Isogeometric Phase-field Modeling of Brittle and Ductile Fracture

Michael J. Borden[#], Thomas J.R. Hughes [†,*], and Chad M. Landis[‡]

[#]Civil, Construction, and Environmental Engineering
North Carolina State University
Box 7908, Raleigh, North Carolina 27695, USA
Email: mjborden@ncsu.edu – Web page: http://www.ce.ncsu.edu

[†] Institute for Computational Engineering and Science
The University of Texas at Austin
201 East 24th St. Stop C0200, Austin, Texas 78712, USA
Email: hughes@ices.utexas.edu – Web page: https://www.ices.utexas.edu

[‡] Aerospace Engineering and Engineering Mechanics
The University of Texas at Austin
210 East 24th St. Stop C0600, Austin, Texas 78712, USA
Email: landis@utexas.edu – Web page: https://www.ae.utexas.edu

ABSTRACT

The phase-field approach to predicting crack initiation and propagation relies on a damage accumulation function to describe the phase, or state, of fracturing material. The material is in some phase between either completely undamaged or completely cracked. A continuous transition between the two extremes of undamaged and completely fractured material allows cracks to be modeled without explicit tracking of discontinuities in the geometry or displacement fields. A significant feature of these models is that the behavior of the crack is completely determined by a coupled system of *partial differential equations*. There are no additional calculations needed to determine crack nucleation, bifurcation, and merging.

In this presentation, we will review our current work on applying second-order and fourth-order phase-field models to quasi-static and dynamic fracture of brittle and ductile materials, within the framework of isogeometric analysis. We will present results for several two- and three-dimensional problems to demonstrate the ability of the phase-field models to capture complex crack propagation patterns.

For background describing our work on brittle fracture, the reader is urged to consult references [1] and [2].

REFERENCES

[1] M.J. Borden, C.V. Verhoosel, M.A. Scott, T.J.R. Hughes, and C.M. Landis, *A phase-field description of dynamic brittle fracture,* Computer Methods in Applied Mechanics and Engineering, Vol's. 217-220, (1 April 2012) 77-95.

[2] M.J. Borden, T.J.R. Hughes, C.M. Landis, and C.V. Verhoosel, *A higher-order phase-field model for brittle fracture: Formulation and analysis within the isogeometric analysis framework,* Computer Methods in Applied Mechanics and Engineering, Vol. 273, (1 May 2014) 100-118.