A Quasi-linear Reproducing Kernel Particle Method for Modeling Brittle Material Damages under Strong Dynamics

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ABSTRACT

Brittle materials under high strain rates, such as high-velocity impact and penetration processes, often lead to severe material fragmentation due to strong shock dynamics. Reproducing Kernel Particle Method (RKPM) relies on polynomial reproducing conditions to yield desired accuracy and convergence properties, but requires appropriate kernel support coverage of neighboring particles to circumvent singularity of the moment matrix when constructing approximation functions with order of approximation greater than zero. In this work, RKPM with quasi-linear approximation is first proposed to achieve nearly linear completeness in the approximation while avoiding moment matrix singularity that often occurs in events with brittle material fragmentation. As such, enhanced accuracy and stability in the RKPM modeling of solids subjected to extreme loads and deformations such as penetration and blast events is achieved. Simulation of concrete walls subjected to bullet penetrations will be presented to demonstrate the effectiveness of the proposed method.