ANALYSIS OF THE INFLUENCE OF THE DIFFERENT VARIABLES INVOLVED IN A DAMAGE PROGRESSION PROBABILITY MODEL

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INTRODUCTION AND MOTIVATION

Nowadays risk based designs (see Burcharth, 2000; Castillo et al. 2004) as well as reliable rehabilitation and maintenance strategies are essential when dealing with coastal structures. In this sense, the probability of failure due to instability of armour layers is one of the main issues in rubble mound breakwaters, and so is improving the knowledge on their deterioration rate. Both stability and damage progression on rubble mound breakwaters have been widely studied under different approaches, using regular/irregular waves and testing diverse geometries and armour units. However, as it was reported by Melby and Kobayashi (1999), there are some damage accumulation modelling difficulties and, in general, there are not many studies about the mean expected damage and the possible deviation due to its own stochastic nature, and no probability density function (PDF), needed for a more precise analysis of damage progression in breakwaters, has been provided.

Motivated by these difficulties, Castillo et al. (2012) made some suggestions on how to build consistent stochastic models avoiding the selection of easy to use mathematical functions, which were replaced by those resulting from a set of properties to be satisfied by the model. Dimensional analysis (using Π Buckingham's theorem), compatibility conditions and the central limit theorem are applied to build the model which is proven to have a normal distribution. Contrary to other existing models that are deterministic, the cumulative distribution function (CDF) of the dimensionless damage (D*) is proposed:

$$F_{D^*(t^*)}(x) = \Phi\left(\frac{(x-\gamma)^{1/b} - \mu_0 - kt^*}{\sqrt{\sigma_0^2 + rt^*}}\right) \qquad [1]$$

where γ and b are breakwater dependent, k, r include wave action and μ_0, σ_0 depend on the initial conditions. This model assumed constant values for slope, relative still water depth at the toe of the structure (h/Dn_{50}) and relative excess specific weight (γ_a/γ_w-1).

OBJECTIVES AND METHODOLOGY

Regarding equation 1, the three major entities involved in the problem (structure, wave action and initial damage) are represented by a pair of parameters in the normal model.

The aim of this study is to accomplish an initial calibration of equation (1) which allows establishing the specific influence of each of the defined entities in the problem. For doing so, several results published by different authors were used and some other physical tests were carried out at the Harbor Research Laboratory of the Polytechnic University of Madrid (see figure 1) to complete the data set and validate the calibrated model. The results are presented together with some suggestions for Port Authorities on how to use the stochastic model.

Figure 1 - Example of damage accumulation test at the HRL (Harbour Research Laboratory) of the Polytechnic University of Madrid.

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