Modelling of incompressible damage with an enhanced-accuracy mixed thermo-mechanical formulation

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ABSTRACT

Currently there is an increment of research effort devoted to the numerical simulation of thermo-mechanical problems in the incompressible limit.

Mixed finite elements have been recently re-examined by the authors to address mechanical problems with enhanced accuracy in the incompressible limit [1] and in strain localization problems [2,3]. They have shown to provide practically mesh-independent results as well as avoid volumetric locking.

In this presentation, a mixed stress/displacement formulation is re-written to accomplish the incompressibility constrain by splitting the flexibility tensor into volumetric and deviatoric components and setting the volumetric part to zero. With the proposed formulation, cracking problems are computed in incompressible situations. A thermal coupling is incorporated to be able to consider the effect of temperature following the method in reference [4]. The influence of temperature gradients in the development of cracks is included in the model. For this, an enhanced version of the FE code COMET [5] has been developed.

The feasibility of the method is assessed through numerical benchmarks which show the capacity of the formulation to produce results with accuracy enhancement in terms of stresses and strains. The mixed finite element formulation has the necessary generality and flexibility to avoid volumetric locking in incompressible situations, producing reliable computations of the structural response, damage pattern, force-displacement curves and crack trajectories without spurious mesh-dependency.

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