Reef—An Ecofriendly and Cost Effective Hard Option for Coastal Conservation

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1. INTRODUCTION

Rubble mound breakwaters are the structures which are meant to reflect and dissipate energy of the wind generated waves and thereby to prevent their incidence on water area intended to protect. Submerged breakwater with its crest at or below still water level (SWL) can cause substantial wave attenuation and can be effectively used in places where tidal variations are small and only partial protection from waves is required, like harbour entrance, beach protection, small craft harbours etc.

The wave breaking over submerged breakwater causes great turbulence on lee side. Current and turbulence together on lee side of submerged breakwater have a strong power of erosion on a sandy bottom and can thus prevent siltation. They also offer resistance through friction and turbulence created by breakwater interference in wave field causing maximum wave damping and energy dissipation, minimum wave reflection and bottom scour, and maximum sand trapping efficiency (Baba, 1985; Pilarczyk and Zeilder, 1996). They are also used for coastal protection.

The reef is a structure which is little more than a homogeneous pile of stones without a layered structure. The hydrodynamic performance of the reef is investigated based upon physical model study to ascertain its suitability as coastal defense structure. The varying geometry and seaward location and wave transmission at the reef will help in designing an optimum structure.

2. LITERATURE REVIEW

The influence of the slope, crest width and depth of submergence of various shapes of submerged breakwaters on wave transmission was studied by

Johnson et al., 1951; Dattatri, 1978; Khader and Rai, 1980; Dick and Brebner, 1968; Smith et al., 1996; Pilarczyk and Zielder, 1996; Twu et al., 2001; Shirlal and Rao, 2003 and Shirlal et al., 2003. Some of the above authors opined that the submerged structure is constructed in a water depth of 1.5 m to 5 m with a slope of 1:2 to 1:3 and a height exceeding 0.7 times the depth of water. A reinforced concrete smooth submerged breakwater experimented in Russia with a seaward slope of 1:1.67 and vertical shoreward slope gives optimum wave transmission with minimum reflection for a tidal range less than 2 m and steepness greater than 0.075 (Baba, 1985). But there are as many opinions as the number of investigators on what should be the crest width of the submerged breakwater. In case of submerged structure the wave attacks on its crest and less on the seaward slope. Hence slope angle is not the governing parameter for stability. Various investigators have tested reefs of stone armour with steeper slopes of 1:1.5, 1:1.67 and 1: 1.75. However, better dissipation of waves, lower reflection and easier transport of sediment over the structure were observed for submerged breakwaters with seaward slopes ranging from 1:2 to 1:3 (Pilarczyk and Zielder, 1996). Ahrens (1984) showed that for a submerged reef, wave reflection is less than 20% for slopes of 1:1.67 for zero freeboard which is critical.

The reef is a structure which is little more than a homogeneous pile of stones whose weight is sufficient to resist the wave attack. A submerged reef is an optimized structure to highest degree. The reef is fundamentally built to break the steep waves and as this structure is submerged and porous, wave reflection is small and wave energy damping and wave transmission are the significant characteristics. The important reef parameters affecting the wave breaking and transmission are structure height, crest width and submergence. Therefore, an experimental investigation was carried out to determine the impact of the above parameters of submerged reef breakwater on wave height attenuation and wave transmission. Ahrens (1984 and 1989), Gadre et al. (1992), Pilarczyk and Zeilder (1996) and Nizam and Yowono (1996) have presented equations and graphs to calculate the armour weight of submerged reef breakwater.

3. DETAILS OF MODEL SETUP

3.1 Wave Flume

Physical model studies are conducted in a two-dimensional wave flume of 50 m × 0.71 m × 1.1 m in which regular waves are generated. It has a smooth concrete bed for a length of 42 m as shown in Fig. 1. The flume has bottom hinged flap type wave generator operated by a 7.5 HP, 11 KW, 1450 rpm induction motor. This motor is regulated by an inverter drive (0-50 Hertz) rotating at 0-155 rpm. The system can generate waves of 0.02 m to 0.24 m of 0.8 sec to 4 sec period in a maximum water depth (d) of 0.5 m.