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Discrete element model for the analysis of fluid-saturated fractured poro-plastic medium based on sharp crack representation with embedded strong discontinuities

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Abstract

In this work, we present a discrete beam lattice model capable of simulating localized failure in a heterogeneous fluid-saturated poro-plastic solid. Coupling conditions between the solid and fluid phase are governed by the Biot's porous media theory, enhanced with the fluid flow through cracks. The basis for development of discrete 2D plane strain model representation of heterogeneous material consisting of material grains, is an assembly of Voronoi cells that are kept together by cohesive links in terms of Timoshenko beams. Localized failure of saturated medium is enabled through embedded discontinuities positioned in cohesive links where Timoshenko beam's longitudinal and transversal directions possess enhanced kinematics representing failure modes I and II. The model can also take into account the fracture process zone with pre-existing microcracks coalescence prior to the localized failure, which is described by the poro-plasticity formulation. Fluid flow is spread across the lattice network by Darcy's law in terms of continuous pore pressures, with a special care taken in computing the lattice permeability parameters. This is brought by the proposed discrete model which can capture the

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