UNIVERSITI TEKNOLOGI MARA
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MEC299

SIMULATION OF A FLOW OVER A MOUND-TYPE BREAKWATER OF DIFFERENT SURFACE ROUGHNESS USING COMPUTATIONAL APPROACH

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A. PROPOSED PROJECT

Wave run-up over coastal structures and breakwaters is one of the most important hydraulic reactions used in crest elevation of designs for coastal structures. The design of rubble mound breakwaters is typically based on an empirical formula and physical modeling. The challenges are typically due to the challenges are typically normally lower. The general problems with physical models of coastal structure tests are costly and time-consuming. However, from all problems state in the experiment before there are several problems which are high cost, take more time to build, and use complex formulas for surface roughness mound breakwater. The objectives are to investigate integration between a traditional rubble mound breakwater and a reservoir to store the wave overtopping from the incoming wave to extract energy. To determine the relative difference in overtopping behavior for various types of armor units leading to roughness factors γf for the database and for use in the neural network prediction of overtopping.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

Wave run-up over coastal structures and breakwaters is one of the most important hydraulic reactions used in crest elevation of designs for coastal structures. The design of rubble mound breakwaters is typically based on an empirical formula and physical modeling. One limitation of this approach is that there are many different aspects of wave interaction with a breakwater, such as elevation of the run-up tip and armor stability and these are treated separately. (Najafi-Jilani et al., 2014) Past research by Vicinanza used a scale of 1:30 model to conduct the test in a wave flume (1.5 m wide and 25 m), His results have shown the overtopping wave over the breakwater structure can be reduced by installing a reservoir, which functions as collecting water for energy generation. More recent work by Vicinanza, aims to examine the wave loading and hydraulic performance of the Overtopping Breakwater for the Energy Conversion (OBREC) structure are reported. However, the use of the numerical method is still limited and this present work attempts to explore this technic. (Musa et al., 2017)

Besides that, the overtopping database of the project (Steendam et al., 2004) contains more than 10000 test results on wave overtopping at coastal structures worldwide and is therefore considerably larger than initially foreseen. The database was used as input for a neural network which resulted in a generic prediction method for overtopping at coastal structures (Pozueta et al., 2004, Van der Meer et al., 2005). The overtopping database of the project (Steendam et al., 2004) contains more than 10000 test results on wave overtopping at coastal structures worldwide and is therefore considerably larger than initially foreseen. The database was used as input for a neural network which resulted in a generic prediction method for overtopping at coastal structures (Pozueta et al., 2004, Van der Meer et al., 2005). (Tom Bruce1 , Jentsje van der Meer2 et al., 2005)

Submerged breakwaters are frequently pointed to as a very promising solution for coastal erosion problems as this type of structure has environmental and aesthetic benefits when compared with similar emerged coastal defense structures. As coastal structures, they are submitted to the wave action and thus, the determination of the wave-induced pressures acting on them seems to be an important subject. The influence of the characteristics of these structures, such as roughness and permeability, have been found to play an important role in the wave energy transmission and dissipation processes and thus, the authors have considered analyzing the importance of these parameters in the wave-induced dynamic pressures acting in submerged breakwaters. (Neves et al., 2007)

Smoothed Particle Hydrodynamics (SPH) is a Lagrangian particle method that is becoming increasingly popular in many engineering flows. SPH computes the trajectories of particles of fluid, which interact according to the Navier-Stokes equations. This Lagrangian method predicts fluid pressure, velocities, and particle trajectories, with no special treatment of the free surface, making it ideal for complicated flow phenomena as experienced at breakwaters. The novel attraction of using SPH in the context of coastal protection structures is that the complex geometries of a breakwater can be modeled leading to an unprecedented description of the flow. Numerous developments have taken place for free-surface flows, in particular for some of the violent flows associated with wave breaking, impact, and propagation (Dalrymple & Rogers 2006). One of the most important developments has been to modify the classical SPH formulation to predict better the pressure field. There now exist several methods to do this including using an Arbitrary Lagrange Euler (ALE) scheme combined with Riemann solvers (Rogers et al. 2010) for weakly compressible schemes or implementing strictly incompressible schemes, the latter being still under development. Herein, we will follow Rogers et al. (2010), who modeled the wave impact and movement of a caisson breakwater in 2-D using the SPH-ALE scheme developed within the physics code. By using correct modeling of roughness and porosity of armor layer, the application of SPH code to assess overtopping and run-up and stability for rough structures could become very promising tool to use as support to empirical formula and Neural Network tool in the design of jetties or coastal defenses(Altomare et al., 2010)

Next, the Accropode blocks are the most used armor blocks on the sloping breakwaters in practical projects because of their low engineering cost, good wave dissipation performance, and strong wave resistance stability. To design an Accropode armored breakwater, the overtopping discharge needs to be estimated reasonably well because it is an important index to determine the top elevation of the breakwater. There are many ways to estimate the overtopping discharge, such as the traditional physical model tests and empirical formulas. In recent years, numerical Water 2020, simulation has become one of the most effective methods to estimate the wave overtopping rate due to the rapid development of computer technology and computational methods. The Accropode blocks are the most commonly used armor blocks on the sloping breakwaters in practical projects because of their low engineering cost, good wave dissipation performance, and strong wave resistance stability. To design an