Abstract

The thesis deals with a class of wave-structure interaction problems arising in Coastal Engineering with emphasis being given for

- developing numerical tools for a class of physical problems associated with wave interaction with porous and flexible structures, and
- investigating the role of various physical parameters on the scattering and trapping of gravity waves by porous and flexible structures.

The class of problems analyzed in the present study are based on suitable applications of the Green's function technique, eigenfunction expansion method, integral equation techniques which include boundary element method, system of Fredholm integral equation and integro-differential equation techniques. These solution techniques are very effective, robust and efficient to deal with structures of arbitrary configurations in water of finite depth in the presence of bottom undulation and in water of infinite depth. In certain specific cases, numerical results based on integral equation methods are compared with the results derived using eigenfunction expansion method. The problems are studied under the assumptions of small amplitude water wave theory and structural responses. Various physical phenomena associated with the wave scattering and trapping by partial and complete structures are analyzed. Both the cases of horizontal and vertical structures are considered in different cases. In case of wave trapping by porous and flexible barriers near a wall, the main objective is to find the optima in wave reflection and wave loads acting on the barrier/rigid wall with suitable combination of waves and structural parameters. For wave interaction with flexible and porous structures of varied configurations analyzed in the thesis, energy identities are established to analyze the amount of wave energy dissipated by the porous structures and used to deform the flexible barrier. Moreover, energy identities are used to validate the accuracy of various computational results analyzed in the thesis. Various physical quantities such as reflection and transmission coefficients, wave forces acting on the structures and the rigid wall, free surface elevation, structural deflection and flow field are computed and analyzed for various values of wave and structural parameters. For most of the physical problems studied in the thesis, numerical convergence of the solution are analyzed and the computational results are validated with known results in the literature.

Keywords: Boundary element method; System of Fredholm integral equation; Integro-differential equation; Eigenfunction expansion; Green's function; Bessel function; surface gravity waves; flexible structure; porous barriers; wave scattering and trapping.