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X-FEM, ED-FEM and Operator Split Computations for Failure of Heterogeneous Reinforced Cement Based Composites

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In this work we address several issues pertaining to efficiency of the computational approach geared towards modeling of inelastic behavior of cement based composites as a heterogeneous material with microstructure, which is represented by a multiscale model. We elaborate upon the case where the scales remain coupled throughout the computations, implying a constant communication between the finite element models employed at each scale.

We also discuss different manners of representing a complex multi-phase microstructure within the framework of the finite element model constructed at that scale, selecting a model problem of two-phase material where each phase has potentially different inelastic behavior.

The uncertainty aspects are also taken into account pertaining to the incomplete information on the material heterogeneities. The latter is presented as an alternative strategy for bridging the scales, which allows replacing the phenomenological model with random fields for parameters.

Finally, we discuss the composites of this kind reinforced with long fibers, and the suitable operator split methodology that allows keeping the standard computer code architecture, along with the probabilistic extension.

We show a large number of illustrative results showing the predictive capabilities of the models of this kind in representing the phenomena of great importance for failure of reinforced composites, such as crack spacing and opening, size effect etc.