Material Point Method Investigations of Trauma to Fluids and Elastic Solids Due to Finite Barriers

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ABSTRACT

A Material Point Method (MPM) algorithm is developed and utilized to investigate how the dynamics of (Langrangian) Navier-Stokes fluids as well as that of elastic solids is affected by trauma due to finite barriers. For the fluid simulations, material point particles are placed in a two dimensional pipe with various initial and boundary conditions and stationary perturbations to fluid flow. Results show that eddy currents are present not only in the wake of the perturbing object but are also responsible for disruption of laminar flow upstream from the barrier. An unfortunately relevant application for sudden finite trauma to an elastic solid involves simulations of an aircraft striking a large building under varying system conditions. The work presented here is introductory in nature; the potential ramifications and importance of continued study is discussed and emphasized.

I. BACKGROUND AND IMPORTANCE

Material Point Method (MPM) simulations have a wide variety of applications and can be used in computational modeling of systems having length scales spanning several orders of magnitude. Recent research on biological and geological systems has shown that fluid flow in ducts and pipes having small, abrupt obstructions can dramatically affect the behavior of the system *vis a vis* the character of fluid flow. In fact it is thought that the onset of certain types of heart attacks involves the transition from laminar blood flow to chaotic, which can be triggered by the presence of plaque or other sources of roughness on the vessel interior [1]. Because of the rapid change in behavior of fluid flow given even small obstructions, it seems that much could be gained by conducting computer simulations of fluidic flow around finite barriers. The MPM method conserves mass and momentum and is nicely suited to simulate a special case of the Navier-Stokes equation, which must be modified in order to deal with a