Application of Wave Model YW-WAM to Coastal Engineering

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ABSTRACT.
In consideration of the fact that the lack of wave observation data made in difficult to obtain deep water wave factors, a wave model of YW-WAM was established based on the observed data of wind field and the universal mathematical model WAM, which could provide rational design wave parameters for coastal engineering. The result of calculation with this model shows that the maximal relative error of wave height obtained with the model is 7% as compared with the measured data, therefore, YW-WAM model can be applied to coastal engineering.

KEY WORDS: wind filed; numerical model of wave; YW-WAM model; experience formula; coastal engineering.

INTRODUCTION
More and more coastal engineering such as ports, docks, bulwarks, etc. have been built or being constructed in the coastal area because of the needs for the oceanic economy. Some hydrodynamic factors (including water level, wave height, wave period, wave direction, etc.) in ocean environment should be obtained before designed these buildings. Among these hydrodynamic factors, the wave factors are the most important parameters because a lot of ocean and coastal engineering which are affected by wave effects. The wave parameters for engineering design are usually calculated by mathematics model. There are two kinds of method to obtain the wave parameters in deep water: One is to directly utilize the long period data of many years from the wave observation stations near the engineering area; the other is to utilize wind field data to calculate wind-wave, then to confirm the wave parameters indirectly. Considering some near-shore engineering areas, lack of the observation data for calculating the wave parameters, this paper proposed a wave model of YW-WAM which utilizes historical weather map to calculate the wind field and wind-wave field. The YW-WAM model was based on the third generation WAM model, some wave generation and dissipation processes are represented in YW-WAM model: generation by wind, dissipation by white-capping, dissipation by depth-induced wave breaking, dissipation by bottom friction and wave-wave interactions in both deep and shallow water. A detailed description of this model are given by Yin et al.(1996).

WAVE MODEL OF YW-WAM AND OTHER MODELS

Wave Model of YW-WAM

The third generation shallow water wave model YWE-WAM was used in the study. This model is based on the wave action balance equation, with most of the source functions taken directly from the standard WAM model of Komen et al. (1984). An explicit representation of the energy dissipation caused by depth-induced breaking in shallow water is taken into account. The basic equations are:

\[
\frac{\partial N}{\partial t} + \nabla [((\tilde{C}_g + \tilde{u})N)] + \frac{\partial}{\partial \sigma} N\sigma + \frac{\partial}{\partial \theta} (c_\theta N) = \frac{S}{\sigma}
\]

\[N = N(\sigma, \theta, x, t) = \frac{F(\sigma, \theta, \tilde{x}, t)}{\sigma}
\]

\[C_g = \frac{1}{2} \left(1 + \frac{2kd}{\sinh 2kd} \right) \sigma k
\]

\[C_\theta = -\frac{1}{k} \left( \frac{\partial \sigma}{\partial \sigma} - \tilde{k} \cdot \tilde{\sigma} \right)
\]

\[C_\sigma = \frac{\partial \sigma}{\partial t} \left( \frac{\tilde{\sigma}}{\tilde{t}} + \tilde{u} \cdot \nabla \tilde{d} \right) - C_g \tilde{k} \cdot \frac{\tilde{u}}{\tilde{\sigma}}.
\]

where \(F(\sigma, \theta)\) is the spectral density, \(\sigma\) is frequency ; \(\tilde{d}, \tilde{k}, \tilde{u}\) are water depth, wave number vector, velocity vector, \(s\) is the space coordinate in the propagation direction, \(\theta\), the two-dimensional space gradient is \(\nabla\), and \(m\) is the spatial coordinate perpendicular to the propagation direction, \(\sigma\). The formulations for propagation speed \(C_g, C_\sigma\) and \(C_\theta\) give a detailed consideration of the effect of varying depth and currents on wave propagation. The Source function may be represented as a superposition of the wind input, nonlinear interactions, white-capping dissipation, bottom friction and depth-