INTERNATIONAL JOURNAL FOR NUMERICAL METHODS IN FLUIDS
Int. J. Numer. Meth. Fluids **29**: 605–621 (1999)

DISCRETE NON-LOCAL ABSORBING BOUNDARY CONDITION FOR EXTERIOR PROBLEMS GOVERNED BY HELMHOLTZ EQUATION

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SUMMARY

The finite element method is employed to approximate the solutions of the Helmholtz equation for water wave radiation and scattering in an unbounded domain. A discrete, non-local and non-reflecting boundary condition is specified at an artificial external boundary by the DNL method, yielding an equivalent problem that is solved in a bounded domain. This procedure formulates a boundary value problem in a bounded region by imposing a relation in the discrete medium between the nodal values at the two last layers. For plane geometry, this relation can be found by straightforward eigenvalue decomposition. For circular geometry, the plane condition is applied at the external layer and this condition is condensed through a structured annular region, resulting in a condition at an inner radius. Exterior problems with a bounded internal physical obstacle are considered. It is well-known that these kind of problems are well-posed, and have a unique solution. Numerical studies based on standard Galerkin methodology examine the dependence of the DNL condition with respect to the circular annular region width. The DNL condition is compared with local boundary conditions of several orders. Numerical examples confirm the important improvement in accuracy obtained by the DNL method over standard conditions. Copyright © 1999 John Wiley & Sons, Ltd.

KEY WORDS: absorbing boundary condition; Helmholtz; discrete; non-local radiation; scattering

1. INTRODUCTION

Water waves elliptic propagation models governed by the Helmholtz equation with variable refraction–diffraction index $k = k(x, y)$ [1,2], have received a wide acceptance for performing engineering simulations of water waves propagation over arbitrary bathymetry and in complex coastal domains.

Numerical solutions of the Helmholtz equation in exterior domains have been sought primarily via techniques that are based on the Helmholtz integral representations of the problem, relating quantities on the physical boundary of the problem [1]. Such formulations are based in the consideration that the bathymetry must be constant in the exterior domain. These formulations are obtained by using fundamental solutions as weighting functions and employing Green's theorem, a procedure that typically is restricted to linear, isotropic and

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CCC 0271–2091/99/050605–17$17.50

Received September 1997
Revised February 1998