NOVEL METHODS FOR MODELING HIGH RATE FRACTURE OF MATERIALS

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ABSTRACT

Recently Karagozian & Case, Inc. (K&C) has developed a hybrid finite element method (FEM) and mesh reproducing kernel method (RKPM) to effectively and accurately simulate dynamic responses of structures when subjected to extreme loads such as those encountered during high speed impacts and penetration problems. The coupling between FEM and RKPM is implemented in an evolutionary way that the code utilizes either pure FEM and RKPM or coupled FEM/RKPM computations. The methodology is designed to evolve a FE domain dynamically into a mesh free domain using triggering criteria provided by the material model using point-wise nodal coupling. The advantages of this approach, in contrast to existing methods that convert finite elements to Smooth Particle Hydrodynamics particles are 1) the increase in accuracy afforded by RKPM in the crack regions, 2) the use of evolution triggers that are natural to physics-based material models, and 3) the computational efficiencies afforded by the use of finite elements in regions that do not fracture. The methodology uses damage indicators provided by the material model to evolve the element conversion from finite element to RKPM dynamically and automatically. This technique is quite general and can be used with any validated physics-based material model, including a visco-plasticity/damage model developed some years at Sandia National Laboratories (so-called BCJ model) that describes plastic deformation and failure in metallic materials subjected to high rate events. This paper assesses the capacity of the FEM/RKPM methodology to predict fracture in benchmark fracture of steel using the BCJ. An assessment of the methodology for the K&C concrete model is also presented.