Higher Order Methods for Simulating Curvilinear Crack Propagation

Friday, March 2nd, 4:00 PM
Maeder Hall, ACEE

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Understanding and predicting fracture propagation has been for a long time a topic of interest for engineers and scientists alike. Its applicability lies in the prediction of failure loads and mechanisms for the safe design of structural and mechanical components. More recently, a new wave of interest in simulating fracture propagation has risen due to the insurgence of hydraulic fracturing for hydrocarbon recovery and its effects on cap rock in CO2 storage.

The main challenges in simulating a propagating fracture can be identified in (1) the continuously evolving displacement discontinuity, (2) the singular nature of the elasticity fields, and (3) the com-putation of the stress intensity factors for the prediction of crack of growth. Current state-of-the-art methods are plagued by low order of accuracy or high computational cost accompanied by complex data structures.

The presentation will discuss a computational framework for the simulation of crack propagation which addresses the challenges of (1)-(3). The key ingredients are a robust meshing tool for evolving domains, a computationally efficient and optimally convergent finite element methods for singular solutions, as well as a family of functionals for the rapidly convergent computation of the stress intensity factors. The framework will be shown to be consistent and predictive, both through numerical examples and mathematical analysis, and its robustness will be showcased in the context of thermoelasticity to investigate the formation of unstable crack patterns in quenched brittle materials.

Maurizio is currently an Assistant Professor in the Department of Civil and En-vironmental Engineering at Princeton University and is a member of Princeton's Institute for the Science and Technology of Materials. He joined Princeton as a Postdoctoral Fellow in September 2016 and spent the first few months of his appointment as a visiting scholar at the Institute for Computational Engi-neering and Sciences at the University of Texas at Austin. He formally joined the faculty at Princeton University in February 2017. He received his Ph.D. at Stanford University in 2016 in Mechanical Engineering in Mechanics and Com-putations. He is a recipient of the Stanford Graduate Fellowship in Science and Engineering, the Juan C. Simo Best Thesis Award, the ICES Post-doctoral Fellowship, and the Robert J. Melosh Medal for the development of novel numerical methods. Prior to Stanford he obtained his M.S. and B.S. in Civil Engineering, with focus on the Mechanics of Materials and Structures. His current interests lie in the realm of computational mechanics, with emphasis on the development of numerical methods for fracture and configurational mechanics, large deformation solid mechanics, reactive multi-phase flow in deformable porous media, as well as constitutive modeling of geo-materials. His work is motivated by the need for predictive tools in energy resources engineering, hazard modeling, and environmental issues.

Social following the seminar outside of Maeder Hall
All are welcome

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