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Fredholm integral equation technique for hydroelastic analysis of a floating flexible porous plate

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Abstract

Oblique surface gravity wave scattering by a floating flexible porous plate is investigated in water of finite and infinite depths under the assumption of small amplitude water wave theory and structural response. Using the Greens function technique, the boundary value problems are converted into a system of Fredholm type integral equations in terms of the velocity potentials and their normal derivatives along the plates which are handled for solutions using Simpsons quadrature formula. Energy relations are derived to check the accuracy of the computed results.Various results of physical interests are computed and analyzed to study the roles of structural flexibility and porosity, wave period and angle of incidence on wave scattering by the plate. Certain results are analyzed to study the effect of edge conditions on the scattering of surface waves by the flexible porous plate. It is observed that depending on the heading angle of the incident waves, with suitable positioning of the plate, tranquility zone can be created by a flexible floating plate. Moreover, the study reveals that a major part of the wave energy can be dissipated with the introduction of structural porosity which will be of immense help in the creation of a tranquility zone for the protection of various marine facilities and infrastructures.

Keywords: Floating elastic plate, Porous-effect parameter, Fredholm integral equation, Greens function, Wave Scattering.

1. Introduction

In the recent decades, there is an increasing interest in the utilization of ocean space for various humanitarian activities with the help of different types of floating platforms. Some of the broad infrastructures related to ocean space utilization are very large floating structures, mobile offshore base, deep sea mining, food production system, floating breakwaters and floating storage facilities (as in Chen et al. (2006) and Wang et al. (2010)). Out of all these facilities, floating breakwaters represent an alternative solution to protect an area from wave attack compared to conventional fixed breakwaters. It can be effective in coastal areas with mild wave environment conditions for protecting harbors, marinas and shorelines aiming at erosion control. Floating breakwaters are suitable at locations having poor soil conditions prohibiting the use of bottom supported breakwaters, deep water locations where bottom connected breakwaters become more expensive. One of the well known floating breakwaters is the Bombarden breakwater which was used to protect Mulberry harbor along the Normandy coast during second world war. The floating breakwaters have minimum interference with water circulation and fish migration (see Sawaragi (1995) and Bettess (2004) for details). Further, floating breakwaters are often less expensive, reusable, quickly deployable and environmental friendly. These structures are often modeled as a floating plate of finite/semi-infinite length (see Andrianov and Hermans (2003)).

To study the scattering of water waves by a floating flexible ice sheet which was modeled as an elastic plate, Meylan and Squire (1994) converted the associated boundary value problems into a system of Fredholm integral equations and solved the

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