BLAST-INDUCED MOTION FROM DIFFRACTION-PHASE LOADING

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ABSTRACT

Blast-induced motion has been well-studied for objects where the accelerating force is dominated by quasi-steady drag and final displacement scales with dynamic pressure impulse for example. However, motion analyses and scaling have not been well developed for blast/target scenarios in which the blast duration is comparable to the early acceleration period typical of IED (Improvised Explosive Device) attacks against personnel or vehicles. Alternatively, this can be considered with respect to the blast wavelength λ approaching the characteristic length of the structure L. Scaling criteria for imparted motion is important for the proper interpretation of blast-wave acceleration injuries developed in animal or other model experiments compared to the human case.

The free-flight motion of blast-wave loaded sphere models, ranging from 39 to 251mm in diameter and having a range of densities, is described where the initial accelerations spanned the regime from drag-dominated to diffraction-dominated. In all cases studied there is some degree of immediate 'kick-off' velocity which increases with sphere size, followed by acceleration or deceleration during the blast duration, followed by a final deceleration during the motion through the negative phase then quiescent air. The unexpected deceleration of larger spheres after their kick-off velocity during the decaying yet high-speed flow of the blast wave seems associated with the persistence of a ring vortex on the downstream side of the sphere. Such behavior would not be revealed by applying drag coefficients determined from restrained spheres in the steady after-flow of a step-function shock wave.