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XFEM-CZM combination for the numerical treatment of ductile fracture

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ABSTRACT

We are here interested in the numerical prediction using commercial finite element computation code of the response of large engineering structures made of ductile materials when submitted to accidental overloads. The challenge consists in reproducing within a unified methodology based on the finite element method (FEM) the different steps of failure as observed in the materials under consideration, namely diffuse microvoiding-induced damage, strain/damage localization then macro-cracking, if any.

The behavior of the material in presence of ductile damage is governed by the microporous plasticity Gurson model in the context of standard FEM and the kinematic consequences of the macro-crack propagation throughout the meshing are described in the context of the eXtended FEM (XFEM), see Crété et al. (2014). A key point for the prediction of ductile fracture is the numerical treatment of the continuous-to-discontinuous transition, intermediate stage, i.e. localization within a narrow band. To describe it, a model of 'cohesive strong discontinuity' and the XFEM are combined. Criteria for the (more or less) diffuse-damage-to-localization and localization-to-macro-cracking transitions are as well proposed.

The feasibility of the methodology has been shown, see Wolf et al. (2017), via the implementation of user element subroutines into the commercial finite element computation code Abaqus, and boundary value problems are solved.

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