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Prediction of wave transmission characteristics at submerged reef breakwater

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Abstract

Submerged reef breakwater is an off shore breakwater, with its crest at or below the sea water level, used for protection of coastal structures and beaches from the erosion caused by wave action. Reef breakwaters are coast parallel structure built wi th an objective of reducing the wave action on the beach. It is constructed with uniformed size armour whose weight is sufficient to resist wave attack. Modeling of co-efficient of wave transmission (K_t) of such reef is a topic chosen for present study. Preliminary equation is derived from dimensional analysis as semi empirical equation which involves different parameters like wave characteristics, reef dimensions and nominal diameter of armour units. Simulation of results is undertaken with modeling in MATLAB. Results obtained are thus compared with experimental results and existing equations from the literature. Finally semi-empirical equation for K_t is established.

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Keywords: *Submerged reef breakwater, Wave transmission Co-efficient, Dimensional analysis, Modelling-MAT Lab, Semi-empirical equation for* K_t.

1. Introduction

Steep waves in ocean causes damage to life, properties, coastal line and it also disturbs ports and harbors. A structure which is built to absorb such wave energy is called breakwater. Normally breakwater maintains calm water zone on lee side and offers protection to coast. Breakwaters are constructed to provide berthing facilities in harbors and also to give protection over the action of steep waves. Submerged reef breakwater is a type of breakwater whose crest is at or below the sea water level as shown in fig 1.

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It is constructed with desired type of armour units without core or secondary layer. Reef structure helps in premature wave breaking and wave energy dissipation which is necessary for erosion control and shore line stabilization. Waves overtop the reef breakwater and transmit wave energy on the lee side. Reef structure can be designed to have a desired value of co-efficient of wave transmission (K_t) for a given site condition. K_t is defined as the ratio of transmitted wave height to the incident wave height.

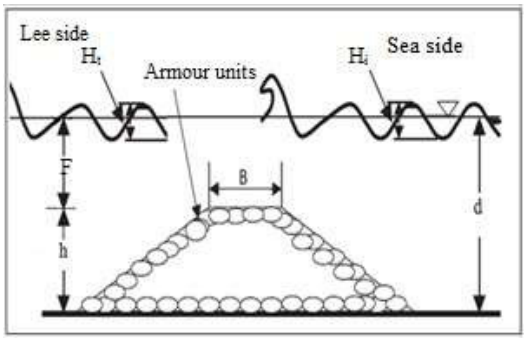

Fig 1. Typical cross section of Submerged Reef Breakwater

2. Literature Review

The reef breakwater is a low crested structure which is little more than a homogeneous pile of stones whose weight is sufficient to resist the wave attack (Ahrens 1989). It is an efficient measure for beach protection without affecting the littoral drift significantly and can be economically constructed to a depth of 2 m to 3 m by using stones of optimum weight, which can be assembled and easily placed with help of boats and 4 to 6 people using locally available materials (Kale and Gadre 1989). They conducted laboratory studies and achieved K_t of 0.5 to 0.6 without significant damage to the armour units. Madsen and White (1976) developed an analytical approach to determine the reflection and transmission coefficients and K_t decreases from 0.35 to 0.15 for H_i/L varying from 2.5×10^{-2} to 3×10^{-2}. Based upon physical model studies an equation for K_t is derived by Van der Meer and d'Angramound (1996), Cox and Clark (1992) and Calabrese et al (2002).

Hanson and Kraus (1991) have presented numerical procedure for computation of wave transmission. Kobayashi and Wurjanto (1989) conducted mathematical model study of transmission over smooth impermeable submerged breakwater and compared with physical model studies. Rambabu and Mani (2005) proposed a Numerical model to predict K_t using Laplace equation for certain boundary condition. Kobayashi et al, (2012) conducted numerical model studies on stability and wave transmission co-efficient on submerged reef breakwater. Physical model studies are conducted by Cox and Clark (1992), Van der Meer (1992), Cornet et al. (1993), d'Angramound et al. (1996), Manu et al.(2012). Many physical model studies have been accomplished by various researchers and scientists to find out wave transmission (K_t) and few numerical studies also found in literature to find out K_t, but those are constrained for certain laboratory conditions and boundary conditions. Hence, there is a need to develop a comprehensive design equation for K_t by the application of dimensional analysis as a semi empirical equation.

3. Objectives of the study

- To develop a semi-empirical equation for Co-efficient of wave transmission (K_t).
- To study the Co-efficient of wave transmission Characteristics K_t of submerged reef breakwater under varying wave characteristics, water depths and crest widths.
- To compare the results obtained by empirical studies with the results of physical model studies.