Force Control of a Square Cylinder in Cross Flow

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Abstract

For a bluff body in cross flow, the flow separate and vortex streets are formed in the wake of the cylinder when the Reynolds number exceeds a critical value. While the vortex shedding, fluctuating forces acting on the bluff body are induced. The periodic fluctuating fluid forces can cause the vibration of elastic structures. Vortex-induced vibration is often dangerous for bluff structures. If resonance is induced, the structures may be fatally destroyed. It is necessary for using some methods to reduce the vortex shedding and the fluctuating force.

A numerical study on reduction of fluid forces acting on a square cylinder in a two-dimensional cross flow is presented in this paper. In order to control the flow around a square cylinder, two small adjunctive cylinders are symmetrically inserted in the near wake of the main cylinder. The schematic view of the model is shown in Figure. A finite element method is used to solve the $N - S$ equation at the Reynolds number of 200. The non-linear coupling terms in the equations are treated separately at different fractional time steps, by an operator splitting time stepping method. The cases with different inserting positions of small control cylinders are calculated.

Figure: Schematic control model.

The computational results show that the small adjunctive cylinders inserted in the separated shear layer of the main square cylinder can cause an obvious variation of the vortex pattern and changing of the fluid forces acting on the main cylinder. The shear layers separated from the main cylinder are divided by two small control cylinders. Vortices then become longer than before. The wake near wall is almost symmetrical and steady. Accordingly, the forces acting on main cylinder are prominently improved. At some proper inserting positions, such as $(L/D = 2.0, A/D = \pm 1.0)$, $(L/D = 3.0, A/D = \pm 1.0)$ and $(L/D = 4.0, A/D = \pm 1.0)$, fluctuating lift acting on the main cylinder can be almost entirely suppressed.