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A generalized finite element method with global–local enrichments for the 3D simulation of propagating cohesive fractures

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ABSTRACT

A novel numerical framework based on the generalized finite element method with global-local enrichments (GFEMgl) is developed for the efficient 3D modeling of propagating fractures, in which a non-linear cohesive law is adopted to capture objectively the amount of dissipated energy during the process of material degradation without the need of adaptive remeshing at the macroscale or artificial regularization parameters. In the proposed scale-bridging strategy, the fine-scale solution provides the coarse-scale problem with information on localized damaged states as well as scale-bridging enrichment functions, thus enabling the accurate solution of the non-linear global problem on coarse meshes. This is to be contrasted with the original GFEMgl approach based on linear elastic fracture mechanics in which the local solution field contributes to only the kinematic description of the global solution. The cohesive crack is capable of propagating through the interior of finite elements in virtue of the concept of partition of unity employed in the generalized finite element method (GFEM), and thus eliminating the need of interfacial surface elements to represent the geometry of discontinuities and the requirement of finite element meshes fitting the cohesive crack surface.