ABSTRACT
Wave diffraction is a fundamental problem in wave theory. At present, a lot of researches have been conducted on the diffraction of the relatively simple port arrangements such as a single jetty, a double jetties, and an island embankment. However, the planar arrangement of many actual breakwaters can be generalized into symmetrical and asymmetrical double jetties, and the research on the wave diffraction of these double jetties is still scarce. The theoretical solutions of wave diffraction problems on symmetrical and asymmetrical vertical jetties are derived in this study.

KEY WORDS: Regular wave; diffraction; breakwaters; mathematical model.

INTRODUCTION
Wave diffraction is a classic problem. Many scholars have conducted a lot of theoretical analyses and experimental researches on the wave diffraction of breakwaters. Based on the linear wave theory and the similarity between water and light wave, with the method of theoretical solution of the light wave diffraction derived by Sommerfeld(1896), Penny and Price(1952) provided the formula for calculation the diffraction coefficient of regular wave behind the vertical rigid impermeable semi-infinite jetty. To facilitate the application of engineers, Wiegel(1962) plotted the graph of diffraction coefficient with the results calculated on the basis of Penny and Price(1952). Penny and Price(1952) also obtained the diffraction solution of the double jetties with superposition of the solution of a single jetty. Sobey and Johnson(1986) formally derived the diffraction solution of the double jetties with the approach of Morse and Rubenstein(1938), who obtained the theoretical solution of electromagnetic wave behind a double jetties and detached breakwater through solving Helmholtz equation with the transformation of elliptic coordinate. Memos(1980) studied the regular wave diffraction of the double jetties shown in Fig.1. Montefusco(1968) derived the regular wave diffraction around the detached breakwater with the method of Morse and Rubenstein(1938).

Goda et al. (1978) for multidirectional seas. In practice, the diffraction coefficients at the single structure tips are mixed either by summing the complex disturb functions (Hotta, 1978) or by summing the energy of the diffracted waves. Nevertheless, these popular shortcuts have been not properly supported by experimental evidence so far and this may lead to some uncertainties in practical applications except for Vicinanza et. al. (2009).

The plan layout form of many actual breakwaters can be generalized as the symmetrical or asymmetrical twin jetties shown as Figs.2 and 3, and the researches on the wave diffraction of these twin jetties are needed. The theoretical solutions of wave diffraction of symmetrical or asymmetrical vertical jetties are derived in this study.

Theoretical formulation of linear regular wave diffraction problem
According to the linear wave theory, the wave diffraction problem can be simplified to the following problem:

\[ \varphi(x, y, z, t) = \text{Re} \{ A \frac{g}{\mu c h (kd)} \text{ch}(kd) \} f(x, y) e^{i(\omega t + \beta)} \] (1)

where the complex function \( f(x, y) \) should satisfy the Helmholtz equation

\[ \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + k^2 f = 0 \] (2)

and the flow boundary condition is