Abstract

In the context of the linearized theory of water waves, this thesis is based on the study of some problems related to wave interaction with elastic plates and horizontal discs. In the present study, major attention is given to generalize/develop mathematical methods based on integral equations with weakly singular/hypersingular kernels for solving a class of problems concerned with the scattering and radiation of water waves by submerged barriers in presence or in absence of bottom deformations.

The entire thesis is divided into five parts. **Part I** is comprised of the introductory part, a brief literature survey related to all the works presented in the thesis, basic equations of the linearized theory of water waves, and some mathematical preliminaries used in the latter part of the thesis. **Part II** involves the study of the interactions of water waves with vertical elastic plates in the presence of non-uniform depth of the water domain. **Part III** deals with problems of wave scattering by inclined elastic plates. **Part IV** is concerned about the interaction of water waves with a submerged horizontal rigid and an elastic disc in presence and in absence of ice-covered surface, respectively. **Part V** highlights the major conclusions and the future scopes of the research accomplished in this thesis.

Part II consists of two Chapters depending on two different problems. In the first problem of **Part II**, wave interaction with a vertical elastic plate in presence of undulating bottom topography is analysed utilizing simple perturbation analysis. Employing simplified perturbation analysis the first-order reflection and transmission coefficients are expressed in terms of integrals involving the shape function describing the bottom deformation and the normal derivative of potential function related to the problem of uniform finite depth. Behaviour of the first order reflection coefficient depending on the plate length, ripple number, ripple amplitude and flexural rigidity of the plate is depicted graphically. The second problem of **Part II** deals with the wave scattering by a submerged vertical elastic plate in presence of a step type bottom topography. Application of Green's integral theorem in two separate domains with different depths and use of the condition on the elastic plate reduce the governing boundary value problem to a set of two coupled integral equations. These integral equations are solved by employing polynomial approximations. In the second problem of **Part II**, an energy identity for the scattering problem in presence of elastic plate is also derived analytically.

Part III also consists of two different problems. In the first problem of **Part III**, the interaction of linear water waves with an inclined elastic plate as a breakwater is analysed whereas the second problem of **Part III** deals with the wave scattering by two asymmetric elastic plates with arbitrary inclinations. By employing Green's integral theorem and using the boundary condition on the plate, both the problems are reduced to integral equations with regular as well as

hypersingular kernels. In the second problem of **Part III**, the boundary value problem reduces to two coupled integral equations. These hypersingular integral equations involve the unknown potential difference functions across the plates, which are approximated by finite series involving Chebyshev polynomials. The unknown coefficients of these finite series are obtained numerically by collocation method. Different physical quantities are then computed numerically using the computed values of the coefficients.

There are two chapters in the **Part IV**. In **Chapter 7**, the interaction of flexural-gravity waves with a submerged disc is studied. Initially, wave scattering problem is studied followed by radiation and radiation-diffraction problems. The problems are solved by transforming them to *two-dimensional* hypersingular integral equations; the hypersingularity being of order three. The hypersingular integral equations involve the unknown potential difference function across the flat disc and this unknown function is approximated by finite series involving associated Legendre polynomials. The effects of the flexural rigidity of the ice cover and submergence depth of the rigid disc on different physical quantities are investigated for all the three cases. It is observed that the submergence depth of a rigid disc causes significant changes in the scattered as well as radiated wave profiles. In **Chapter 8**, a method based on hypersingular integral approach, Fourier series expansion of quantities in angular variables, reduction of hypersingular integrals into Fredholm integrals and modal analysis is presented to study the problem of wave interaction with submerged elastic disc.

Keywords: Water wave scattering; Wave radiation; Flexural-gravity wave; Linear theory; Vertical elastic plates; Inclined elastic plates; Asymmetric barriers; Bottom deformation; Submerged rigid disc; Submerged elastic disc; Reflection coefficient; Transmission coefficient; Hydrodynamic force; Shear force; Shear strain; Total scattering cross-section; Added mass and damping coefficient; Green's function method; Simple Perturbation analysis; Coupled integral equations; Hypersingular integral equation; Polynomial approximation; Expansion-Collocation; Modal analysis.