Proceedings of the Eighteenth (2008) International Offshore and Polar Engineering Conference
Vancouver, BC, Canada, July 6-11, 2008
Copyright © 2008 by The International Society of Offshore and Polar Engineers (ISOPE)
ISBN 978-1-880653-70-8 (Set); ISBN 1-880653-68-0 (Set)

Wave Reflection from Absorbing-type Breakwaters

Ching-Yun Yueh, Shih-Hsuan Chuang and Ming-Tsung Wu
Department of Harbor and River Engineering, National Taiwan Ocean University
Keelung, TAIWAN, China

ABSTRACT

The reflection of normal incident waves by absorbing-type breakwaters is investigated in this paper. The breakwaters consist of a perforated wall, a porous caisson and an impermeable back wall. The flow field is divided into four regions: a porous caisson region and three pure water regions. Under the assumptions of linear wave theory, the Darcy's law in the perforated wall, and the pore velocity potential theory of Sollitt and Cross (1972) in the porous caisson region, a 2-D BEM model is created to calculate the reflection coefficients of water waves by several properties of the breakwaters. The numerical model is calibrated by previous numerical studies of the limiting cases of a partially perforated-wall caisson breakwater and a vertical porous breakwater with an impermeable back wall. Generally speaking, the evaluation of the wave dissipation in absorbing-type breakwaters is bigger than a partially perforated-wall caisson breakwater. The reflection coefficient value implies the performance of wave absorbers in this study. Therefore, we examine the major factors that affect the reflection coefficient.

KEY WORDS: porous caisson; BEM; Darcy's law; reflection.

INTRODUCTION

Breakwaters that are widely used along shorelines, channel entrances, beaches, harbors, or marinas may vary in type according to their use. A traditional and the simplest form of breakwater, a rubble mound breakwaters, is quite suitable but very expensive for increasing water depths. Recently, many new types of breakwaters have been proposed and extensively studied for controlling ocean waves efficiently. In recent decades, perforated breakwaters have become popular as they can allow water waves to transmit through it, reduce the wave reflection and wave run-up in front of the structures.

Thick permeable structures were considered by several researchers. Sollitt and Cross (1972) used Lorentz's principle of equivalent work to analyze the problem about ocean wave reflection and transmission at a permeable breakwater. Kondo (1979) developed an analytical model for calculating the reflection coefficient of a perforated-wall caisson breakwater with one or two perforated wall, which was verified with his experimental data. Sawaragi and Iwata (1979) considered the dissipation characteristic of wave energy of porous structures under irregular waves based on the reflection and transmission coefficient of a single slit wall and wave surface equations. Madsen (1983) presented a theoretical solution for the refection of linear shallow-water waves from a vertical homogeneous wave absorber on a horizontal bottom. Fugazza and Natale (1992) proposed a closed-form solution for wave reflection from a multi-chamber perforated-wall caisson, which overcame the calculating difficulty of the previous method. Mallayachari and Sundar (1994) presented reflection characteristics of permeable seawalls with distinct forms obtained by BEM. Isaacson *et al*. (2000) described a theoretical analysis for wave reflection from a breakwater consisting of a perforated front wall, an impermeable back wall, and a rock-filled core. Twu and Lin (1991) conducted a research on the reflection of normal incident waves from multiple vertical porous plates. Yip and Chwang (2000) proposed a theoretical solution to assess the hydrodynamic performance of a caisson with perforated front wall and a horizontal plate in it. Li *et al*. (2002, 2003) on the basis of the eigen-expansion method and matching conditions of different fluid regions, a theoretical analysis is given and associated numerical model is used to assess the action of obliquely incident waves on a breakwater with single or double-layered partially perforated front wall and an impermeable back wall. Kee *et al*. (2006) applying Green's theorem in each of the fluid regions, investigated wave absorbing performance of the caisson breakwater with an internal horizontal or slightly inclined porous plate.

To elucidate the interaction of waves with porous structures, many investigations have been carried out, such as Twu and Lin (1990), Li (1995), Yu (1995), Sahoo *et al*. (2000), Williams *et al*. (2000), Teng *et al*. (2004), Li *et al*. (2006), Suh *et al*. (2006) and Li *et al*. (2007).

In this paper, the wave reflection from the absorbing-type breakwater consisted of a porous caisson breakwater with a partially permeable front plate, a solid back wall and a wave chamber between them has been evaluated by multi-domain BEM. In the present study, the effects of porous effect parameter G , the relative water depth in the wave absorbing chamber, the effect of porosity, the relative chamber width, and the relative water depth kh are further discussed. Some of the numerical results are shown in Figs. 5~7.

THEORY