SIMULATION OF STRAIN LOCALIZATION IN MULTI-PHASE MEDIA BY A MULTI-SCALE APPROACH

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Abstract

We consider discontinuities in displacements and fluid flow to simulate localized failure and corresponding fluid accumulation in multiphase porous media. Localized dissipation inequalities obtained from a three-phase poro-plastic model (Callari and Abati, 2007a) are employed in a multi-scale approach, thus extending the results presented for the fully saturated case by Callari and Armero (2002,2004). For the appearance of aforementioned strong discontinuities, we re-obtain the same condition characterizing fully saturated porous solids (Armero and Callari, 1999). Singular dilatancy and singular small-scale contents of liquid and gas are related by localized mass balances on the discontinuity.
The numerical formulation is based on the connection between large and small scale fields by a weak equation relating local stresses with traction vector on the discontinuity (Armero, 1999). The proposed multi-scale finite element method employs the formulation presented by Callari and Abati (2007b) for the large scale fields, locally enhanced by unregularized discontinuous interpolations of small-scale displacements and fluid flow.
The plane strain compression of a porous sample is simulated with a proper treatment of interface between specimen and atmosphere (Abati and Callari, 2007). Numerical solutions are practically indifferent to mesh size and alignment, in terms of discontinuity path and propagation history, pore pressures, saturation degree, reaction, relative permeability.

Keywords: coupled problems, enhanced finite elements, multi-phase media, porous solids, strain localization.

Presenting Author's biography

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