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British Precast
Flooring Federation

Application Guide for the Specification and Installation of Concrete Toppings to Beam & EPS Block Suspended Floors

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Forward

The aim of this application guide is to provide a central source of information relating to suspended beam and EPS flooring systems. It should be read in conjunction with the independent third party assessment relative to the floor system which is being considered.

General note: this guide has been produced assuming micro fibres will only be allowed on NHBC sites when used in a non-structural capacity (refer to section 1.4).

Contents Page

1. Reinforcement type

There are four types of reinforcement that may be used in any of the floor systems covered by an independent third party assessment such as a BBA or BDA / KIWA certificate. A concrete slab cast in accordance with these recommendations satisfies the requirements of the NHBC Standards.

1.1 Macro polymer fibre

Macro polymer fibres provide post cracking flexural strength to the concrete and can be used with all types of infill blocks between the beams. Typical dimensions are 40 - 50mm long fibres with diameters of 0.30 to 1.0mm diameter complying to BS EN 14889-2. Accepted products are stated on the relevant third party assessment certificates for each flooring system. It should be noted that some macro polymer fibre products are supplied pre-blended with micro fibres to provide additional robustness. These products are identified on the relevant third party assessment certificates for each flooring system.

Figure 1 – macro polymer fibres

1.2 Steel fibre

Steel fibres provide post cracking flexural strength to the concrete and can be used with all types of infill blocks between the beams. These types of fibres are common place in self-compacting concrete. Typical dimensions are 30 to 60mm long with diameters 0.6mm to 1.0mm in compliance with BS EN 14889-1. It should be noted that some steel fibre products are supplied pre blended with micro fibres to provide additional robustness. These products are identified on the relevant third party assessment certificates for each flooring system

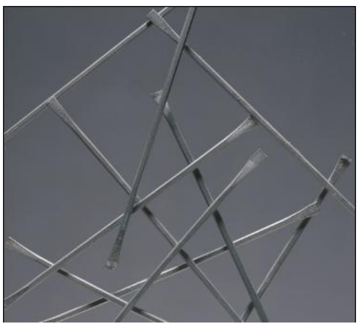

Figure 2 – steel fibres

1.3 Welded steel fabric reinforcement

Welded steel fabric complying to BS 4483 may be used with the concrete topping and can be used with all types of infill blocks between the beams. The minimum requirement shall be A142 mesh placed at mid height of the slab using a suitable chair system. Open ended fabric (flying ends) is recommended to overcome build up when overlapping mesh. Alternatively the fabric can be butted together and lapped using loose bar with the minimum lap being 40 x the diameter of the reinforcement bar. Please note that it is not recommended to walk on the mesh once placed and care shall be taken to avoid the risk of trips and falls.

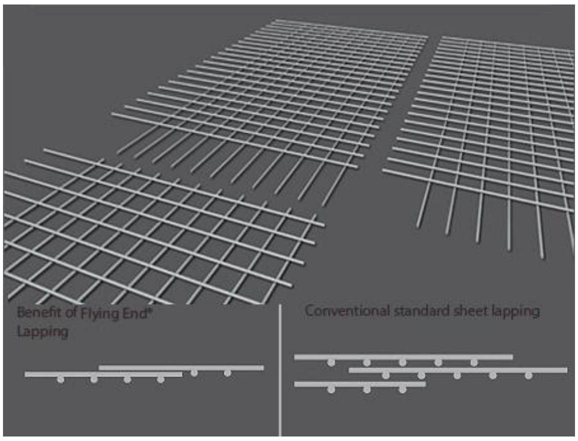

Figure 3 – open ended welded fabric

1.4 Micro fibre

When a resisting type infill block (type R2 to BS EN 15037-4) is used between the beams then micro fibres may be used to enhance the performance of the non-structural screed. When using non–resisting type infill blocks (type R1 to BS EN 15037-4) it may still be possible to use micro fibres on non NHBC sites subject to the appropriate design checks. The minimum requirement for micro synthetic fibres in non-NHBC sites shall consist of 12mm long (minimum), 22 microns diameter (minimum) monofilament polypropylene fibre at a minimum dosage of $0.91kg/m^3$ complying to BS EN 14889-2. Accepted products are stated on the relevant third party assessment certificates for each flooring system.

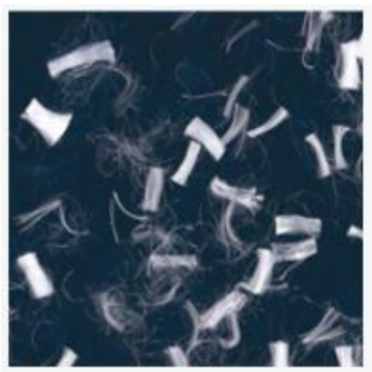

Figure 4 – micro fibres

2. Concrete type

Two types of concrete are typically used to form the topping above the beam and EPS block system. In both cases the minimum strength class is C25/30 and should ideally have a minimum sand content of 47.5% to aid the placement and finishing of the concrete. Concrete shall be a designed concrete conforming to BS 8500-2.

2.1 Standard concrete

Ideally the maximum aggregate size should be 10mm but up to 20mm can be used. The recommended consistence class is not less than S3 (100[90] – 150[170]mm), but preferably S4 (160[150] –210[230]mm). The higher consistence class minimises the temptation for site operatives to add uncontrolled water on site, which may result in excessive bleeding, segregation, surface dusting and poor quality surface finish.


Figure 5 – slump test

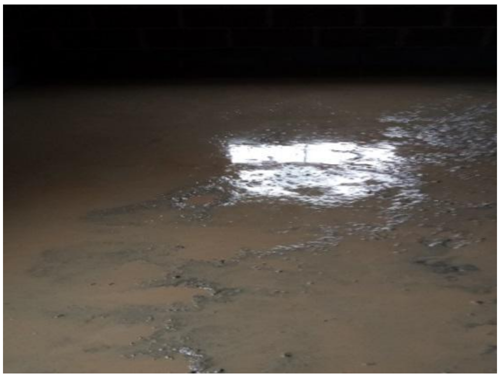
Figure 6 – excessive bleeding

2.2 Self-compacting concrete (SCC)

The maximum aggregate size for this type of concrete should be 10mm with a slump-flow class of SF1 (550 to 650mm) or SF2 (660 to 750mm).


Figure 7 – slump-flow test


Figure 8 – slump-flow test

3. Batching requirements

Two methods of batching are used in producing concrete; dry batching and wet batching. In either case the fibres can be supplied in specialist bags that dissolve within the concrete. The fibres should be added as per manufacturer's instruction, where no specific guidance is available general guidance is given below. Should a concrete be specified with a blend of micro and macro/steel fibres it is recommended that the micro fibres are added first with approximately a third of the added water and ideally part of the sggregate. This allows the fibres to be evenly distributed within the concrete prior to adding the macro/steel fibres.

3.1 Dry batching

All the constituents excluding the fibres should be loaded into the truck mixer with enough water added to achieve a target slump of 70mm. The truck should then mix the constituents for a minimum of five minutes until the concrete mix is in a consistent uniform state. The fibres should now be added to the truck mixer at a rate of one bag per 30 seconds along with the remaining water to achieve the required consistency and mixed at full speed for another five minutes.

3.2 Wet batching

All the constituents including the fibres should be added to the plant mixer. The bags of fibres can be added directly into the plant mixer via the inspection hatch on the top or by placing the bags on to the conveyor belt at a rate of one bag every 30 seconds.

4. Environmental window

4.1 Min and max temperatures

Unless special precautions are taken the minimum air temperature that concrete can be placed is 3.0°C and rising, i.e. the temperature is predicted / forecast to increase throughout the day. However, the temperature of actual concrete should be above 5.0°C at the time of placing. It should be noted that the temperature on site may differ from the temperature at the batching plant. Any concrete that is placed below this temperature is at the risk of the contractor. The maximum air temperature that the concrete shall be placed is 30°C and decreasing, i.e. the temperature is predicted / forecast to start to decrease. The advice is to cast concrete in the early part of the day during winter months and at the end of the day on very hot summer days.

4.2 Rain

Concrete should not be poured during rainfall it will have a detrimental effect on the aesthetic appearance of the finished concrete and can cause fibres to be present on the surface (Figure 9). If rain is forecast then a protective cover shall be placed over the concrete immediately after placement. If concrete is to be poured after rainfall then it is imperative that any water which has pooled on top of the membrane (Figure 10) is entirely removed.

For small amounts of water a squeegy / mop and bucket may be used or if the plot is flooded then a pump may be requried.

Figure 9 – rain damage

Figure 10 – pooled water

4.3 Overnight frost

If the concrete is placed and frost occurs overnight then the concrete can be damaged due to ice crystals forming within the concrete causing micro-cracking and surface scaling. At low temperatures the hydration process will be slowed, resulting in lower strength gain or no strength gain at all if the temperature is near freezing. In this event, the concrete will need to be removed and the slab re-cast. If the concrete is to be laid during cold temperatures and special measures taken then a thermocouple and data logger should be used to record the temperature.

Figure 11 – frost damage

4.4 Effect of wind

The effect of wind passing over the surface of the concrete should not be overlooked as this can have a significant detrimental impact on the quality of the concrete slab. For example a prolonged warm breeze can result in the surface of the concrete drying out too quick and result in the formation of surface cracks. The use of effective curing practices will help prevent cracking through premature drying.

5. Membrane

A membrane under the slab may not always be required but should be considered. However, where a membrane is specified then the following should apply.

Placing a damp proof or gas resisting membrane under the concrete topping can provide a slip plane which can help mitigate against shrinkage cracks. The membrane shall be pulled sufficiently tight to ensure that any folds or ripples are removed and the membrane lies smooth and flat over the floor construction below. Creases in the membrane can act as crack inducers and must be avoided. In addition care needs to be taken to ensure the membrane follows the profile of the perimeter wall so that there is full depth concrete at the edges. It is recommended that the membrane is weighted down to prevent it moving in the event of strong winds. All service openings penetrating the membrane shall be suitably taped to prevent loss of concrete. All joints shall be lapped by 300mm (minimum) and taped.

Figure 12 – membrane in place

6. Finishing methods for the concrete

Various methods are available depending on the type of concrete being used and the required finish. For self-compacting concrete the requirement is to dapple the concrete (Figure 13) to allow it to form a uniform depth and surface finish. For S3 and S4 slump class concrete the concrete needs to be compacted and levelled out. The best method of achieving this is to use a razorback or vibrating beam to tamp the top surface. A powered roller beam (contra-rotating) can also be used for this same purpose as well as a vibration screeder (magic screed). The surface can be power floated once it has hardened sufficiently.


Figure 13 – dappling the SCC concrete

Should any macro polymer fibres still protrude from the top of the hardened concrete these can either be scraped off or burnt off taking all reasonable care so as not to compromise integrity of the residual topping. The simplest method to minimise protruding fibres is to pass over the concrete with a skip float whilst it is still in its fresh state to push down any fibres that are protruding. This is not normally required for steel fibres as they tend to lay within the concrete due to the greater self-weight of the individual fibre. However, should any fibres still protrude then these will need to be cut / snipped of.

7. Protection and curing of the freshly laid concrete

The recommended method is to apply a spray applied membrane forming compound used fully in accordance with the manufacturer's instructions or plastic sheeting to cover the concrete and retain moisture. If rain is forecast then polythene sheeting fixed to a frame should be placed over the slab with the polythene sheeting extending to cover the sides of the frame. If the concrete is to be power floated then the polythene sheeting can be simply laid over the finished floor and weighted down. If inclement weather is forecast the concrete should be protected for a minimum 48 hours. The slab should not be loaded until it is at least 7 days old but could be suitable for light foot traffic after 24 hours and can be worked on after 72 hours. Unevenly applied or insufficient curing agent can render it ineffective.


Figure 14 – curing agent applied

8. Joint construction / crack control

To prevent shrinkage cracks construction joints should be incorporated into the slab to restrict bay sizes. The appropriate positioning of joints should be determined by the structural engineers. The following recommendations should be considered:

- A maximum bay size of $40m^2$ is recommended
- The theoretical spacing of joints should be 40 x the depth of the concrete (in metres). However, due to the relatively shallow depth of the concrete the theoretical joint centres may not be practical to achieve on site
- An aspect ratio greater than 2:1 should be avoided, i.e. long thin slabs
- Where the internal walls are built through the slab then a joint should be formed across the door threshold where the wall separates the two rooms

A compressible insulating material around the perimeter of the plot is required by the Building Regulations to thermally isolate the floor slab from the external wall. However, this has another advantage in that it allows expansion and contraction of the concrete slab. Placement of a similar material is recommended along the edge of internal walls that are built through the slab and around service penetrations to prevent concrete from adhering to the walls and services, thus reducing the propensity of the concrete to crack at these locations. Depending if the internal walls are built through the slab or built off the slab will influence the joint centres. If the wall is built through the slab then it is recommended that there is a joint across the doorway to the internal rooms.


Figure 15 – perimeter detail

Where a re-entrant corner is present in the floor slab then diagonal loose bars or A142 mesh reinforcement local to the corner is recommended for fibre reinforced concrete. A minimum of two loose bars, 10mm diameter, 1m long shall be placed at 45^0 across the corner at mid height of the slab. If mesh reinforcement is to be used then a 500mm x 500mm corner shall be cut out of a 1m x 1m square section and placed at mid height of the slab. All reinforcement should be placed at mid height of the slab.

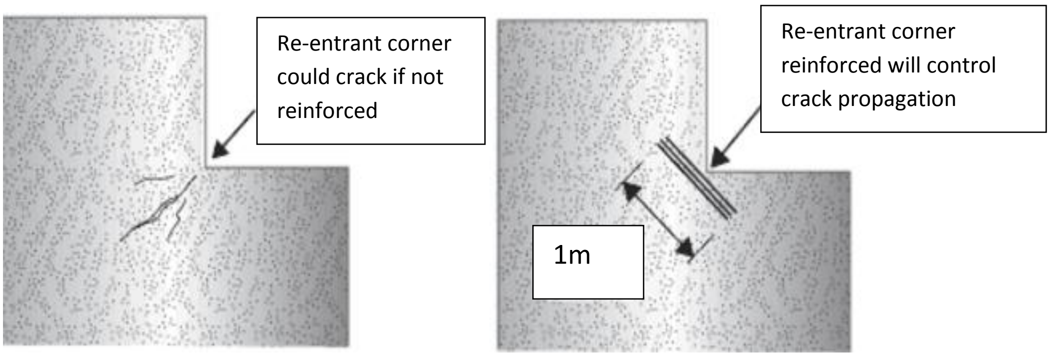

Figure 16 – re-entrant corners

Substructure walls that do not pass through the slab such as those used for a porch may induce hogging moments in the slab as it passes over the wall. Consideration should be given to these forces as they could cause cracking of the slab.

9. Procurement, traceability, record of concrete delivery with fibre type and dosage

It is important to procure concrete mixes for structural toppings and non-structural screeds in accordance with the beam and block floor manufacturer's technical literature or the floor designers specification. Copies of the delivery ticket need to be kept as this identifies the type of fibre, dosage, aggregate size, target flow / slump and strength of the concrete. This should be available for Building Control/Warranty purposes in order to demonstrate that the correct concrete specification has been placed.

10. What not to do!!!!

The following list is not exhaustive but includes the main areas to avoid. Further information is presented in the BRMCA document 'Ready-mixed concrete – Practical guide for site personnel'.

1. Do not add additional water to the concrete mix. Often fibre reinforced concretes look dryer as the concrete is more cohesive than non-fibre concrete. As such it appears that the concrete is too dry and that additional water is required to achieve the consistency. Don't be fooled by its appearance.
2. Do not cast the slab if the temperature is likely to fall below 5^{o}C during the curing period. For this reason avoid placing concrete on a cold winters afternoon.
3. Do not omit the spray on curing agent when it has been specified.
4. Do not try and power float concrete until it has reached sufficient hardness.
5. Do not pour the concrete on hot sunny days unless it is adequately protected.
6. Do not attempt to mix the fibres into the concrete when it has been discharged from the delivery truck.

Failure to consider the guidance contained within this document may result in the formation of cracks through the structural concrete topping as shown in Figure 17.

Figure 17 – large crack through the full depth of the hardened slab

11. Crack remediation

If cracking occurs, the significance of the cracks shall be assessed on the basis of their effect, if any, on the structural capacity of the floor and their potential to result in damaged floor finishes. This will depend on the type of in-fill blocks being used and crack width, orientation and position relative to the supporting beams. Cracks may be structurally repaired or the affected areas removed and re-cast. Remedial repair proposals for damaged structural concrete toppings should be agreed with the floor designer before being implemented.