Hydrodynamic Characteristics of Slit Caisson Quay Wall against the Oblique Wave Incidence

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ABSTRACT

In the present study, a new type of slit caisson quay wall has been proposed to reduce the wave reflection and the stem wave simultaneously. The specialized configuration of the slit caisson quay wall was devised as a series of detached slit caissons which are connected by the open chamber. In order to verify the wave dissipation induced by the combined effect of the perforated wall and the open chamber, the physical model tests including the two-dimensional and the three-dimensional cases were conducted. As a result of the several tests, it was found that the proposed type of slit caisson quay wall has a sufficient dissipation effect against the oblique wave incidence.

KEY WORDS: Laboratory experiment; slit caisson, quay wall; stem wave; reflection coefficient

INTRODUCTION

A perforated-wall caisson quay wall is often used to remedy the drawbacks of a vertical caisson quay wall. It reduces not only wave reflection but also wave overtopping. It also reduces wave forces, especially impulsive wave forces, acting on the caisson (Takahashi and Shimosako, 1994; Takahashi et al., 1994).

A conventional perforated-wall caisson consists of the front slit wall, back wall and the water chamber between the front wall and back wall. The weight of the slit caisson is less than that of a vertical solid caisson with the same width, and most of this weight is concentrated on the rear side of the caisson. Hence, the wider width of the perforated-wall caisson is often required to satisfy the design criteria against sliding and overturning.

In addition, particularly in the case where the bearing capacity of the seabed is not large enough, the excessive weight on the rear side of the caisson may have an adverse effect. In order to solve these problems, a partially perforated-wall caisson is also often used, which provides an additional weight to the front side of the caisson. In this case, however, other hydraulic performance characteristics of the caisson such as wave reflection and overtopping may become worse compared with a fully perforated-wall caisson.

In order to examine the reflection characteristics of a perforated-wall caisson, hydraulic model tests have been used (Jarlan, 1968; Terret et al., 1968; Bennett et al., 1992; Park et al., 1993; Suh et al., 2001). Efforts have also been made toward developing numerical models for predicting the reflection coefficient (Kondo, 1979; Kakuno et al., 1992; Bennett et al., 1992; Fugazza and Natale, 1992; Suh and Park, 1995; Suh et al., 2001).

Recently, Suh et al. (2006) examined the use of the numerical model of Suh and Park (1995), which was developed to predict the reflection of regular waves from a fully perforated-wall caisson breakwater, for predicting the regular or irregular wave reflection from a partially perforated-wall caisson breakwater. A laboratory experiment was carried out to examine the validity of the model for irregular wave reflection, which showed reasonable agreements between measurement and prediction for both frequency-averaged reflection coefficients and reflected wave spectra.

When waves propagate with the oblique angle to the coastal structures such as breakwater and quay wall, the complex wave characteristics, that is, wave propagation, reflection and stem wave, are generated in front of the vertical wall. In the view of the stability and serviceability of coastal structures, the stem wave is the most important factor to be concerned to reduce the wave height in front of structures.

In the present study, we proposed a new type of slit caisson quay wall for reducing the wave reflection and the stem wave. The specialized configuration of the slit caisson quay wall was devised as a series of detached slit caissons which are connected by the open chamber. In order to verify the wave dissipation induced by the combined effect of the perforated wall and the open chamber, the physical model tests including the two-dimensional and the three-dimensional cases were conducted.

Fig. 1 Site location of Incheon new port