Second Order Solution to the Wave Diffraction Problem Around a Detached Breakwater

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ABSTRACT

In this thesis the problem of wave diffraction around a vertical, rigid, impervious, thin, isolated breakwater is studied. Theoretical and numerical tools are developed to account for the effect of wave steepness and nonlinear wave interaction.

At first the problem is formulated using the Stokes Wave Theory in the form of a perturbation series expansion correct to the second-order. Then a solution is presented using linear theory, to solve the diffraction problem using the method of Green Functions (Weber's Solution). The Green Function formulation (an integral equation) is subsequently solved using a numerical approximation method.

Once the solution for wave potential in the wave field is attained correct in the first-order, the second-order wave potential is expressed in terms of a series. A theoretical method is presented that allows for the influence of the nonlinear terms present in the second-order free surface boundary condition. The influence of the breakwater in the second-order is accounted for, using a series of terms the first of which is a radiating free wave

that has a frequency twice the frequency of the incoming wave. The rest of the terms represent standing wave patterns which decay exponentially with distance from the breakwater. This series is obtained from a system of integral equations similar to the integral equation used in the first-order. This system satisfies the boundary condition on the breakwater correct to the second order. The numerical methods necessary for the solution of such a system are presented and they were applied in a computer model.

From the results obtained from the computer model it is observed that for waves with steepness over 1% the second-order term is important inside the wave shadow in the breakwater lee. The second order term becomes very important in the region very near the breakwater, especially for long breakwaters (b/L>2.0); its significance increases as the relative depth decreases. The second order terms corresponding to standing wave patterns are insignificant compared to the first- and second-order term corresponding to free progressive waves.

Robert L. Wiegel

Chairmen of Thesis Committee

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