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FINITE ELEMENT MODELLING OF FLUID FLOW AND CRACK PROPAGATION IN POROUS MEDIA

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Fluid flow through cracks in a porous medium can have a major influence on the deformation and flow characteristics. Pore pressure build up and crack propagation are two coupled sub problems that should be considered when modelling fluid flow through fractured porous media. In this work, a subgrid scale model is used to capture fluid flow inside the crack by considering mass balance of the fluid, which is then coupled to the macroscale relations. The fluid flow in the intact medium is modelled in a standard manner using Darcy's relation, while in the discontinuity, flow is modelled using Stokes' equation. Crack propagation is simulated using the cohesive zone model.

Several discretisation techniques including interface elements, remeshing, extended finite element method and isogeometric analysis [1] have been used to numerically model fluid flow in fractured porous media. When the location of crack and the propagation path are known a priori, the use of interface elements is sufficiently general and has the advantage of being simple to formulate and implement. The use of zero thickness interface elements to model hydraulic fracture has been reported in [2] and [3]. The present work uses a conventional finite element framework to model fluid flow and crack propagation in a fluid saturated porous medium by incorporating standard interface elements with each node augmented with pressure degrees of freedom of different multiplicity. The physical consequences of considering one, two and three pressure degrees of freedom are elucidated.

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