Workshop on Experimental and Computational Fracture Mechanics
March 4-6, 2024, Baton Rouge, LA

A MATRIX-FREE MULTIGRID SOLVER FOR PHASE-FIELD FRACTURE PROBLEMS

Leon M. Kolditz, Thomas Wick

ABSTRACT

The variational phase-field approach has become a widely used ansatz for simulating fracture problems in a quasi-static setting. We will present an efficient, quasi-monolithic numerical solver for nonlinear phase-field fracture problems. The two main challenges of the underlying phase-field fracture model are several nonlinear terms on the one hand and an irreversibility constraint on the other hand. The former is addressed by linearizing the crucial terms with an extrapolation using previous incremental step information. The irreversibility condition is controlled by a primal-dual active set method in which the material domain is split up into an active set, where the constraint is active, and an inactive set. Then, the nonlinear system is solved on the inactive set in a monolithic fashion with Newton's Method, where the inner linear system is solved by a generalized minimal residual solver (GMRES) and a multigrid preconditioner. The implementation is done in a matrix-free framework to enhance memory efficiency. We will provide a numerical test to show the performance of the solver.