POST-BOUSSINESQ MODEL FOR NONLINEAR IRREGULAR WAVE PROPAGATION IN PORTS AND WAVE-STRUCTURE INTERACTION

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SCIENTIFIC BACKGROUND

Karambas and Memos (2009) have presented a protocol version of a post-Boussinesq type wave model with a system of 2-DH equations for fully dispersive and weakly nonlinear irregular waves over any finite water depth. The model in its two-dimensional formulation, involves in total five terms in each momentum equation, including the classical shallow water terms and only one frequency dispersion term. The latter is expressed through convolution integrals, which are estimated using appropriate impulse functions.

SCOPE OF RESEARCH

In this work, an updated version of the aforementioned model is introduced. It is implemented for wave propagation and transformation (due to shoaling, refraction, diffraction, bottom friction, wave breaking, runup, wave-structure interaction etc.) in nearshore zones and inside ports. One of the main goals is the model's thorough validation, thus it is tested against experimental data of wave transmission over and through breakwaters, uni- and multi-directional spectral wave transformation over complex bathymetries and diffraction through a breakwater gap. Case studies of model application over realistic variable bathymetries at characteristic Greek ports are also presented.

NEW FEATURES OF NUMERICAL MODEL

The new model version incorporates wave generation at any longitudinal or lateral open boundary by source term addition able to simulate both uni- and multi-directional irregular waves for several angles and directions, avoiding unphysical diffraction in case of oblique incident waves. Peripheral enhanced sponge layer methodology is also introduced to minimize irrational wave reflection. Moreover, by extending the model presented by Karambas (2003), the present external wave is coupled with a porous flow model. The 'dry bed' boundary condition is used to simulate wave runup and overtopping of rubble mound breakwaters. In this way the wave reflection from and transmission through and over the breakwater is simulated. In order to avoid the above detailed description (which requires very small space step), for practical cases we can simply represent the wave reflection from and transmission through of rubble mound breakwaters. Thus, following Madsen and White (1976) approach, instead of the rubble-mound breakwater, we consider an equivalent idealized vertically faced homogeneous porous structure with a frictional area in front of it. The flow resistance within the structure is simulated by introducing an additional term in the momentum equation given by the Dupuit-Forchheimer formula. Energy loss on the rough slope (of the realistic breakwater) is represented by an appropriate friction coefficient, given in Karambas and Bowers (1996). In this way we can obtain the desired pre-estimated values of the reflection and transmission coefficients.

MODEL VALIDATION AND APPLICATION

Evaluation of the model's performance is conducted by comparisons of simulation results with experimental data (Fig. 1) of regular and irregular wave diffraction around semi-infinite breakwaters and through breakwater gaps (Yu et al. 2000). Validation of model results against experimental data is proven to be satisfactory. Fig. 2 presents plotted results of wave transmission with and without overtopping.

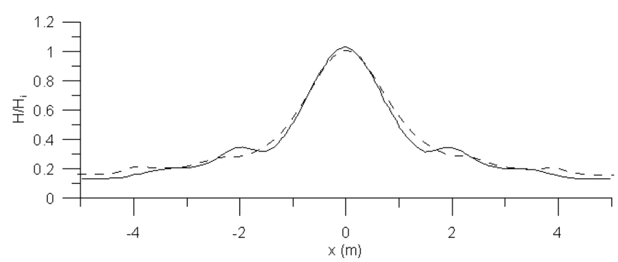

Figure 1 - Comparisons of wave diffraction coefficient $K_D=H/H_i$ through a breakwater gap (solid line: experimental data, dashed line: model output).

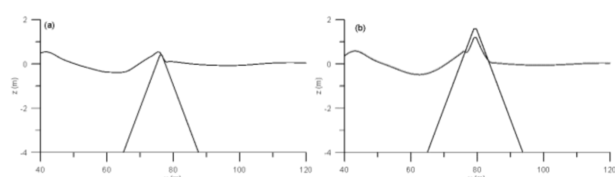

Figure 2 - Wave transmission over (left) and through (right) a breakwater with (a) and without (b) overtopping.

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