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S.N. Chan, Q.S. Qiao, Joseph H.W. Lee

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On the three-dimensional flow of a stable tangential vortex intake

S.N. Chan[a,b], Q.S. Qiao[a], Joseph H.W. Lee[a,*]

[a] *Department of Civil and Environmental Engineering, The Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong, China*
[b] *Institute for Advanced Study, The Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong, China*

Abstract

Tangential vortex intakes are compact hydraulic structures commonly used in water supply, drainage and sewerage systems to convey water from high to low elevations efficiently. Tangential vortex designs can be designed to ensure stable flows for all discharges, with high energy dissipation in the absence of significant air entrainment. However, due to the complex three-dimensional (3D) flow in the tangential vortex intake, current theoretical models are not sufficiently complete to interpret the flow process reliably. This paper presents a 3D computational fluid dynamics study of a steady tangential vortex intake flow using the Volume-of-Fluid method. For the first time, the CFD model predictions are validated against detailed point velocity measurements using laser doppler anemometry (LDA) for a wide range of inflow conditions. For a flow less than the free drainage discharge, the inflow does not interfere with the swirling flow in the drop shaft. The streamwise horizontal x-velocity at the channel-dropshaft junction varies linearly with vertical distance, while the vertical velocity follows a parabolic relation. For larger discharges the pressure and inflow velocity field is notably modified by the dropshaft swirling flow interacting with the inflow issued from the junction. While the swirling flow in the dropshaft is highly asymmetrical, it is found that the local tangential velocity can be well-approximated

*Corresponding author
Email address: `jhwlee@ust.hk` (Joseph H.W. Lee)