COMPUTATIONAL ANALYSIS OF BLAST-INDUCED DEBRIS DYNAMICS

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This study deals with the computational simulation of blast-induced debris dynamics. This is achieved by integrating a recently developed concrete model, the Lattice Discrete Particle Model (LDPM) within a novel fluid-solid interaction algorithm called the Immersed Finite Element Method.

LDPM simulates the mesostructure of concrete by a three-dimensional assemblage of particles whose position within the volume of interest is generated randomly according to the given grain size distribution. A three-dimensional domain tessellation, based on the Delaunay tetrahedralization of the generated aggregate centers, generates a system of cells embedding the aggregate particles and interacting through triangular facets. A mesoscale constitutive law governs the interaction between adjacent cells and it simulates various features of the mesocale response, including cohesive fracturing, strain softening in tension, strain hardening in compression, material compaction due to pose collapse, frictional slip, rate and creep effect for dynamics, and fragmentation.

IFEM, as the classical Immersed Boundary Method (IBM), is characterized by the fact that it does not require remeshing to accommodate the evolving solid-fluid interface. This feature is crucial when a multitude of solid objects interact with the fluid as, for example, in the case of blast-induced fragmentation. Within the IFEM, however, contrarily to the IBM, the solid material can be described with a detailed constitutive model such as the one derived from LDPM. The solid description is no longer limited to just a boundary layer and can occupy a volume space in the computational domain.

In this paper, after reviewing LDPM and IFEM formulations several example of solid-fluid interaction will be presented and discussed. These will include the analysis of the dynamics of fragments emanating from a reinforced concrete wall subject to blast loading.

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