ABSTRACT

The unsteady wake response of a circular cylinder to periodic small-amplitude perturbations superimposed on the inflow velocity is studied as a generic configuration for fluid-structure interaction. In the first part, results from an experimental study using non-invasive optical techniques such as laser-Doppler velocimetry and particle image velocimetry made in an unsteady flow water tunnel are shown for subcritical Reynolds numbers [1-6]. The different responses may be broadly classified as ‘wake resonance’ and ‘shear layer excitation’ based on the patterns of vorticity distribution and spectral characteristics of the velocity fluctuations. Large-eddy simulations of the same problem are shown in the second part [7-9]. This computational study complements the experiments with data for the fluctuating forces exerted on the cylinder and their phasing as a function of the perturbation frequency within the synchronization range. It is found that as the timing of vortex shedding changes systematically across the synchronization range a similar change to the phase of the forces is induced. In the third part, results from direct time integration of the Navier–Stokes equations at low Reynolds numbers are shown. In this case, some salient features of the forced cylinder wake including nonharmonic effects can be identified [10]. The implications of the above results for the corresponding case of a vibrating cylinder excited by different modes of vortex shedding in its wake are discussed.

REFERENCES