VIOLENT AND IMPULSIVE WAVE OVERTOPPING AT VERTICAL WALLS WITH LARGE FREEBOARDS

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INTRODUCTION

Vertical walls are designed and built to protect coastal areas or harbours. Typically, these structures are installed in relatively deep water where incoming waves are reflected without breaking. In such cases the available prediction methods for wave overtopping discharge are well established. When the relative water depth h/H_{m0} becomes smaller, waves start shoaling on the foreshore and breaking can occur leading to impulsive conditions. The present overtopping prediction methods (EurOtop, 2018) under impulsive conditions have been proposed by Van der Meer & Bruce (2014) including data from the VOWS project (Bruce et al.; 2001). Wave overtopping is strongly related to the relative freeboard R_c/H_{m0}, and for impulsive overtopping EurOtop suggests that for $R_c/H_{m0} > 3$ there still might be significant overtopping but there is no data to validate such an extrapolation. Also the well-known overtopping graphs of Goda (2000) show that overtopping could be present for very large freeboards and impulsive waves – see the red box in Figure. 1.
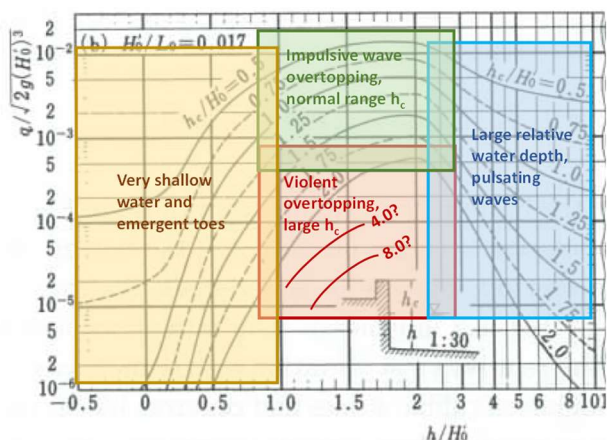

Figure 1 - Mean overtopping at a plain vertical wall under various conditions of wave overtopping, based on Goda (2000). The red block includes no previous data.

AIM OF THE RESEARCH

Violent overtopping goes high into the air, suggesting that also for very large relative freeboards there still will be overtopping. The range of applicability of the violent wave overtopping curves in EurOtop is limited to $R_c/H_{m0} = 3.3$. The objective of the present research is to investigate the mean discharge and volumes per wave from impulsive and violent overtopping at vertical walls with very large freeboards (up to $R_c/H_{m0} = 10$). The results from the 2D experimental campaign conducted at the University of Roma Tre and at the University of Edinburgh within the WOW21 project (Wave Overtopping at Walls 2021) in collaboration with IHE Delft (Ngxabani, 2021) are described and investigated.

PHYSICAL MODEL AND WAVE CONDITIONS

The model was a vertical wall over a foreshore slope 1:50 in Rome and 1:10 in Edinburgh. In total, 183 tests were carried out at the two flumes. The water depth at the vertical wall toe ranged from 0.30m down to -0.05m (emerged toe) in six steps of 0.05m. Two wave heights H_{m0} with three different steepnesses (0.01, 0.03, 0.05) were tested for each water level. The paper gives the results from this project together with the original data of EurOtop. The prediction performance of existing empirical formulae has been evaluated and extended to a wider applicability range, see Fig. 2 for a summary.
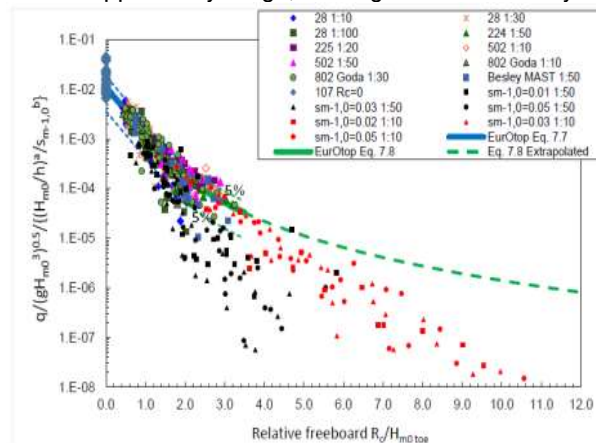

Figure 2 - All data of vertical seawalls on sloping foreshore for impulsive waves (Van der Meer and Bruce 2014) plotted with new wave overtopping results for a 1:10 (red) and 1:50 (black) foreshore slope.

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