Wave Reflections from Perforated Breakwaters Having Resonant Channels

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ABSTRACT

In this study, a new concept perforated breakwater is proposed, which is having resonant channels. In the channels, perforated plates are installed for dissipating wave energy induced by flow separations. The breakwater has two advantages compared with conventional perforated breakwater having wave chamber with slotted walls. One is easy to control the target wave condition for dissipating wave energy, and the other is having the high structural safety because the structural members are not exposed to impact waves, directly. To evaluate wave reflection characteristics of the proposed breakwater, numerical experiment was carried out by using Galerkin’s finite element model based on the linear potential theory. The results indicated that considerable energy dissipation occurs near the resonant period of channel, and wave reflection characteristics are affected by channel width and depth of channel inlet. Moreover, numerical calculation was done to investigate the applicability of multi-channel case having different resonant periods and discussions were made.

KEY WORDS: Wave reflection; resonant channel; perforated breakwater; numerical analysis; finite element method; linear wave.

Nowadays, various types of breakwaters are being constructed, from conventional rubble mound breakwater to floating breakwater. One of the recent trends for the breakwaters in Korea is to construct perforated breakwater because it can reduce wave reflections and maximum wave forces acting on the breakwater. In general, the perforated breakwater has wave chambers with slotted vertical walls. However this type of breakwater has two weak points. One is hard to control long period waves because the performance of the wave energy dissipation is directly related to the width of the chamber. Another is the structural weakness of slotted wall structure exposed to the wave impacts.

Many researchers have interested in interaction analysis between waves and perforated breakwaters. Kondo (1979) analyzed double porous wall cases. Kakuno and Oda (1986), and Martin and Dalrymple (1988) investigated structural design to reduce wave reflection by analyzing interaction of wave-cylinder array. Kakuno et al (1992) considered a cylinder array with backside wall. Park et al (1993) presented the hydraulic experiment result for perforated breakwaters. Suh and Park (1995) proposed analytical solutions for interaction between wave and slotted wall breakwater. Fujita et al (2003) had adopted L-shaped bulkhead inside the caisson of the breakwater and or seawall to get low wave reflection performance. Suh et al (2006) also made experiment on the partially perforated caisson breakwaters to discuss the reflection characteristics. Lee et al (2011) introduced cylindrical slit type breakwater/seawall to reduce wave reflection allowing wave transmission. Unfortunately, no alternative was proposed for solving the problems of the conventional perforated breakwater aforementioned, although a lot of study has been performed. In this study, a new concept perforated breakwater is proposed, which is having a resonant channel (see Fig. 1). In the channel, the perforated plates are installed for dissipating wave energy induced by flow separations. The breakwater has merits compared with conventional perforated breakwater having wave chamber with slotted walls. One is easy to control the target wave condition for dissipating wave energy, and the other is having the high structural safety because the structural members are not exposed to impact waves, directly.

![Fig. 1 Definition sketch of a perforated breakwater having resonant channels.](image)

To evaluate wave reflection characteristics of the proposed breakwater, numerical experiments were carried out by using Galerkin’s finite element method.