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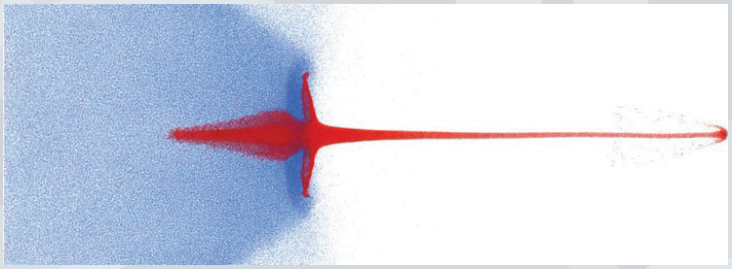
γSPH™ Solver

Modeling of Shaped Charge Jet and Penetration

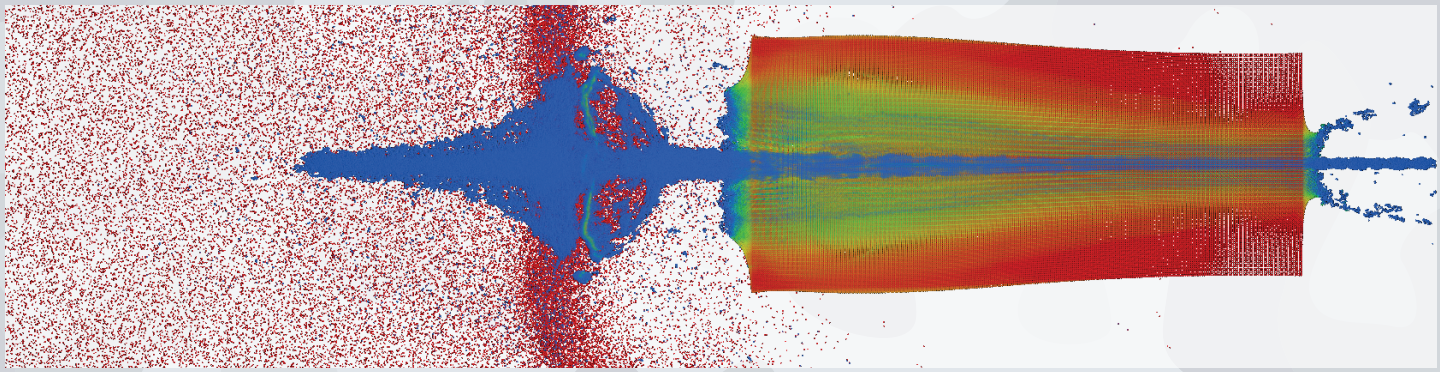
CASE STUDY

A Shaped Charge is a block of explosive with a cavity on one side placed in a container. The cavity is in general lined with metal. When the explosive is detonated, the liner collapses, inverts and a part of the material forms a Jet. The velocity of the Jet tip can have a magnitude on the order of 7-12 km/s which can penetrate tank armor. Modeling Shaped Charges involves extreme deformation and is not well-suited to modeling with Lagrangian Finite Elements. Not even the IMPETUS accurate high order ASET™ Elements can handle such large deformation. Instead one can utilize the γSPH™ mesh free particle solver to accurately capture the high deformation response. The Solver has been used for investigating Hypervelocity, Explosive Formed Projectiles, Ballistic impact into Concrete Targets just to mention a few. In order to verify that the γSPH™ Solver is accurate for Shaped Charge applications numerical results were compared with experimental results. The experiments are presented in [1] and the Sharped Charge is one that is designed and used by the Ballistic Research Laboratory. The charge uses a 42° angle cone with a copper liner and aluminum housing. The high explosive is 875 grams of Octal. Thickness of the liner is 0.20574 cm and outside cone diameter is 8.382 cm. A Jet is formed which impacts a steel armor plate. Jet tip velocity and penetration depth were measured.



γSPH™ was used to model the same set-up. Both the Shaped Charge and the target are modeled with particles. Excellent agreement is obtained for both Jet Velocity and Penetration Depth. The simulation required 25 million particles for an accurate result and the runtime was only 14 hours on a standard workstation equipped with GPUs.

Response Parameter	Experiments	IMPETUS γSPH
Jet Velocity	8300 m/s	8100 m/s
Penetration Depth	395-410 mm	409 mm



Key Features and Benefits:

- The γSPH™ Solver was used to model the Shaped Charge Jet impact experiment described in [1].
- The numerical results compare very well with experimental measurements of Jet Velocity and Penetration Depth.
- The Solver utilizes GPU technology for high performance computing on a single workstation or a single node of a cluster.
- Very high resolution models are critical to capturing the forming and breaking of the Jet and the level of damage created by the impact which requires a robust and accurate particle based method.

[1] J. Bolstad and D. Mandell, "Calculation of a Shaped Charge Jet using MESA-2D and MESA-3D Hydrodynamic Computer Codes", Los Alamos National Laboratory, Report LA-12274, 1992.

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