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A DISCRETE NON-LOCAL (DNL) OUTGOING BOUNDARY CONDITION FOR DIFFRACTION OF SURFACE WAVES

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SUMMARY

A discrete non-local (DNL) boundary condition is used to solve the water waves propagation problem over variable depth. This condition is obtained by means of full solution of the discrete Helmholtz operator in a structured network. We consider a simulation of wave propagation around a circular island located on either a paraboloidal shoal or constant depth bathymetry. Such examples confirm the important improvement in accuracy for the DNL method over standard conditions in the near field. © 1998 John Wiley & Sons, Ltd.

KEY WORDS outgoing boundary condition; Berkhoff; discrete; non-local; surface waves; scattering

1. INTRODUCTION

When a long wave (for example, a tsunami) is propagating over waters of variable depth, it may be greatly amplified due to the variation of sea bed topography and/or at the coast; this is a highly non-linear phenomenon. The scattering of waves by a circular island located on a paraboloidal shoal is a well-known problem of long wave propagation;[1–11] (see Figure 1).

The calculation of diffraction of water waves over a varying sea bed, based on finite element methods, was done by Berkhoff[12] and Chen and Mei[13–15] initially. Chen and Mei used a Fourier–Bessel expansion as an exterior solution in a wave diffraction problem and a specially devised variational statement to link the exterior solution with finite element solutions in the interior domain.

Zienkiewicz *et al.*[6–9] made an important contribution in this way, when they proposed a general methodology for the solution about this problem. There were several strategies which allowed one to link finite element solutions to any kind of Helmholtz equation exterior solution (analytical, series or boundary integral).

This problem has also been solved by Tsay and Liu,[16] Houston,[17] Xu *et al.*[18] and Bonet,[19] who incorporated the exact radiation condition at infinity in the numerical scheme by means of a 'sponge-filters' method.

Different procedures based on 'infinite elements' to solve the exterior problem governed by the Helmholtz equation on an unbounded domain are given by Zienkiewicz and Bettess[10,11] and H. S. Chen.[20] They used of 3- and 2-node shape functions, respectively, to approximate the

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