A novel FE approach to strain localization problems based on a three field formulation

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ABSTRACT

In this work, a novel FE approach to strain localization problems based on a three fields formulation (displacements, pressures and effective deviatoric stresses) is presented. The final objective is the numerical simulation of mode-I, mode-II and mixed-mode fracture mechanisms. On one hand, the good performance of the mixed displacement-pressure formulation when pure shear-mode failure mechanisms are induced is demonstrated in refs. [1] and [2]. In this case, the challenge is the necessity of controlling the volumetric locking induced by the isochoric nature of the deformations in the strain localization zone.

On the other hand, more recent publications (see [3], [4] and [5]) clearly demonstrate the advantages of an accurate definition of the stress field in the pre-peak phase in order to capture tensile-cracking, especially to identify the correct crack propagation direction (without the use of any auxiliary tracking techniques). This objective can be achieved using an mixed displacement-strain method.

In this work, the advantages of both formulations combined into a unified three-field formulation based on linear interpolation of displacements, pressures and the deviatoric part of the stress tensor. A stabilization techniques based on orthogonal sub-scale grid (OSS) is introduced to overcome the restrictions posed by the Babuska-Brezzi condition.

Numerical examples show the accuracy of the proposed formulation in different strain localization benchmarks.

REFERENCES