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Experimental study and analysis of wave parameters effect on rubble-mound breakwater toe

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Abstract

Physical Model study is an important tool to evaluate the dominate parameters, formulas and also optimizing the design criteria on coastal structures. This experimental study deals with the 2D toe stability and scour depth at the trunk section of rubble-mound breakwater in a wave flume. Two breakwater models with slopes of 1:1.2 and 1:0.66, different conditions of bed, waves and water level (8cm≤H≤12cm, 2s≤T≤4s, 48cm≤h≤54cm) are employed to analyze the toe stability and scour depth. The tests are conducted with regular waves. It is found that the scour depth in front of the rubble-mound breakwater depends on wave height, structure slope, water level and wave period, but the results reveal that the effect of wave period on scour depth is more than others. Countermeasures for toe stability are also investigated for the different conditions. The results show that the effect of period must be taken into account as a significant parameter on damage of rubble-mound breakwater toe, so that long period waves with more energy can be a threat for rubble-mound breakwater. Also the results of the toe stability and scour depth are given in the form of diagrams.

1- Introduction

One of the important parts of rubble mound breakwater is toe. Most breakwater designs have a toe structure. The toe is located on the sea side of the breakwater and is basically the transition zone from primary armour layer to deeper lying layers. A toe contains two basic functions:

The first is that it supports the above laying armour layer. The horizontal forces created by the gravitational forces of the primary armour layer need to be absorbed by the supporting underlying structure. The toe reinforces the rock or concrete elements of which the primary armour layer is built. Another one is that toe prevents erosion of underlying layers. Sub layers are stabilized by putting heavier rock on the top of them based on filter rules that in this way, smaller stones are not washed out. The existence of scour around breakwaters is one of the main failure modes of these types of structures. During the lifetime of a breakwater, it may encounter a range of seabed conditions, i.e. the bed may be flattened, rippled or surrounded by scour holes. This can be due to the complicated flow generated by the interaction between the incoming flow, the structure and the seabed. Scour is a threat for the stability and integrity of breakwaters which are usually exposed to currents, waves, and combined waves and currents.

When waves attack at right angles to the breakwater, the scour in front of the breakwater will be a two-dimensional process. The two-dimensional scour in front of breakwaters was