MODELING EARTHQUAKE DYNAMIC RUPTURE WITH HYBRID FINITE ELEMENT - SPECTRAL BOUNDARY INTEGRAL APPROACH

Xiao MA, ***Mohamed ABDELMEGUID***, ***Ahmed ELBANNA***

Civil and Environmental Engineering Department, University of Illinois at Urbana Champaign, Urbana, USA

Earthquakes are among the costliest natural hazards on earth. The dynamical instabilities responsible for these events are linked to fundamental physics of fluid filled granular materials and rocks in the subsurface subjected to extreme geophysical conditions and coupled with long range static and dynamic stress transfer. Advances in computational earthquake dynamics are opening new opportunities in addressing the conundrum of scales in this extreme mechanics and societally relevant problem. Here, we will present a hybrid method that combines Finite element method (FEM) and Spectral boundary integral (SBI) equation through the consistent exchange of displacement and traction boundary conditions, thereby benefiting from the flexibility of FEM in handling problems with nonlinearities or small-scale heterogeneities and from the superior performance and accuracy of SBI. We validate the hybrid method using a benchmark problem from SCEC dynamic rupture simulation validation exercises and show that the method enables exact near field truncation of the elastodynamic solution. We demonstrate the capability and computational efficiency of the hybrid scheme for resolving off-fault complexities using an unique model of a fault zone with explicit representation of small scale secondary faults and branches enabling new insights into earthquake rupture dynamics that may not be realizable in homogenized plasticity or damage models. We are also planning to show preliminary results for earthquake cycle simulation using the hybrid scheme across both the dynamic and quasidynamic limits incorporating different examples of material and geometrical complexities.