Characteristics of Extreme Waves in Shallow Water Regions and their Application to Design Method for Harbor and Coastal Structures

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Synopsis

Since our country is surrounded by sea, the large-scale disasters in coastal areas have been caused by ocean waves constantly. In particular, coastal disasters due to long-period swells induced by heavy storms and catastrophic typhoons have increased in the Japanese coasts and harbors recently. It is important to make clear those wave characteristics and to propose the countermeasures against those disasters. On the other hand, the large-scale developments of oceans such as the offshore extensions of the harbors have been advanced to use ocean space effectively. It is important to evaluate the extreme wave occurrences and effects of the extreme waves on harbor and coastal structures for the developments of oceans. However, the current design method for harbor and coastal structures is specified by not long-period swells and extreme waves but wind waves. Therefore, it is necessary to introduce a new concept of the design, to improve accuracy of the design force and to propose new effective countermeasures in the future.

The purpose of this study is to study the characteristics of long-period swells and extreme waves in shallow water regions and to apply these wave characteristics to design method for harbor and coastal structures by using the physical experiments and numerical simulations. The main conclusions of this study are as follows.

1) The long waves induced by wave grouping of long-period swells have great effects on the wave overtopping on seawalls. Moreover, it is possible to decrease the wave overtopping discharge of long-period swell by placing the effective countermeasures according to the seawall sections and wave field in front of the seawall.
2) The dimensionless water depth plays a significant role in understanding freak wave occurrence in shallow water regions. Moreover, it is possible to understand the freak wave occurrence in shallow water regions using the Boussinesq model data, if appropriate higher-order nonlinear correction is considered analytically. Finally, it is possible to estimate wave pressures on breakwaters with the deviation from wind wave distribution if the occurrence frequency of maximum wave heights is considered.

Key Words: Long-period swell, Extreme wave, Wave overtopping, Wave pressure, Long wave, Nonlinear interaction

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