Wave impacts on storm walls: Large scale experiments in the Delta flume

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1. Introduction

Coasts of low lying countries, such as The Netherlands, Belgium, UK and Germany are often comprised of a gentle foreshore and shallow waters, followed by a dike and a promenade. At the end of the promenade buildings or storm walls are constructed. In this setting waves can overtop the dike and impact on the storm wall or building. Commonly design guidance for overtopping and overtopped bore impacts for this set-up are developed in relatively deep water conditions, neglecting the dissipation of wave energy due to depth-limited wave breaking on the foreshore. Recently, the reduction in overtopping, the increase in wave periods at the toe have been experimentally studied for shallow water and gentle foreshore conditions. Furthermore, numerical simulation have been performed in the past. Small scale experiments of overtopped wave impacts on walls are conducted and design guidance for overtopped wave impacts on walls for shallow water and gentle foreshore conditions were derived. However, a validation based on large scale experimental data of overtopped wave impacts for this set-up is still missing.

2. WaLoWa objectives

Within the European project 'Wave Loads on Walls' (WaLoWa) model tests in the Delta flume (The Netherlands) have been conducted in March 2017. The project is a cooperation of Ghent University (Belgium), TU Delft (The Netherlands), RWTH Aachen (Germany), University of Bari, University of Florence (Italy) and Flanders Hydraulics Research (Belgium). The project is financed by a grant by Hydralab+ in the framework of the EC Horizon 2020 program. The program provides researchers access to large scale coastal engineering test facilities in Europe. The main objectives are: (a) to study the impact behavior of overtopped waves on vertical structures (b) to study scale effects by comparing the obtained results to small-scale experiments conducted using a similar geometry, (c) to analyze bed profile changes and suspended sediment concentration of the sandy foreshore, (d) to validate numerical models in terms of wave evolution over the foreshore and wave impacts on the wall, (e) to study the overtopped flow formation on the promenade and (f) to apply new measurement techniques for this set-up.

3. Experimental set-up

The scale model geometry is divided into four parts: (1) A sandy foreshore with a slope of 1/35 over a flume length of 80m, made from ~1000m³ of sand, (2) Both a concrete dike with a 1/2 slope and (3) a 2.3m wide promenade are attached to the foreshore, (4) A vertical, 1.6m high wall at the end of the promenade. All values are given in model scale using Froude similarity 1/4.3 and are given more detailed in Streicher et al. (2017). Irregular and Bichromatic waves were tested during the experiments. Waves representing a storm with a 1000 year return period and an additional water level to account for sea level rise result in the tested superstorm conditions. In (part 1) the incoming wave parameters and morphological evolution of the sand bed are measured, in (part 2) the run-up and overtopping are surveyed. In (part 3) the overtopping flow parameters layer thickness and velocity are monitored and in (part 4) the impact forces and pressures on the wall and the flow aeration are measured.

4. Discussion

During the VLIZ talk the large-scale WALOWA model tests, conducted in the largest wave flume facility of the world, will be presented. An outline of the objectives, model construction, test program and measured parameters will be given. With the obtained large-scale data set a detailed study of wave impact processes along the coasts of shallow waters and gentle foreshores is enabled and numerical model validation facilitated. The importance of large-scale physical model testing in coastal engineering will be addressed by highlighting preliminary results. More detailed the pressure distribution induced by a wave impacting the wall will be discussed.

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Reference

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