Abstract

The present thesis deals with some problems associated with the interaction of surface gravity waves with rigid and permeable barriers under the consideration of the theory of linear water waves. In the present study, major emphasis is given to generalize/develop mathematical tools based on integral equations for solving a class of physical problems concerned with the scattering of water waves by barriers of various geometrical configurations. The main objective of this study is to investigate the effect of various physical parameters on the reflective properties of the structures.

The content of the thesis is divided into eight chapters. Chapters 1 and 2 are the introductory part of the thesis. A general introduction, brief literature survey and mathematical preliminaries required to study different problems of this thesis are discussed in these chapters. In Chapter 3, the problems involving rigid and permeable vertical barriers in deep water are re-examined. With the help of Havelock's theorems the associated problems are reduced to integral equations in which the kernels are either weakly singular or hypersingular. Two direct approximation methods of solutions are developed and utilized to determine approximate solutions of the integral equations. The all important physical quantity, called the reflection coefficient, is evaluated numerically, by the use of the approximate solutions of the integral equations. An energy identity for permeable plate is derived using the Havelock's theorems. Chapter 4 is devoted to examine the effect of nearly vertical permeable barrier (surface piercing barrier and bottom standing barrier) on the propagation of water waves. A simplified perturbation technique together with an application of Green's integral theorem is employed to evaluate the first order corrections to the reflection and the transmission coefficients. Chapter 5 deals with the problem of oblique water wave scattering by a pair of asymmetric permeable vertical barriers. The barriers are present in water of uniform finite depth and the permeability is not uniform. A mathematical model for non-uniform permeable barrier is prescribed in this chapter. The velocity potential is expanded using Havelock's expansion theorem. The associated boundary value problem is transformed into two coupled Fredholm integral equations using the Havelock's inversion theorem and the conditions on the permeable barriers. Using the solution of the coupled integral equations, the reflection and the transmission coefficients and the amount of energy dissipation by the permeable barriers are evaluated. Chapters 7 and 8 concern with the reflective properties of dual asymmetric permeable circular arc shaped and elliptic arc shaped plates in deep water respectively. The permeability of the plates varies along the circumferences of the plates. The problems are formulated in terms of two coupled hypersingular integral equations for the difference of potentials across the plates. Exploiting the conditions at the edges of the plates, the potential difference functions are approximated by expanding them in terms of finite series involving Chebyshev polynomials of the second kind, multiplied by an appropriate weight function and then solved numerically by a collocation method. The solutions are utilized in computing the reflection and the transmission coefficients, the hydrodynamic forces acting on the plates and the amount of dissipated wave energy. Chapter 8 highlights the conclusion as well as the future scope of the

research carried out in this thesis.

Keywords: Water wave scattering; Linear theory; Permeable barrier; Non-uniform permeability; Asymmetric barriers; Reflection coefficient; Transmission coefficient; Energy identity; Hydrodynamic force; Havelock's theorems; Green's integral theorem; Hypersingular integral equation; Fredholm integral equation; Galerkin approximation.