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Abstract

Low Crested Structures (LCS) are offshore breakwaters used for coastal protection which present some potential advantages over conventional breakwaters, specially from the environmental point of view. Among these advantages a smaller visual impact and the fact that they result in a partial barrier for water and sediment fluxes, allowing higher renovation rates may be noticed.

Given the progressive increase in the use of this kind of structures and the lack of reliable design rules, it becomes necessary the study of the hydro-morphodynamic processes taking place around such kind of structures. These processes interact with the LCS in a complex way, and hence their impact and functional behaviour are difficult to predict. The objective of this work is to study, using numerical simulation and experimental data in a physical model analysis, the processes acting around a Low Crested Structure. Besides, the structure dynamic characterization and their implication on the induced morphological impact on a beach have been undertaken.

Then, analysis of hydrodynamic data measured in a wave basin in Aalborg (Denmark) has been done. On this experiment, different structures layouts were tested varying the freeboard (emerged, submerged and zero freeboard) and the width of the crest berm. At the same time, different wave conditions were experimented. Measured wave heights and current velocities, have been compared against numerical model results obtained with the numerical codes LIMWAVE (wave propagation model) and LIMCIR (circulation model), both developed in the Laboratori d'Enginyeria Marítima (LIM-UPC). From this comparison it may be concluded that both models are able to simulate correctly the main processes taking place in the vicinity of different kind of Low Crested Structures under the action of different incident wave conditions. The used models are able to simulate in a reasonable way the wave height reduction in the structures leeside, as well as the different circulation patterns, which basically depend on the breakwater freeboard.

In addition, a study of the transmission over the structures has been done for the selected tests. The wave transmission over the structure, or the degree of wave height reduction promoted by the structure, is an important variable in terms of the structure-induced hydro-morphodynamic impact on the beach. The importance of wave transmission arises since it may play an important role in the circulation pattern found behind a breakwater. Different wave transmission formulations obtained from the literature have been used and compared against measurements. The computed values of k_T suggest a clearly influence of the freeboard obtaining that for emerged situations k_T increase with wave height. In contrast, when the structure is submerged k_T decrease with incident wave height increase. This pattern shows the structure filter effect to the wave height.

A characterization of the structure dynamic behaviour has been also done analysing the circulation promoted with different structures layout. Different current patterns have been found for emerged and submerged structures: the circulation is dominated by diffraction in the former case, whereas wave breaking and transmission dominates the latter. This different mechanism controlling circulation has apparently high impact on the sediment transport pattern which may be around both such kind of structures. Some authors (Pylarczyk, 2003 and Hanson & Kraus, 1990) have suggested the use of k_T as a key parameter to simulate the morphological impact of LCS on the coast. The present work has demonstrated that such affirmations may be taken carefully because of the different k_T behaviour found for emerged and submerged structure. Furthermore the numerical models have probed to simulate correctly the LCS dynamic behaviour and hence it may be concluded that they constitute the most suitable engineering tool for predicting the hydro-morphodynamic impact of Low Crested Structures.