WAVE RUN-UP AND OVERTOPPING IN RUBBLE-MOUND BREAKWATERS UNDER OBLIQUE WAVE INCIDENCE

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MOTIVATION

Former investigations on wave run-up and overtopping of (impermeable and permeable) coastal structures aimed at quantifying the influence of oblique waves on mean overtopping discharge, water layer thickness and velocities by developing empirical formulas of a reduction factor for wave obliquity, γ_β (e.g. EurOtop, 2007; Nørgaard et al., 2013). However, most formulas did not consider very oblique waves.

The existing data gaps triggered the interest in developing the present experimental work, whose main goal is to contribute to a new whole understanding of the phenomena to mitigate future sea level rise impacts in European coastal structures, including the run-up and overtopping characterization on rough and permeable slopes. The key point is to extend the range of wave steepness values in run-up, overtopping and armour layer stability studies, focusing on oblique extreme wave conditions and on their effects on a sloping breakwater's trunk armour and roundhead.

BREAKWATER MODEL

A stretch of a rubble mound breakwater (head and part of the adjoining trunk, with a slope of 1(V):2(H)) was built in the wave basin of the Leibniz Universität Hannover to assess, under extreme wave conditions (wave steepness of 0.055) the structure behaviour in what concerns wave run-up, overtopping and damage progression of the armour layer. The breakwater trunk is 7.5m long and the head has the same cross-section as the exposed part of the breakwater. The total model is 9.0m long, 0.82m high and 3.0m wide. Details of the model can be found at the data storage report (Santos et al. 2019).

The waves in the model were measured with arrays made of six acoustic wave probes. Capacitive wave gauges, 0.87m long, were deployed over the armour layer to measure wave run-up. Three were deployed at the breakwater trunk, close to the measuring sections of wave overtopping, and two at the breakwater head. Three 500l overtopping reservoirs were deployed along the breakwater trunk and the water volume inside each of them was weighted with a load cell. Figure 1 presents one of the overtopping reservoirs and the corresponding run-up wave gauge.

Figure 1 – General layout at the entrance of an overtopping reservoir

TEST PROGRAMME

For each incident wave angle, at least 4 different wave conditions acted on the model (Hs=0.10m, 0.15m, 0.175m and 0.20m and the corresponding peak periods Tp=1.19s, 1.45s, 1.57s and 1.68s).

For long-crested waves and the water depth of 0.60m, 5 incident wave angles (40º, 55º, 65º, 75º and 90º) were considered, whereas with the water depth of 0.68m, the number of incident angles was reduced to 3 (40º,55º, 65º). The influence of the directional spreading of short-crested waves was investigated for the lowest water depth (0.60m) and the incident angles of 40º and 65º, the directional spreading being 50º. Finally, for the incident angle of 40º results were also obtained for the highest water depth (0.68m) and short-crested waves with a directional spreading of 50º.

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