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ABSTRACT

Inertia effects and stress jumps in events of projectile impact on structural target system are critical in exhibiting distinctive features of penetration paradigms based on impact severance and material behaviour. Brief timing and concurrent modes of deformation/failure makes this event difficult to be either experimentally investigated or modelled via one-dimensional wave propagation based analytical models. Whereas, numerical framework provides a potential approach for determining exclusive effects of major influencing parameters. But material constitutive model needs to be coupled after proper characterization. In case of ductile metal under high strain rate, one such characterization is identification of Johnson-Cook or Zerilli-Armstrong plasticity coefficients. Noting unique variation of strain and strain rate over a Taylor test specimens, a mathematical model is formulated to resolve the deformed geometry as functional of material parameters. And an optimization scheme is then followed to inversely reconstruct those parameters by minimizing error between experimental measurements and model output.

Regarding numerical framework, mesh-based techniques are ill-equipped to account for large deformation scenario unless computationally exhaustive refinement/rezonation are performed. Mesh-less techniques are useful in this regard, when material damage is explicitly coupled or continuum-based strength reduction criteria are used. But, existing strategies of discrete crack modelling in particle-based simulations mostly relies on continuous tracking of crack-path and discontinuous enrichment of basis function along the crack line - and is difficult in case of multitude of cracks interacting. Here a strategy is developed to model crack initiation and propagation within Smoothed Particle Hydrodynamics (SPH)-based simulation. While discretizing the continuum, an efficient immediate neighbour interaction is formulated by using suitable spring-like connectivity among discrete particles. Degradation of those pseudo-springs - manifested through an interaction quotient - is determined through a material damage evolution law. A fully damaged spring is considered as the initiation of crack between connected particles and propagation is captured through the sequence of failure of such damaged springs. The potential of the proposed strategy is demonstrated via unique impact events showing dynamic traversing of plastic hinges, arbitrary propagation of crack path, dynamic kinking of interfacial cracks, ballistic sensitivity of pre-notch in ductile beams and fragments formation in brittle ceramics.