Abstract

Turbulent characteristics in wall-wake flows downstream of wall-mounted and near-wall cylinders are investigated. The distributions of the defect of streamwise velocity, Reynolds shear stress and turbulence intensities exhibit a certain degree of self-preserving characteristic when they are scaled by their respective peak defect values. For the velocity defect distributions, the vertical distances are scaled by the half-width of peak defect measured from the bottommost point of the cylinders. However, for the distributions of the defects of the Reynolds shear stress and the turbulence intensities, the vertical distances are scaled by the half-width of Reynolds shear stress defect. The values of the peak defects of all the quantities gradually reduce with the distance downstream from the cylinders signifying the recovery of their undisturbed upstream distributions. The third-order correlations and quadrant analysis reveal that for the wall-mounted cylinder, a streamwise acceleration associated with a downward flux in the inner-layer of wall-wake composes sweeps and a streamwise deceleration associated with an upward flux in the outer-layer forms ejections. On the other hand, for the near-wall cylinder, a streamwise deceleration associated with a downward flux in the inner-layer of wall-wake flow and the gap flow produces the inward interaction events, while the outer-layer characteristic is similar to that of wall-mounted cylinder. The turbulent kinetic energy (TKE) budget in the wake flow is characterized by a high negative pressure energy diffusion rate in addition to high TKE dissipation and diffusion rates and that in the gap flow by a minor positive peak of pressure energy diffusion rate and a minor negative peak of TKE diffusion rate. In the wake flow, the mean duration of bursting events is shorter than their mean interval of occurrence. The turbulent length scale length scales in the wake flow decrease as compared to those in the upstream distributions.

Author keywords: Flow characteristics; Hydraulics; Open-channel flow; Streamflow; Turbulent flow; Wakes.