Proceedings of the 9th International Conference on Physical Modelling in Coastal Engineering (Coastlab24)
Delft, Netherlands, May 13-16, 2024

Extended Abstract, DOI: 10.59490/coastlab.2024.787

EFFECTIVENESS OF STILLING WAVE BASINS IN REDUCING WAVE OVERTOPPING ON DIKES AND RUBBLE MOUND BREAKWATERS

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KEYWORDS: Overtopping discharge, Stilling wave basin, Impermeable sloping structure, Rubble mound breakwater

Motivated by the impacts of Climate Change (CC), such as rising sea levels and the increased intensity and frequency of storms, the importance of adapting our coastal defense structures has never been more important (Toimil, 2020). With CC causing coastal structures to be exposed to more extreme hydraulic conditions than originally designed for, there is an increased risk of these structures failing in terms of stability and hydraulic performance, such as wave overtopping. To reduce wave overtopping, structural modifications of existing coastal structures are often adopted and in this work the analysis of wave overtopping discharge at slope structures equipped with Stilling Wave Basins (SWB) at their crest (Figure 1) is investigated.

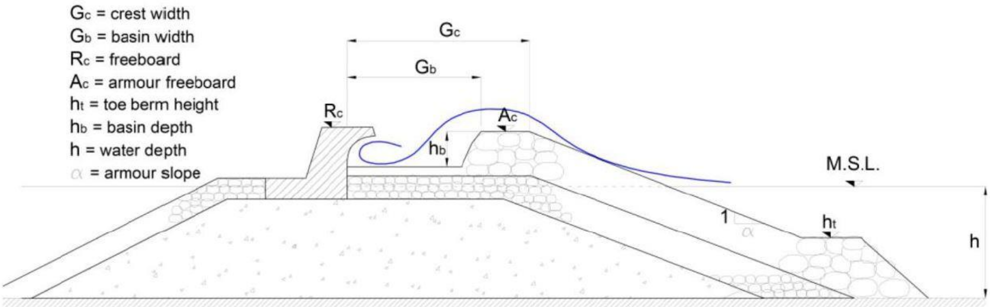

Figure 1 Conceptual design of stilling wave basin and parameter definitions (adapted from Grossi et al., 2017)

The SWB is a cost-effective solution to counteract wave overtopping without having to raise the crest level of coastal structures. The geometry of the SWB is relatively simple and economical to construct, especially in existing rubble mound structures with large, low-crest berms, where some rocks in front of the wave wall could be shifted seaward to create a higher outer crest and a rear dissipating basin. These basins are designed to capture and dissipate the energy of waves that hit the crest wall, thereby reducing the potential for overtopping.

The general equation to estimate the average overtopping discharge is expressed as a function of the non-dimensional freeboard Rc/Hm0, where the non-dimensional overtopping discharge Q decreases exponentially as the non-dimensional freeboard increases. In the EurOtop, 2018 the main equations are collected and the average discharge for slope structure can be predicted with the following expressions for breaking and non-breaking wave conditions:

$$\frac{q}{\sqrt{g\,H_{m0}^3}} = \frac{0.023}{\sqrt{\tan\alpha}}\,\gamma_b\,\xi_{m-1,0}\,\exp\left(-(2.7\,\frac{R_c}{\xi_{m-1,0}\;H_{m0}\,\gamma_b\,\boldsymbol{\gamma_f}\,\gamma_\beta\,\gamma_v})^{1.3}\right)$$

With a maximum of

$$\frac{q}{\sqrt{g\,H_{m0}^3}} = 0.09\,\exp\left(\ -(1.5\ \frac{R_c}{H_{m0}\,\boldsymbol{\gamma_f}\,\gamma_\beta\,\gamma^*})^{1.3}\right)$$

γ are the correction factors to account hydraulic (γ_β, for a oblique wave attack) and geometric effects such as the presence of a SWB (γ_b, γ_v, γ_f, γ^*, for a berm, a wave wall, roughness elements on the slope and crest modifications, respectively).

The primary focus of this work is to more thoroughly comprehend the reduction effect of an SWB on average overtopping discharge in dikes and rubble mound breakwaters. The paper provides a comprehensive review of existing formulae (Geeraerts et al., 2007, Van Doorslaer et al, 2015, Grossi et al., 2017, EurOtop, 2018) on SWB and evaluates its effectiveness. In the present analysis the dataset considered by Grossi et al., 2017 was re-analysed in a different way together with data from CLASH database (van der Meer et al., 2009) and from the study of Pepi et al., 2022. Through data-driven analysis a reduction factor suitable to account for the SWB impact is then proposed.

Overall, by combining historical data with current findings, this work provides insights into the role and potential of SWBs in enhancing the resilience of coastal structures against the mounting threats posed by CC. This structural modifications, while promising, requires careful consideration of the design aspects. These crucial aspects and their implications will be presented and extensively discussed during the conference.

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