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Towards 3D-Modeling of failure for composites by the extended finite-element method and level sets

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ABSTRACT

This contribution is concerned with the development of the eXtended Finite Element Method to model failure in three dimensions. Exemplarily, we employ this method to composites which are characterized by a specific heterogeneous microstructure. Materials like fiber reinforced concrete or polymers are typical examples.

In the present study, the inelastic behavior of quasi-brittle materials is modeled by the cohesive zone theory in a discrete way. For the discretization of distinct cracks and material interfaces we apply an extended finite element model [1] which is supported by a level set technique [2] to describe the geometry of these internal features of the composite. This is accomplished through enriching the kinematical description with so-called ridge functions at interfaces and Heaviside functions at cracks [3]. The present appoach addresses the modelling of eventually debonding material interfaces, which is an important failure mechanism in composites, and the evolution and propagation of matrix cracks in the different material constituents in three dimensions.

Numerical examples for simple test specimens are presented to demonstrate the versatility of the proposed discretization method simulating textile fiber reinforced concrete. In the case of modeling debonding between two material constituents, the failure surface is already known and we easily get a continuous crack surface. This is not the case for general three-dimensional matrix cracks, where the crack path is not known a priori but has to be determined by crack initiation and evolution criteria. A major task herein is the geometrical description of the three-dimensional crack surface.

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