Use of Riemann solvers for multi-phase modelling

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Riemann solver is a principal element of the two-stage Godunov method. The method is customary for a variety of CFD codes and it is not equally accepted in the codes dealing with the structural response.

The present paper describes a design and use of Riemann solvers in wave-propagation codes for a range of multi-phase rate-sensitive materials which might be involved in the structural and hydrocode calculations. The models involved in the study are those for porous material, damaging material and a multi-phase material with the velocity nonequilibrium.

Numerical results obtained with the Riemann solvers are validated with shock propagation data availabe in literature. One dimensional wave-propagation codes on the basis of the Godunov method, which are employing the present Riemann solvers, have been developed for the materials mentioned above. Examples of the porous materials analysed numerically include Aluminium foams and sand in which the process of compaction and the influence of the gaseous phase are studied. An example of the damaging material is Borosilicate glass where development of the failure wave is being analysed. The two-phase material with the velocity nonequilibrium is a material consisting of solid particles expanded by the blast products; evolution of the phase nonequilibrium is considered in this material.

Good agreement of the numerical results with experimental data demonstrates applicability of the Riemann solvers for the problems considered.