Universidade do Minho
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ASSESSMENT OF THE POST-CRACKING BEHAVIOUR OF SFRSCC BY FLEXURAL AND TENSILE TESTS

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INTRODUCTION

Steel fibre reinforced self compacting concrete (SFRSCC) is often known as a material with high energy absorption capacity in tension. Although it seems that tensile properties of SFRSCC can directly be driven from the uniaxial tensile test, several unexpected parameters, however, can affect the results. To avoid the difficulties of the uniaxial tensile test setup, post cracking behaviour of SFRSCC can be determined indirectly based on flexural responses as recommended by international codes. In the present study the tensile behaviour of a SFRSCC was assessed from flexural and tensile tests and the obtained results were utilized in a proposed design oriented approach to calculate the resisting bending moment of a SFRSCC strip.

FLEXURAL TEST

Six SFRSCC beams (S1 to S6) with dimensions of 600x150x150 mm were prepared and tested in a three point bending test configuration. To ensure crack localization, a notch with a height of 75 mm and a width of 5 mm was executed at the middle length of the specimens. The test was carried out in displacement control, while crack tip opening displacement (CTOD) was measured by an LVDT. Fig. 1 includes the obtained Force-CTOD curves.

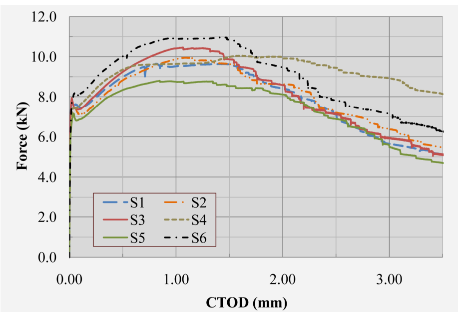

Fig. 1: Force versus CTOD responses obtained from three point notched SFRSCC beam bending tests.

UNIAXIAL TENSILE TEST

To determine the tensile behaviour of SFRSCC in tension, each flexural specimen was segmented according to the pattern schematized in Fig. 2, and 8 prismatic specimens were extracted for the uniaxial tensile tests. Each specimen had a length of 250 mm and a cross section of 70x70 mm.

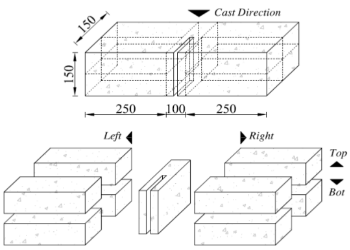

Fig. 2: Segmentation of beam into uniaxial specimens

Two transverse notches with a width and depth of 5 mm were executed at middle length of each specimen. Regarding the position of specimen in Left or Right side of the notch and in Top or Bottom layer of section with respect to the casting, LT, LB, RT, and RB designations were attributed to the specimens (see Fig. 2). The uniaxial tensile test setup is shown in Fig. 3. The test was carried out in displacement control. Test results are depicted in Fig. 4, where n_f is the number of fibres counted on fracture surfaces.

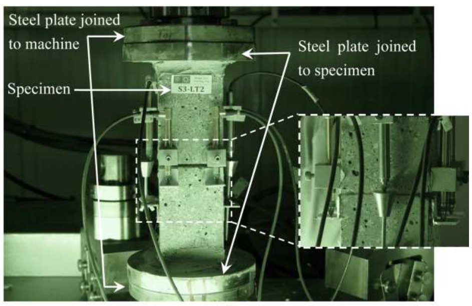

Fig. 3: Uniaxial tensile test setup

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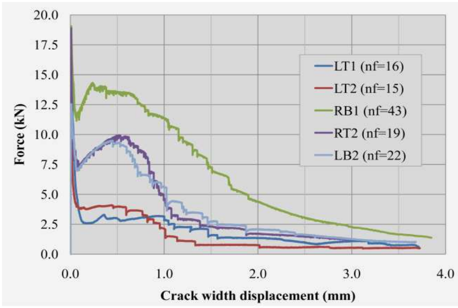

Fig. 4: Force-crack width displacement relationship recorded in uniaxial tensile tests.

According to the obtained results it can be concluded that the number of fibres has a clear influence on the post-cracking behavior of SFRSCC, with an increase of the performance of the composite with n_f.

FLEXURAL CAPACITY OF SFRSCC

Using the values obtained from the experimental tests, the stress-strain diagrams depicted in Figs. 5a and 5b were determined for adopted SFRSCC according to CEB-FIP Model Code 2010. The constitutive laws were utilized in FLEX software to calculate moment–curvature response of a cross section of a SFRSCC strip with a width of 1000 mm and height of 300 mm. FLEX is based on a design oriented approach that has been developed by the Authors (Taheri et al 2011) to predict the flexural response of strain softening or strain hardening FRC sections reinforced with longitudinal steel and/or fibre reinforced polymeric (FRP) bars. FLEX adopts a simplified post peak response in tension as depicted by the dashed line in Fig. 5a, where stress and strain of the first post-peak point coordinate is designated by the ordered pair of (x,y). Assuming the parity of fracture energy (G_f), four distinct ordered pair of (x,y), designated POS1 to 4, were adopted.
In Fig. 6 are compared the results determined by FLEX

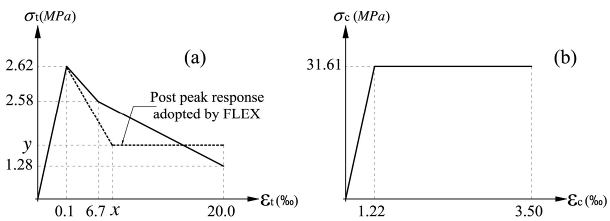

Fig. 5: Design constitutive law of SFRSCC (a) in tension, (b) in compression

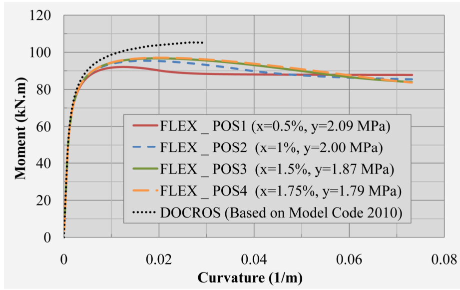

Fig. 6: Moment curvature responses

and DOCROS (Basto and Barros 2008), adopting the approach proposed by CEB-FIP Model Code 2010. Despite significant effects of stress and strain values at the first post peak point on bending responses have already been reported (Taheri et al 2010), it seems that taking a constant value of G_f for adopted tensile responses, the dispersion of the flexural responses is relatively low.

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AUTHORS’ BIOGRAPHIES

Hamidreza Salehian was born in Tehran, Iran. He obtained his BSc from Semnan University in 2001 and his MSc from Ferdowsi University of Mashhad in 2004. His master thesis was about FRP-confined concrete columns. In between 2004 to 2009, He was lecturer of civil engineering department and research manager of IA University of Semnan. His Email address is: selehian@civil.uminho.pt.