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# ANALYSIS OF STRONG DISCONTINUITIES IN PARTIALLY-SATURATED POROPLASTIC SOLIDS

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## ABSTRACT

This contribution presents an analysis of strong discontinuities in partially-saturated porous solids to model their failure. The analysis considers discontinuous displacement fields and corresponding singular distributions of strain, as well as singular distributions of fluid contents corresponding to discontinuous flows of gaseous and liquid phases, modelling their accumulation and/or drainage in the localized failures of interest. The underlying model in these considerations is a three-phase poro-plastic model in the classical macroscopic thermodynamic framework due to Biot, with the hyperelastic part accommodating the more general laws developed in [2]. This model provides the proper framework for the extension of the results presented in [3,4] for the fully saturated case, characterizing then the appearance and constitutive relations of strong discontinuities in the multi-scale framework originally presented in [1]. In this context, the small-scale problem is defined by the localized mass balances of liquid and gas contents, both related to singular dilatancy of the discontinuity, besides the mechanical response driven by the assumed effective traction. This requires the consideration of the proper pore pressures and saturation degrees on the discontinuity. This small-scale problem is then connected to the large-scale coupled problem through a weak equilibrium statement between this traction and the stresses in the bulk. A main feature of the proposed method is the direct approximation of this equation by finite elements enhanced with singular fields of strain and fluid contents. These enhancements are kept local at the element level, allowing the static condensation of the different enhanced parameters and, hence, a simple and very efficient numerical implementation in existing finite element codes. We present different numerical simulations that illustrate the range of application of the developed models and the performance of the new finite element methods.

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