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MULTISCALE MODELING OF RECYCLED AGGREGATE CONCRETE AND FIBER REINFORCED CONCRETE

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Multiscale models based on the use of Coupling Finite Elements (CFEs) [1] and a Mesh Fragmentation Technique (MFT) [2] are presented. The CFEs allow the use of the same strategy to deal with two problems of non-matching meshes addressed in this work. One is regarding the coupling of different subdomains of multiscale models (non-overlapping meshes), and the other corresponds to the coupling of discrete steel fibers into the bulk finite elements (overlapping meshes). Thus, for problems where the material failure concentrates in a specific region, a lower scale can be applied only in this region of interest, increasing the performance in terms of computational time. For steel fiber reinforced concrete, a non-rigid coupling procedure is proposed to describe the complex nonlinear behaviour of the fiber-concrete interaction by adopting an appropriate constitutive damage model. To avoid the necessity of the widely used crack tracking schemes, a technique based on the insertion of special interface finite elements (three-node triangular or four-node tetrahedral elements) in between all regular finite elements of the mesh was applied [2]. It can be shown that, as the aspect ratio of the interface element increases (ratio of the largest to the smallest dimension), the element's strains also increase approaching the same kinematics as the Continuum Strong Discontinuity Approach (CSDA). As a consequence, standard continuum constitutive models, which tend toward discrete constitutive relations as the aspect ratio increases, can be applied to describe fracture process. Finally, to handle cases where the region with nonlinear behavior is not easy to anticipate, an adaptive concurrent multiscale model [3] is presented. In this case, the concrete initially idealized as a homogeneous material is gradually replaced and enhanced by a heterogeneous multiphase one.

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