8th World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

CRACK TIP PLASTICITY AND ASYMPTOTIC STRAIN FIELDS IN EXTENDED FINITE ELEMENT FORMULATION

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Key Words: *Crack tip, Plasticity, Singular Strain, Extended Finite Element Method.*

ABSTRACT

A recent work [1] has shown the important role that crack tip enhancement plays in accurately predicting slip distribution along a frictional crack in extended finite element simulations. A simple Heaviside enrichment is generally not sufficient and results in slip that could be significantly smaller than what it would be with a crack tip enrichment. This is because finite elements enriched only with the Heaviside function cannot capture the strain singularity at the crack tip. In Reference [2] a crack tip enrichment strategy was proposed that alleviates the shortcoming of the Heaviside-only enrichment for isotropic linearly elastic solids with a crack. In this work we reassess the applicability of this crack-tip enrichment technique in the presence of small-scale near-tip plastic yielding. Following the Hutchinson [3] and Rice/Rosengren [4] HRR formulation, we utilize a power-hardening elastoplastic theory to develop a crack-tip enrichment strategy for use with the extended finite element simulations in the presence of small-scale yielding and asymptotic near-tip strain fields of a stationary crack. The technique is implemented in the context of a newly developed self-contact algorithm for frictional crack propagation with the extended finite element method [5].

This project is supported by the US Department of Energy Grant Number DE-FG02-03ER15454 and the US National Science Foundation through the CMG (Collaborations in Mathematical Geosciences) Program Grant Number CMG-0417521.

REFERENCES

[1] R.I. Borja. “Assumed enhanced strain and the extended finite element methods: A unification of concepts.” *Comput. Methods Appl. Mech. Engrg.*, in review.

[2] T. Belytschko and T. Black. “Elastic crack growth in finite elements with minimal remeshing.” *Int. J. Numer. Meth. Engng.*, Vol. **10**, pp. 601–622, (1999).

[3] J.W. Hutchinson. “Plastic stress and strain fields at a crack tip.” *J. Mech. Phys. Solids*, Vol. **16**, pp. 337–347, (1968).

[4] J.R. Rice and G.F. Rosengren. “Plane strain deformation near a crack tip in a power-law hardening material.” *J. Mech. Phys. Solids*, Vol. **16**, pp. 1–12, (1968).

[5] F. Liu and R.I. Borja. “A self-contact algorithm for frictional crack propagation with the extended finite element method.” *Int. J. Numer. Meth. Engng.*, in review.