Numerical and Experimental Investigation into Crack Localization in Fibre Reinforced Cementitious Composites

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ABSTRACT

A numerical and experimental study is presented in which the performance of a finite element based model for fibre reinforced cementitious composites (FRCCs) is assessed in situations when significant distributed cracking localizes.

The constitutive model for FRCCs [1] is based on micromechanical solutions and employs a two-phase composite based on the Eshelby matrix-inclusion solution and the Mori-Tanaka homogenization scheme and also simulates directional microcracking. An exterior point Eshelby based criterion is employed to model crack-initiation in the matrix-inclusion interface. Microcrack surfaces are assumed to be rough and able to regain contact under both normal and shear displacements. As cracks start to develop, the crack-bridging action of fibres is simulated using a local constitutive equation that accounts for the debonding and pull-out of fibre groups with different orientations. It is shown that the combination of directional cracking, two-phase composite description, rough contact and fibre-bridging sub-models allows microcracking behaviour deriving from both tensile and compressive loads to be modelled in a unified manner and the constitutive model captures very well the characteristic mechanical behaviour of FRCCs.

Furthermore, the crack evolution and localization processes are investigated in a dual study comprising respectively:

(i) laboratory based experimental tests on RC/FRC beams subjected to flexure in which the evolution of surface cracks was monitored using a digital image correlation (DIC) system and;

(ii) numerical experiments using the discrete lattice model of Grassl and Antonelli [2] which explores the evolution and coalescence of microcracks and formation of macro-cracks in FRC specimens subjected to uniaxial tension.

The performance of the model is assessed through a series of FE simulations of RC/FRC beams subjected to four-point-bending.

REFERENCES