Plastic Deformation of ASTM A36 Steel Using Two-Stage Light Gas Gun

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Objective

To characterize material deformation in high velocity impact.

To validate material models for computation simulation purposes.

Abstract

This ongoing research is an attempt to study the plastic deformation of A36 steel plate (0.5" thick) under hypervelocity impact.

Plastic deformation of the target plate was simulated using finite element software LS-DYNA.

Gas Gun Facility

Three major components – pump tube, launch tube, drift tube.

Hydrogen or, Helium gas accelerates 5.60 mm diameter projectile into a target chamber.

Target plate is bolted to a frame in the target chamber.

Lasers are used as trigger which measures projectile travel time i.e. speed.

A Multiplexed Photon Doppler Velocimetry (MPDV) is used to collect the shock data.

Projectile & Target Details

Projectile: Lexan (5.60 mm diameter)

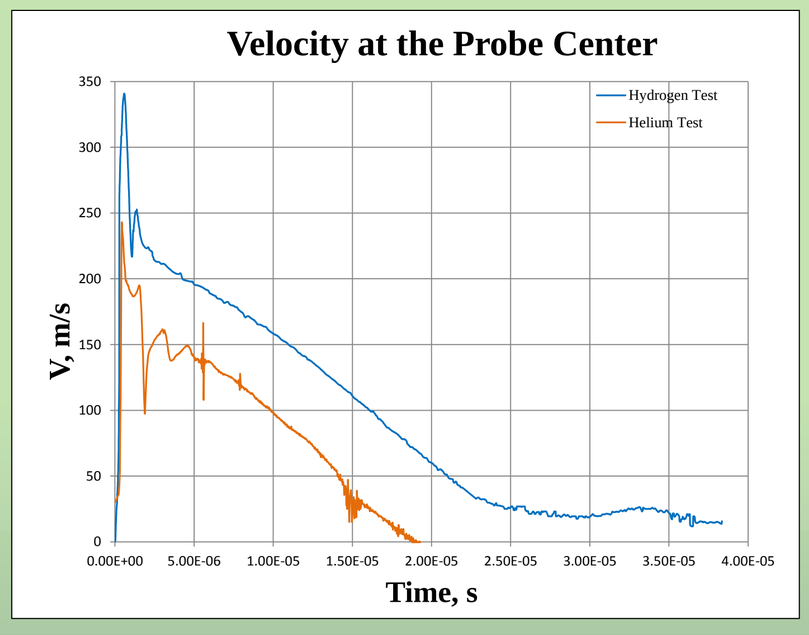
Target: A36 steel plate (152.4 mm x 152.4 mm x 12.7 mm)

Projectile penetrates into the target material and create deformation on the other side.

Gas Gun Experiment Schematic

Result

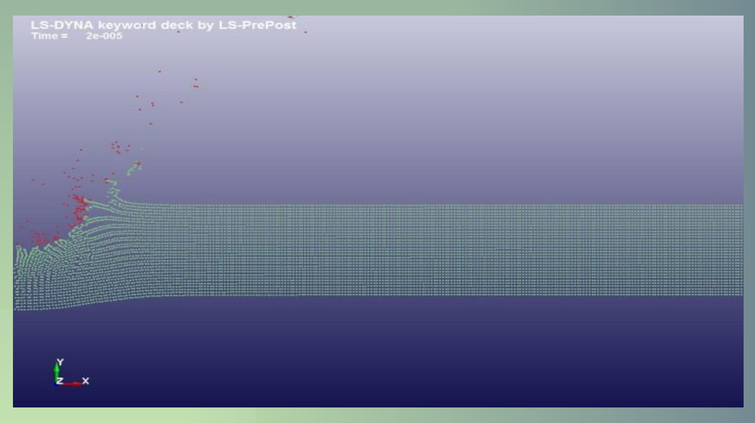
Propellant	Velocity km/s	Diameter mm	Penetration mm	Bulge mm
Hydrogen	6.57	18.06	8.58	4.31
Helium	5.34	17.01	6.32	2.32



Numerical Development

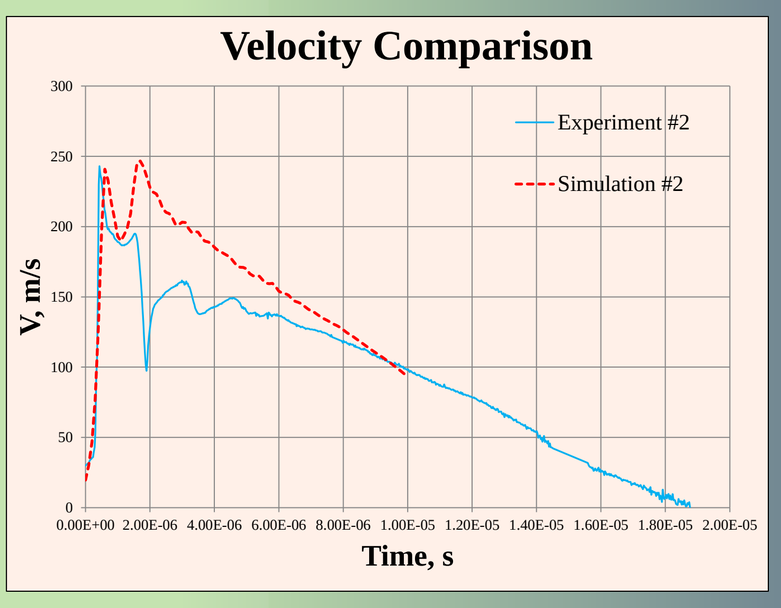
2D axisymmetric, smooth particle hydrodynamics (SPH) model in LS-DYNA.

*MAT_JOHNSON_COOK material card for plate and projectile.



Experimental vs. FEA

Propellant	Velocity km/s	Diameter mm	Penetration mm	Bulge mm
Experiment	6.57	18.06	8.58	4.31
FEA		18.18	6.52	3.09
Experiment	5.33	17.01	6.32	2.32
FEA		17.56	5.18	2.16



Future Work

Understanding the materials model for high velocity impact simulation.

Analyzing impact data using 32-channel MPDV system.

High speed imaging facility to understand the deformation behavior more precisely.

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