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Large-eddy simulations of a flexible cylinder in axial flow

BEHROUZ KARAMI, ELIAS BALARAS, PHILIPPE BARDET, The George Washington University — A slender cylinder immersed in axial flow shows different behavior for different flow and material properties. Several studies have pointed to the importance of the dimensionless velocity, $\mathcal{U} = (\rho\mathcal{A}/\mathcal{E}\mathcal{I})^{\prime\cdot\nabla}\mathcal{U}_\wr\mathcal{D}$, relating the fluid and structural inertia. However, it is not clear how this behavior changes for different Reynolds numbers and flow regimes, while keeping $\mathcal{U}$ constant. In this study a slender cylinder immersed in axial flow is considered as an one-dimensional beam. The fluid-structure interaction is simulated using an immersed-boundary method for a series of Re numbers. A non-linear Euler-Bernouli hypothesis is utilized to account for the deflection and rotation of the cylinder. It is observed that for small dimensionless velocities the cylinder oscillates with small amplitude around its axis. Increasing $\mathcal{U}$ results in buckling of the cylinder. For higher $\mathcal{U}$ beam looses its quasi steady buckled state and flutters. It is investigated that how this behavior changes for different Re and different flow regimes (laminar vs turbulent boundary layers). Overall buckling occurs at higher $\mathcal{U}$ at laminar flow conditions. The results are in agreement both qualitatively and quantitatively with experiments in the literature.

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