

## **A Study of Wave Behaviors on Harbor due to the Porous Quay-Wall**

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### **ABSTRACT**

The purpose of this study is to investigate wave behaviors in a harbor due to the porous quay-wall. In this study, model tests of wave behavior on quay-wall will be proceed in a wave flume under various condition of incident wave. Introduce these results into a DRBEM model of harbor tranquility to discuss the influence of real wave absorption characteristics of solid boundaries on the harbor tranquility simulation results. With all these results, the present numerical model of harbor tranquility can be modified to approach the real situation and to be more applicable in harbor.

**KEY WORDS:** Porous quay-wall; DRBEM; Harbor tranquility;

### **INTRODUCTION**

The resonant problem is a very important topic for designing or planning a harbor. Researchers till now still devote plenty of time on this problem by using theoretical, numerical or even experimental method trying to investigate the mechanism of wave-induced oscillation inside a harbor. In order to economize on time during planning and designing, numerical approach seems to be more efficient than hydraulic model experiment. Therefore, various the numerical schemes were developed to analyze wave refraction, diffraction, reflection, and dissipation problems. For example, Mile and Munk (1961) considered wave energy radiation effect to expand from the harbor entrance to offshore and furthermore, applied Green function to analyze harbor oscillation, which also found the phenomenon of harbor paradox. Ippen and Goda (1963) applied Fourier transformation method to solve the harbor resonance of rectangular harbor and obtained the solution by matching the wave amplitude and velocity approximately at the entrance. Lee (1969) discovered the energy trapped by the harbor that leads to the amplitude of oscillation far greater than incident wave amplitude. Hwang and Tuck (1970) used boundary integrate method to calculate oscillation in harbor of constant depth with arbitrary shape. Berkhoff (1972) derived the well-known mild slope equation to describe wave refraction and diffraction, and applied Finite Element Method to solve the combined effects of wave refraction-diffraction problem. The sea-bottom friction and absorption boundary was

considered by Chen (1986), and by using Hybrid Boundary Element Method to analyze wave-induced oscillation in a harbor with arbitrary shape and depth. Chou and Lin (1986) used a boundary element method to analyze wave-induced oscillation in a harbor of arbitrary shape with rigid quays in variable water depth. Tsay et al (1989) considered the effects of topographical variation and energy dissipation, and developed a finite element numerical model to investigate wave refraction, diffraction, reflection, and dissipation phenomenon. Chou and Han (1993) employed a boundary element method and under the consideration of the effect of partial reflection along boundaries to develop a numerical method for predicting wave height distribution in a harbor of arbitrary shape and variable water depth. Su et al (1993) considered wave energy dissipation due to a porous wave absorber. A numerical model was also developed to solve the porous-wall harbor in a practical harbor. Nardini and Brebbia (1982) first proposed Dual Reciprocity Boundary Element Method (DRBEM) for free vibration analysis. The DRBEM technique was then used by Lin et al (1999) to study wave-induced oscillation. Hsiao and Fang (2005) employed and modified the mild-slope equation (Chen, 1986) as the governing equation and used the DRBEM numerical technique to solve the resonant problem with the affection of energy dissipation.

According to the references as above, the numerical simulation of harbor tranquility always treats the reflection coefficients of solid boundaries as constant for all wave periods, which is differ from real situation that the reflection coefficients of a solid boundary are varied by the wave period. In this study, Reflection coefficients of porous quay-wall are obtained from laboratory experiment, and furthermore are introduced these results into the present numerical model of tranquility harbor to improve the present numerical model and discuss the influence of real wave absorption characteristics of solid boundaries.

### **MATHEMATIC FORMULATION**

The definition sketch of the analytical domain is shown in Fig. 1. A Cartesian coordinate system is employed. The x and y axes lie in the plane of still water level with the origin at the middle-point of the opening of the harbor entrance. The computational domain is divided into two regions,  $D_1$  and  $D_2$  by a pseudo-boundary  $\Gamma_2$ . The exterior