THE DEVELOPMENT OF THE MPM FOR SIMULATING THE EVOLUTION OF FAILURE INVOLVING MULTI-DEGREES OF DISCONTINUITY

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To simulate the evolution of failure involving multi-degrees of discontinuity, a robust spatial discretization method is being developed, with zoom-in and zoom-out options, based on the Material Point Method (MPM). As shown in the recent publications [1-4], the evolution of localized failure can be simulated via the transition among elliptic, parabolic and hyperbolic governing differential equations so that the problem remains well-posed without introducing higher order terms in space. In this presentation, a simple numerical procedure is designed for large-scale model-based simulation of failure evolution, as summarized as below.

The transition from continuous to discontinuous failure modes is identified through the discontinuous bifurcation analysis of the acoustic tensor governing rate-dependent inelasticity. A discrete constitutive model is then used to predict material failure as a decohesion or separation of continuum. As a result, experimental data available could be employed to verify the model-based simulation, and no higher order terms in space are needed to simulate a complete process of failure evolution. To focus on the moving domain of influence, a silent boundary method is developed, based on the framework of the MPM, so that a small computational domain could be used to simulate the evolution of material failure involving multi-degrees of discontinuity under different loading conditions. With the zoom-in and zoom-out options, the proposed computational procedure could be effectively adopted for multi-scale simulation.

A parametric study is conducted to demonstrate the effects of aspect ratio and failure mode on the evolution of failure patterns under different boundary conditions. Sample problems, such as impact, penetration, fragmentation and film delamination, are considered to demonstrate the potential of the proposed solution procedure in multi-scale simulation of multi-physical phenomena.

References

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