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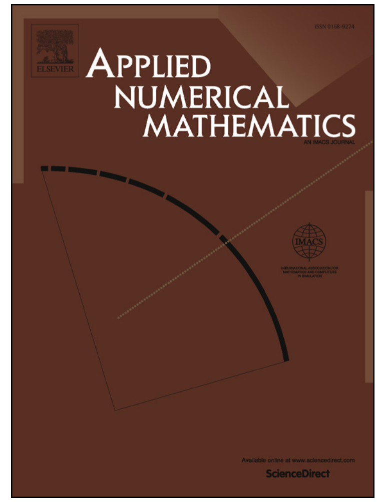

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María González, Virginia Selgas

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Analysis of a velocity-stress-pressure formulation for a fluid-structure interaction problem

María González* and Virginia Selgas †

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Abstract

We consider a fluid-structure interaction problem consisting of the time-dependent Stokes equations in the fluid domain coupled with the equations of linear elastodynamics in the solid domain. For simplicity, all changes of geometry are neglected. We propose a new method in terms of the fluid velocity, the fluid pressure, the structural velocity and the Cauchy stress tensor. We show that the new weak formulation is well-posed. Then, we propose a new semidiscrete problem where the velocities and the fluid pressure are approximated using a stable pair for the Stokes problem in the fluid domain and compatible finite elements in the solid domain. We obtain *a priori* estimates for the solution of the semidiscrete problem, prove the convergence of these solutions to the solution of the weak formulation and obtain error estimates. A time discretization based on the backward Euler method leads to a fully discrete scheme in which the computation of the approximated Cauchy stress tensor can be decoupled from that of the remaining unknowns at each time step. The displacements in the structure (if needed) can be recovered by quadrature. Finally, some numerical experiments showing the performance of the method are provided.

Mathematics Subject Classifications (1991): 65N15, 65N30, 65N50, 74B05, 74S05

Key words: Fluid-structure interaction, Stokes equations, incompressible fluid, linear elastodynamics, finite element, semidiscrete scheme.

*Departamento de Matemáticas, Universidade da Coruña, Campus de Elviña s/n, 15071, A Coruña (Spain). E-mail: maria.gonzalez.taboada@udc.es, mgtaboad@udc.es

†Departamento de Matemáticas, Universidad de Oviedo, Escuela Politécnica de Ingeniería, 33203, Gijón (Spain). E-mail: selgasvirginia@uniovi.es