Hydroelasticity of a Circular Plate in Deep Water

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Recently, the study of hydroelastic behavior of very large floating platforms (VLFP) in waves and diffraction of surface waves by VLFP obtained great interest. In this kind of problems the VLFP is modeled as a thin plate with elastic properties. Our approach and results for the semi-infinite plate and for the strip of infinite length has been published in [1] and has been discussed at 'Days on Diffraction - 2002'.

Here we present an analytical study for a platform in the form of a circle. The circular plate of radius r_0 floats at the surface of a deep, ideal, incompressible fluid. We use the thin plate theory and integro-differential formulation as described in [1]. The velocity potential is the soluton of Laplace equation $\Delta\Phi = 0$ in the fluid together with surface conditions. The plate deflection can be represented in the following form:

$$w(\rho, \varphi) = \sum_{m=1}^{3} \sum_{n=0}^{N} a_{mn} J_n(\kappa_m \rho) \cos n\varphi, \tag{1}$$

where a_{mn} are the unknown amplitude functions and κ_m are the reduced wave numbers - the roots of dispersion relation. In the same way, we represent the Green function for infinite depth as a series of Bessel functions with some coefficients. We apply Graf's addition theorem to the Green function.

After some steps of analysis and integration of the polar coordinates we obtain $N+1$ integro-differential equations:

$$(\mathcal{D}\Delta^2 - \mu + 1) \sum_{m=1}^{3} a_{mn} J_n(\kappa_m \rho) + k_0 \int_0^\infty (\mathcal{D}\Delta^2 - \mu) \sum_{m=1}^{3} a_{mn} J_n(k\rho) \times$$

$$\frac{k r_0}{(k-k_0)(k^2-\kappa_m^2)} \left[k J_{n+1}(k r_0) J_n(\kappa_m r_0) - \kappa_m J_n(k r_0) J_{n+1}(\kappa_m r_0) \right] dk = A\epsilon_n J_n(k_0 \rho), \tag{2}$$

where k_0 is the wave number, A is the wave height, $\mathcal{D}$ and μ are physical parameters of problem, and k denotes the complex coordinate. By transforming the integrals and using the Wronskian, from these equations, we obtain the relations to determine the amplitudes a_{mn}. The system can be completed by edge conditions (the edge of the plate is free of shear force and bending moments).

The details will be presented and discussed at 'Days on Diffraction - 2003' and the comparison of our approach to problems for plates with one infinite dimension. We show the obtained numerical results for various physical parameters.

References

[1] A.I.Andrianov, A.J.Hermans. The Influence of Water Depth on the Hydroelastic Response of a Very Large Floating Platform. 2003, *Marine Structures, in press.*