ABSTRACT

Wang, Xiaowo MSCE, Purdue University, November 2011. Characterization of Non-linear Constitutive Models for Coupled Mesh-free and Finite Element Simulation of Large Transient Deformations . Major Professor: Arun Prakash.

Finite element methods is the most widely used tool to approxiate mechanics problems in different fields of science and engineering. However, the capability of conventianal finite element methods is limited for problems involving large transient deformations, steep gradients, fracture or fragmentation.. Researchers have developed alternative methods such as mesh-free methods and enriched finite element methods to deal with the difficulties associated with these problem. However, depending upon their implementation, mesh-free and/or enrichment methods also suffer from some drawbacks such as greater computational cost, inconsistent enforcement of the essential boundary conditions and inaccurate integration of the discretized weak form. In the current approach, we use spatial domain decomposition simulate large parts of a problem domain with finite elements and couple it with a refined mesh-free discretization in small regions of interest, possibly containing high spatial and/or temporal gradients. This helps keep the overall computational cost of the simulation down, without sacrificing accuracy of the solution.

As the use of mesh-free methods in conjunction with finite element methods becomes widespread, the need for constitutive models suitable for such coupled simulations has grown. In the present study, we investigate the numerical characteristics and performance of hyperelastic and elasto-plastic micromechanically-based constitutive models. A critical evaluation of the computational performance of the coupling method itself and some of the issues involved with its computational implementation will be presented. Results from numerical simulations of transient non-linear prob-

lems in solid mechanics will also be presented to demonstrate the effectiveness of this coupled mesh-free and finite element approach.