Abstract

The results of an experimental study on turbulent flow characteristics in submerged plane offset jets are presented. The vertical profiles of time-averaged velocity components, Reynolds stresses, third-order correlations of velocity fluctuations and turbulent kinetic energy (TKE) fluxes at different horizontal locations are depicted to show their variations with horizontal distance. Also, the horizontal profiles of boundary shear stress are furnished. The jet profile in the pre-attachment region and the length dimensions related to the physical characteristics of submerged offset jets are obtained from the velocity profiles. The profiles of velocity and Reynolds stresses are analysed in the context of the self-similarity and the decay of their representative scales. The self-similarity characteristic in the pre-attachment and wall jet regions is better preserved than that in the impingement region. The similarity characteristic of individual profiles of horizontal velocity in different regions of submerged offset jets is examined by using the velocity scale as jet velocity and the vertical length scale as the jet half-width from the point of occurrence of jet velocity in the pre-attachment region and from the solid boundary in the impingement and wall jet regions. The vertical profiles of horizontal and vertical Reynolds normal stresses at different horizontal distances demonstrate that in the pre-attachment region, the jet layer is characterised by two peaks occurring at the points of inflection of a horizontal velocity profile in the inner and outer layers of jet, respectively. Based on the two-dimensional Reynolds averaged Navier–Stokes equations, the Reynolds shear stress profiles within the jet layer are theoretically derived. Analyses of the third-order correlations and the TKE fluxes reveal that within the jet layer in the pre-attachment region, an upward advection of low-speed fluid streaks induces a strong retardation to the jet; while in the wall jet region, an inrush of low-speed fluid streaks induces a weak retardation. The TKE budget suggests that within the jet layer, the TKE diffusion rate and the pressure energy diffusion rate oppose each other, and the peak of the dissipation rate lags from that of the corresponding production rate. Further, the anisotropic invariant maps (AIMs) appear to be a looping trend within the jet layer.

Key words: hydraulics, jets, submerged offset jets, turbulent flows, boundary layer