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Evaluation of the behavior of self-compacting concrete beams reinforced with steel fibers

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Abstract – SCC with addition of industrial waste is used, and steel fibers (l/d = 50 and V_f = 1%) are incorporated in order to assess the behavior of reinforced self-compacting concrete beams. For that, were made reinforced concrete beams of dimensions (12,5 x 23,5 x 132) cm, which were tested by four-point bending. The addition of the steel fibers to the SCC promoted slight gain in the load capacity of the beam, with lower displacements in the middle span, lower deformations in the reinforcement bars and improved cracking control, compared to the others beams produced with conventional concretes.

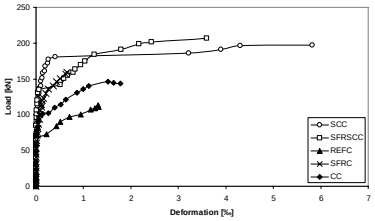
The self-compacting concrete (SCC) has been characterized as a great evolution in the concrete technology, being able to fill all empty spaces of the formwork and self-compacting only by action of its own weight. If steel fibers are added to SCC, without prejudice its properties in the fresh state, new advantages and possibilities of applications will provide concretes more efficient.

From mechanical point of view, the concrete (conventional or self-compacting) presents a lower behavior when subject to the tension stress, when compared to the its actuation over efforts of compression. Many researches seek optimize the properties of concrete, together with the development of new components and additions, to get the better performance possible of the material compensating limitations of constitutive nature and/or improving its positive features. An alternative to improve the concrete properties in the hardened state can be the adoption of a composite material, like the reinforced bars generally used in the structural concrete, or the use of short fibers with random distribution in the volume of concrete, or yet the use of both bars and fibers together. According Kim and Mai [1]: “in fiber composites, both the fiber and the matrix retain their original physical and chemical identities, yet together they produce a combination of mechanical properties that cannot be achieved with either of the constituents acting alone, due to the presence of an interface between these two constituents”.

In this context, in the present study were produced five concretes, a self-compacting concrete (SCC), a steel fiber reinforced self-compacting concrete (SFRSCC), a reference concrete (REFC), a steel fiber reinforced reference concrete (SFRC) and a conventional concrete (CC). For each concrete analyzed was made a reinforced beam of dimensions (12,5 x 23,5 x 132) cm (Figure 1), which was tested by four-point bending, at the 28 days of age. In the beams were registered the deformations in the stirrups (Figure 2) and in the longitudinal reinforcement bars and in the region of compressed concrete. Furthermore, mechanical properties of the concretes were determined at the 28 days, like compressive strength and elasticity modulus according NBR 8522 [2], on cylindrical specimens of 10 cm (diameter) x 20 cm (height) (Figure 3), and tensile strength in the bending on the prismatic specimens of dimensions (15 x 15 x 50) cm.

The results of the tests shown that the self-compacting concretes (SCC and SFRSCC) presented the higher compressive strengths, but achieved lower elasticity modulus values, when compared with the reference concretes (REFC and SFRC). In the tensile strength test, the SFRSCC showed a higher behavior, analyzed through of the ultimate load and of the load x deflection curves of the specimens (Figure 2). The addition of the steel fibers to the SCC promoted slight gain in the load capacity of the beam, with lower displacements in the middle span, lower deformations in the reinforcement bars and improved cracking control, compared to the others beams produced with reference and conventional concretes.

Figure 1: Beam test.



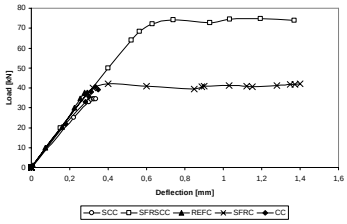


Figure 2: Load x Deformation curves.

Figure 3: Elasticity Modulus test.

References

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[2] Associação Brasileira de Normas Técnicas. NBR 8522. (2008) Concreto. Determinação do módulo estático de elasticidade à compressão. Rio de Janeiro.