

# WAVE OVERTOPPING OVER A SEA DIKE WITH STILLING WAVE BASIN AND SHALLOW FORESHORE

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## INTRODUCTION AND RESEARCH OBJECTIVE

In the past decade, sea dikes were renovated at different locations along the Belgian coast using the concept of a stilling wave basin. Fig. 1 shows a square along the coast in Ostend city, equipped with a stilling wave basin (SWB). Although different in geometrical details, all sea dikes use the same concept: (i) the impact of the incoming waves is reduced by the first seaward wall; (ii) overtopping waves are reflected by the second landward wall, positioned at a certain distance of the first wall on the dike's crest and (iii) the overtopped volume is flowing back through voids in the seaward wall. In this way, overtopping discharges can be kept to tolerable limits whilst maintaining the crest elevation as low as possible (to minimize visual impact).



Figure 1 - sea dike with stilling wave basin at Ostend city

In the framework of the safety assessment requested by the Flemish Government, the entire coastline needs to be evaluated (every 6 years) against normative storm conditions, including sea level rise scenarios (De Roo et al., 2022). This assessment consists of the calculation of tolerable wave overtopping, the evaluation of the stability of the revetment and the quantification of dune erosion. In general, wave overtopping is calculated using numerical modelling. However, the specific geometry of a dike with stilling wave basin is a complicating factor in a (relatively) fast and accurate modelling approach. For an efficient assessment of the expected average wave overtopping discharge, employing a wave overtopping formula would be preferred.

Geeraerts et al. (2006), among others, studied the performance of the SWB-concept for breaking and non-breaking waves on a dike slope with a toe in deep(er) water conditions. However, up to date, no influence

factor(s) are available in literature in the specific case of a coastal dike with shallow foreshore, as present along the Belgian coastline. This knowledge gap constitutes the main objective of this research: to describe the effect of the stilling wave basin by means of a reduction factor ( $\gamma_{SWB}$ ) in eq. (5.15) of the Eurotop Manual (Allsop et al., 2018), written as:

$$Q^* = 10^{-c} \cdot \exp\left(-\frac{R^*}{\gamma_{SWB}}\right) \quad (1)$$

with dimensionless discharge  $Q^* = q / \sqrt{gH_{m0}^3}$ , freeboard  $R^* = R_c / \gamma_f \cdot \gamma_\beta \cdot H_{m0} \cdot (0.33 + 0.022\xi_{m-1,0})$  and exponent  $c$  a stochastic variable with mean -0.79 and standard deviation 0.29. The reduction factor should be (ideally) a function of the geometrical properties of the dike structure only, depicted in Fig. 2. The reduction factor will be investigated based on experimental research in a wave flume of Flanders Hydraulics, Antwerp (Belgium).

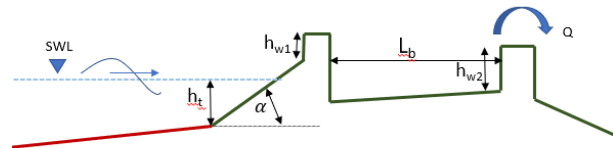


Figure 2 - definition sketch of SWB-dike geometry

## DESIGN OF EXPERIMENTS

2D scale model tests will be conducted in the (small) wave flume at Flanders Hydraulics ( $L=41.3\text{m}$ ,  $W=0.70\text{m}$ ,  $D=0.86\text{m}$ ). The flume is equipped with a piston-type wave generation with 2<sup>nd</sup> order wave theory and reflection compensation that can operate in a max. water depth of 0.5 m. A fixed flume bathymetry with a foreshore slope of 1:50 will be installed.

In order to achieve a reliable fitting of eq. (1) through the experimentally obtained data points ( $R^*$ ,  $Q^*$ ), a sufficiently wide range of  $R^*$ -values (between 1 and 8) should be obtained by varying (i) the hydraulic boundary conditions (water level and spectral wave characteristics at the dike toe, maintaining shallow water conditions at the dike toe), and (ii) the geometry with the dike slope angle ( $\alpha$ ) and the front and back wall heights ( $h_{w1}$  and  $h_{w2}$ ) being of primary effect. The void ratio in the first wall (for drainage) will be examined too. A fixed basin length ( $L_b$ ) will be applied in all tests, since it is known from prior research (Geeraerts et al., 2006) this parameter has a limited effect on the wave overtopping reduction.

Prior to conducting the experiments with the SWB-dike

layout, a benchmark test series with a simple smooth dike ( $h_{w1}=0$ ) will be performed to confirm whether the experimentally measured discharges comply with eq. (1), given the potential influence of scale or other model effects.

In the design of experiments, particular attention will be paid to the setup of the wave overtopping measurement equipment. In addition to a wide range of mean wave overtopping discharges, also individual overtopping volumes will be measured. This requires a careful design of the instrumentation setup (load cells, wave overtopping detection system, pump calibration and signal treatment), which will be supported by the research in Victor (2012).

## RESULTS

The experiments are currently in preparation and will be conducted early 2024, with the aim to present results at the conference.

## REFERENCES

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