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VORTEX SHEDDING AND VORTEX FORMATION FROM A PAIR OF IN-LINE FORCED OSCILLATING TANDEM ARRANGED CIRCULAR CYINDERS IN A UNIFORM FLOW

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Visualization method(s): streak line tracer method, laser light sheet
Other keywords: vortex, lock-in, in-line oscillation, tandem cylinders

ABSTRACT: In this study, the vortex shedding characteristics and the flow patterns of vortex shedding from a pair of tandem arranged circular cylinders oscillating along the direction of flow were investigated by visualizing water flow experiment. The experiment was performed in a 4m^3 closed circuit water channel in which a cylinder's oscillator was equipped on a carriage. The test cylinders are made from hollow aluminum with 16mm of outside diameters, 14mm caliber, 600mm length. A pair of tandem arranged circular cylinders is mounted on the oscillator and oscillates periodically to the direction of the flow. The flow visualization was done with the aid of the laser light sheet technique which was based on the dye injection method. In the plane of the laser light sheet at a depth of 140mm below the water surface, the flow was visualized by means of tracer ink (Rhodamine B or poster paint), which oozed out from two dye ports at plus-minus 60 degrees from the front stagnation point of the circular cylinder. The visualized flow feature was monitored by a CCD video camera and recorded on video tapes. The main experimental parameters given by frequency ratio f/f_K (the ratio of cylinder oscillation frequency f to natural Karman vortex's frequency f_K: f/f_K=0~7), amplitude ratio $2a/d$ (the ratio of half amplitude of cylinder motion a to the outside diameter of cylinder d: $2a/d$=0.25, 0.5, 0.75 and 1.0), distance ratio L/d (the ratio of cylinder distance L to the diameter of cylinder d: L/d=1.5, 2.5 and 5.5) and main flow velocity U=0.041m/s. The Reynolds number which is based on the main flow velocity U and the cylinder diameter d is 640. The mean vortex shedding frequency was measured by counting the visualized vortices for a certain time at the observation point. As a result of the experiments, the variations of mean vortex shedding frequency were investigated. Also in the case of tandem cylinders, the lock in phenomenon was observed. And it is obtained that although the cylinder oscillation frequency f is lower than the natural Karman vortex's frequency f_K, the lock-in phenomenon can be seen even in tandem arrangement case. The lock-in ranges have been shown in each distance ratio L/d. It is found that the lock-in ranges become wide when comparing with the single cylinder case. The lock-in map in case of L/d=5.5 is shown in Fig.1 by way of example. The typical flow patterns of the lock-in or un-lock-in states were shown every distance ratio L/d. In distance ratios L/d=2.5 and 5.5, the twin vortex street from the 2nd cylinder (rear set cylinder) was not seen. Some representative flow patterns are shown in Fig. 2.

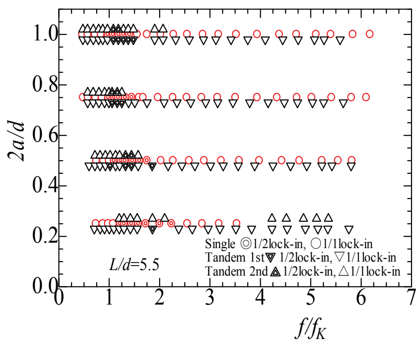

Fig. 1 Lock-in map in the case of distance ratio L/d=5.5

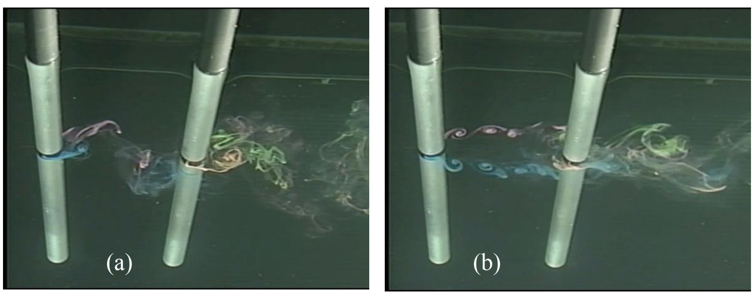

Fig. 2 Representative flow patterns in lock-in state, int case of L/d=5.5, $2a/d$=0.25, (a) f/f_K=1.44, (b) f/f_K=2.98