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Abstract

This study is aimed to investigate numerically and experimentally the interaction of a solitary wave with a bottom-mounted vertical thin plate with focuses on the wave induced fluid kinematics and vortex flow patterns. A streamfunction-vorticity free-surface (SVFS) based fully nonlinear viscous wave model solved in a transient boundary-fitted coordinate system with locally overlaid grids is applied to study this wave-plate interaction problem. Qualitative comparisons between numerically generated flow patterns around the plate and the experimental observations, including images from both the particle-tracking and the laser-dye visualization methods, are presented. The shear-layer velocity profiles are compared quantitatively with the experimental measurements. The detailed flow characteristics and formed vortices including the effect of the shape of the plate top on the vortex formation and development are numerically investigated. For a thin vertical plate, the flow characteristics that are affected by the dimensionless parameters of incident-wave height and plate height are also investigated. The numerical visualizations illustrated by the virtual transport of particle-tracing, streamlines, and equi-vorticity lines are useful to understand the kinematic behaviors of the induced vortical motions. Furthermore, the pressure gradient, shear stress, and maximum wave force are examined to detail the hydrodynamic impacts on the submerged plate.

Keywords: solitary wave, vertical plate, vortical flow, flow visualization, streamfunction, vorticity.