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PENALTY-PROJECTION METHOD FOR MONOLITHIC FLUID STRUCTURE INTERACTION SOLVER

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In this paper we present the results of Fluid-Structure Interaction (FSI) computations of an incompressible solid object and a laminar incompressible viscous flow using a penalty-projection monolithic algorithm. The mathematical problem consists of solving the Navier-Stokes and structural mechanical equations to reproduce strong interactions between a fluid and an incompressible hyperelastic material when large displacements occur. It is well known that the projection method can be efficiently used in fluid problems. On the contrary the use of the projection method in incompressible solid leads to the incorrect evaluation of stresses on the boundary solid. This is due to the boundary conditions imposed on the projected pressure equation. In order to correct the boundary stresses an iterative technique should be used. The penalty method, applied together with the projection method, may enforce the correct boundary conditions. In particular we propose to compute the pressure field by using a proper penalty algorithm which

enforces iteratively the incompressibility constraint. Then we project the velocity solution in the divergent free space to ensure the vanishing of the velocity field divergence. This technique reduces the degrees of freedom of the problem and, as a consequence, the computational cost of the solution algorithm. In order to verify the accuracy of the proposed method we compare the results with the one obtained by using the classical monolithic approach. The numerical results show the stability and robustness of the proposed algorithm for appropriate value of the penalty parameter together with a reduction of the computational effort compared to the standard algorithms.