COMPARISON OF EXISTING FORMULATIONS FOR ESTIMATING THE OVERTOPPING RATE IN HARBOUR BREAKWATERS

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1. Introduction

The purpose of the research work as summarised in this article, resulting from diverse work carried out at the CEDEX, is to compare formulations as developed by different authors in matters of sloping and vertical breakwater overtopping. Accordingly, existing formulations for estimating the overtopping rate were first compiled and analysed, following which such formulations were compared with results as measured in a series of tests performed at the CEDEX Ports and Coasts Study Centre as to the Cabo Prioriño, Ferrol breakwater and the third alignment Melilla breakwater.

2. Overtopping Rate

Overtopping quantification in fact involves obvious difficulties with only a few measurements having been made on a prototype. On the other hand, ascertaining same in a reduced scale physical model is not complicated, but the values obtained are distorted by scale effects and the absence of aeration such that it can only be deemed as an approximation to what actually occurs. Nevertheless, this work is considered highly useful for estimating damage that may occur in the area sheltered by the breakwater.

The scale effects of physical overtopping models are mainly due to the impossibility of reducing the properties of water (drop size and spray are similar in the model and in reality), to performing tests, in most cases, without reproducing wind and, to a lesser extent, to using fresh water. This all leads to the overtopping phenomenon being one of the aspects most difficult to reproduce in physical models and, for a greater approximation to reality, makes for tests being used in large sized facilities, generating wave and wind. Under these conditions, the physical model approach considerably improves and results may be quantitatively considered too.

The overtopping rate is normally taken into consideration for calculating overtopping. The calculation is based on empirical expressions obtained from laboratory tests and it is therefore obvious that the formulations obtained depend not only on environmental conditions – wave height, wave period and water level - but also on the model's characteristics and are only applicable in the range of validity of the tests carried out in each case.

3. Research Methodology

Existing formulations were compared with the result of a series of tests carried out at the CEDEX Ports and Coasts Study Centre.

This research has been structured into two parts, the first devoted to sloping and the second to vertical breakwaters since the response of a breakwater to wave action mainly depends on its type. The formulas of Bradbury (1988), Aminti (1988), Pedersen (1996), Berenguer and Baonza (2006) and the EurOtop (2007) were applied to the tests selected for sloping breakwaters. The formulas of Allsop (1995), Franco (1993) and the EurOtop (2007) were applied for the study of vertical breakwater overtopping. The state-of-the-art in these matters was previously analysed both in sloping and vertical breakwaters. The validity of applying the different formulations was first

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analysed for the cases selected and it was verified that the test's characteristics matched the limitations imposed by the different authors.

4. Advance Results

Significant disparity was observed in the trends and the degree of matching shown in the application of the different formulations in the two study cases selected.

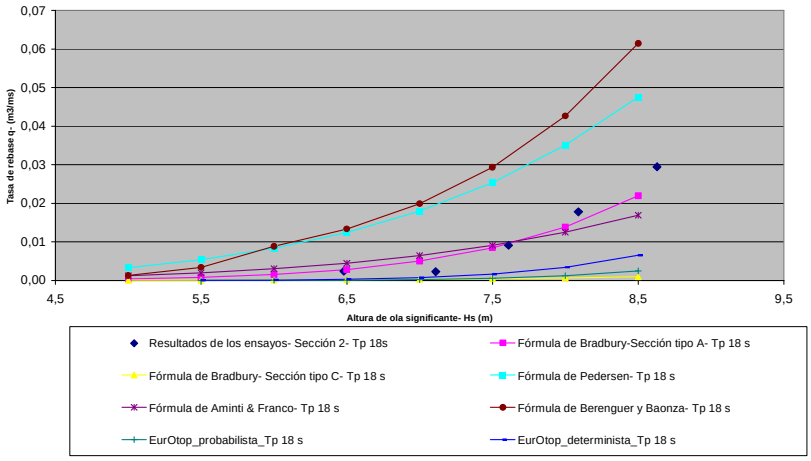

Figure 1. Comparison between overtopping rates measured and calculated for several formulations. Sloping breakwater. "Tests on a 2d physical model of the breakwater for the extension to Ferrol Harbour in Cabo Prioriño". The test data and those obtained with Aminti and Bradbury's formulations are observed to match well despite the fact that not all the limitations as imposed by the authors for applying their formulas with a full guarantee were complied with.

Formulations as shown in this article are based on empirical expressions obtained from laboratory tests and, therefore, are only valid for the geometric conditions (standard cross section) and hydrodynamic conditions (wave action, water level) reproduced in the tests used for obtaining them. The range of application of the formulations analysed does not fully coincide with that of the tests selected for their comparison, which were chosen so that they were representative for most formulations. Nevertheless, the results of this comparison are illustrative of the disparity in values obtained with each of the formulations as just pointed out. Accordingly, although physical models display some problems fundamentally deriving from scale effects, they are still the most precise, reliable tool for the specific study of each case, especially when large dimensioned models are adopted and wind is generated.

References

Burcharth, H.F.; Hughes, S.A. (2006). 'Coastal Engineering Manual (CEM) '. Ed., Vincent, L.; Demirbilek,Z.

CLASH (2005). (www.clash-eu.org)

EurOtop (2007). "Wave Overtopping of Sea Defences and Related Structures: Assessment manual". The EurOtop Team: Allsop, N.W.H.; Bruce, T.; Kortenhaus, A.; Pullen, T.; Schüttrumpf, H.; van der Meer, J.W. (www.overtopping-manual.com).

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