Fibre-reinforced self-compacting concrete

The use of self-compacting concrete (SCC) continues to increase as both contractors and designers appreciate the many benefits that adopting such solutions can bring to a project. ***Simon Evans*** *of* ***Fibre Concrete Solutions*** *looks at its use with structural fibres.*

In many instances, SCC is adopted in areas where accessibility can be a challenge – either the physical pouring of concrete due to the congestion of reinforcement and the physical size of the pour area, or the ability to provide resources and equipment to place, compact and finish the concrete.

Further efficiencies can be made by replacing traditional reinforcement and adopting fibres to provide structural reinforcement and further enhance the qualities of the SCC.

On-site, the benefits of SCC are numerous. The fact that mechanical compaction of the concrete is not required reduces labour and equipment, so saving time and reducing costs. There is no need for further finishing works to be undertaken, resulting in reduction of noise and disturbance to other trades on-site or residential areas.

Fibres can be added to SCC in the same manner that would be used for standard ready-mixed concrete. The same testing regime is adopted in verifying the suitability of the mix, with a measurement of flow rate being taken, rather than slump tests used for regular ready-mixed concrete.

Like all concretes, specific mixes will be adopted based on the application, together with the materials available. The type and dosage of fibre that is added to SCC will depend on the end use and the performance required, based on all relevant parameters.

Applications that would benefit from the use of a fibre-reinforced SCC solution include:

- residential floors (beam and block)
- residential floors (insulated ground/ suspended slabs)
- screeds and toppings for precast floors
- precast applications
- foundations.

In these instances, the type of fibre and dosage will be critical to providing the necessary structural performance. All fibres should comply with EN 14889 Part 1 or Part 2[(1)]. Where the fibre is being used to enhance the load-bearing capacity of the SCC, it is important to ensure the appropriate fibre dosage is being specified. An easy check is to ensure that the dosage is equivalent or greater than that given on the individual fibre's declaration of performance (DOP) for its 'effect on strength'. This defines the CE compliance for the minimum dosage that meets structural performance levels

Above: Self-compacting concrete is easy to discharge and place.

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(where the reinforcement of the concrete is to enhance its load-bearing capacity). For example, Nexus 85 macro-fibres achieve structural compliance at a dosage rate of 2.5kg/m^3.

An engineer will be able to assess the fabric for either the bending moment or the direct tensile capacity. Performance of the fibre-reinforced concrete (FRC) is established through beam testing undertaken in accordance with EN 14651[2], which provides the residual flexural tensile strength of the FRC for either a steel- or macro-fibre solution, as required by EN 14889. This data can then be used in the appropriate design calculations adopting methodology outlined in publication, such as Concrete Society Technical Report 34[3], Technical Report 63[4] or *fib Model Code for Concrete Structures*[5].

Beam-and-block topping

Where SCC is used as a topping in beam-and-block floors, specific guidance is given in third-party certification, such as those published by the British Board of Agrément (BBA) and others. Here, characteristics for the SCC are specified regarding the strength, consistence and sand content.

Our own FCS certificates provide approval for both Zenith 60 steel fibres and Nexus 85 macro-synthetic fibres to be used in conjunction with all BBA-approved beam-and-block solutions – adopting SCC and complying with NHBC requirements.

Insulated ground/suspended slabs

As with the benefits for beam-and-block topping applications, SCC and fibres provide an ideal combination for ground slabs and insulated suspended slabs on ground for housing and small commercial/retail applications. The ease of placement, and the lack of time-consuming finishing operations and associated noise, make this combination ideal for housing, schools, shops and offices built in residential areas or where access is restricted to specific daytime hours. The type and dosage of fibres will depend on the structural requirements, design loading and spacing of joints, if applicable.

Topping on precast floors

The use of SCC as a topping for precast floors, should be considered a natural solution, especially when considering the issues of working at height. By combining SCC with fibre reinforcement and removing the need to crane and place fabric reinforcement, the complementary benefits of using both technologies can be realised. To enable a fibre alternative to be proposed as a replacement for traditional steel fabric, a detailed understanding of the design is required.

This will allow the designer to establish an equivalent performance between the FRC and the traditional fabric reinforcement.

Precast elements

Where in-situ bending stresses are minimal, SCC and fibres may be used to simplify reinforcement location and replace steel fabric used for crack control. Where applicable, removing all steel bars may permit thinner sections of FRC due to the removal of cover requirements to the bars. This is particularly applicable to exterior precast elements such as wall panels, feeding troughs

Slump-flow test.

and decorative planters. SCC and fibres may also be used in prestressed beams to improve resistance to accidental impact damage and even permit the replacement of shear reinforcement in I beams.

Footings

Mass concrete is often adopted for simple footings and trench solutions. Eliminating the need for compaction, combined with the flowability, make SCC a natural choice. Where structural enhancement is a requirement to the load-bearing capacity of the foundation, fibres can be considered, based on the appropriate design parameters – maintaining all the benefits of easy placement, without the need for additional traditional reinforcement work.

SCC is proven to increase productivity by eliminating the need for vibration, offering a simple-to-use concrete that has a high flow rate. There are also benefits to health and safety, by reducing the risk to site operatives from vibration 'white finger' and the need to move less workable traditional concrete.

FRC offers many of the same productivity and health and safety benefits. The reinforcement for the concrete is premixed into the SCC. There is no requirement to lift, cut, place and fix reinforcement or fabric into position, eliminating hours of site preparation time and potential injury to workers.

Therefore, if you want to realise the true benefits of SCC in reinforced concrete applications, adopting an appropriately designed fibre-concrete solution is the obvious answer. ■

References:

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4. CONCRETE SOCIETY. *Guidance for the design of steel-fibre-reinforced concrete*. Technical Report 63, The Concrete Society, Camberley, 2007.
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Zenith 60 steel fibres were applied for this self-compacting concrete structural topping.