

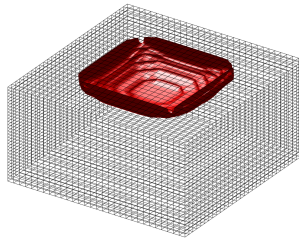
PHASE-FIELD FRACTURE MODELS FOR LINEARIZED AND FINITE STRAINS

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ABSTRACT

While cracks are actually sharp two-dimensional hypersurfaces the phase-field fracture approach regularizes the sharp material discontinuities with smooth transitions between broken and unbroken regions. The evolution of the phase-field follows an evolution equation where the driving forces of crack growth are derived from an energy minimization principle, typically based on an Ambrosio-Tortorelli type functional. Modifications allow accounting for the no-healing irreversibility constraint of crack evolution and, especially important, for the asymmetry of fracture, i.e., the fact that cracks only grow under tensile loadings but not under compression. Further modifications consider the evolution problem at finite strains using energy densities, which are polyconvex functions of the deformation, [1, 2].

In this contribution different decompositions of the elastic energy and the pros and cons of variational and ad hoc formulations for the crack driving forces will be discussed. The latter may base on positive principal stresses or strains for example. We compare different models in linearized and in finite elasticity and present recent results on the mathematical analysis for a phase-field model at finite strains, where we formulate the phase-field with energy densities in terms of the modified invariants of the right Cauchy-Green strain tensor. To illustrate the capability of a phase-field fracture approach we present finite element simulations of brittle fracture and compare it to our experimental results. The main challenge of such fracture simulations is, that it requires the ability of a numerical method to predict crack nucleation and fracture without stress concentration at a notch or at an initial crack.



- [1] C. Bilgen, K. Weinberg. On the crack-driving force of phase-field models in linearized and finite elasticity *Comp. Meth. in Appl. Mech. and Engng*, 353:348–372, 2019
- [2] C. Bilgen, A. Kopaničáková, R. Krause, K. Weinberg. A phase-field approach to conchoidal fracture. *Meccanica*, 53:1203-1219, 2018