Characteristics of turbulent flow past a vertical flat plate

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Flow past an infinitely spanned vertical flat plate is simulated to investigate its statistical features at Re ≤ 10,000 based on the height of the plate (h). We apply direct and large eddy[1,2] simulations at low and high Reynolds numbers, respectively. Figure 1(a) shows the contours of the instantaneous spanwise vorticity at Re = 5,000. One can clearly observe a shear-layer vortex roll-up together with a Kármán vortex shedding. The ratio of the frequency of the shear-layer instability (f_{SL}) to that of the Kármán vortex shedding (f_K) is obtained for Re = 2,000 – 10,000, and shows a power law of $f_{SL}/f_K \sim \mathrm{Re}^{0.66}$ (Fig. 1b). This is very close to the power law for the flow over a circular cylinder ($\sim\mathrm{Re}^{0.67}$) suggested by Prasad & Williamson[3]. Figure 2 shows the mean-square of the vertical velocity fluctuations (v_{rms}^2), measured at $x/h = 1$, for Re = 200 – 10,000. A distinguished feature from this figure is the existence of double peaks around $y/h = \pm 0.3$ for Re ≥ 500. These double peaks do not exist for flow over a circular cylinder. Instantaneous vortical structures responsible for this phenomenon will be discussed in detail.

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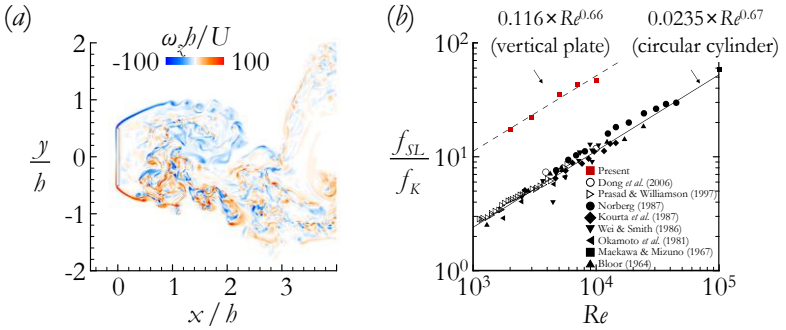

Figure 1 Shear layer instability: (a) contours of the instantaneous spanwise vorticity at Re = 5,000; (b) f_{SL}/f_K vs. Re.

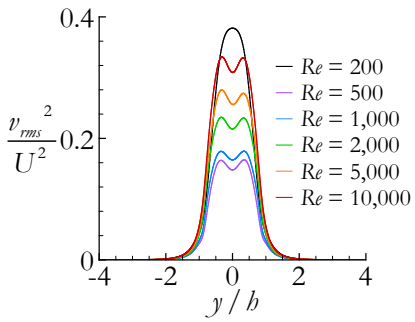

Figure 2 v_{rms}^2 vs. y at $x/h = 1$.

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[1] Park et al., *Phys. Fluids* **18(12)**, 125109 (2006).
[2] Lee et al., *Phys. Fluids* **22(7)**, 075106 (2010).
[3] Prasad and Williamson., *J. Fluid Mech.* **333**, 375-402 (1997).