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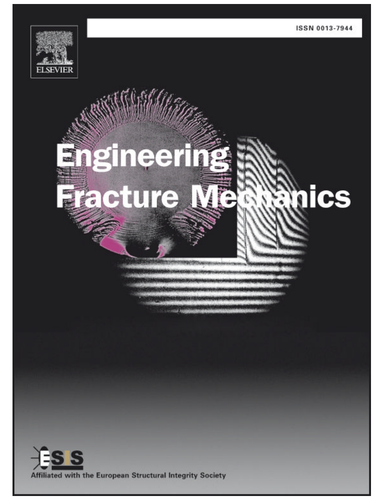

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Modeling of hydraulic fracturing using a porous-media phase-field approach with reference to experimental data

Yousef Heider[a,d,*], Sönke Reiche[b], Philipp Siebert[c], Bernd Markert[a]

[a]*Institute of General Mechanics, RWTH Aachen University, Templergraben 64, 52062 Aachen, Germany*
[b]*Institute for Applied Geophysics and Geothermal Energy, RWTH Aachen University, Mathieustr. 10, 52074 Aachen, Germany*
[c]*Chair of Geotechnical Engineering, RWTH Aachen University, Mies-van-der-Rohe-Str. 1, 52074 Aachen, Germany*
[d]*Department of Civil Engineering and Engineering Mechanics, Columbia University, New York, NY 10027, USA*

Abstract

The underlying study introduces a numerical modeling framework and a comparison with experimental data of hydraulic fracture in dense low-permeable brittle rocks. This is based on the continuum theory of porous media (TPM) extended by a diffusive phase-field modeling (PFM) approach. Proceeding with a biphasic material consisting of a solid and a fluid phase, the mechanical behaviors, such as the solid deformation and the pore-fluid flow are described using the macroscopic TPM. The hydraulically-driven cracking is modeled in the sense of brittle fracture using the energy-minimization-based PFM procedure, which employs a scalar-valued phase-field variable to approximate the sharp edge of the crack by a diffusive transition zone. The combined TPM-PFM approach allows to model additional related phenomena, such as the permanent local changes of the intrinsic permeability and the volume fractions of the constituents in the crack and at the crack-domain interface. For the purpose of model calibration, simulations of 2D and 3D initial-boundary-value problems (IBVP) are introduced and compared to laboratory experiments on hydraulic fracturing. The results show that experimentally-derived pressure curves and estimated fracture lengths are well predicted in the proposed numerical simulations. It is also worth mentioning that the TPM-PFM approach can straightforwardly be implemented in common continuum finite element packages, allowing for a robust solution of hydraulic fracture problems.

Keywords: Hydraulic fracturing, Phase-field model, Porous media, Enhanced geothermal systems, Rock fracturing experiment
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[*]Corresponding author
Email address: heider@iam.rwth-aachen.de (Yousef Heider)