ROUGHNESS FACTOR FOR MULTI-LAYER ARMOUR AS OVERTOPPING ESTIMATOR

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INTRODUCTION

Nowadays one of the most challenging problem for engineers is to adapt existing coastal structures to climate changes. Wave overtopping is highly sensitive to the increasing extreme water depths due to higher storm surges coupled with sea level rise. One way to face these problems for rubble mound breakwaters is to add one or more layers to the existing armour (see Burcharth et al. (2014)). One example of this solution is presented in Cecioni et al. (2019) where a further tetrapod double layer has been added to the existing tetrapod armour at Piombino breakwater.

Prediction of wave overtopping of coastal structures is presently obtained from empirical formulae in EurOtop (2018). Here below the general formulae for the average overtopping discharge on a slope with the mean value approach are shown (Equations 5.10 & 5.11 EurOtop - 2018)

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

With a maximum of

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

For the case of overtopping over multi-layer armour, no validated method exists, so prediction must be based upon assumptions and judgement, with related uncertainties.

AIM OF THE RESEARCH

This study is focused on the effects of different types of armour (rock and tetrapod), the number of layers (1 to 4) on a 1:2.0 slope and other structural characteristics on the roughness factor γ_f. The main effects of porosity and roughness will be investigated. This paper analyzes the results of several new physical model tests of different rubble mound breakwaters reproduced since summer 2019 at the new medium scale random wave flume of the Department of Engineering of Roma Tre University.

PHYSICAL MODEL AND WAVE CONDITIONS

The laboratory facility is a wave flume 20 m long, 0.605 m wide and 1 m high; it is equipped with a 1.35 m stroke piston for the wave generation and the AWASYS Active Wave Absorption System. The models are conventional rubble mound breakwaters with a crown wall and a toe berm. In order to compare different units of different sizes, a standard test situation and standard cross-section is required, based on design conditions for the structures. The standard cross-section is presented in Figure 1, where H_0 is the design wave height (i.e. maximum H_{m0} for design of armour) and D_n is the armour unit nominal diameter.

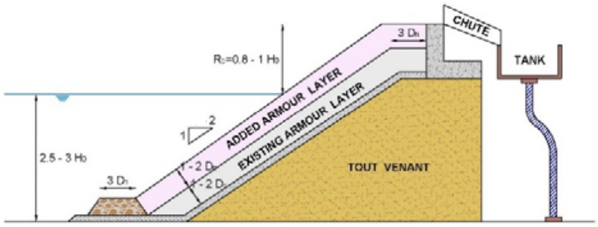

Figure 1 - Model cross-section and device for measuring overtopping volumes

For each model, different wave conditions are tested progressively increasing the relative freeboard in the range $0.7 < R_c/H_{m0} < 1.9$.

At the Conference, the laboratory results will be presented in detail, investigating the influence of the hydraulic and structural conditions on the roughness factor, comparing the findings against existing prediction methods for such structures (Bruce et al. (2009), Eldrup and Lykke Andersen (2018).

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