Modeling of Elastic-Plastic Fracture By a Phase Field Approach

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ABSTRACT

In this contribution a phase field approach is used to model elastic-plastic fracture with linear isotropic hardening. In conventional fracture models cracks are described by sharp surfaces and remeshing techniques are needed to continuously adapt the finite element mesh to the new crack topology. In phase field models however, a scalar valued order parameter describes the state of the material in terms of fracture independent of the mesh.

As a starting point a phase field model for brittle fracture [1] is used. A plastic dissipation potential is added to the energy functional, consisting of the elastic energy and a Griffith type fracture energy. A degradation function models not only the change of stiffness between intact and fractured material, but also the coupling of plastic deformation and the evolution of fracture. This type of coupling allows for the application of an unaltered, well established radial return algorithm [2] to determine elastic-plastic deformations on element level. Another advantage of the proposed coupling is the possibility to solve the global system of differential equations, formed by the transient approximation of the quasi-static evolution equation of the fracture field and the mechanical field equations, in a monolithic iterative solution scheme.

Numerical simulations and analytic considerations demonstrate, that if the conventional, quadratic degradation function is used, the nominal plastic material parameters do not coincide with the effective parameters of the model and a reinterpretation of the parameters is necessary in order to relate simulation results to experimental data [3]. Furthermore, it will be shown, that using certain cubic degradation functions [4] such a distinction between effective and nominal parameters is not necessary. Moreover the performance and results of simulations applying a monolithic iteration scheme are compared with simulations using a staggered solution scheme.

**REFERENCES**

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