Wake features of a rectangular cylinder undergoing unsteady galloping oscillations in smooth and turbulent flow

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For low to medium values of the mass-damping parameter (Scruton number), the transverse galloping instability presents unsteady features that cannot be captured by the classical quasi-steady theory. A prominent unsteady effect is the action of vortex shedding[1]. In smooth flow, the main aspects of unsteady galloping are fairly clear. In contrast, the behavior in turbulent flow is more complicated, and several features have not been understood yet[2]. In particular, the delay of the instability onset beyond the vortex-resonance wind speed (U_r) in case of small-scale incoming turbulence (Fig. 1) is a puzzling effect that still requires a sensible explanation.

Furthermore, in a previous paper[3] the adaptation of a wake-oscillator model to the unsteady-galloping problem has suggested that the strong nonlinearity of the wake dynamics is essential to reproduce the strong interference between vortex shedding and galloping observed in the experiments. Such an effect may also be responsible for the previously mentioned delay of the galloping onset in turbulent flow. This conjecture is tested in the present work through detailed measurements in the wake of a rectangular cylinder with a side ratio of 1.5 (elastically suspended in the wind tunnel with the short side facing the flow).

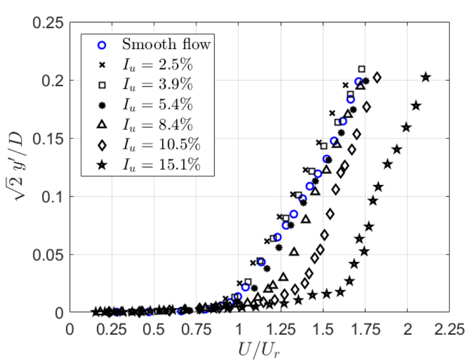

Figure 1: Amplitude-velocity curves recorded in the wind tunnel in small-scale turbulent flow of various intensities (I_u), for a medium value of the mass-damping parameter[2].

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