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Wave field analysis in a harbor with irregular geometry through boundary integral of Helmholtz equation with corner contributions. (English) Zbl 1391.76071

Summary: A mathematical model has been designed to analyze the wave characteristics in a harbor, averting any possible situation of occasional extreme wave hazards due to the seasonal weather conditions. Helmholtz equation has been considered with appropriate boundary conditions on the basis of small amplitude hypothesis. Further, a solution of the Helmholtz equation is given by Green’s identity formula and then it is utilized to predict the ocean surface wave fields due to refraction and diffraction of various directional incident waves in the context of the shallow water waves. The corner angle coefficient is firstly determined at each corner segment on the boundary of the harbor and then corner contribution on the boundary is imposed by multiplying the corner angle coefficient to the boundary wave field. Further, the Chebyshev point discretization is implemented on the boundary of harbor to improve the numerical accuracy at the sharp corners. This numerical model is validated through the quantitative comparison with existing studies in literature. Further the logarithmic convergence rate is achieved for the proposed numerical scheme as well. We have implemented this numerical model practically on the Pohang New Harbor (PNH), Pohang, South Korea to compute the resonance modes for various directional incident waves. Furthermore, the wave elevation is obtained in the whole interior domain of the harbor at various modes of resonance with specific incident waves. In conclusion, this numerical scheme is a competent tool to foster the prediction of the ocean surface wave field on the boundary and interior of the harbors with complex geometries.

MSC:
76B15 Water waves, gravity waves; dispersion and scattering, nonlinear interaction
86A05 Hydrology, hydrography, oceanography

Keywords:
Helmholtz equation; corner point algorithm; amplification factor; resonance mode; ocean surface wave elevation; Pohang new harbor

Software:
Matlab

Full Text: DOI

References: