



Firth RibRaft Floor System

Appraisal

This Appraisal relates to certain uses of the Firth RibRaft floor system ("the system") that do not require specific design. Firth Industries Ltd supply some of the components of the system, including the concrete, and provide design and installation information for use by others. No specialist building skills are necessary to design and install the system.

The system has been appraised for use as a reinforced concrete slab-on-ground floor construction for domestic or residential buildings covered by the scope of NZS 3604:1999 "Timber Framed Buildings." The use of the system must also meet the limitations specified in Clause 3 "Scope" of Section 1 of the Firth RibRaft Floor System Manual, May 2000 (referred to as the RibRaft Manual).



The Appraisal covers standard non-specific design and construction details for the system when the supporting ground:

- meets the requirements of the definition of good ground as given in NZS 3604:1999 except that the minimum ultimate bearing capacity shall be as stipulated in the RibRaft Manual;
- is not damp as defined in Clause 3.5 of Section 1 of the RibRaft Manual.

Building Regulations

New Zealand Building Code (NZBC)

In the opinion of Opus International Consultants (Opus), when the system is used in accordance with the conditions of this Appraisal, the relevant provisions of the following NZBC clauses will be met: B1 Structure, B2 Durability, E2 External Moisture.

Product Information

General

The system is a reinforced concrete waffle raft ground floor slab system. There are many ways the system can be engineered and constructed. However, only one non-specific design is covered by this Appraisal.

The non-specific detail consists of an 85mm thick top slab supported by a grid of ribs normally 100 mm wide at a maximum spacing of 1200mm x 1200mm centres. The overall depth is 305mm. Edge beams and ribs under loadbearing walls are 300mm wide to provide for the extra load carried by these members. Construction is directly on levelled ground covered with a DPM (damp proof membrane).

Polystyrene waffle pods 1100mm square and 220mm thick are placed directly on levelled ground. These are arranged in such a way that a reinforced concrete floor slab with a grid of reinforced concrete ribs and edge beams is formed when concrete is placed onto them. Pods may be cut to suit specific layout architecture and also to accommodate services.

Reinforcing steel consists of steel mesh in the top slab with reinforcing bars in the ribs and edge beams. 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.

There are two Firth concrete products that can be used in the system.

- Raftmix is a 20 MPa 80mm 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 wheel barrow over planks set up over the pods.
- Raftmix Pump is a 20 MPa 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.

Conventional timber or steel formwork is used to form the edge of the slab. Specific shear keys provide resistance to horizontal loads (earthquake or wind).

To assist installers, Firth Industries has an optional instructional video that shows the basics of installing the system.

Supply

[remove, replace or add]

The components of the system are only available through Firth Industries, distributors of Firth Industries and 1 (registered) installers of the system. The components are designed to ensure that the system is constructed in the correct manner by only allowing one method of construction. These components are:

Raftmix and Raftmix Pump concrete
Polystyrene RibRaft waffle pods
RibRaft rib and edge beam spacers
Polystyrene RibRaft shear key supports

Other necessary components of the system available from general building material suppliers are:

Reinforcing steel 2 ((Grade 430 and Grade 300 as applicable) complying with NZS 3402:1989 "Steel Bars for the Reinforcement of Concrete").
665 Reinforcing mesh complying with NZS 3422:1975 "Welded Fabric of Drawn Steel Wire for Concrete Reinforcement".
Mesh chairs (40mm).
Sand complying with the requirements of Section 7 of NZS 3604:1999.
Damp proof membrane (DPM) complying with the requirements of Section 7 of NZS 3604:1999.

Handling and Storage

No specific precautions are required with respect to handling or storage of the RibRaft components.

Design Information

General

Standard designs for construction that fall within the scope of this appraisal are provided in the RibRaft Manual.

B1 Structure

The system when used and installed in accordance with the designs in the RibRaft Manual, will meet the requirements of the New Zealand Building Code clauses B1.3.1, B1.3.2, and B1.3.4 for B1.3.3 (a), (b), (f), (g), (h), (j), (m), (p) and (q) i.e. for loads arising from gravity, earthquake, snow, wind, human impact, differential movement, influences of non-structural elements and contents, and creep and shrinkage.

B2 Durability

The system will meet the provisions of the New Zealand Building Code clause B2.3.1(a) provided the concrete construction conforms to NZS 3109:1997 "Concrete Construction". The RibRaft Manual provides specific instructions in this regard and floor slabs

installed in accordance with those instructions will comply with that standard.

The system does not require maintenance to ensure ongoing compliance with the durability requirements of the building code. However, in common with all concrete slab-on-ground construction, property owners should ensure that large trees are kept sufficiently far away from the edge of the slab as to prevent the tree roots from disturbing the soil moisture conditions under the slab. As a guide, trees should be as far from the edge of the slab as they are tall when fully grown. The property owner shall also ensure that the ground level around the system is maintained so that it is never below the bottom of the system. This can be ensured by paving or landscaping around the building.

E2 External Moisture

The construction details follow the practice of NZS 3604:1999 with respect to ensuring against damage to building components as a result of external moisture entering through the concrete slab, and meet the requirements of the New Zealand Building Code clause E2.3.3.

The finished floor level of the system above the ground level must meet the requirements of NZS 3604:1999. These are easily met by the standard construction details, but property owners must ensure that subsequent landscaping does not compromise these clearances.

Installation

Installation of the system must be as detailed in Section 2 of the RibRaft Manual. The special rib and edge beam spacers provide for reinforcing steel to be retained in the correct positions. The steel bars then provide weight to hold the waffle pods in place while concrete is placed.

It is very important that the sand bed is accurately levelled, as this establishes the height of the pods and the concrete cover to the reinforcing mesh.

All shear keys must be poured on top of Firth's 100 mm thick polystyrene Shear Keys Supports.

Basis of Appraisal

Structural calculations were carried out by Opus International Consultants Ltd. Loadings were derived from NZS 4203:1992 "General structural design and design loadings for buildings" and concrete materials properties from NZS 3101:1995 "Concrete Structures Standard".

The capacity of the RibRaft system to withstand dead, live and bracing load conditions was established using a Microstran analysis of the slab, where the slab is

supported along lines of ribs and edge beams on a number of elastic springs representing the stiffness of the soil. Values of soil stiffness for different safe bearing capacity soils were determined from Stockwell's correlation of safe bearing capacity with Scala penetrometer readings, and derivation of soil elastic stiffness from Scala penetrometer readings by a combination of Stockwell (1977) and Bowles (1988).

The construction requirements of NZS 3101:1995 were used to establish the durability of the system. The design of the system to withstand inputs from bracing panels has been based on a comparison with the foundations in NZS 3604:1999 and NZS 4229:1999 "Concrete Masonry Buildings not Requiring Specific Design".

The construction details to ensure compliance with respect to external moisture were compared with Acceptable Solution E2/AS1 Section 4.2.

Other Investigations

Opus International Consultants have viewed site installations that demonstrate the workability and practicality of the system. Opus International Consultants also examined the factory production of the components and ongoing quality assurance. The manufacture of the concrete, which is to NZS 3104:1991 "Concrete Production - High Grade and Special Grade" has been examined by Opus International Consultants.

As at April 2000, there had been at least 1500 buildings built using the system. No problems had been encountered in the construction or performance of these floors.

Sources of Information

- NZS 3101:1995 "Concrete Structures Standard"
- NZS 3104:1991 "Concrete Production - High Grade and Special Grade"
- 3. [NZS3104:2003 "Specification for Concrete Production"]
- NZS 3109:1997 "Concrete Construction"
- 4. [NZS 3402:1989 "Steel Bars for the Reinforcement of Concrete"]
- 4. [NZS 3422:1975 "Welded Fabric of Drawn Steel Wire for Concrete Reinforcement"]
- 4. [AS/NZS 4671 "Steel Reinforcing Materials"]
- NZS 3604:1999 "Timber Framed Buildings"
- NZS 4203:1992 "General structural design and design loadings for buildings"
- NZS 4229:1999 "Concrete Masonry Buildings not Requiring Specific Design"
- Firth RibRaft Floor System Manual, May 2000
- The Building Regulations 1992.
- New Zealand Building Code Handbook and Approved Documents, Building Industry Authority, 1992.
- Joseph Bowles, Text book: "Foundation Analysis And Design" 1988

M. J Stockwell, paper: "Determination Of Allowable Bearing Pressure Under Small Structures" NZ

engineering 1977

Conditions of Appraisal

The Appraisal will remain valid subject to the following:

1. The product continues to comply with the manufacturing specification and quality measures of Firth Industries Ltd. These specifications and quality assurance measures are as viewed and approved by Opus International Consultants.
2. The system complies with the conditions of this Appraisal and with the RibRaft Manual.
3. Firth Industries Ltd continues to have the product reviewed by Opus International Consultants every two years from the date of issue.
4. The overall quality and expected performance of the product is maintained. Firth Industries Ltd shall notify Opus International Consultants of any changes in specification or quality assurance measures prior to them coming into effect.

Opus International Consultants is satisfied that the calculations, documentation and performance in use show the Firth RibRaft Floor System is fit for the purpose for which it has been appraised.



Appraisal Manager
for Opus International Consultants Ltd
Date: May 2000

Appraisal revised in March 2005
to remove any reference to H1 Energy Efficiency

Enquiries about the current status or technical aspects of this Appraisal should be made to:

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The opinions expressed in this Appraisal relating to compliance with the New Zealand Building Code are in respect of the New Zealand Building Code in force at the date of issue of this Appraisal.