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Author: Dr. Shengyu Zou
CISAS – "G. Colombo" Center of Studies and Activities for Space, University of Padova, Italy

Dr. Lorenzo Olivieri
CISAS "G. Colombo" - University of Padova, Italy
Mr. MA ZHAOXIA
China Aerodynamics Research and Development Center(CARDC), China
Dr. Cinzia Giacomuzzo
University of Padova, CISAS – "G. Colombo" Center of Studies and Activities for Space,, Italy
Prof. Alessandro Francesconi
University of Padova - DII/CISAS, Italy

FRAGMENTATION OF THIN PLATES SUBJECTED TO HYPERVELOCITY IMPACT WITH ELLIPSOID SHAPED PROJECTILES

Abstract

Projectile shape has a crucial influence on the fragmentation of plates subjected to hypervelocity impact. However, most of analytic and empirical models for predicting fragmentation in hypervelocity impact are based on spherical projectile. This paper presents a work performed for characterizing fragmentation of aluminum thin plates due to normal incoming aluminum ellipsoid shaped projectile. The work is done through numerical simulation, and aims to determine empirical models to estimate fragments characteristics.

Firstly, a series of simulations has been carried out relying on smoothed particle hydrodynamics (SPH) methodology. The simulations were calibrated and verified with experiment data of spherical projectiles. In the present study, only normal impact has been considered, the aspect ratio of ellipsoid shaped projectiles (L/d) ranged from 0.05 to 5, and impact velocity was limited in the range of 4 km/s to 7 km/s. Fragment cloud was assumed to consist of a primary fragment, spalling fragments from eroded part of projectile and fragments from target plate. In the post-process of simulations, critical fragmentation characteristics including perforation hole size, mass and velocity of primary fragment, spray angle of fragments cloud and mass distribution of spalling fragments, were analyzed and tabulated with varying impact condition parameters.

Additionally, empirical equations with multivariable power terms were proposed to characterize critical fragmentation characteristics. Independent variables including Impact velocity, projectile aspect ratio, geometrical sizes and densities of both projectile and target plate, have been selected to build the empirical relationship. Constants included in the equations were fit with simulation data. Comparison between the empirical fit models and the SPH simulation data indicated a good agreement. The empirical model can be used to predict critical fragmentation characteristics for given aspect ratio and impact velocity of aluminum projectile onto aluminum thin plate.