SIMULATION ON THE EFECT OF SUBMERGED BREAKWATER TO THE WAVE TRANSMISSION AND RUN-UP

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To My Beloved Mother and Father …

Thanks for all your pray, attention and spiritual support…

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ABSTRACT

The construction of submerged breakwater is one of the methods to reduce the effect of wave energy on the beach. Submerged breakwater has many advantages compared to emerge breakwater such lower construction cost, a higher aesthetic values and have a lower environmental impact to the surrounding areas. The aim of this study is to simulate and investigate the effect of submerged breakwater to the value of wave transmission coefficient, K_t and also the run-up value on the beach slope. The initial data for wave period, wave height, water depth and beach slope was taken from experimental dataset done by Saville, (1955). Several submerged breakwater height will be tested in the numerical simulation which will follow the experimental setup done by Chiranjeevi Rambabu and Mani (2005). The numerical simulation will be based on the Non-Linear Shallow Water Equation (NLSWE). As a results, the wave transmission coefficient, K_t value will decrease in relation to the increase of submerged breakwater height. This will caused the increase energy during breaking and also the velocity speed of the wave induced currents. The increased of the current speed will resulted in a higher run-up value. The effective submerged breakwater height is determined by its wave reduction capabilities which influence the run-up values.

ABSTRAK

Pembinaan tembol pemecah ombak tenggelam permukaan adalah salah satu cara untuk mengurangkan kesan kuasa ombak ke atas permukaan pantai. Terdapat banyak kelebihan tembok pemecah ombak tenggelam permukaan berbanding pembinaan tembok pemecah ombak timbul permukaan diantaranya kos pembinaan yang lebih rendah, nilai estatik yang lebih tinggi malah memberikan kesan semulajadi yang lebih baik ke atas kawasan sekitarnya. Tujuan kajian ini adalah untuk menilai kesan pembinaan pemecah ombak tenggelam permukaan ke atas nilai koeffensi K_t dan nilai *run-up* diatas kecerunan pantai. Data utama seperti nilai masa ombak, ketinggian ombak, kedalaman air dan kecerunan pantai diambil daripada data ekperimen yang dilakukan oleh Saville (1955). Beberapa ketinggian tembok pemecah ombak tenggelam permukaan telah dipilih untuk diujikaji didalam simulasi komputer mengikut keadaan ekperimen yang dilakukan oleh Chiranjeevi Rambabu dan Mani (2005). Simulasi adalah berdasarkan '*Non-Linear Shallow Water Equation*' (NLSWE). Keputusan simulasi menunjukkan nilai koeffensi K_t akan berkurangan dengan peningkatan ketinggian tembok pemecah ombak tenggelam permukaan. Ini akan mengakibatkan peningkatan tenaga semasa pemecahan ombak dan juga peningkatan kelajuan arus ombak. Peningkatan kelajuan arus ombak ini akan mengakibatkan peningkatan kadar *run-up*. Ketinggian tembok pemecah ombak tenggelam permukaan yang effektif adalah bergantung kepada kebolehan struktur untuk mengurangkan kuasa ombak yang boleh member kesan kepada nilai *run-up*.

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K_t	-	Wave transmission coefficient
d	-	Water depth from the toe of submerged breakwater to *SWL*
d_s	-	Water depth from top of the breakwater crest to *SWL*
h_s	-	Submerged breakwater structure height from ocean bed
B	-	Submerged breakwater crest width
H	-	Wave height
E	-	Wave energy
T, t	-	Wave period
L	-	Wave length
g	-	Acceleration of gravity
d/gT^2	-	Dimensionless water depth
H/gT^2	-	Dimensionless wave steepness
h_s/d	-	Structure height to water depth ratio
SWL	-	Still water level
I_r	-	Iribarren parameter
f	-	Friction factor
η	-	Deviation height from the SWL
ρ	-	Water density
α	-	Slope of breakwater structure on the seaward side
θ, β	-	Slope of beach profile
F	-	Freeboard - measured height of breakwater crest from SWL. Negative value if structure is submerged

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CHAPTER 1

INTRODUCTION

1.1 General

Coastal area is a country natural treasure trove which is priceless not only due to its diverse marine ecosystems but also crucial for the continuation of the country economic progress. However this area is facing continues threat of destruction due to action of natural forces such as wind and waves and also due to the interference of human activities. The establishment of coastal protection system is an important step in order to minimize the destruction and also to rehabilitate the damaged coastal area.

Countries with a large coastline area such as United State of America, Australia and Japan are the pioneer in implementing coastal protection systems. This system can be implemented in the form of soft or hard approached. Soft approached dictates the coastal protection systems that does not require permanent protection structure such as better conservation regulation, stricter law enforcement, giving greater public awareness etc. The hard approached is the opposite where permanent structures need to be constructed in order to protect the shoreline area. These permanent structures such as jetties, sea wall, tide gate, emerged breakwater, submerged breakwater etc.

1.2 Background problem

Wave and current forces is the source of many coastal engineering problems. These natural forces not only cause damage the coastal area but also damage the properties of the communities located along the coastal area. The need to provide protection to the coastline area is crucial in order to avoid further devastation. The construction of shoreline protection structure such as submerged breakwater is one of the methods available in order to reduce this problem.

However in order to ensure the submerged breakwater structure effectiveness, the determination of the submerged breakwater dimension need to consider many factors such as the local wave parameters, material to be used for the submerged breakwater, the location of the breakwater etc. All this parameter will influence the submerged breakwater wave transmission coefficient which also can be the basis of measuring the structure effectiveness. The purpose of this study is to investigate the effect of different submerged breakwater geometry have on the wave transmission and run-up values.

1.3 Importance of study

The main function of constructing submerged breakwater structure is as a wave reduction structure. The submerged breakwater will act as an artificial barrier which will reduce the energy of the propagating wave and currents. However the effectiveness of the submerged breakwater structure depends very much on the structure geometry such as breakwater height and crest width. This study is done in order to investigate the effect of the structure geometry has on the submerged breakwater wave reduction capabilities or wave transmission coefficient values.

Without the additional submerged breakwater structure acting as an artificial barrier the coastal area will be subjected to the devastative impact of the high wave and current forces. This energy of this wave will hit the beach surface with great force, which will then dislodge the loose soil particle on the slope surface. The repeating impact of the high wave on the slope of the beach will expedite the coastal erosion problems. Apart from expediting the coastal erosion problems, the high wave impacting the slope of the beach will also caused high run-up value. This high run-up value will cause the excessive water to spill over on land and will caused flesh flooding. The frequent flesh flooding in the coastal area will allow sea water excess in order to infiltrate more easily into the ground water table. Due to the salinity of the sea water, excessive amount of sea water infiltration will contaminate the fresh ground water table in the coastal area.

1.4 Objective

The objective of this study will involve two different criteria or case study.

1.4.1 Case without submerged breakwater

A) To investigate the effect of friction factor has on the value of run-up on the slope of the beach

B) To investigate the effect of different wave characteristics has on the value of run-up on the slope of the beach

1.4.2 Case with submerged breakwater

A) To simulate and investigate the effect of submerged breakwater with different geometry has on wave transmission coefficient value, Kt

B) To evaluate the effect of submerged breakwater with different geometry has on values of run up at the slope of beach

1.5 Scope of work

The purpose of this study is to investigate the effect of submerged breakwater with different design geometry has on the wave transmission coefficient value K_t and also the value of run-up at the beach slope. This study will be conducted by using computer program in order to simulate and produced numerical calculation on the wave transmission propagating above the submerged breakwater and also the run-up value over the slope of the beach. The computer program will be using the Non-linear Shallow Water equation NLSWE based model which was first developed by Kobayashi, et al. (1987) and further developed by Pedrozo-Acuna (2005).

There are many factors that will influence the wave transmission coefficient value K_t,. However for this study, the focus will be on the influence factors due to the different wave characteristic and different submerged breakwater geometry. For the factor involves the different wave characteristic the simulation data will be based on the dataset produced by Saville (1955). A total six different wave characteristic will be used in the numerical simulation. As for the different submerged breakwater geometry focus will be on the submerged breakwater ratio comprises of structure height to depth ratio h_s/d and also breakwater crest width to depth ratio B/d which will based on the work done by Chiranjevee Rambabu and Mani (2005). Other influence factors for the submerged breakwater structure such as breakwater structure slope, impermeability, structure orientation were not being considered.

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