Spacetime Simulation of Seismic Response

Ian McNamara[1], Amit Madhukar[1], Robert Haber[1], Ahmed Elbanna[2], Reza Abedi[3]

[1]Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, 1206 W. Green St., Urbana, IL 61801
[2]Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, 205 N. Mathews Ave., Urbana, IL 61801
[3]Mechanical, Aerospace & Biomedical Engineering, University of Tennessee Space Institute (UTSI) / Knoxville (UTK), 411 B. H. Goethert Parkway, Tullahoma, TN 37388

Abstract

Analytical and numerical investigations of the dynamic behavior of faults has generated new insights into the mechanics of seismic response, including for example, intersonic fracture [1] and the role of velocity-weakening friction in determining whether the rupture mode is self-healing or crack-like [2]. Numerical simulation provides an important complement to observational, experimental, and analytical investigations, due to its ability to model complex configurations and reveal details of response that are not easily measured in the field or laboratory [3]. However, dynamic, frictional contact and rupture are still challenging problems in numerical simulation, especially when high-fidelity models suitable for scientific investigation are needed. We present an adaptive, spacetime discontinuous Galerkin finite element model for seismic research, adapted from previous work on engineering fracture mechanics [4], that we hope meets these requirements. The model includes a contact model with velocity-weakening friction that enforces Riemann conditions to preserve the characteristic structure of the underlying elastodynamic model. An interfacial damage model, supported by powerful mesh adaptation and a stochastic nucleation criterion, represents mode-II fracture in simulations of fault branching and extension. We present numerical results to demonstrate the spacetime model's capability for high-resolution simulation of seismic physics.

References

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