Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 194 (2017) 166 – 173

Procedia Engineering

www.elsevier.com/locate/procedia

10th International Conference on Marine Technology, MARTEC 2016

Numerical Simulation of Wave Flow Over the Overtopping Breakwater for Energy Conversion (OBREC) Device

M.Azlan Musa[a], A.Yazid Maliki[a], M.Fadhli Ahmad[a*], W.Nik Sani[a], Omar Yaakob[b] and K.B.Samo[a]

[a]School of Ocean Engineering, University Malaysia Terengganu, 21030 Kuala Terengganu, Malaysia
[b]Department of Mechanical Engineering, University Technology Malaysia, 81310 UTM Johor Bahru, Malaysia
*Corresponding Author; fadhli@umt.edu.my

Abstract

A number of Wave Energy Converters (WEC) have been proposed by many researchers, but most of them are not economically competitive as a contender in the energy market. This article intends to contribute to the development of very viable concept, which called as Overtopping Breakwater for Energy Conversion (OBREC) aims to fully utilize traditional breakwaters and capturing wave energy. The OBREC and its concept have been physically modeled and tested in Aalborg University since 2012 until 2014 and showed the promising results. In present work, the most-recent CFD of FLOW 3D technology is used to provide a more reliable approach in analyzing wave flow over the structure, in particular, OBREC device. Thus, the numerical simulations are carried out for validating overtopping discharge performance from the previous experimental and prediction methods. The result shows a good agreement with the experimental data. Hence, FLOW 3D is highly capable in handling coastal issues, especially for evaluating overtopping wave parameters.

Keywords: Wave overtopping; OBREC, CFD modeling

1. Introduction

Much research attempting to explore ocean wave technologies, but there are unable to reach the level of technical maturity and only a few devices have reached full-scale prototype development. The challenges are typically due to

doi:10.1016/j.proeng.2017.08.131

construction, installation, maintenance and prototype cost, which are relatively high [1-2] and the overall efficiency is

Nomenclatures

$q_{reservoir}$	is average overtopping discharge in the reservoir, l/s/m
H_{mo}	is incident significant wave height in the frequency domain at the toe of the structure, m
R_r	is crest freeboard of reservoir; i.e. the vertical distance between the crest of the sloping plate and the stillwater level, m
R_r^*	R_r / H_{m0}= relative crest freeboard of reservoir, [-]
$L_{m-1,0}$	deep water wave length referenced to $T_{m-1,0}$, m
d_w	is height of sloping plate, m
ΔR_c	is $R_c - d_w$, m
R_c	is crest freeboard of crown wall; i.e. the vertical distance between the crest of the vertical wall and the still water level, m
$SrR*$	is non dimensional wave-structure steepness
$T_{m-1,0}$	is spectral incident energy wave period at the toe of the structure, s

normally lower [3]. To resolve this issues, much focus has been on the development of the hybrid concept utilizing OBREC device, which is seen more suitable and competitive as a renewable-energy device.

OBREC integrated with breakwater has intensively been modeled and tested by Vicinanza in 2012 [1] [4-7]. This device essentially is an integration between a traditional rubble mound breakwater and a reservoir to store the wave overtopping from the incoming wave to extract energy via low head turbines. The present study focuses on hydraulic performance and impacts of wave loads on the breakwater using the experimental approach.

The general problems with physical models of coastal structure test are costly and time-consuming[8].Therefore, the study aim to utilize the feasibility of using CFD of FLOW 3D technology as a cheaper approach in analyzing wave overtopping on the OBREC structure. The specific purpose is to validate the performance of the numerical model against the experiments of the OBREC presented in [1][4].

2. Current Approach

Past research by Vicinanza [1] used a scale of 1:30 model to conduct the test in a wave flume (1.5 m wide and 25 m), as shown in Figure 1. His results have shown the overtopping wave over the breakwater structure can be reduced by installing reservoir, which functioning as collecting water for energy generation. More recent work by Vicinanza, aims to examine the wave loading and hydraulic performance on OBREC structure are reported in [4-5]. However, the used of numerical method is still limited and this present work attempts to explored this technic.

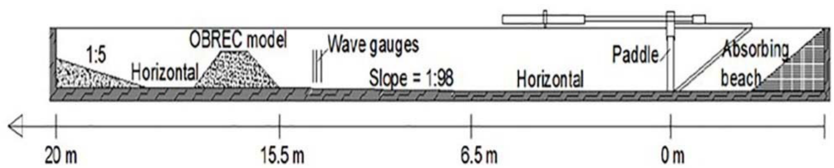

Fig 1. Experimental setup by current researcher

3. Numerical Simulation

Computer Fluid Dynamic (CFD) of FLOW 3D is based on the RANS which designed for turbulence simulation and Volume of Fluid (VOF) for free surface computation methods [9]. Latest descriptions of FLOW 3D performance in wave analysis are presented in references [10-17]. In the present study, validation is used to assess how accurately the computational of FLOW 3D compare with the experimental data. Therefore, all previous experimental geometries in reference [1] have been reconstructed using structural design parameters, as shown in Table 1.