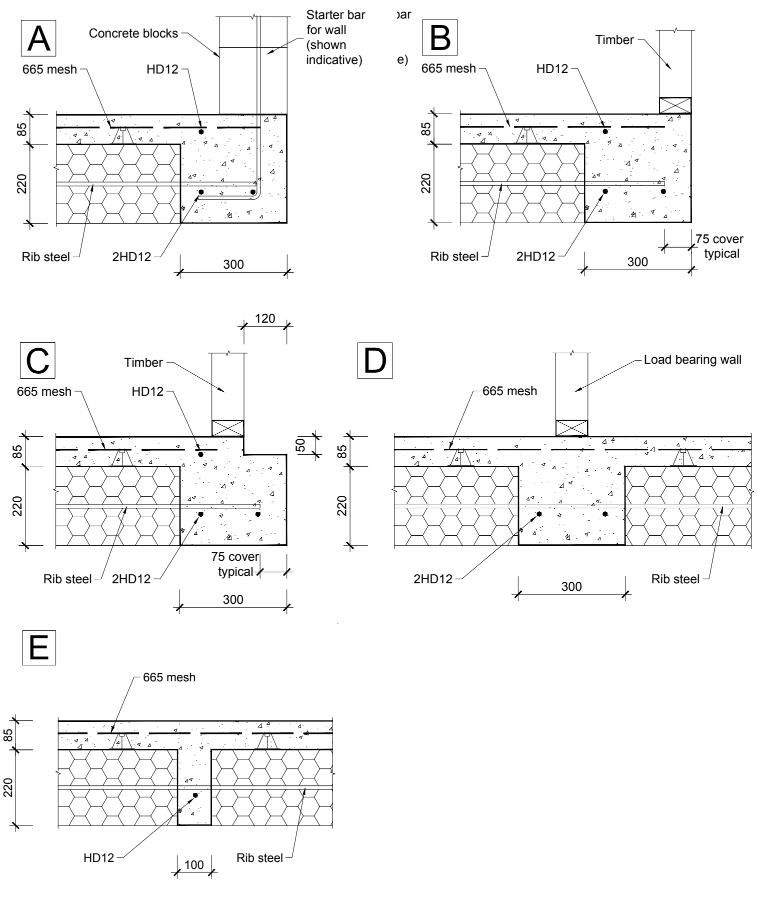


Figure 5 *Standard RibRaft Construction Details*

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.

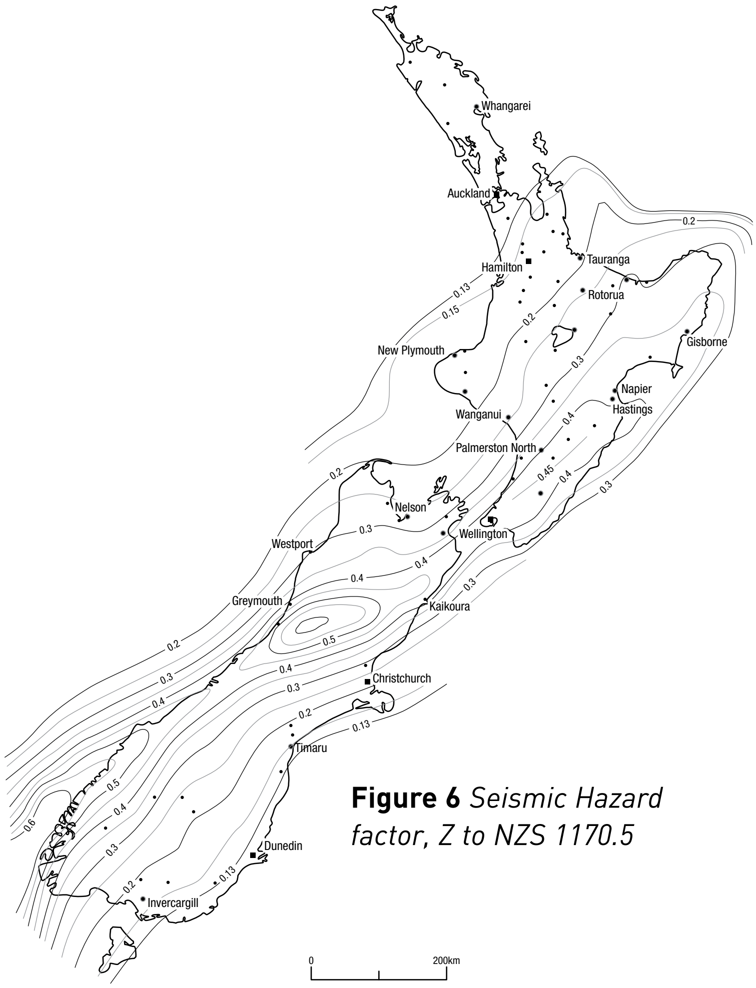


Figure 6 *Seismic Hazard factor, Z to NZS 1170.5*

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.

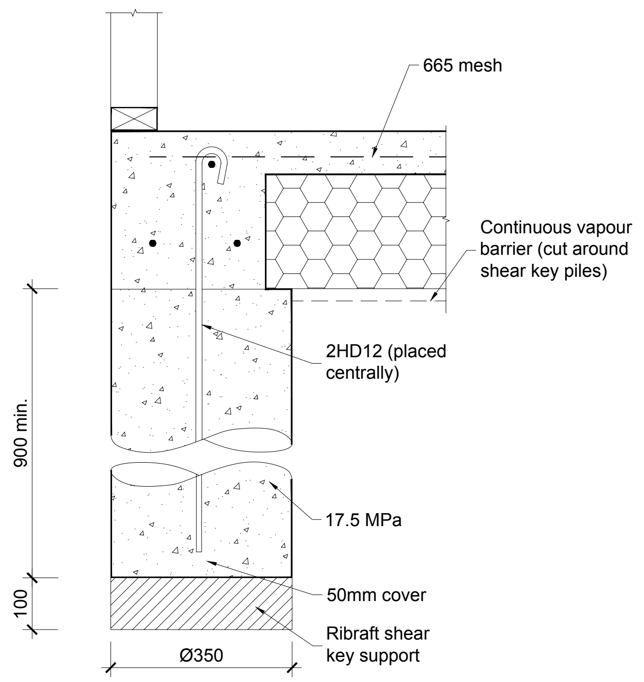


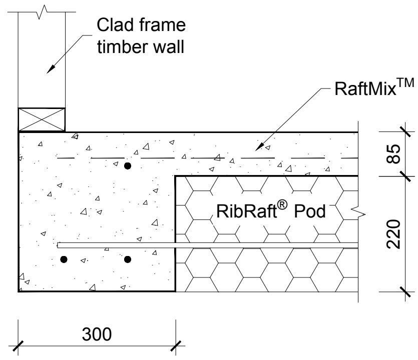
Figure 7 *RibRaft Shear Key*

6 OTHER DESIGN DETAILS

6.1 R-Values

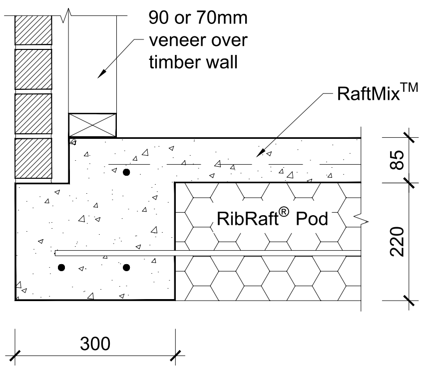
The insulation performance of a building element is measured by the "R-Value". The schedule method is the simplest method to achieve compliance with Clause H1 of the Building Code. Using this method the minimum R-Values required for floors are R1.3 for light timber frame construction, and typically R1.5 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.



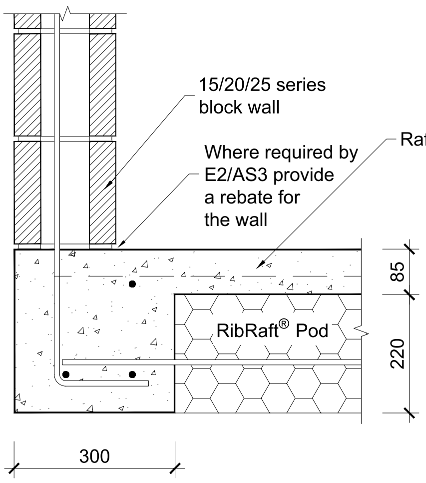
	Floor Area To Perimeter Ratio m^2/m									
	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.50	4.00
R-value $m^2\,^oC/W$	1.48	1.52	1.64	1.75	1.86	1.97	2.07	2.17	2.38	2.57

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



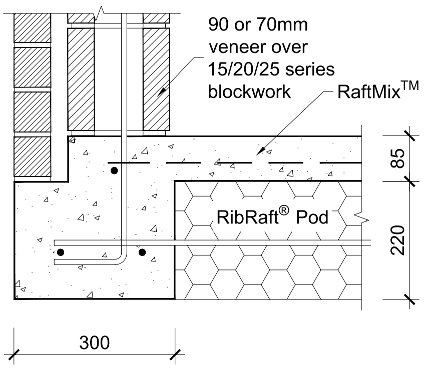
	Floor Area To Perimeter Ratio m^2/m									
	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.50	4.00
R-value $m^2\,^oC/W$	1.54	1.67	1.80	1.93	2.05	2.17	2.28	2.40	2.62	2.84

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



	Block	Floor Area To Perimeter Ratio m²/m									
		1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.50	4.00
R-value m² °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 m²/m									
		1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.50	4.00
R-value m² °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
300m 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:*

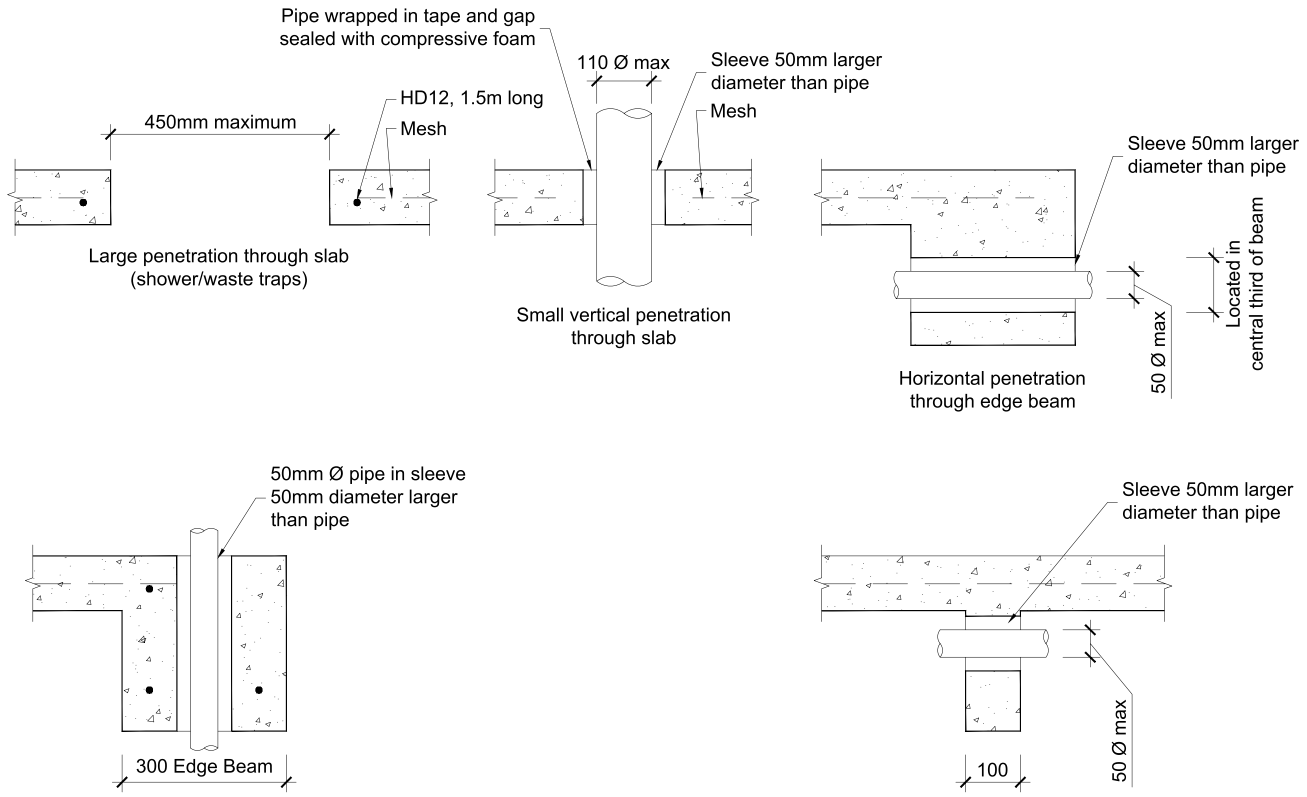


Figure 12 *Example of detailing requirements for services*

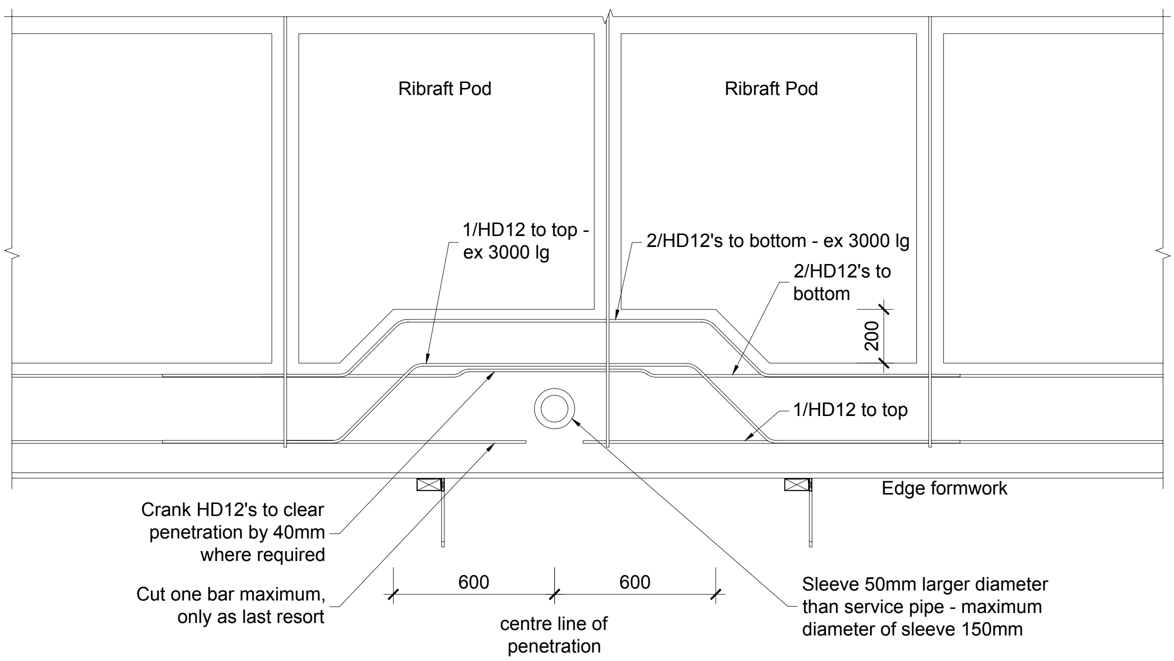


Figure 13 *Localised increase in width at edge beam where vertical services up to 100mm diameter are required*

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

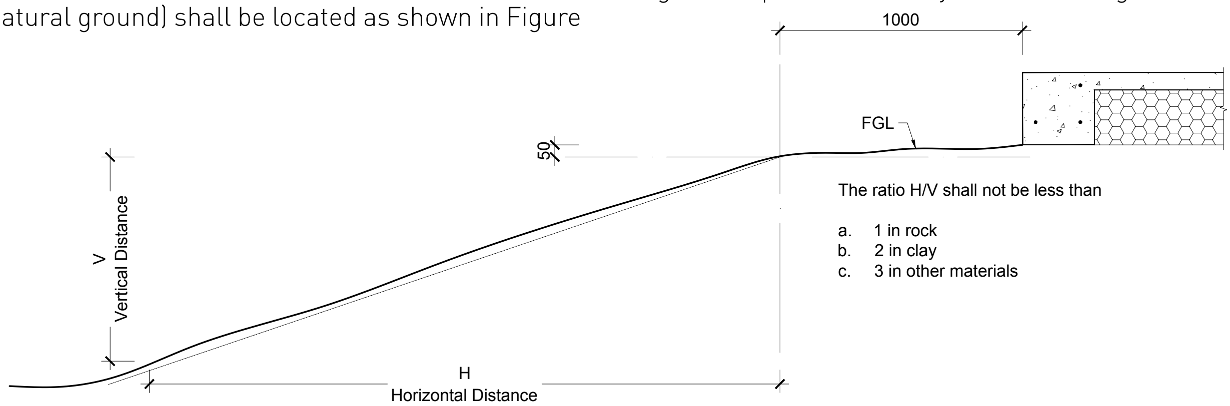


Figure 1 *Relationship of RibRaft to Sloping Ground Surface*

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

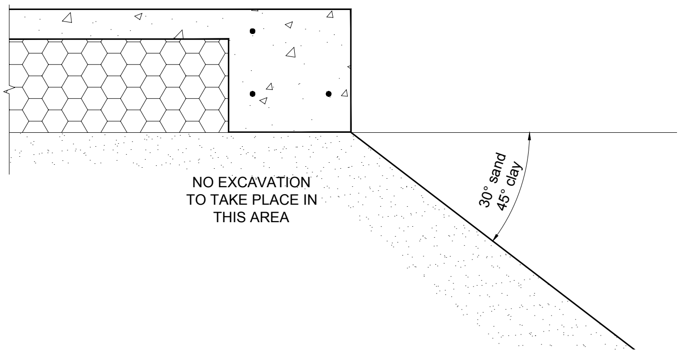


Figure 2 *Temporary Excavation Limited*

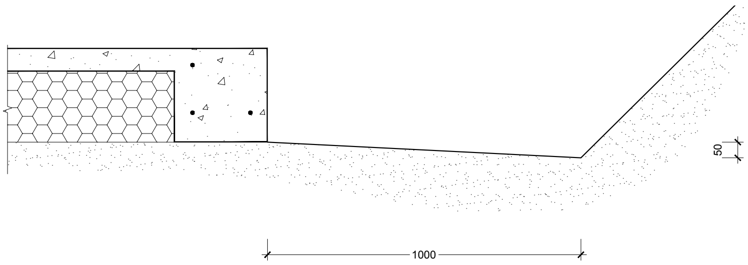


Figure 3 *Site Grading*

3 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 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.

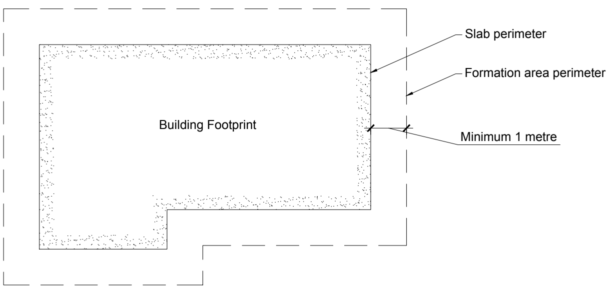


Figure 4 *Plan of Formation Area*

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).

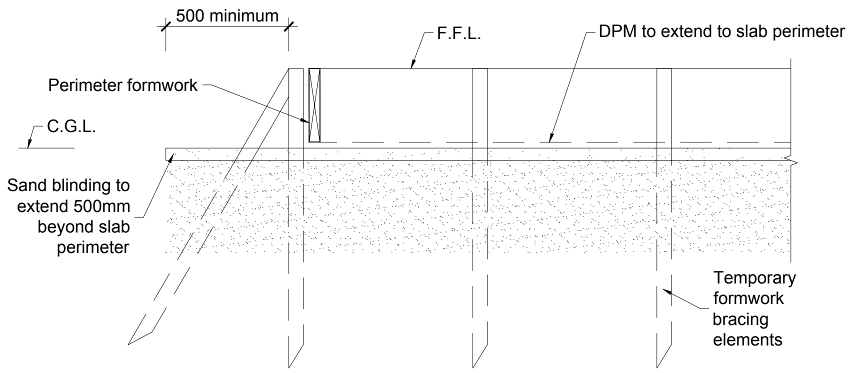


Figure 5 *Sand Blinding/DPM/Formwork Details*

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).

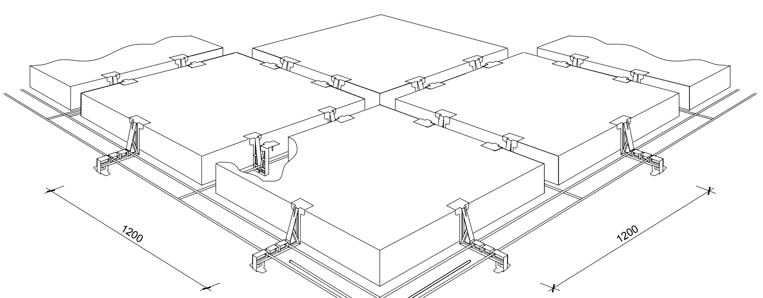


Figure 6 *Detailed Layout of Pods and Spacers (mesh and top steel omitted for clarity)*

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.

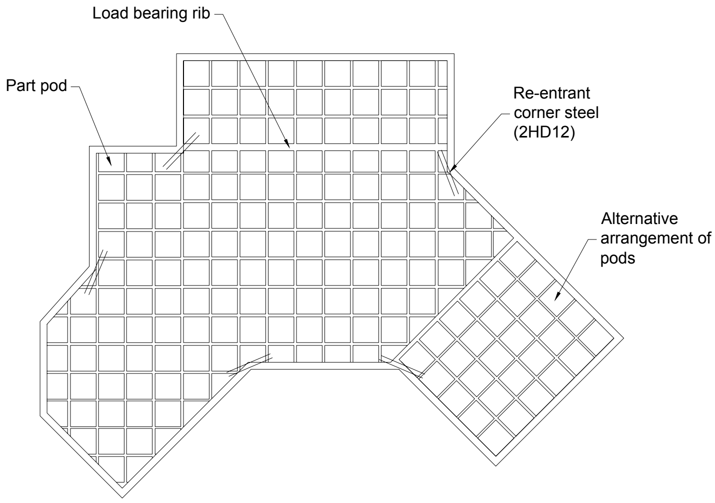


Figure 7 *Typical Pod and Rib Layout*

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).

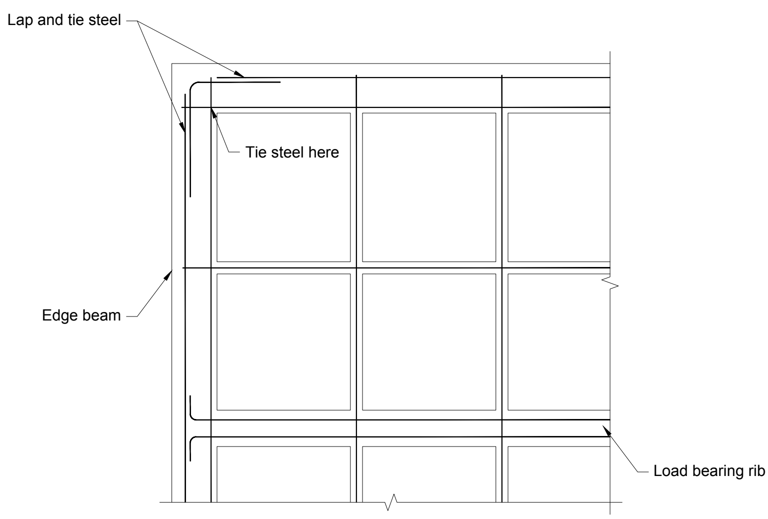


Figure 8 *Corner Steel Layout*

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:

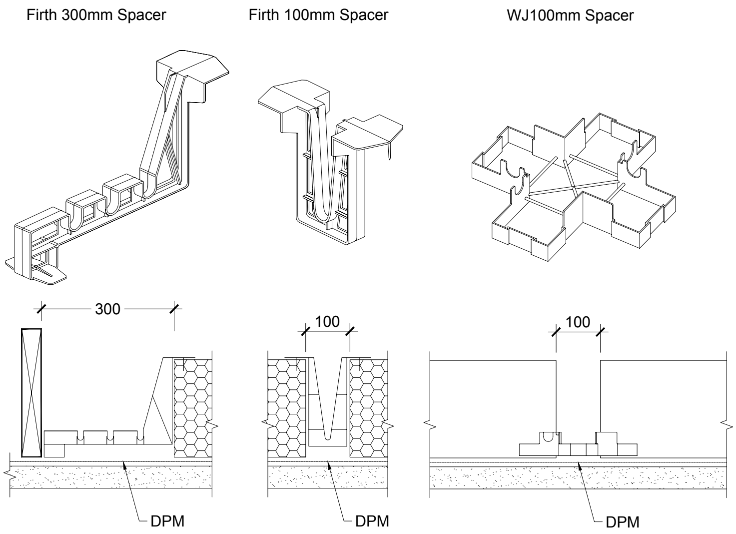


Figure 9 *Spacer Details*

- 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.

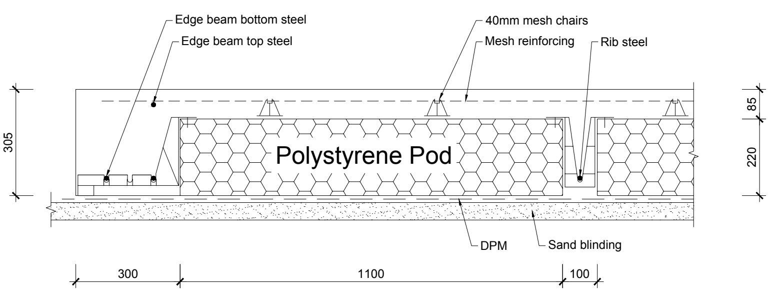


Figure 10 Detailed Section

3.12 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.

4 SHEAR KEYS

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.

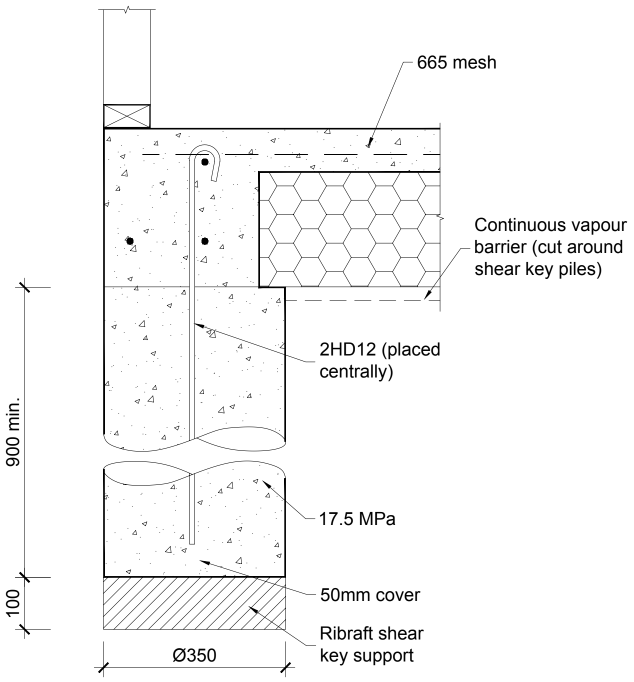


Figure 11 *Shear Pile Construction Detail*

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.	

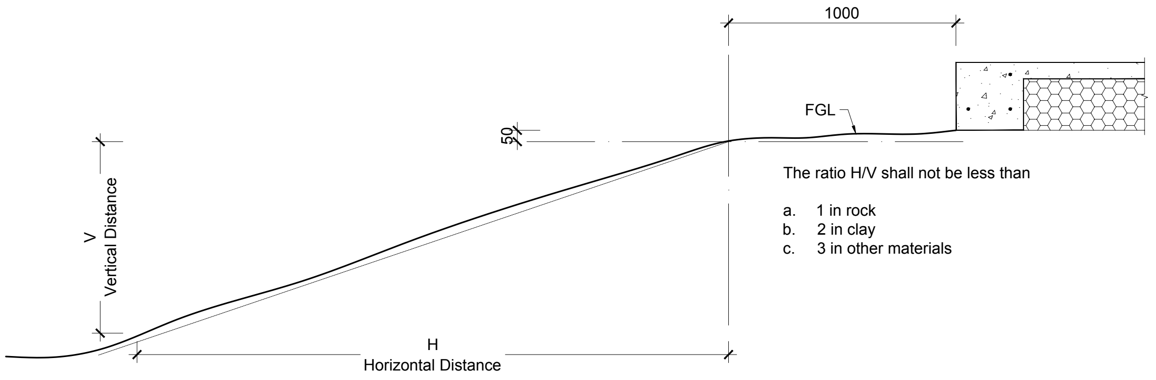
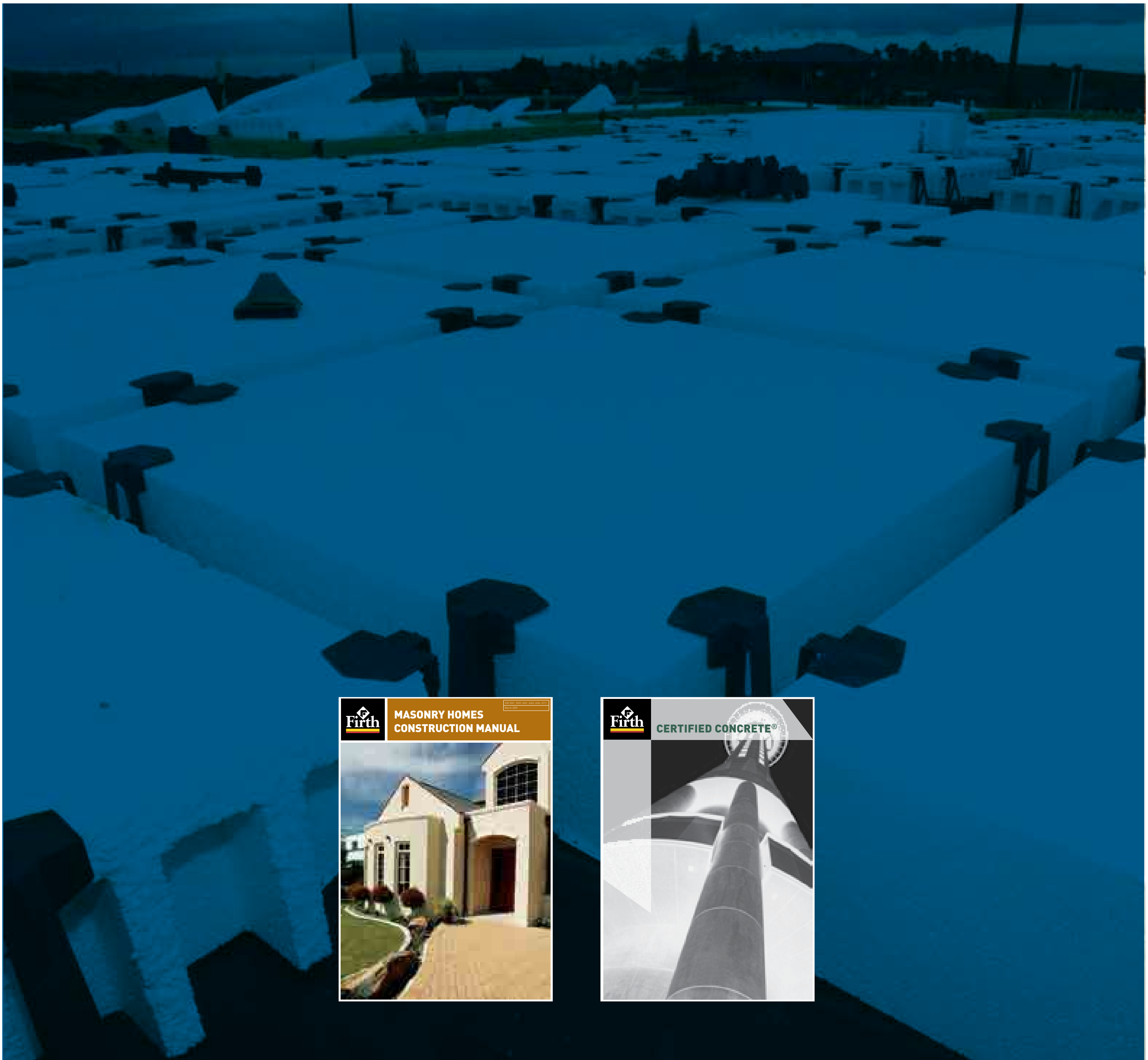


Figure 1 *Relationship of RibRaft to Sloping Ground Surface*

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.



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

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