A STATISTICAL MODEL FOR DAMAGE ACCUMULATION IN BREAKWATERS

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INTRODUCTION & OBJECTIVES

Rehabilitation and maintenance studies are a great concern for Port Authorities and other Administrations.

For a complete risk analysis, probability of failure due to instability of the armour layer must be analyzed and therefore a knowledge on its deterioration rate is needed.

Breakwater armour stability is highly variable and difficult to quantify for many variables are involved in the problem.

Breakwater armour stability is stochastic in nature as both loading and armour conditions are. There is uncertainty in armour placing and shape and in loading by waves and water level.

Damage progression (GPYC,UGR, 2004)

Dimensionality, compatibility conditions and the central limit theorem are suggested to be considered for building consistent statistical models reproducing random breakwater damage progression due to general random wave actions.

METHODOLOGY

Assuming a breakwater with initial random damage (due, for instance, to the construction process) is exposed to the action of a sequence of waves with random height and period during a given time period, its damage increases with time. To define this progression, we proceed in the following steps:

1.The set of variables playing a role in the problem under study is identified.
2. The most general formula relating all these variables in terms of dimensionless ratios using the Π Buckingham's theorem is obtained.
3. The most general formula giving the damage in terms of the number of regular waves is derived using functional equations.
4. The deterministic cumulative damage corresponding to sequences of different regular waves and irregular waves is calculated.
5. Damage pdf due to a random initial damage and the above sequences is calculated.
6. Damage pdf due to a random initial damage and random variation of wave intensities is calculated.

Several variables are included in the problem under study as wave period, height and number, slope, water depth, armour characteristics, etc. If we include the variables related to geometry and wave action in Q*, the dimensionless damage can be defined as:

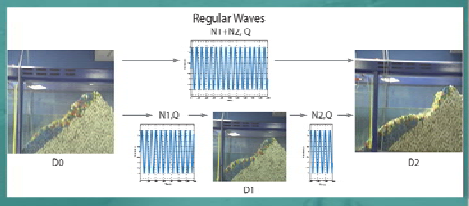
$$d^* = h(d_0^*, N^*, Q^*)$$

Compatibility condition

$$d^* = h\left(d_0^*, N_1^* + N_2^*, Q^*\right) = h\left(h\left(d_0^*, N_1^*, Q^*\right), N_2^*, Q^*\right)$$

$$d^* = h\left(d_0^*, N^*, Q^*\right) = \phi\left(\phi^{-1}\left(d_0^*, Q^*\right) + N^*, Q^*\right);$$

$$\forall\, d_0^*, N^*$$



Compatibility condition

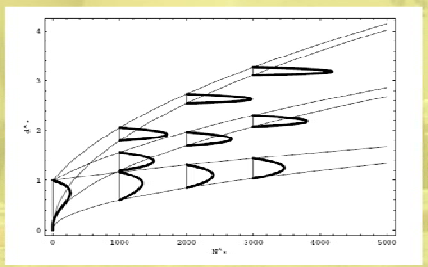
CONCLUSIONS:

Damage progression is stochastic and so should be the model describing it.

An arbitrary function cannot be chosen for describing damage accumulation in breakwaters.

Some compatibility and dimensionality conditions must be fulfilled.

More research is needed to define ϕ function.



Evolution of dimensionless damage pdf

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