Linearized RM flow for incompressible elastic solids

- Richtmyer - Meshkov (RM) flow describes the instability, caused by the passage of a shock wave, of the interface separating two materials.
- Analytical study based on simplifications: purely elastic, incompressible Neo-Hookean materials; plane strain; shock replaced by impulse; small perturbation amplitude.
- Modal decomposition and Laplace transform in time. Location of poles in complex s-plane indicate the stability of the flow depending on material properties (shear modulus, density).
- Initial behavior of a fluid, constant growth rate of the interface.
- Long term behavior is stable with two variants: decaying oscillatory and pure oscillatory. Initial vorticity deposited by the impulse is advected off the interface by shear waves travelling into the materials.

Converging shocks in elastic-plastic solids

- Radially symmetric motion of a continuum elastic-plastic medium induced by collapse of cylindrical and spherical imploding shock waves.
- Motion just behind the shock is approximated by Whitman’s Shock Dynamics (WSD). An analytical expression for the Mach number of the shock as function of the radius obtained integrating along characteristics and applying Rankine-Hugoniot relations.
- Different compressible Neo-Hookean constitutive laws are tested. Strong shock limit behavior highly dependent on law used. Numerical simulations show good agreement with approximated WSD results.
- Shocks accelerated by increasing shear modulus, effect attenuated by reducing the yield stress (elastic – perfectly plastic materials).
- Elastic-plastic transition cannot be explained by WSD. Numerical simulations show a complex structure: elastic precursor – plastic region, with the plastic region overtaking the elastic precursor as shock strengthens.

RM flow in converging solids

- Analytical study following approach used for incompressible planar case. Further simplifications needed to get working results: assume interface moves at constant speed even if the sink flow (typical of incompressible flows in converging geometries) accelerates the interface as it approaches the origin.
- Results valid for a small time period after the motion is originated by the impulse.
- Exact solutions in terms of Bessel functions in the complex Laplace s-plane. Difficult to locate poles. Some simplifications available for different curvature parameters.
- Solid – solid and fluid – solid cases studied.
- Need of numerical simulations to complete study of the motion.
  - Tune numerical solver for computing amplitude and growth rate on-the-fly.
  - Increase speed of solver by using 2D equations with plane strain assumption
  - Convergence and mesh resolution study for small amplitude smeared interfaces.
  - Reduce to simplest case for code testing before running experiments: ideal gas.
  - Compare numerical results with linear theory in planar case, then extend to converging geometry.
- FUTURE WORK: reshock effect, study of the quintuple point (2 compression shocks, 2 shear shocks, interface), extension to WSD theory to more complex situations.

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