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MESO-SCALE FE AND MORPHOLOGICAL MODELING OF CEMENTITIOUS MATERIAL

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The present work is part of an approach that attempts to represent the quasi-brittle behavior of heterogeneous materials such as cementitious ones. The guideline followed fits in a sequenced multi-scale framework for which descriptions of the material are selected at a thin scale (mesoscopic or microscopic) and information is transferred to a larger scale (macroscopic). It shows how the explicit representation of heterogeneities offers interesting prospects on identification, understanding and modeling of macroscopic behaviors. In practice, from a simple description of each phases and interfaces behavior, a structural effect that leads to more complex macroscopic behavior is observed. This work is therefore focusing on two main axes. On the one hand, the morphological representation of the heterogeneities is handle using the excursion sets theory. Randomly shaped inclusions, which geometrical and topological characteristics are analytically controlled, are produced by applying a threshold on realizations of correlated Random Fields. On the other hand, the FE implementation of both heterogeneity and local degradation behavior (micro-cracking) are dealt with by a double kinematics enhancement (weak and strong discontinuity) using the Embedded Finite Element Method. Finally, combining both axes of the problematic, the resulting model is tested by modeling cementitious materials at the meso-scale under uniaxial loadings mainly. It reveals an emergent macroscopic response that exhibits several features such as asymmetry of the tension-compression stress-strain relationship, cracks patterns or historical-dependency, which are typical of concrete-like materials.

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