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An effective and efficient prediction of hydrodynamic performance of curtainwall-pile breakwaters

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Abstract

This paper describes hydrodynamic characteristics of a curtainwall-pile breakwater (CPB), the upper part of which is a vertical wall, and the lower part consisting of an array of vertical piles. For regular waves, using eigenfunction expansion method, a numerical method have been developed that can compute wave transmission, reflection, and other hydrodynamic characteristics of the breakwater. To achieve effective prediction of hydrodynamic performance of curtainwall-pile breakwaters and overcome problem of underestimation of energy loss evanescent wave are considered. Then optimum number of necessary evanescent waves for an effective and efficient prediction is discussed for various hydrodynamic quantities of interest.

Keywords: Curtainwall-pile breakwater, eigenfunction expansion method, evanescent waves.

1. INTRODUCTION

Coasts play an important role in economy of each country for their strategic location for residential, recreational, and industrial activities. Hence, a need has arisen to protect and maintain these coasts against waves and currents. It is necessary to consider cost-effective and environment friendly structures that decrease the effect of these waves and currents before they reach the coast.

In general, the width and the weight of traditional type breakwaters (rubble mound and gravity types) increase with water depth, requiring a great amount of construction material and high sea bed bearing capacity. Also, these types block littoral drift and cause severe erosion or accretion in neighboring beaches. In addition, they prevent the circulation of water and so deteriorate the water quality near the coast. In some places, they obstruct the passage of fishes and bottom dwelling organism [1].

For solving the above-mentioned problems, permeable thin structures are suggested. One of the common permeable breakwaters may be a perforated breakwater. A perforated wall breakwater consisting of a perforated front wall, a solid back wall and a wave-absorbing chamber between them was initially proposed by Jarlan (1961). As is well known, the perforated wall breakwater has two main advantages. One is to dissipate the incident wave energy and reduce the wave reflection from the breakwater, and the other is to reduce the wave force acting on the structure [2].

The perforated, slotted and CPB breakwaters, are not only more economical based on construction material, time, and labor (because of considerable reduction of wave force and over turning wave moment) but also, induce lower reflection and transmission and wave run-up. Besides slotted and curtain-wall and CPB breakwaters allow better water circulation and retain water quality in marine environment [3].

Pile or slotted breakwaters are low cost breakwaters, and several researches have been carried out on the interaction of regular waves with slotted barriers in the absence of currents(Kakuno and Liu, 1993 [4]; Isaacson et al., 1998 [5]; Huang, 2007 [6]). Recently interaction of tsunami wave with slotted barriers has been examined (Huang and Yuan, 2009 [7]).

Curtainwall-pile breakwater (CPB hereinafter) was proposed by Suh et al. (2007) [8], the upper part of which is a vertical wall and the lower part consists of an array of vertical piles. They developed a mathematical model to predict hydrodynamic characteristics of pile-supported vertical wall breakwaters, using eigenfunction expansion method.

Recent researches show that hydrodynamic performance of multiple-row CPB is enhanced compared with a single-row breakwater, while difference between double-row and triple-row breakwaters is marginal [9].

In present study, the method proposed by Mei et al. (1974) as indicated by Suh et al., (2007) [8] is adopted but there is other method which has been proposed by Sollitt and Cross (1972). The former has a