EXPERIMENTAL STUDY OF TURBULENT JETS UNDER JONSWAP WAVES

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An experimental study of vertical jet discharged under random surface waves with JONSWAP spectra has been carried out. The experiments were conducted in a 27m long, 1.5m wide & 1.5m deep random wave flume. A 13.5mm-diameter jet was mounted vertically at the channel bed and connected via a PVC pipe to a constant head tank placed above the wave flume. Water was fed from the constant head tank and discharged via a nozzle to the wave flume at two different initial jet velocities W_0 of 0.53 and 1.038m/s. The water depth was maintained at 0.5m at all times. To determine the jet-wave interaction behaviour, progressive random waves with a JONSWAP spectrum were generated by the DHI random wave maker located at one end of the wave flume. The temporal variation of the water surface was monitored by a wave gauge located close to the jet nozzle. Instantaneous and time-averaged jet characteristics, including centerline velocity profile, jet width spreading rate and radial velocity profiles were measured experimentally by an acoustic Doppler velocimeter (ADV).

The centerline velocity decay rate shows a piecewise linear relationship along the vertical direction (Fig. 1). Two flow regions, the jet momentum dominated near field (JDNF) and the wave momentum dominated far field (WDFF), can be identified to describe the phenomenon. The transition point between JDNF and WDFF in this study occurs at $z \sim l_w$, where z is the vertical distance from the outlet and l_w is a length scale relating the jet momentum and wave velocity. Similar observations for the jet width were obtained. The jet width spreading rate varies linearly for $z < l_w$ in JDNF and varies nonlinearly for $z > l_w$ in WDFF (Fig. 2). The time-averaged radial velocity profile follows the normal distribution, though twin peak velocity profiles sometimes occur in the jet far field. The turbulence intensity for the jet in waves is larger than that in stagnant ambience (Fig. 3). The large turbulence is due to the large velocity fluctuation under the wave induced fluid motion. In addition, the distance required to reach the peak turbulence intensity was shown to be dependent on the wave momentum as well as the jet momentum.

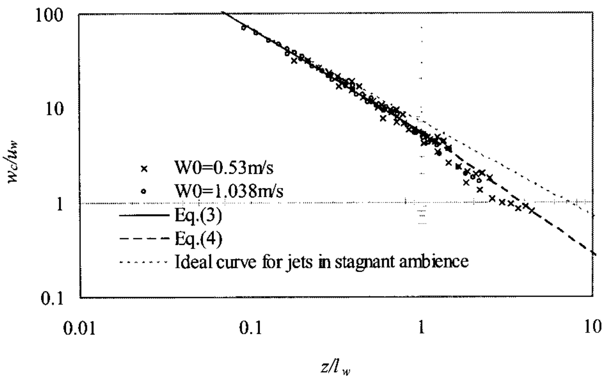

Fig. 1 Centerline velocity decays along jet axis

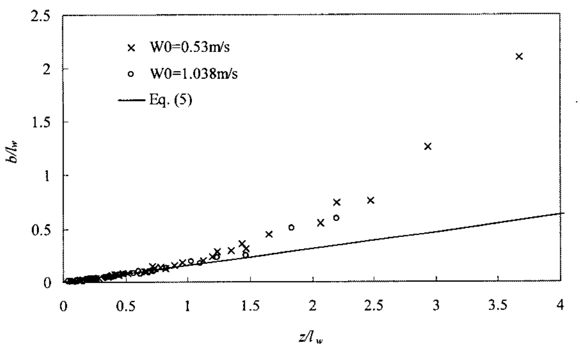

Fig. 2 Variations of jet width against jet distance

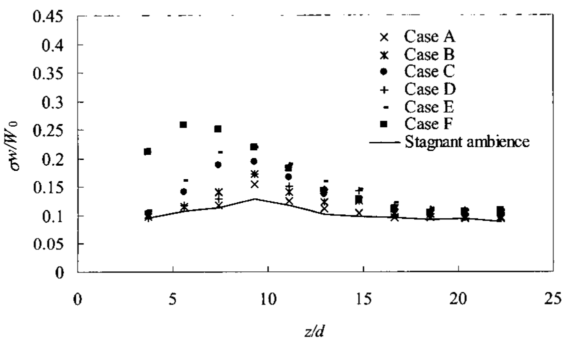

Fig. 3 Variations of turbulence intensity along jet axis for jet with W_0=0.53m/s