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Pseudospectral Modelling For Flow past a Long Flexible Cylinder

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Extended Abstract

The current study aims to simulate the complex oscillation of a long flexible cylinder. This fluid-structure interaction problem is important in ocean engineering, civil engineering and so on. For instance, a riser in ocean has to interact with the current. Another example is a cable of a bridge, which vibrates due to coming wind. An in-house numerical model was developed using pseudopsectral methods [1] coupled with the direct-forcing immersed boundary (DFIB) method [2] to investigate this phenomenon. The model was validated first by simulations of flow through a fixed cylinder in a free stream. Drag coefficients obtained by the proposed model and other publications were compared and good agreement was found. The preciseness and convergence analysis are presented in the validation section. A solid body can be identified more precisely using the adopted PSME-DFIB model. The proposed numerical model was used to simulate the flow-induced vibration of an elastically mounted rigid cylinder. The variation of vibration frequency and maximum amplitude with respect to Reynolds number and reduced velocity was investigated in the lock-in region and compared against published literature. When solids move through grids, the coordinate transformation can eliminate noise in the resultant force, as determined by the numerical integral. In addition, the in-house PSME-DFIB model was used to investigate the flow-induced vibration of an infinitely long flexible cylinder at various wavelengths, cylinder tensions at low Reynolds numbers. A short-wavelength cylinder was considered due to the feasibility of simulations. The effects of cylinder vibration on the flow patterns were also explored in detail. Given the initial displacement, the cylinder vibration was produced a stable standing wave response in the early stage, and gradually turned into a traveling wave response. This physical phenomenon is consistent with others experimental and numerical solution. An intertwined vortex is produced the standing wave response produces. The vortex of the traveling wave occurs an oblique shedding. Finally, this study investigated different phase velocities. Since the phase velocities affected the natural frequency and wavelength of the cylinder, vortex patterns and their transformation at different phase velocity were summarized.

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