The 25th Australasian Conference on Mechanics of Structures and Materials (ACMSM25)
5-7 December 2018 – Brisbane, Queensland, Australia

AN EMBEDDED CRACK MODEL FOR THE SIMULATION OF THE COMPLEX INTERACTIONS IN FIBRE REINFORCED CONCRETE

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Abstract:

There are several benefits of introducing steel fibres in reinforced concrete. They can improve the structural ductility, reduce the permeability, and provide more resistance to cracking caused by loading and shrinkage. Steel fibres are mainly activated when they are crossed by active cracks in what is known by the bridging effect. They are mostly inactive otherwise. With the progress of damage, the fibres can be pulled out or fail, in which case the bond with the cementitious matrix is a critical factor for accurate simulations. Although existing models that are able to simulate fibres as discrete elements can achieve realistic predictions, difficulties are found in the generation of complex meshes with numerous randomly-oriented fibres, namely due to the requirement of excessive degrees of freedom and long computational times. The formulation herein proposed, embeds both discrete fibres and cracks within the finite elements, while accounting for the main features of the fibre behaviour, including the main effects such as the bond between fibre and cementitious material and snubbing. It should be highlighted that the fibre behaviour is modelled without the need for additional degrees of freedom. An advanced constitutive behaviour law is implemented that accounts for the changes depending on the inclination angle of the fibre relative to the crack and its embedment length. For fracture simulation, the model uses the Discrete Strong Discontinuous Approach (DSDA), where the jumps related to the opening of the cracks are transmitted to the parent element as a rigid body motion. Several numerical tests are used to assess the performance of the numerical technique, which include comparison with other formulations and experimental data.

Keywords: *Fracture analysis; fibre reinforced concrete; discrete crack propagation; Discrete Strong Discontinuous Approach (DSDA)*