AN ARTIFICIAL-VISCOSITY METHOD FOR THE LAGRANGIAN ANALYSIS OF SHOCKS IN SOLIDS WITH STRENGTH ON UNSTRUCTURED, ARBITRARY-ORDER TETRAHEDRAL MESHES

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We present an artificial viscosity scheme tailored to finite-deformation Lagrangian calculations of shocks in materials with or without strength on unstructured tetrahedral meshes of arbitrary order. The artificial viscous stresses are deviatoric and satisfy material-frame indifference exactly, an essential requirement for the proper simulation of solids undergoing large deformations. In addition, plastic deformations are essentially volume preserving, which prevents the use of low-order finite element such as linear four-node tetrahedra and suggests the use of high-order elements instead. The artificial viscosity model presented here was designed to address this requirement. We have assessed the performance of the method on selected tests, including: a two-dimensional shock tube problem on an ideal gas; a two-dimensional piston problem on tantalum without strength; and a three-dimensional plate impact problem on tantalum with strength. In all cases, the artificial viscosity scheme returns stable and ostensibly oscillation-free solutions on meshes which greatly underresolve the actual shock thickness. The scheme typically spreads the shock over 4 to 6 elements and captures accurately the shock velocities and jump conditions. This artificial viscosity model is currently being used in a shock-physics capability to simulate the dynamic response of materials under detonation loading.

References

[1] A. Lew, R. Radovitzky and M. Ortiz, "An Artificial-Viscosity Method for the Lagrangian Analysis of Shocks in Solids with Strength on Unstructured, Arbitrary-Order Tetrahedral Meshes," *Journal of Computer-Aided Material Design* , v. 8, p. 213-231, 2001.