Coupling of mixed finite element and stabilized boundary element methods for a fluid–solid interaction problem in 3D

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Abstract

We introduce and analyze the coupling of a mixed finite element and a boundary element for a three-dimensional time-harmonic fluid–solid interaction problem. We consider a formulation in which the Cauchy stress tensor and the rotation are the main variables in the elastic structure and use the usual pressure formulation in the acoustic fluid. The mixed variational formulation in the solid is completed with boundary integral equations relating the Cauchy data of the acoustic problem on the coupling interface. A crucial point in our formulation is the stabilization technique introduced by Hiptmair and coworkers to avoid the well-known instability issue appearing in the boundary element method treatment of the exterior Helmholtz problem. The main novelty of this formulation, with respect to a previous approach, consists in reducing the computational domain to the solid media and providing a more accurate treatment of the far field effect. We show that the continuous problem is well-posed and propose a conforming Galerkin method based on the lowest-order Arnold–Falk–Winther mixed finite element. Finally, we prove that the numerical scheme is convergent with optimal order.