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Experimental evaluation and computational simulation of structures subject to high velocity impact loading

A series of experimental studies were conducted to study the plastic deformation of metallic plates under hypervelocity impact using a two-stage light gas gun. In these experiments, cylindrical Lexan projectiles were fired at target plates with velocities in the range of 4.0-6.0 km/s. Target materials studied include steel alloys, forged titanium, and additive manufactured titanium. Experiments were designed to produce a front side impact crater and a permanent bulging deformation on the back surface of the target without inducing complete perforation of the plates. Free surface velocities from the back surface of target plates were measured using the newly developed multiplexed photonic doppler velocimetry (MPDV) system. Trends in deformation patterns and failure modes for different target plate materials will be presented. Under these impact conditions, very high pressure and temperature states cause the target materials to behave like a fluid. Equation of state and complex material models are needed in the simulation models. Two different modeling approaches have been used to simulate the experiments. A Lagrangian based smooth particle hydrodynamics (SPH) method was used within LS-Dyna. SPH is a meshless numerical technique where the bodies are represented by particles or interpolation points. Two dimensional axisymmetric simulations were also conducted using CTH, an Eulerian hydrodynamics code. Both techniques were able to simulate the large deformations that developed over 2-5 microseconds. Rear surface velocity profiles versus time were calculated at several points near the impact center. Model features and comparisons with experimental data will be presented.

Biography

Brendan J O'Toole is Director of the Center for Materials and Structures, Professor, and Chair of the Department of Mechanical Engineering at the University of Nevada Las Vegas. He completed his PhD in Mechanical Engineering from the University of Delaware. His research interests include experimental characterization of metallic and composite material properties under a variety of loading conditions and dynamic computational analysis of structures subject to impact and explosive loading.

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