# WAVE OVERTOPPING OVER A DIKE FOR VARIABLE WATER LEVEL

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## INTRODUCTION

The still water level (SWL) during a storm is always dynamic (storm surge). The variability of the water level can be schematized as a time-varying hydrograph of a certain duration. The average wave overtopping discharge q is a function of the ratio between the freeboard $R_c$ (the structure crest elevation above SWL) and the significant wave height $H_{m0}$. Since the variation during a storm of the SWL changes the freeboard $R_c$, the wave overtopping discharge is variable. Typically, in the laboratory the wave overtopping on coastal defense structures is investigated for a constant water level (CWL) and a pre-determined structural exposure time frame. This exposure time frame is often representative for the storm surge peak or for a statistically representative number of individual waves (e.g. 1000 waves), not considering any variable water level (VWL). Prediction of the average wave overtopping discharge of coastal structures is derived from empirical formulae, e.g. EurOtop, 2018 for the average overtopping discharge over a dike slope and CWL (see Eq.1).

$$\frac{q}{\sqrt{g\,H_{m0}^3}} = 0.09\exp\left(-(1.5\,\frac{R_c}{H_{m0}\,\boldsymbol{\gamma_f}\,\gamma_\beta\,\gamma^*})^{1.3}\right) \qquad (1)$$

where $\gamma_f$, $\gamma_\beta$, $\gamma^*$ are the influencing factors, affecting the average overtopping discharge, related to roughness, oblique wave attack and influence of different structure geometries respectively. For the case of wave overtopping in VWL conditions, no validated prediction formulae exist (Kerpen et al. 2020) and the prediction is rather based on safe assumptions and engineering judgement.

## AIM AND METHODOLOGY OF THE RESEARCH

This research investigated the influence of a VWL on the prediction of the average wave overtopping discharge q. Physical model test were conducted in the wave flume at Ghent University for a situation with VWL and a prediction method including VWL effects was derived. The wave flume at Ghent University is 30 m long, 1.0 m wide and 1.2 m high. The model consists of a dike (smooth impermeable slope) with a slope angle cot(α) = 2. A total of 139 tests were performed, both under CWL and VWL conditions. Different storm durations (from 15 min to 120 min) and storm surges (0.15, 0.10, 0.05, 0.025 m) were tested in model scale (Froude length scale 1-to-20). By combining tests with different durations, the data-set was synthetically enlarged, resulting in 3873 tests used for the analysis.

## ANALYSIS

Firstly, calibration tests to evaluate the performance of the active wave absorption system in VWL situations, were analyzed. Secondly, the experimental data were processed to derive the incident and reflected wave conditions. Thirdly, the CWL and VWL results in terms of wave overtopping, both average discharge q and individual volumes Vi, were calculated.

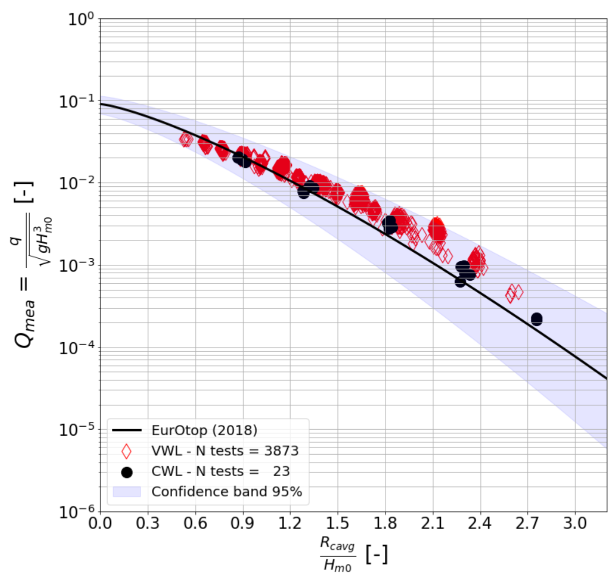


Figure 1 - non-dimensional average overtopping discharge versus non-dimensional freeboard for VWL (red diamonds) and CWL (black dots) tests, and prediction using Eq. (1)

The prediction performance of Eq. (1) (EurOtop 2018) was evaluated, and its limitation was identified. At the conference the results from this experimental campaign will be presented, to demonstrate the influence of the VWL on the prediction of average overtopping discharge q, not previously investigated yet.

## REFERENCES

Kerpen et al. (2020): Effect of variations in water level and wave steepness on the robustness of wave overtopping estimation., Journal of Marine Science and Engineering, Volume 8, pp 63

Van der Meer et al. (2018): EurOtop, Manual on wave overtopping of sea defences and related Structures. An overtopping manual largely based on European research, but for worldwide application. www.overtopping-manual.com