

BEYOND THE LAGRANGIAN – ADVANCED ANALYSIS TECHNIQUES FOR MODELLING EXTREME DEFORMATION AND FLUID FLOW

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ABSTRACT

The majority of finite element analysis undertaken today uses a Lagrangian description, where the nodes of a mesh are directly constrained to material points. This technique has many advantages, is it very easy to track free surfaces and hence apply loads and constraints. However, under conditions of high strain the mesh can become distorted, degrading the solution accuracy. Under extreme loading conditions element distortion may become so severe that the analysis fails to complete. This paper presents some alternative modelling techniques which can provide a solution where the Lagrangian approach is no longer sufficient. Example applications of each method are presented to demonstrate the capabilities.

The Eulerian description, where the mesh is completely uncoupled from the material, does not suffer from distortion as the elements remain fixed. This allows severe deformation and even fragmentation of the material, and when coupled with traditional Lagrangian capabilities, provides solutions for applications such as tank sloshing, aircraft ditching and birdstrike.

Smooth Particle Hydrodynamics (SPH) is a particle method, where each element represents a discrete material point and elements interact with near neighbours using special kernel functions. SPH is intended to model bulk material behaviour and again this may include extreme deformation and fragmentation with applications in blast & penetration, drop testing of fluid filled containers and birdstrike.

The discrete element method (DEM) is another particle method, intended for modelling the interaction of large numbers of discrete particles. Each rigid particle represents an individual lump of material and all particles may interact, both with other particles as well as other element types, with any material compliance built into the contact definition. Applications of DEM include aggregate transport, particulate sorting and shot peening.

SUGGESTED THEMES

Abaqus, CEL, SPH, DEM, extreme deformation