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XFEM Modelling of transition of micro damage mechanics into quasi-brittle fracture

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ABSTRACT

Numerical modelling of tensile cracking in quasi-brittle materials is one of the important topics in computational failure mechanics. In order to have a realistic analysis of failure in a structure, it is necessary to find the location and initiation time of damage and the way damage is transformed into a macro crack. In this paper, a new technique is presented for modelling the initiation and propagation of cracks in quasi-brittle materials by using the elastic-damage model in the framework of the extended finite element method (XFEM).

quasi-brittle materials experience a complicated non-linear mechanical response due to the occurrence of strain localization. The classical finite element simulations can not efficiently perform to describe the thickness of localization. These models suffer from the mesh sensitivity and may provide non-realistic results in some cases, because the strain becomes concentrated in one element and the load-displacement response may become mesh-dependent. such classical models can be extended in the form of a characteristic length to correctly model the thickness of localization zones [1].

In this study, the XFEM technique is applied for modelling crack propagation in quasi-brittle fracture using the elastic-damage model. First, a continuous elastic-damage analysis is carried out. When the criterion of crack initiation is satisfied, a crack is introduced in the element by the extended finite element technique. The hiviside enrichment function is added to the classical degrees of freedom to simulate the discontinuity in both tangential and normal directions to the crack [2, 3]. Finally, an example of crack initiation and propagation is presented to demonstrate the capabilities of the proposed method.

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