Treyssède, Fabien; **Ben Tahar, Mabrouk**

Jump conditions for unsteady small perturbations at fluid-solid interfaces in the presence of initial flow and prestress. (English) Zbl 1231.74115

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Summary: The goal of this paper is to investigate jump conditions for unsteady small perturbations at impermeable interfaces, slip or bonded, plane or not, between fluids and structures in the presence of initial flow and prestress. Based on conservative equations obtained from a mixed Eulerian-Lagrangian description, interface conditions are first derived in an elegant and straightforward manner thanks to the concept of generalized functions in distribution theory. These conditions are validated with exact conditions derived from a direct linearization of the standard jump conditions. For a straightforward comparison between both approaches, all conditions are written in terms of a curvilinear coordinate system attached to the interface. The normal Lagrangian displacement continuity across the interface is proved to be a sufficient condition. The jump conditions for mass, momentum, energy and entropy are discussed, yielding conditions for the Lagrangian perturbations of displacement, stress, heat flux and temperature. Displacement and stress jump conditions are shown to coincide with literature results. The mixed Eulerian-Lagrangian description is likely to be advantageous over its fully Eulerian or Lagrangian counterparts. It yields an interesting unification between existing formulations for inviscid fluids (Galbrun's equation) and solids (updated Lagrangian formulation), together with simpler jump conditions.

MSC:

74F10 Fluid-solid interactions (including aero- and hydro-elasticity, porosity, etc.)
74B05 Classical linear elasticity
74S30 Other numerical methods in solid mechanics (MSC2010)
76D05 Navier-Stokes equations for incompressible viscous fluids
76M25 Other numerical methods (fluid mechanics) (MSC2010)

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