# COMPUTER SIMULATION OF WAVE OVERTOPPING RATE ON VERTICAL WALL BY BOUSSINESQ WAVE MODEL

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## INTRODUCTION

Recently, Boussinesq equation models have been used in research on wave overtopping. The advantage of this model is that compared to the NLSW model or the NS model, it is possible to simulate a wider wave field to the intermediate water depth. This model can set offshore boundary conditions further away from the structure, so that the start of the wave breaking can be figured out and the wave propagation from the foreshore can be well reproduced. When waves propagate to the shallow water, the nonlinearity of the waves is increasing as the ratio of amplitude and water depth increases. In order to simulate the wave transformation in shallow water, a strong nonlinear wave model is required. In addition, the 2D wave model capable of simulation of wave field in a wide area is needed for study of the countermeasures of wave overtopping. In this study, a computer simulation model capable of calculating the wave overtopping rate in a horizontal wave field was established by adding a subroutine to the FUNWAVE-TVD model, a fully nonlinear Bussinesq wave model. The subroutine was composed by coding the wave overtopping rate equations of EurOtop (2018) and Goda (2009)'s empirical formulas obtained from many experimental and field observations. The verification of the model was carried out by comparing the computer simulation results of the wave overtopping rate of irregular waves on the vertical wall with new experiment results in Korea. Froude similitude with a length scale of 1/36(model/prototype) is assumed in the following prototype computations.

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In the subroutine, a vertical wall and a composite structure are distinguished by the ratio between the depths of the structure mound and the seabed. Also the equation of non-impulsive conditions or impulsive conditions is applied depending on the occurrence of wave breaking in front of the structure. The water depth conditions for verification are 3 cases of 10.8, 14.4, and 18.0 m in front of the structure, and the bottom slope seaward of the horizontal mound crest is 1/40. The freeboard $R_c$ includes 7 cases at 0.9 m intervals from 1.8 to 7.2 m. The model area consists of 2000x160 m, and the grid interval is 2.0 m. The sponge boundary layers are placed on both seaward and landward sides of the model area, and the periodic boundary condition is applied at the lateral boundary. The irregular waves are reproduced using the TMA spectrum. The results of the model for non-impulsive conditions are well matched with the experimental results in the entire range of relative freeboard. Particularly, for $R_c/H_{mo} < 0.8$, it is consistent with the trend line of the experiment. For $R_c/H_{mo} > 0.8$, it is similar to the EurOtop 2007 equation(Figure 1). The graph of the experiment results for impulsive conditions is shown using the EurOtop 2007 equation for the plotting purpose. This simulation model based on the EurOtop 2018 equation. The results of the model are consistent with the experiment in the range of $0.1 < h_* R_c/H_{mo} < 0.3$ but slight deviations occur outside this range. The details including the differences between EurOtop 2007 and 2018 will be presented at ICCE2022.

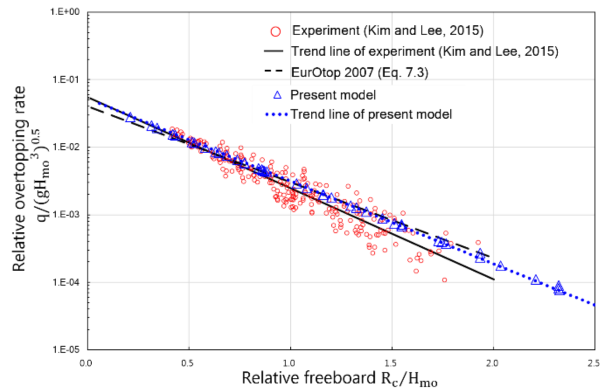


Figure 1 - Comparison results of relative overtopping rate on vertical wall for non-impulsive conditions

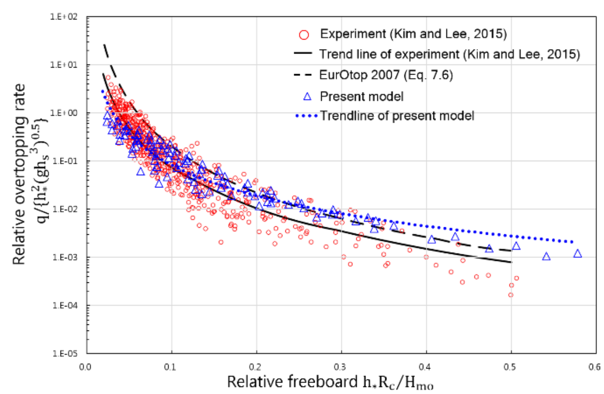


Figure 2 - Comparison results of relative overtopping rate on vertical wall for impulsive conditions where $h_*$ is wave breaking parameter in EurOtop 2007