Overtopping induced by oblique waves at Station quay – Oostende

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The harbor of Oostende extended recently and the length and the orientation of the groins protecting the harbor entrance changed. The new configuration exposes the harbor quay in front of the train station to certain wave directions, at large angle respect to the quay normal. Therefore it became necessary to estimate the vulnerability of this quay for extreme storm such as the 1000 year return storm (Hs=4.75m, Tp=12s, water level +8.0m TAW). It was calculated (Gruwez *et al.*, 2011) that for this storm the waves approach the Oostende Station quay at an angle of approximately 80°, the H_s=1.5m and T_p=12s. Storm return walls are planned to be built on this quay and their position and height have to be proportional with the estimated overtopping.

For classical configurations the EurOtop manual (2007) proposes validated formulas to calculate the overtopping discharge. In the case of perpendicular wave attack on a storm return wall the overtopping is maximum, but for larger wave angles a reduction factor is applied to reflect the decrease in overtopping discharge. This factor decreases gradually for wave angles between 0° and 45° and it keeps a constant value for wave angles larger than 45°. It is very probable that the overtopping discharge will keep the decreasing trend for larger wave angles. To quantify the reduction of the overtopping for very oblique waves a 3D physical experiment was designed in the wave tank of Flanders Hydraulics Research, Antwerp. The scale of the experiment was decided to be 1:50 and the structure replicating a harbor quay has 8m length, 0.2m height and 1m width, in model scale. On top of the structure a storm return wall (0.02/0.04m) is placed at different positions with respect to the front edge of the quay. On the back of the structure 16 boxes were placed to collect the overtopping volumes. The water level is ranging between -0.015 and +0.020m with respect to the quay level, while the waves have H_s=0.03-0.06m and T_p=1.1-1.7s. The wave angle used for simulations is 80° with respect to the normal. The wave characteristics are measured using many wave gauges placed in arrays in such way to both separate incident and reflected waves and characterize the total wave height pattern at the toe of the structure. Because the wave paddle has no active absorption system passive absorption mattresses were placed around the basin to minimize the wave reflection.

After finishing of the planned tests, a clear decrease in the measured overtopping volumes with respect to those calculated was observed. A high variability of the overtopping volumes along the structure was also observed. Detailed wave climate analysis was performed and the variation of the wave height along the structure is correlated with the overtopping. The main results of the experiment are new overtopping reduction factors for very oblique waves at the vertical quays as well as for different heights and positions of the storm return wall.

References

EurOtop Overtopping Manual. 2007. Wave Overtopping of Sea Defences and Related Structures: Assessment Manual (Die Kuste version).

Gruwez V., A. Bolle., W. Hassan, T. Verwaest and F. Mostaert. 2011. Numerieke modellering van het extreem golfklimaat in de Belgische havens. Deel 1: Haven van Oostende. Versie 2_0. WL Rapporten, 769_03. Waterbouwkundig Laboratorium & IMDC (I/RA/11273/11.113/VGR).