The Influence of Berm and Roughness on Wave Overtopping at Rock-armoured Dikes

A. Marconi[1*], W. Chen[2,3], M.R.A. van Gent[3], J.J. Warmink[2], S.J.M.H. Hulscher[2]

1 University of Roma Tre, Rome, Italy; 2 University of Twente, Enschede, The Netherlands; 3 Deltares, Delft, The Netherlands

*Correspondence YP: alb.marconi@stud.uniroma3.it

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ROMA TRE UNIVERSITÀ DEGLI STUDI

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UNIVERSITY OF TWENTE.

Abstract

Average overtopping discharge is a crucial parameter for design and reinforcement of dikes. Rock armours and berms are widely used to reduce wave overtopping discharge by introducing slope roughness and energy dissipation. Since-methods for estimating the influence of a rock berm and roughness of rock armour at dikes on the average overtopping discharge still need to be developed and/or validated, this study aims to empirically develop better quantification of the reductive influence of rock armour on wave overtopping, compared to existing procedures. That is derived based on the analysis of experimental data from physical model tests. Moreover, the influence of roughness of a rock armour applied only on part of waterside slopes is estimated by introducing location weighting coefficients. Results show that the newly derived methods for evaluating the influence of berm and roughness for rock-armoured dikes lead to significantly better predictions of the average wave overtopping within the tested ranges compared to existing ones.

Keywords: dikes, coastal structures, wave overtopping, physical model tests, rocks.

Methods

Physical model tests were performed in the Pacific Basin (Deltares). The following model cross-sections were investigated:

- Rocks on the whole slope
- Rocks on the upper slope only
- Rocks on the upper slope and berm
- Rocks on the berm only

Figure 1-2: Examples of cross-sections tested in the basin.

Results

Empirical coefficients for the berm and roughness influence factors γ_b and γ_f have been recalibrated.

$$\gamma_b = 1 - b_0 \frac{r_b(1 - r_{dh})}{\sqrt{S_{m-1,0}}} \qquad [1]$$

$$\gamma_f = 1 - c_0 \frac{R_c}{H_{m0}\ \xi_{m-1,0}} \qquad [2]$$

Least squares method was used by minimising the difference between measured and calculated values for average wave overtopping discharge, resulting in:

b_0=0.19 ; c_0=0.70

Influence of location weighting coefficients (α_1, α_2, α_3), needed in Eq. [3] when varying roughness on the waterside slopes of a dike is present, was also investigated.

$$\gamma_f = \frac{\alpha_1 \gamma_{f,1} L_1 + \alpha_2 \gamma_{f,2} L_2 + \alpha_3 \gamma_{f,3} L_3}{\alpha_1 L_1 + \alpha_2 L_2 + \alpha_3 L_3} \qquad [3]$$

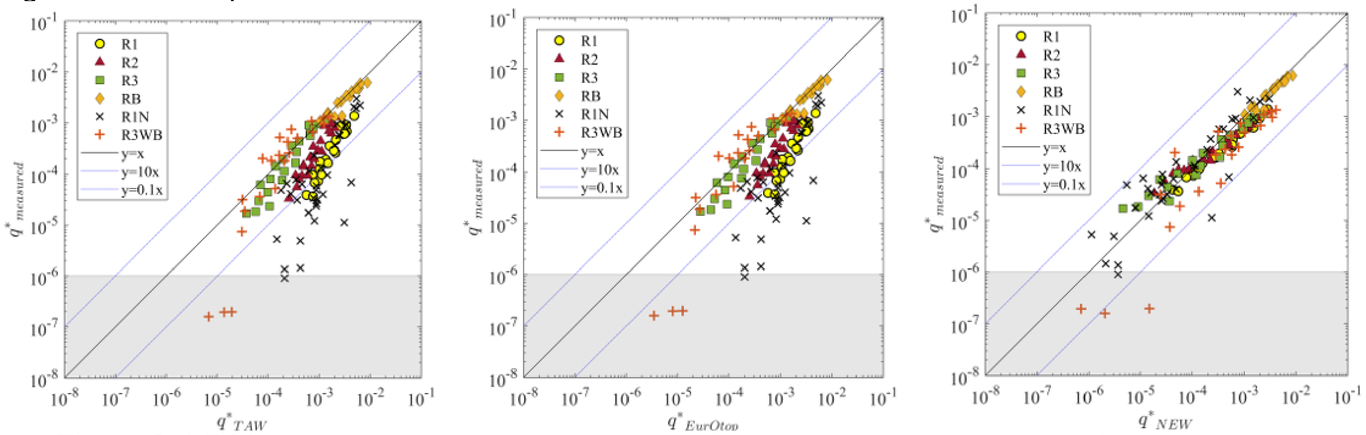

Figure 3-4-5:Measured and calculated dimensionless overtopping discharges for all datasets, using (a) TAW (2002), (b) EurOtop (2018) and (c) new methods for the estimation of influence factors.

Conclusions

Test results confirm that the application of a berm and rock armour significantly reduces the average overtopping discharge compared to that at smooth straight slopes. New expressions for berm and roughness influence factors of rock-armoured dikes are derived based on experimental data by calibrating the empirical coefficients as b_0=0.19 and c_0=0.70. It was also found that, for Eq. [3], the values of location weighting coefficients as proposed by Chen et al. (2020a) (α_1=0.65, α_2=0.22, α_3=0.13) for structures with other slope protections, appear to be valid for rock-armoured slopes as well.

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