



Best Practice Guide for Placing and Finishing Steel Fibre reinforced concrete for Firth RibRaft Floors

Introduction

This document has been prepared to provide guidance to the installers of steel fibre reinforced concrete in Firth RibRaft flooring options. The mix code commonly used in this situations being RP2519TC2 or RP2519TC3. These mix codes have been specifically formulated to have high workability (slump) and sufficient paste content to assist in the embedment of the steel fibres. However, like any concrete floor construction, it is important that good placing and finishing practises are followed to ensure a fit for purpose end product.

Also provided is a realistic expectation of the finished surface.

Site/earth works

The building footprint shall be excavated to a suitable depth to ensure all organic material is removed (top soil, roots etc). Excavation shall extend beyond the footprint a distance shown on the drawings which is typically twice the depth of compacted hardfill beneath the concrete slab. Precautions shall be taken to prevent silt laden runoff from leaving the site should rain occur.

Sub-base/subgrade

Excavated material shall be replaced with hardfill material compacted in maximum layers of 150 mm or as specified by the design engineer. Refer specific project drawings/specification for minimum hardfill layer under slab. A blinding layer of 0-5 mm sand or crusher dust shall cover base material to a maximum thickness of 25 mm (for final hand screeding). The finished level of compacted hardfill shall be determined specifically by the designer for each site. The subgrade/sub-base should be inspected by the design engineer when this is a condition of the building consent, or where concerns exist that the ground conditions are not those implied by the design.

Formwork setup

Perimeter shutters shall be set to profiles or string lines with top edge at FFL. Setting level of shutters must allow for variation across prepared base and final hand screed of sand blinding layer (to +/- 5mm). Shutters shall be adequately braced to ensure minimal movement occurs under full load of wet vibrated concrete and construction loadings. Forms shall prevent the leakage of grout at joints which can result in a boney surface finish. For TC3 solutions, where a base slab is provided, the perimeter forms shall have nails, cleats, chalk lines or other suitable guide level indicators placed to allow base slab screeding to determined level (typically 180 mm).

Base slab setup and pouring (TC3 solutions)

Where specified on the drawings, 2-HD12 off cut rods are provided at re-entrant corners, securely locate trim bars and ensure movement does not occur during base pouring operation.

The base slab shall be conducted in a single pour and use Firth Raftmix TC3 steel fibre reinforced mix (RP2519TC3). Raftmix TC3 concrete is designed to have a moderately high slump (140-170 mm at site) to aid ease of placement, pumping and surface compaction of steel fibres. As provided in NZS3109 up to 10 litres/m³ water may be added to bring concrete to the design slump however this is only permitted when the concrete is less than 60 minutes old and the design slump is not exceeded. The addition of water shall always be noted on delivery docket.

The general process of placing and compacting is described on the attached poster number 3 produced by the Cement and Concrete Association and the NZ Ready Mixed Concrete Association. For concrete containing fibres it is important that the slab is thoroughly vibrated as this assists in bringing the cement paste to the surface and hence burying the fibres. Immersion or hand held vibrating screed shall be used over the full slab area.

The base slab shall be poured, raked, screeded, bull floated, pole trowled and finished with a light broom finish. Kelli floating may be appropriate to ensure surface is finished to +/-3 mm. The brooming process is important to ensure an appropriate coefficient of friction exists between the base slab and releveable TC3 floor. The process of brooming will expose some fibres on the surface. Any fibres which could damage the overlying polythene should be snipped at the base slab surface.

As the base slab is not being hard trowled, it is potentially more susceptible to plastic shrinkage cracking in warm and/or windy conditions. Steps shall be taken to reduce risk of plastic cracking (ie water misting or use of aliphatic alcohol sprays).

If more than 3 days will lapse between setup of top raft slab and base pour, steps must be taken to aid curing of base slab (water, curing spray, polythene etc).

Shrinkage control saw cutting is not normally specified for base slab.

Top slab setup (TC2 or TC3)

Setup of the RibRaft TC2 or TC3 top slab is largely common to standard RibRafts with the exception that the TC2 and TC3 versions are more heavily reinforced and the TC3 version includes RaftJacks. TC2 and TC3 RibRafts will most commonly use a steel fibre reinforced concrete mix (RP2519TC2 or RP2519TC3). For decorative concretes with honed finishes a non-fibre reinforced concrete mix may be specified however the ribs and beams will require shear reinforcing (stirrups). The steps shown below are a guide only, and variations are permitted provided good construction practices are followed and the finished setup top slab complies in all respects to project specific drawings and details. For TC2 installations ignore the references to Raftjacks.

1. Check surface to ensure no protrusions exist which could damage polythene.
2. Roll out polythene DPC over base slab and tape joints as per NZS3604. Any localised overcuts or tears shall be repaired with polythene tape.
3. Setup string lines (at FFL height) or place chalk lines on base slab locating principal centrelines of Raftjacks and foundation beams.

4. Cut polythene in a square just larger than the baseplate of the Raftjack at RaftJact locations (where applicable)
5. Install Raftjacks on baseslab. Raftjacks shall be fixed to base slab using split drives (Ramset 6 mm dia x 75 mm long-zinc-6.5 mm drill diameter-substitution of split drives is not acceptable). Position of Raft jacks shall be +/- 10 mm of the theoretical location as shown on specific project drawings. Floor contractor to double check that Raftjack positions do not collide with internal fit out or plumbing (use alternative Raftjack location as shown in project drawings if required). If localised base slab level variations exist, a light grind or surface rubbing may be needed to provide a level and even bearing for the Raftjack. The verticality of the plastic barrel of the Raftjack shall be checked once fixed with small handheld spirit level to ensure vertical accuracy.
6. Place square of DPM with hole to allow for raftjack stem and tape to Raftjack base plate. DPM square to overlap DPM by 200mm and taped as per NZS3604.
7. Laser or dumpy level shall be used to locate the exact top level of the Raftjack. Base slab level variations may require individual jack adjustment (up / down). Raftjacks can provide for 10 mm total vertical adjustment (+/-5 mm).
8. Pods shall be laid out and glued to polythene (TC3 version only) exactly as per project pod layout drawing. Solvent based glues shall not be used. Pod location is crucial and must not be modified from layout shown on project drawing without approval from slab designer. As pods and spacers are placed ensure perimeter spacers are in correct orientation to position perimeter beam bars avoiding Raftjacks and other obstacles.
9. Prior to placing reinforcing, check that correct grades (500E) and diameters on site. Place bottom layer reinforcing bars to perimeter, internal and rib beams. All internal beams (excl 100 mm ribs) to have 300 mm 90 degree hook when terminating at perimeter beam. All laps to be minimum 60 x bar diameter (ie 720 mm). All other details refer specific project drawings.
10. Plumbing (and other cast in services) shall be fitted by cutting into pods and running to perimeter forms at specified falls. Localised cranking of beam reinforcing bars is permitted as per standard Ribraft details and shown on project drawings. Under no circumstances shall any bars be terminated at services or movement of Raftjacks without the written permission of the slab designer.
11. Top reinforcing and mesh shall be placed and fixed securely to provide top cover as required on project drawings (typically 30 mm). Cranked spacer DH12 bars are recommended at perimeter to ensure support of top bars under mesh (weight of mesh, bars and wet concrete causes top reinforcing to sag past the support of the mesh chairs on perimeter pods). R6 spirals around Raftjacks to be wound in once mesh is trimmed and fixed and tied to mesh.
12. Mesh chairs shall be used in sufficient numbers to ensure top reinforcing stays in correct position under construction and wet concrete loads. Lower height setting of mesh chairs may be required in vicinity of laps/joints of mesh sheets to ensure top layer of mesh at laps is at correct height.

13. Re-check levels of mesh and Raftjacks with laser/dumpy level to ensure correct height position.

Pouring/placing

Firth concrete mix RP2519TC3 for TC3 systems and RP2519TC2 for TC2 systems is most commonly specified. This mix is designed to have a suitable strength at a higher slump (target 140-160 mm). The mix also incorporates additives to provide shrinkage control and shear resistance (includes steel fibres). Pumping concrete is the recommended method of delivering the fresh concrete to the work face. Other methods of delivery may be suitable however approval from Firth or project engineer is required. For placing and finishing guidelines refer below and to CCANZ's posters number 3 and 5.

1. It is generally preferable to start pour at the garage (allows a harder, flatter finish), and work away. Controlling the flow from the pump nozzle is crucial, and in no circumstances shall concrete pressure be directed between and under pods. If pods lift during pouring, the pour shall be aborted and concrete cleaned out.
2. Follow behind pour face with immersion (spud) type vibrator to all concrete (beams, ribs and top slab). A hand held vibrating screed may be used to reduce the appearance of fibres at the finished surface. Adequate vibration is **essential** to ensure structural integrity and settlement of fibres beneath the finished surface.
3. Care must be taken around Raftjacks to ensure damage, or movement does not occur. Under no circumstances shall Raftjacks be stood on or levered against. If movement or damage is noticed during pouring, pour shall be halted, concrete dugout and Raftjack securely reinstated.
4. Following vibration, normal concrete finishing techniques shall be carried out (refer poster number 5). Screed off concrete using normal screeding tools or vibrating screeds. Bull float to push down aggregates and fibres left at the surface during the screeding operation. An extra pass or two with the bull float is recommended in order to get 2-3mm of paste at the surface of the concrete to cover the fibres and coarse aggregate. Finish the edges with steel trowel and the interior of the slab surface with troweling machines. With Steel fibre reinforced floors better results (less fibres on the surface) are typically achieved when the final troweling is started slightly later than normal. Any fibres present in the final trowelling phases shall be picked out and inprint finished over. It is important that final troweling does not commence until all the bleed water has evaporated as premature commencement of troweling can lead to surface delamination or dusting. Plastic caps of Raftjacks shall each be re-located if finishing process has formed film of slurry over top. Caps shall be scraped and wiped clean to provide ease of location.
5. Hot and/or windy conditions present during pouring/finishing require steps be taken for the protection of the concrete to prevent plastic cracking. Protection measures include:
 - a. Aliphatic alcohol sprays

- b. Water vapour misting over surface (ie from water blaster directed upward, and wind carrying mist over slab surface)
 - c. Positioning wind breaks
- 6. Curing the slab is crucial to ensure strength gain of concrete and protection from early age cracking. Suitable methods of curing include:
 - a. Water spraying/ponding
 - b. Curing membrane sprays
 - c. Polythene covering
- 7. If environmental conditions forecast greater than 12 degrees variation of day time to overnight temperatures, then measures to protect slab from thermal shock shall be employed, these include:
 - a. Planning the pour time to minimise the temperature variations the concrete will experience.
 - b. Covering surface with fabric, plastic covers or polythene.

Most often, shrinkage saw cutting of top slab is not required. However sometimes the shape and sizes of floor plan will require cuts to control shrinkage and movement, refer project drawings for requirement or placement.

Forms shall not be struck on the day of the pour, and consideration should be given to leaving forms in place for 2-3 days following pour in very cold or shaded locations.

Saw cutting

For most TC2 and TC3 designs the floor is not saw cut. The reason for this is that the mesh in these floors has an important structural function. It is perceived that it is preferable to have some random cracking than it is to risk accidentally cutting the mesh. It is important that the designers explain this to potential customers. However, the depth of the RibRaft flooring system, the levels of reinforcement, and the combination of mesh with fibres, typically means that when/if drying shrinkage cracks form their widths are narrow.

Finish expectations

The Building Amendment Act 2013 introduced new consumer protection measures which became effective on 1 January 2015. MBIE are in the process of developing guidance to the industry on what constitutes a defect and the definition of acceptable/unacceptable defects. Early drafts of the MBIE guidance document suggest that for a concrete floor it is recognised that some cracking in concrete is common and not necessarily a sign of poor workmanship. Provisional suggestion by MBIE are that that cracks up to 0.5mm wide are acceptable provided the cracks do not increase in width.

It is also recognised that the levelness of the floor is important. NZS3114 requires an even plane within $\pm 5\text{mm}$ for every 3m direction for a carpeted floors and $\pm 3\text{mm}$ for tiled and vinyl floors. Individual mounds should be less than 3mm high and depressions less than 3mm deep. In addition no abrupt deviations greater than specified in NZS3114 should exist.

Visible reinforcing or bony concrete should not exist along the slab edge.

Concrete is a natural material and shade variation can be expected. Often slight colour variations will fade with time.

This document provides guidance on the placing and finishing of fibre reinforced concrete with the aim of minimising the number of fibres which are exposed on the upper surface. Fibres on the surface do not pose a structural or durability issue, however with a 200m² floor slab there will be approximately 1 million fibres within the body of the concrete so some fibres on the surface can be expected. Sometimes the fibre can appear after a period of time when minor erosion of the surface occurs due to wear. However good vibration, bull floating and troweling can usually result in very few fibres being present on the surface.

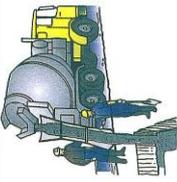
Should fibres be visible, and this raises concern, the fibres can typically be remove using pliers and the imprint then filled with a cementitious putty such as Dricon High Strength Superset which is available in 6kg pails.

PLACING AND COMPACTING

PLACING

- Make sure you can see what you are doing
 - Lights may be needed for thin and/or deep formwork
- Concrete mixers, skips and pumps can easily place the concrete exactly where it is needed
- Make sure that you order the right type of concrete with the correct slump for your placing method because you should not add water to a mix on site
 - A different type of concrete is used for pumping than is used for placing with a skip for example
 - Only small amounts of water may be added to a mix on site to make up for loss of water during travel, and may only be authorised by the Ready Mix supplier
- Placing must be done at the correct speed
 - Too fast and the compacting gang will not be able to keep up
 - Too slow and the mix will stiffen making compaction very difficult
- Concrete should be placed in layers to make sure that it is compacted properly
 - With poker vibrators the layers shouldn't be deeper than the length of the head
 - With vibrating beams layers shouldn't be deeper than 150 mm
- When dropping concrete from a height use tubes and/or baffle boards to prevent damage to the formwork

1 CONCRETE MIXERS CAN PLACE THE CONCRETE EXACTLY WHERE IT IS NEEDED.



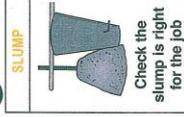
2 TUBES ATTACHED TO SKIPS CAN AIM THE CONCRETE IN THE RIGHT DIRECTION.



3 CONCRETE PUMPS CAN MOVE THE CONCRETE LONG DISTANCES TO WHERE IT IS NEEDED.



4 SLUMP



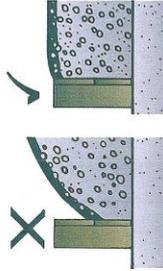
Check the slump is right for the job

ON SITE

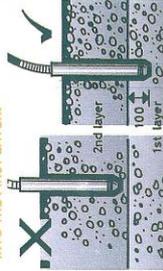
Site workers must NOT add water to the concrete

Ready Mix suppliers may add up to 10 litres/m³ to adjust the slump

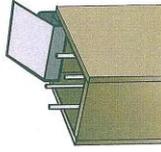
5 DON'T PLACE CONCRETE IN PILES BUT IN FLAT, EVEN LAYERS.



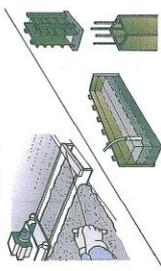
6 DON'T MAKE THE SECOND LAYER TOO THICK. THE POKER MUST GO 100mm INTO THE FIRST LAYER.



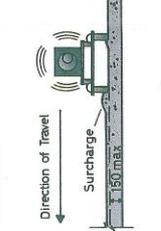
7 Baffle boards protect the formwork from being damaged by dropped concrete.



8 FOR THIN SLABS USE A BEAM VIBRATOR. FOR COLUMNS, WALLS AND THICK SLABS USE POKER VIBRATORS.



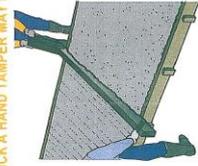
9 ALWAYS HAVE A SURCHARGE OF CONCRETE IN FRONT OF ANY BEAM VIBRATOR.



10 DOUBLE BEAM VIBRATORS REQUIRE NO FINISHING ON SOME JOBS.



11 FOR SMALL JOB SLABS UP TO 100mm THICK A HAND TAMPER MAY BE USED.



12 POKER VIBRATORS SHOULD BE USED ALONG THE EDGES OF SLABS WHEN COMPACTING WITH A BEAM



COMPACTING

- Air is always trapped in concrete when it is being mixed.
- The aim of compaction is to remove as much of this air as possible.
- Why does getting rid of the air matter?
 - Air holes reduce the strength of concrete.
 - If you don't compact concrete, it may only be half as strong as it should be.
 - Air holes in the concrete stop a good bond forming between the concrete and the reinforcing steel making the structure weaker.
 - Large air holes can cause ugly marks on the surface.
- Use the right compaction equipment for each job.
 - Poker vibrators for beams, columns, walls and deep slabs.
 - Beam vibrators for thin layered slabs.
 - Clamp-on vibrators can be used on special formwork, especially in the precast industry.
- Always have spare compacting equipment in case of a breakdown.
- For more information on the use of poker vibrators see Poster No 4 "Using a Poker Vibrator".



THE NEW ZEALAND
READY MIXED
CONCRETE
ASSOCIATION INC.

SAFETY ON SITE: Suitable protective clothing should be worn when handling wet concrete

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Cement & Concrete Association of New Zealand

METHODS OF FINISHING CONCRETE

PLANNING

Labour Resources

Make sure you have enough labour for the job size. Typical finishes have the following labour output production.

Floating

- Wood float - 3 to 4 m²/hour
- Hand steel float 3 to 4m²/hour
- Power float - 6 to 8m²/hour

Power Trowelling

- 1 pass - 6 to 8m²/hour
- 2 passes - 10 to 12 m²/hour

Equipment

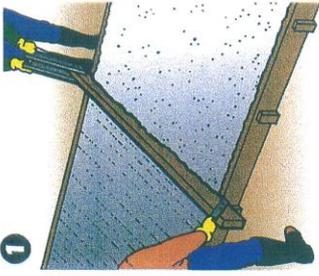
Make sure you have enough equipment for the job. Make sure you know where to get replacement gear for power equipment.

Typical gear list:

- Square Mouthed shovels.
- Concrete Rakes
- Straightedge
- Edging trowels
- Power Finishing
- Float
- Trowel
- Hand finishing
- Bull float
- Wood float
- Steel Trowels
- Special broom to suit a textured finish.
- Special finishes: you will need to check you have all the special gear, such as imprinting stamps, etc.

WEATHER

- Do not concrete slabs that are exposed to the weather if rain is forecast. It is virtually impossible to repair a rain-damaged surface.
- Have some sheets of polythene available to cover the slab if you do get caught by a shower of rain.

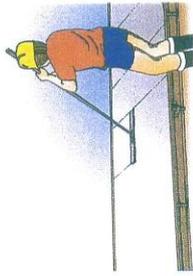


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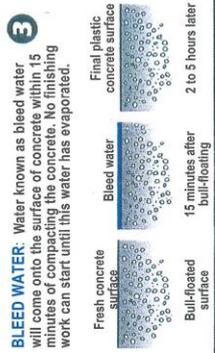
SCORED FINISH (U1): This is the simplest finish to produce - the surface is formed with a hand tamping beam during the placement and compaction of the concrete.



2



FLOATED FINISH (U2): Concrete surface being levelled with a "bull float". On the forward stroke the float is pushed with the handle lowered, on the returns stroke the float is pulled with the handle raised.



3 BLEED WATER: Water known as bleed water will come onto the surface of concrete within 15 minutes after finishing. The finishing work can start until this water has evaporated.

4 WAITING TIME

- Winter**
- In cold weather the waiting period could be up to 5 hours.
 - The wetter the concrete, you use the longer the wait.

Summer

- In hot weather, the waiting time could be two hours.
- If it is drying faster than two hours, then plastic surface cracking is likely to occur.
- To stop the rapid drying, mist spray with water or an aliphatic alcohol special mixture onto the plastic surface of the concrete. This should extend the drying time to 2 hours which will allow time for excess water layers to escape through the still plastic upper surface.



6

POWER FLOATING a slab surface.

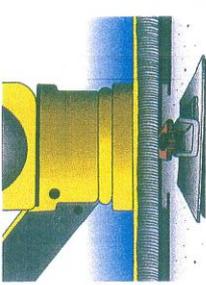


7

HAND TROWELLING: The finish near edge is improved with steel hand trowel.



8



POWER TROWELLING can start when the surface has dried and is not sticky to the palm of the hand. The close-up view is of the trowel blade lifted during final stages.

THE PROCESS

- The basic steps are shown in the numbered sequence 1 to 8.
- There must be a waiting period for bleed water to evaporate from the slab surface.
- Be warned that in the summer, evaporation can be too rapid leading to plastic cracking.
- In the summer, surface stiffening may still leave the lower parts of the slab in a plastic state. This can lead to problems of a rolling surface while trying to finish.
- As soon as the concrete has hardened enough to avoid surface marking, usually after 2 passes of steel trowelling, start the curing process, using for example a membrane spray. See Curing Poster No 6

TYPES OF FINISHES

Make sure you understand the specification requirements in NZS 3114 before you start. The finish designations in NZS 3114 are:

- U1** Scored Finish - see Step 1
- U2** Floated Finish - typically bull floating after the U1 finish.
- U3** Trowelled Finish - developed from a U2 finish after bleed water on the surface has evaporated.
- U4** Vibrating steel beam - surface left untouched from beam.
- U5/6** Broom finishes - different textures.
- U11** Early Age Grinding - usually applied to a U2 finish 36-48 hours after completing.

Note: there are other special finishes in NZS 3114; those using the letter E are Exposed Aggregate finishes.

SLAB PROTECTION

- Have the curing process decided before you start the job - See Curing Poster No 6
- In summer, make sure you can apply a mist spray of water or a special aliphatic alcohol to slow down the surface evaporation of water. This is very important with special concretes often used on commercial/industrial floors.
- In winter or in summer where there can be a big change in temperature between day and night, make sure you cover the slab.



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