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Numerical prediction of performance of submerged breakwaters

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Abstract

The results of a numerical model study on the transmission characteristics of a submerged breakwater are presented. Study aimed to determine the effect of depth of submergence, crest width, initial wave conditions and material properties on the transmission characteristics of the submerged breakwater. The results highlight the optimum crest width of the breakwater and optimum clear spacing between two breakwaters. A submerged permeable breakwater with $d_s/d=0.5$, $p=0.3$ and $f=1.0$, reduces the transmission coefficient by about 10% than the impermeable breakwater. The results indicates an optimum width ratio of $B/d=0.75$ for achieving minimum transmission. By restricting the effective width ratio of the series of breakwaters to 0.75, studies were conducted to determine the effect of clear spacing between breakwaters on transmission coefficient, suggesting an optimum clear spacing of $w/b=2.00$ to obtain K_t below 0.6.

Keywords: Depth of submergence; Crest width; Submerged breakwater; Porosity; Friction; Transmission coefficient

1. Introduction

With the developmental activities, the dynamic equilibrium of the coastal region is disturbed resulting in coastal erosion and accretion. Coastal erosion is a severe problem

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Nomenclature

H_i	incident wave height
T	wave period
g	acceleration due to gravity
d	water depth
d_s	depth of submergence
h_s	height of the structure
B	crest width
p	porosity
f	friction coefficient
w	clear spacing
b	crest of series of breakwater
K_t	transmission coefficient

worldwide, threatening the coastal properties, degradation of valuable land and natural resources, disruption to fishing, shipping and tourism. The development of coastal facilities has necessitated proper management of the sea front warranting for construction of coastal protective structures. The choice of the structure would depend on the wave environment and the morphology of the coastal region. Shore-parallel, detached breakwaters have succeeded in a number of coasts to mitigate the erosion. They provide good shelter for the leeside, but unfortunately their emerged crests obstruct the aesthetic view of the sea. Furthermore, a significant reflected wave is likely to create problems of scour on the seabed in front of the structure. To solve this problem, a submerged breakwater is developed as an alternative means. The main function of these breakwaters is to protect the seaward area from the severe wave actions, by attenuating the wave pass over the structure. Submerged breakwaters absorb some of incoming wave energy by causing the waves to break prematurely, thus diminishing the transmitted wave energy. These structures trap the sediment entering into the protected zone, on the leeside of breakwater, enhances to chance of building up of the beach. The main parameters used to describe the general geometry of a submerged breakwater are shown in Fig. 1(a). Fig. 1(b) shows series of submerged breakwaters separated by a clear spacing (w).

The studies conducted by Dick and Brebner (1968) on solid and permeable type submerged breakwaters indicate that these breakwaters with near zero submergence are capable of reducing the incident wave energy by 50%. Raman et al. (1977) reported on the damping action of rectangular and rigid vertical submerged barriers and expressed the transmission coefficients in terms of the transmitted energy to the total power of the incident wave. Further it is stated that in case of rectangular submerged barrier, the top width of the barrier plays an important role in controlling transmission coefficient. The test on wave transmission and reflection characteristics of laboratory breakwater conducted by Seelig (1980) indicate that both the depth of submergence and top width are important in determining the performance of the breakwater and it is suggested that for near zero submergence the submerged breakwater is efficient in reducing the transmission.