Micro-mechanical Analysis of Fiber Reinforced Cementitious Composites using Cohesive Crack Modeling

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Abstract

In the present work discusses the modeling of the fiber bridging and debonding appearing in fiber reinforced cementitious composites (FRCC) during crack propagation. This is done in order to examine the assumptions typically used in modeling cohesive laws in FRCC. Often a superposition scheme for the fiber bridging cohesive stresses and the matrix cohesive law (the fictitious crack model) is employed, in order to arrive at an average cohesive law for fiber reinforced concrete. The primary purpose of the modeling presented here is to validate this superposition scheme.

A 3 dimensional model of a Representative Volume Element (RVE) is set up in DIANA. The mortar is modeled by use of brick elements (CHX60), the fiber by use of wedge elements (CTP45), while interface elements (CQ48I) are used to model the debonding of the fiber and the crack propagation in mortar. During debonding, the interface between the mortar and the fiber is exposed to tractions in the normal direction as well as the tangential directions, i.e. mixed mode crack propagation and opening. In order to simulate this, a user defined incremental mixed mode cohesive material model is employed. In this model the normal tractions, $\sigma = \sigma(\delta_t, \delta_n)$, and the tangential tractions, $\tau = \tau(\delta_t, \delta_n)$, are described as functions of both the displacement in the tangential, δ_t, and the normal, δ_n, direction. The model has been developed in FORTRAN and implemented into the DIANA as a user routine. The three basic cases: debonding and pull-out of a straight fiber perpendicular to the crack face, crack propagation in pure mortar and crack propagation in a RVE with mortar and fiber are analyzed. Finally, a comparison between the numerical and an analytical model for fiber debonding and pull-out is performed.