EXPERIMENTAL INVESTIGATION ON SUBMERGED REEF

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ABSTRACT

Submerged artificial reef have multipurpose benefits. They have great potential for environmental and recreational benefits in addition to shoreline protection and stabilisation. One such reef was proposed along the southern coast of Indian peninsula. As a part of studies experiments were performed to measure wave transformation and breaking over the physical model of the submerged reef with triangular steel wedge connected to shore and with a scale of 1:10. Experimental studies have been carried out to study the details of wave transformation and breaking over the submerged reef for regular wave in head sea condition and influence of water levels on breaking and wave transformation. The effect of design parameters like wave height, wave period and submergence depth of the reef were assessed from experiments. The results show that the relative water depth over the reef crest is a major factor influencing the breaking and transformation characteristics. The paper also covers the impact of submerged reefs on the waves and generation of secondary waves when the incident wave period is large and seaward slope of the reef is gentle. It is inferred from the experiment that waves break over the submerged reef dissipating most of the wave energy.

Keywords: Submerged artificial reef, Wave transformation, Wave breaking, Transmission coefficient, Steel wedge reef, Submergence depth.

1. INTRODUCTION

Coastal areas are subjected to geomorphological changes due to natural and manmade activities. Artificial reef is considered an effective way in preventing coastal erosion due to its multipurpose benefits as compared to other shore protection methods. Artificial reefs are manmade underwater structure built to promote marine life, coastal protection, shoreline stabilisation and recreational activities. Due to increased use of artificial reefs in coastal environment, it is necessary to study the various design parameters of these reefs as the behaviour of waves and beach in presence of these artificial reefs is not well established. Also there is no fixed model or design of these reefs available.
Wide crested submerged reefs dissipate the incoming wave energy by forcing waves to break on top of the reef thereby drastically reducing the wave energy reaching the shore. Wave attenuation also occurs due to turbulence and nonlinear interaction between the reef and the incoming waves. Waves in the leeward side will be shorter and smaller and help in accumulation of sediments. These types of offshore reefs are custom-designed to trap sediment for each unique zone for different application. Due to various complexities associated with wave attenuation, breaking and refraction, numerous physical and numerical model tests were performed to determine the reef configuration.

In this paper the experimental investigation of wave transformation and breaking over the submerged reef with triangular steel wedge connected to shore is carried out. The submerged reef was tested for regular and random wave at different water levels in Shallow Wave Basin at IIT Madras, India. The reef is designed for conditions of South East Coast of India. The reef makes an angle of 13° with respect to the shore line and envisaged to trap the sediments from the long shore sediment transport. The submerged reef has a triangular wedge-shaped steel structure with armour stones and concrete cubes, the first of its kind in India. The main part of the submerged reef is triangular shaped steel wedge weighing 900 t (in prototype) with dimensions 60 m × 50 m × 2.5 m with slope on either side resting on stone bed. The model studies were carried out in 1:10 model scale for head sea condition with wave heights 5 cm to 15 cm with wave period 1.9 s to 3 s. The present paper describes the experimental study details of wave transformation and breaking over the submerged reef for regular wave in head sea condition. The influence of water levels on breaking and wave transformation is also studied.

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2. EXPERIMENTAL SETUP

The experiments were carried out in the Shallow Wave Basin of the Department of Ocean Engineering, Indian Institute of Technology Madras, India. The basin has length of 19 m, width 15 m and height 1 m. Experiments were carried out for three different water levels i.e 50 cm, 54 cm and 58 cm. The Shallow Wave Basin is equipped with a wave maker with five piston type paddles operating at one end, through a servo actuator with a remote-control system, used to generate both regular and random waves. This is executed with a personal computer connected to the servo activator and another computer is dedicated for data acquisition of the signals from the wave probes and run-up meter through an amplifier. An artificial beach (wave absorber) on the other end is provided with the combination of parabolic perforated Fiber-Reinforced Polymer (FRP) sheet and rubble mound to absorb the waves. The top view of the shallow wave basin with the test model is shown in Figure 1.

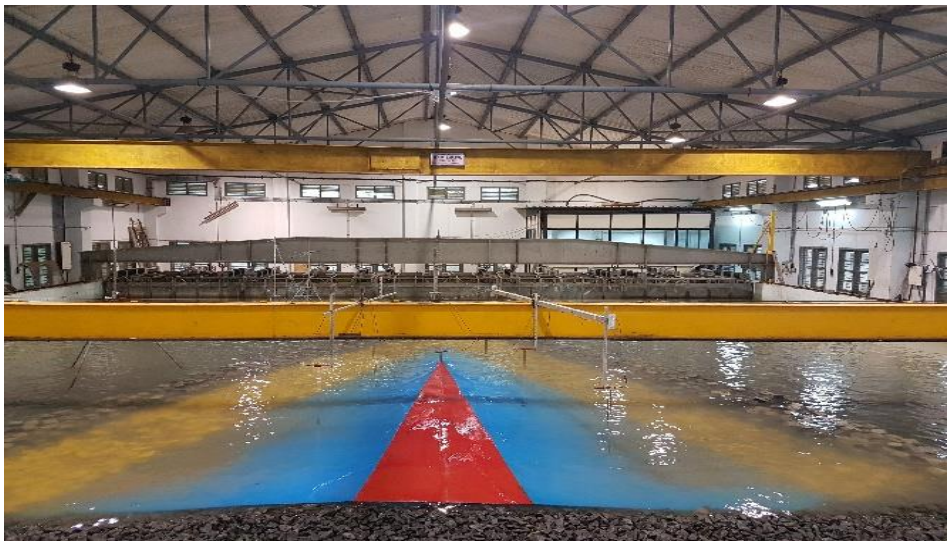

Figure 1: Top view of the experimental set-up in the shallow wave basin of IIT Madras

3. CONCLUSIONS

The main findings for regular wave in head sea condition on the reef being installed in India are given below.

1. Intensity of the wave breaking increases as the submergence depth of the reef crest is reduced.
2. When crest of reef is submerged long period waves get attenuated and generate dispersive tail wave.
3. The wave with higher incident height shows more shoaling on the upward slope of the submerged reef as compared to the lower incident wave height. Hence wave transformation depends on the incident wave height.
4. Transmission coefficient increases with increase in submergence depth and wave period and decreases with increase in wave height.
5. Wave breaking is enhanced by the submerged reef.

4. REFERENCES

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