A Novel Formulation of Ductile Fracture by the Phase-field Method

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ABSTRACT

Fracture plays an important role in industrial application, including load capacity estimation and bearing prediction etc. The loading patterns, e.g. static loading, impact loading as well as cyclic loading etc. largely influence the fracture evolution. Therefore, the studies of appropriate experiments and realistic numerical simulations are particularly important for crack initiation, growth direction, propagation as well as branching. Regarding a continuum approximation approach of the sharp crack, the phase-field method is intensively studied and employed for structural analysis during the last decade. The main advantage is that it does not depend on any explicit criterion for fracture evolution and the results obtained by the phase-field method show good agreement with other numerical strategies and experiments.

Regarding elasto-plastic materials, the load-displacement curve shows ductile fracture, as experiments indicate. Hence, a brittle phase-field model cannot properly simulate these properties and corresponding ductile phase-field models have been studied in [1] and [2]. In this contribution, a novel ductile phase-field model is proposed and the critical energy release rate is assumed to be dependent on the accumulative hardening variable. With this assumption, increasing the plastic deformation will decrease the fracture resistance, which results in a structural failure for large plastic deformation. The driving force to evolve the phase-field is still coming from the elastic strain potential by means of a volumetric and deviatoric split. This approach is formulated and implemented into the context of the Finite Element (FE) framework. For verification and evaluation, numerical examples are performed and discussed. Last but not least, conclusions and future perspectives close this presentation.

REFERENCES

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