Regularizing effects of a thin elastic interface with mass in fluid-multi-layered structure interaction problems

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Motivated by modeling blood flow in human arteries, we study a fluid-structure interaction problem in a 2D cylinder, in which the cylinder wall is composed of multiple structural layers, each with possibly different mechanical characteristics and thickness. In the problem presented in this talk the structure is composed of two layers: a thin elastic layer modeled by the 1D wave equation, and a thick elastic layer modeled by the 2D equations of linear elasticity. The flow of an incompressible, viscous fluid is modeled by the Navier-Stokes equations, and driven by the time-dependent dynamics pressure data. The thin structure is in contact with the fluid thereby serving as a fluid-structure interface with mass. The coupling between the fluid and the structure is nonlinear. The resulting problem is a nonlinear, moving-boundary problem of parabolic-hyperbolic-hyperbolic type. We show that the model problem has a well-defined energy, and that the energy is bounded by the work done by the inlet and outlet dynamic pressure data. The spaces of weak solutions reveal that the presence of a thin fluid-structure interface with mass regularizes the evolution of the fluid-structure interface. We present the main ideas behind the constructive proof of the existence of a weak solution for the considered problem, which follows ideas developed in [1], [2], [3]. All theoretical results will be illustrated with numerical examples.

References

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