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TRANSIENT FLUID AND SOLID DYNAMICS ON LINEAR TETRAHEDRAL FINITE ELEMENTS: AN ACCURATE AND STABLE VARIATIONAL MULTI-SCALE APPROACH

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A new tetrahedral finite element for transient dynamic computations of fluids [1] and solids [2] is presented. It utilizes the simplest possible finite element interpolations: Piece-wise linear continuous functions are used for displacements and pressures (P1/P1), while the deviatoric part of the stress tensor (if present, as in the case of solids) is evaluated with simple single-point quadrature formulas. The variational multiscale stabilization eliminates the pressure checkerboard instabilities affecting the numerical solution in the case of the Darcy-type operator related to compressible fluids computations, or the Stokes-type operator related to solid dynamics computations. The formulation is extended to strong shock computations in fluids and to elastic-plastic flow in solids. Extensive tests of shock flows in fluids, and of linear elasticity and finite elastoplasticity (compressible as well as nearly incompressible) will be presented. Because of its simplicity, the proposed element could favorably impact complex geometry, fluid/structure interaction, and embedded discontinuity computations. Time permitting, a number of preliminary results on fluid-structure interaction problems will also be presented.

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