The Hydraulic Characteristics of Submerged Breakwater Covered with Functional Block

B.K. Sohn, H.S. Kim, S.J. Jeong*

Fisheries Engineering Division, National Fisheries R&D Institute

Busan, Korea

*Fisheries Resources Restoration Development and Management Center, National Fisheries R&D Institute

Busan, Korea

ABSTRACT

This paper presents a design of submerged breakwater, which functions as an eco-structure in marine environment. Newly patented blocks were applied to arm the submerged breakwater for providing inhabitable space of fisheries as well as its stability. To investigate the wave transmission of the proposed submerged breakwater, parametric studies were conducted through two dimensional hydraulic tests, which were carried out at the National Fisheries Research and Development Institute (NFRDI) in South Korea. Those parameters are relative crest width (B/L), wave steepness (H/L), relative crest depth (h_B/H), and submerged breakwater configurations. The hydraulic experimental results can be used to predict the performance of the proposed submerged breakwater covered with the multi-functional blocks.

KEY WORDS: Submerged breakwater; wave control; stability; functional block; wave transmission.

INTRODUCTION

Among coastal facilities, submerged breakwaters are used not only for controlling waves but also for creating quiet zones in the background of the submerged breakwaters and controlling erosion. In addition to these unique functions of submerged breakwaters, recently there are opinions to utilize submerged breakwaters as fish reefs and fishing grounds to increase and manage marine resources in coastal waters.

Submerged breakwaters have various advantages including the maintenance of natural sea landscape, prevention of pollution at ports and fishery harbors through improving seawater exchange by flowing water over the crest, and the improvement of marine ecosystem through functioning as fish reefs (Kim, Y.W. et al., 2003).

Moreover, there are elementary and deployment technologies for improvement in the environment of fishing grounds and the proliferation of marine biological resources through the control and fostering of ecosystem including bottom-mounted and floating fish reefs, seaweed reefs, training levees, artificial upwelling structures and structures for improving bottom materials (Kim, H.J. et al., 1996).

In Korea, there has been no case of design and construction of submerged breakwaters that can provide composite functions for wave control and fish reefs, and related research has also been very rare. Accordingly, the present study purposed to analyze the hydraulic characteristics of submerged breakwaters armored with functional blocks, which can maintain composite functions, instead of TTP that is used widely as armor blocks for submerged breakwaters, by comparing them with those using conventional TTP through two-dimensional hydraulic simulation on the stability and wave control function. Through this study, we expect to provide alternatives and basic data for the increase and management of marine resources in coastal zones, which have been largely overlooked in the design and construction of submerged breakwaters.

HYDRAULIC SIMULATION

In order to examine the stability and wave control of submerged breakwaters armored with the newly developed functional blocks, we defined major influential factors as in Fig. 1. Submerged breakwaters reduce the energy of waves from the open sea through low crest depth, slope inclination, etc., and in particular, they often cause forced breaking waves. In addition, we can examine change in the wave transmission ratio (the ratio of the height of transmitted wave to the height of incident wave) according to the crest depth and crest width of submerged breakwaters, and consider the height of incident wave (H_i), wave period (T), installation water depth (h_t), crest width (B), crest height (h_B), porosity (e), shape coefficient (S), slope inclination (θ), viscosity coefficient (μ), fluid density (ρ), gravity acceleration (g), maximum water particle velocity (V_{max}), etc. as in Equation (1). In this study, we applied Froude's law of similarity because this is a hydraulic experiment on gravity-type submerged breakwaters in which the impact of the inertia term is prevalent over the impact of the viscosity term (Sohn, B.K. and Ryu, C.R., 2001).

$$\phi_1 = (H_i, T, h_f, B, h_B, e, S, \mu, V_{max}, \rho, g) = 0 \qquad (1)$$

When dimensional analysis is according to Buckinghum's π-theorem using wave transmission ratio (K_T) in the background of submerged breakwaters as a dependent variable and H_i, g, μ as repeating variables, and each non-dimensional quantity is adjusted for each physical