6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Hydraulic fracture of a porous thick-walled hollow sphere

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Keywords: *hydraulic fracture, porous geomaterial, thick-walled hollow sphere*

The aim of this work is to analyse the nonlinear response of a porous thick-walled hollow sphere subjected to inner fluid pressure. In particular, we aim to find out how Biot coefficient and Poisson's ratio of the material influence the fracture process. Spherical symmetry is assumed so that the hydromechanical fracture problem is expressed by means of an ordinary differential equation of the radial displacement with respect to the radius of the sphere. For the elastic response, we derive the analytical hydro-mechanical solution based on the work in [3], which is a hydro-mechanical extension of the well known mechanical case described for instance in [2]. It is assumed that the material is fully saturated and that the application of the fluid pressure distribution changes so slowly that a steady state always exist.

For the extension to fracture, the crack openings are smeared out into an inelastic strain, which is used in a one-dimensional damage model for the stiffness reduction. The resulting nonlinear ordinary differential equation, which is presented here for the first time for the general case of non-zero Poisson's ratio, is solved numerically by means of a finite difference scheme. The hollow thick-walled sphere is divided into a cracked inner and elastic outer sphere following the approach in [1]. A sensitivity study reveals that both Biot coefficient and Poisson's ratio have a very strong influence on the hydromechanical response of the thick-walled hollow sphere.

REFERENCES

[1] C. Fahy, S. Wheeler, D. Gallipoli, P. Grassl, Corrosion induced cracking modelled by a coupled transport-structural approach. *Cement and Concrete Research*, Vol. **94**, pp. 24–35, 2017.

[2] S. P. Timoshenko, J. N. Goodier, *Theory of elasticity*. McGraw-Hill, 1987.

[3] P. Grassl and C. Fahy and D. Gallipoli and S. J. Wheeler, On a 2D hydro-mechanical lattice approach for modelling hydraulic fracture. *Journal of the Mechanics and Physics of Solids*, Vol. **75**, pp. 104–118, 2015.