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Fully coupled hydro-mechanical modelling of fractured porous media

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In this study, we propose a methodology based on the Finite Element Method for coupling flow and geomechanics in geological media consisting of porous rock with fractures. The governing equations are derived in terms of displacements and pore pressures. The solution of the resulting global equations follows a fully coupled approach and an adaptive time integration scheme. The classical theory of poroelasticity describes the mechanical behaviour of the rock matrix. However, some hydraulic parameters, such as porosity and permeability, are dependent on the occurrence of finite-strains. Zero-thickness interface elements [1,2] represent pre-existing fractures characterized by nonlinear behaviour of hydraulic and mechanical properties. The permeability in each interface element is dependent on the hydraulic aperture of the fractures. In turn, the normal stiffness is dependent on the normal stress on the fracture plane according to the Bandis closure model [3]. This relationship avoids inconsistent negative apertures due to high compression stresses. Numerical simulations in media with dominant fractures were performed. The results show the effect of fractures in the development of preferential flow paths and demonstrate the accuracy and robustness of the proposed approach for hydro-mechanical analysis in fractured porous media.

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