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Turbulent flow interaction with a circular cylinder

Abstract

This paper presents a comprehensive experimental study on the unsteady pressure exerted on the surface of a round cylinder in smooth and turbulent flows. A highly instrumented cylinder with several static pressure taps and dynamic pressure transducers at different spanwise and peripheral locations was used, enabling extensive dynamic surface pressure, coherence, and turbulence length-scale analysis. The effects of the free-stream turbulence and turbulent length scale are investigated by placing the turbulent-generating grids within the wind tunnel duct. For both the laminar and turbulent incident flows, the surface pressure results show the emergence of the fundamental, first and second harmonics at most peripheral angles, while at the cylinder base, the surface pressure spectra are dominated by the first harmonic. It has also been observed that an increase in the level of the turbulence intensity results in an increase in the energy level of unsteady pressure acting on the cylinder. An increase in the length scale of the incoming flow structures is shown to result in an increase in the energy level of the tonal frequencies and the broadband content of the surface pressure spectra. The spanwise coherence results have also shown that an increase in the length scale of the flow structures increases the spanwise correlation length of the flow structures at the vortex shedding frequency at the stagnation point, while at the cylinder base, the spanwise correlation length decreases at the vortex shedding frequency.