Validation of Abaqus Explicit – CEL for classes of problems of interest to the U.S. Army

P. Carlucci[1], C. Mougeotte[1], and J. Huidi[2]

[1]U.S. Army – ARDEC, Picatinny Arsenal, Picatinny, NJ 07806
[2]SIMULIA – Dassault Systemes Simulia Corp. – 166 Valley Street, Providence, RI 02909

Abstract: In developing weapon systems for the warfighter, the US Army uses modeling and simulation tools to support the design, test and manufacturing of these systems. One of these tools is Abaqus/Explicit, including the coupled Eulerian-Lagrangian capability CEL. The addition of CEL in version 6.7EF-1 opened the door to a new realm of problems that could not be previously be modeled. With the addition of this new capability came the need for internal validation to establish a level of confidence for the class of problems of interest to the U.S. Army. Over the course of 2 years, several validation problems were modeled and the results compared to either experimental or analytical results. A few of these problems were selected for this paper, including the dynamic tensile extrusion of copper, JWL equation of state of explosive expansion, and compressible inviscid flow in a shock tube. The details of these analyses and comparison to experiment will be discussed along with their practical implications.

Keywords: Dynamics, Experimental Verification, Failure, Johnson-Cook, Explicit, CEL, JWL, Explosive, Ideal-Gas, Shock, Compressible inviscid flow.

1. Dynamic Tensile Extrusion of Copper

1.1 Description of Experiment

The Dynamic Tensile Extrusion test was developed at Los Alamos National Lab (Gray III, 2005) for the purpose of characterizing the influence of copper grain size on high strain rate/large strain response. A 7.62mm diameter copper sphere is launched at ~400 m/s into a tool steel die. Entrance angle is 80 degrees and exit diameter is 2.28 mm. The test arrangement is shown in Figure 1. This experiment was selected to be modeled in Abaqus/CEL for several reasons: a high rate, large strain problem that is not possible to be modeled well with a conventional lagrange technique; relatively simple geometry with a complex nonlinear result which is a challenge for any code to simulate properly; rates and strains that are in the range that are applicable to problems of interest to the U.S. Army; readily available experimental data for comparison and validation.