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A micromorphic phase-field model for fracture in porous media

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The phase-field fracture model is a promising alternative to discrete fracture models (e.g., cohesive zone and extended finite element models) due to its ability to operate on a fixed mesh and the straightforward handling of complex fracture topologies (crack branching, kinking and merging). However, the phase-field fracture model requires solving a 'global' variational inequality problem. This is due to the higher regularity requirements on the phase-field function space and the notion of fracture irreversibility. In this contribution, a micromorphic phase-field fracture model is proposed. Herein, the phase-field is transformed to a local variable, and a micromorphic variable is introduced, which regularizes the fracture problem. This results in a 'local' fracture irreversibility constraint for the phase-field, which is relatively easier to treat in a computational framework. The energy functional for the standard phase-field fracture model is extended to micromorphic phase-field fracture model in two steps. The phase-field in the gradient term is replaced by the micromorphic variable, and then a penalty term is added corresponding to the difference between the phase-field and micromorphic variable [1]. Furthermore, the energy functional pertaining to the micromorphic phase-field fracture model is extended towards porous media, and augmented with transport equation for the pressure field. The efficacy of the proposed model is demonstrated through numerical examples from linear elastic fracture mechanics and porous media (hydraulic fracture and desiccation cracking).

REFERENCES

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