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NUMERICAL TOOLS FOR WAVE OVERTOPPING AT RUBBLE MOUND BREAKWATERS WITH SUBMERGED BERMS

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ABSTRACT

In the era of climate change, the adaptation of existing coastal structures as a response to potential increasing loads, has become a trending topic in coastal engineering. The combination of sea level rise, storm surge, tides and waves is going to dramatically increase the wave overtopping.

In this context, this research is focused on the evaluation of wave overtopping for conventional rubble mound breakwaters, modified by the introduction of a submerged berm. Recent studies illustrated how the introduction of emerged berms on the seaward slope reduces the wave overtopping. The goal then becomes to turn the spotlight on the submerged berms, whose effectiveness has yet to be attested, although it has proven useful in reducing wave loads on the armour layer and seabed pressure under the structure. Therefore, the reliability of two different numerical models in detecting overtopping phenomenon have been assessed.

IHFOAM and SWASH have been used (see Figure 1). The first one can solve both Reynolds Averaged Navier Stokes and the Volume Averaged Reynolds Averaged Navier–Stokes equations. The second one solves the non-linear shallow water equations with a non-hydrostatic pressure term, representing a simplified form of the Navier-Stokes equations, with associated limited computational cost. The numerical models have been validated based on experimental tests carried out in a wave flume at the University of L'Aquila.

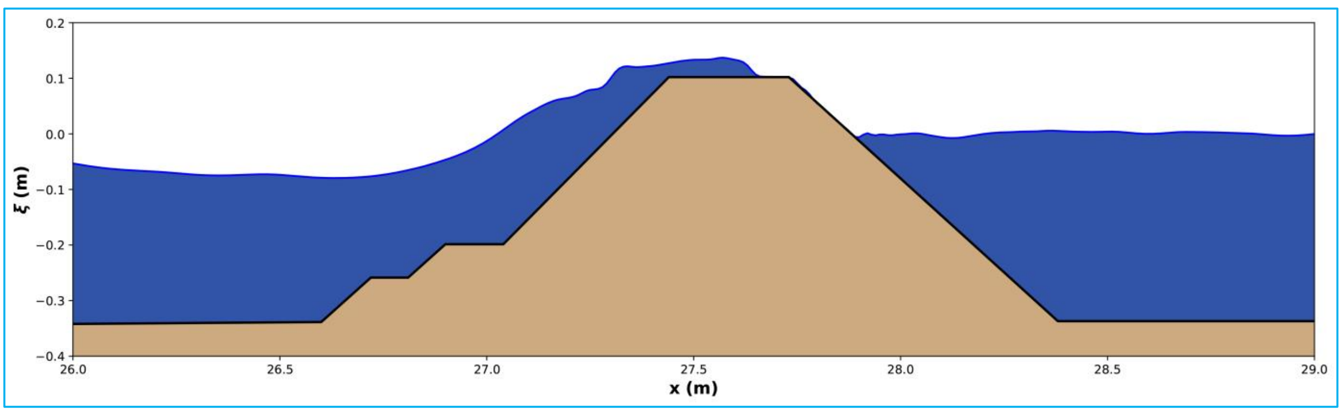

Figure 1. Wave overtopping at rubble mound breakwater, reproduced in SWASH.

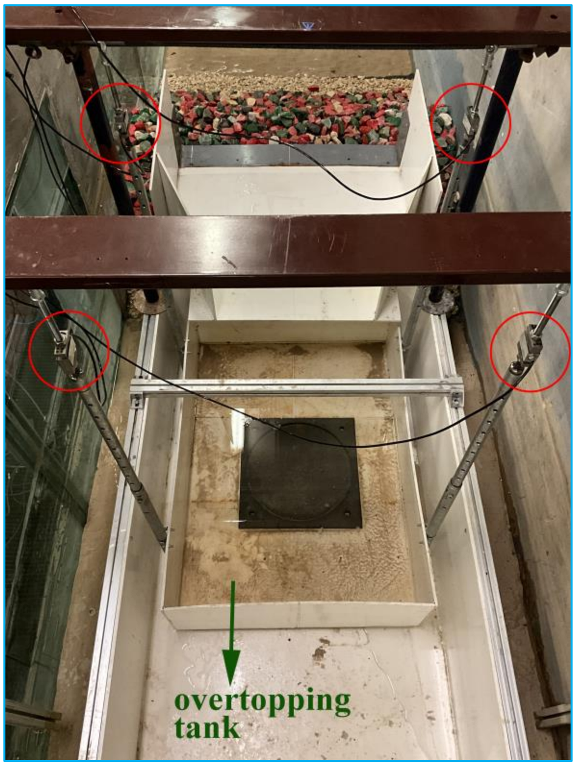

Figure 2. Experimental device for the overtopping measurement. In the red circles the load cells.

In Figure 2, the experimental device for the overtopping measurement is illustrated. The chute, deployed at the end of the breakwater crest, allows the overtopped volumes to be collected in the overtopping tank (as highlighted in Figure 2). The overtopping tank is disconnected from the chute and from the larger tank in which is collocated.

As an example, Figure 3 shows the time-series of the cumulated wave-overtopping discharge, during one of the performed tests. The comparison between the observed and computed cumulated overtopping discharges represents one of the parameters to establish the reliability of the employed numerical tools.

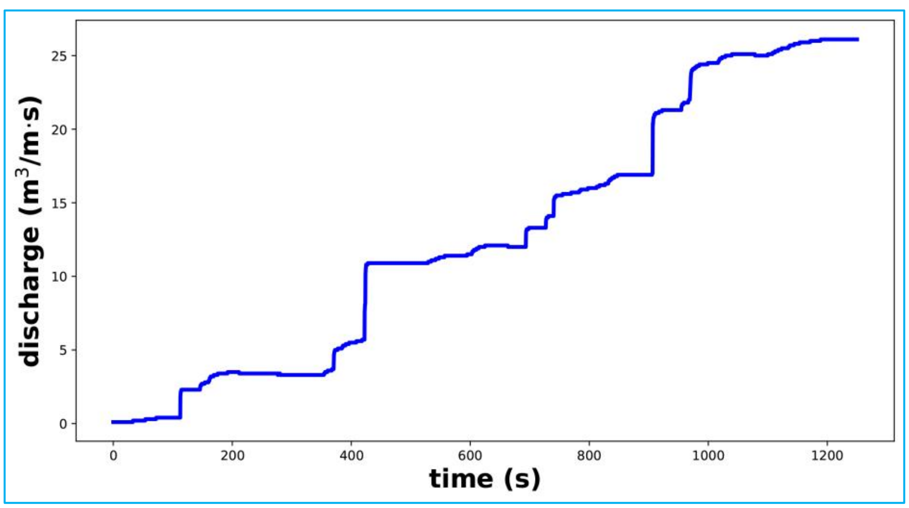

Figure 3. Experimental device for the overtopping measurement. In the red circles the load cells.

After highlighting their strengths and weaknesses, the numerical tools have been employed to evaluate the role of the submerged berm configuration on the overtopping discharge.