Numerical experiment of the vortex shedding from an oscillating circular cylinder in a uniform flow by the vortex method

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ABSTRACT

Since the vortex method which is the Lagrange type flow analyzing method does not need a calculation lattice unlike the region type analyzing method such as finite difference method and finite element method, analysis is easily possible also for the flow of the around of complicated shape. Moreover, since it is the technique of analyzing a flow by following the behaviour of the turbulent flow vortex more than the minimum vortex element size directly in Lagrange, it is possible to reproduce exactly the flow accompanied by large-scale separation and a large-scale reverse flow as well as the analysis of an unsteady flow. So, it is a technique suitable for cause investigation of phenomena made into a problem in engineering, such as a flow induced vibration excited by the flow. Recent development of the lagrangian vortex method and its application into fluid machinery and fluid engineering are shown in reference [1].

In this study, the flow features of vortex shedding from a circular cylinder forced-oscillating in the in-line direction were investigated by use of numerical simulation at the Reynolds number Re=500, with varied amplitude ratio and varied frequency ratio. The numerical experiment was performed at the two-dimensional calculation for incompressible and viscous flow. The circular cylinder was divided into 40 panels which distributed the vortices. Every calculation continued to more than non-dimensional time T=100. The main parameters of numerical experiment were the oscillation amplitude ratio $2a/d$, the oscillation frequency ratio f/f_K. The amplitude ratio is defined by the ratio of half-amplitude of cylinder motion a to the outside diameter of cylinder d. The frequency ratio is defined by the ratio of circular cylinder oscillation frequency f to natural Karman vortex shedding frequency f_K. The amplitude ratio is three kinds, is 0.0, 0.25 and 0.5, respectively. The oscillation frequency ratio is 15 kinds, is from 0.2 to 3.0 every 0.2 steps.

As a result of calculations, two typical flow patterns of the lock-in were shown, and it was confirmed that the calculated flow pattern were reasonable agreement with previous experiment results [2]. The fluid force act on the oscillating cylinder was investigated. It was clarified that the amplitude of the lift coefficient was larger than the amplitude of the drag coefficient in the lock-in of alternate vortex shedding, and the amplitude of the drag coefficient was larger than the amplitude of the lift coefficient in the lock-in of simultaneous vortex shedding. When the amplitude ratio grows, this tendency becomes remarkable.

REFERENCES

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