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Fluid-Structure Interaction of Moving Flexible Bodies Using Overset Meshing, solids4Foam, and preCICE

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Synopsis

Fluid-Structure Interaction (FSI) plays an important role in understanding the interaction between fluid flow and deformable structures. This study presents the numerical simulation of a flexible hollow cylinder subjected to fluid flow using a coupled FSI approach. OpenFOAM was used for computational fluid dynamics analysis, solids4Foam for structural analysis, and preCICE for two-way coupling between the fluid and structural solvers. An overset mesh technique was implemented to allow smooth motion of the cylinder without severe mesh distortion. Dirichlet boundary condition is used for solving velocity near around interface while Neumann boundary condition is used for solving traction or forces around interface. The simulation captured unsteady wake formation, vortex shedding, pressure variation, structural deformation, and stress distribution around the cylinder. FFT analysis of the lift coefficient and cylinder displacement was performed to determine the dominant fluid and structural vibration frequencies. The obtained Strouhal number showed good agreement with standard values for circular cylinder flow. The results demonstrate that the coupled OpenFOAM-solids4Foam-preCICE framework can effectively simulate overset FSI problems involving flexible moving bodies while maintaining stable two-way interaction between the fluid and structural domains.

Keywords: Fluid-Structure Interaction, Overset Mesh, OpenFOAM, solids4Foam, preCICE, Flexible Hollow Cylinder, FFT Analysis