Interaction of Free Surface Waves and Floating Elastic Plates

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We study the hydroelastic behaviour of a floating elastic plate and its response to incident surface water waves. A thin plate with elastic properties serves as a model for a very large floating platform (VLFP) designed for the purpose of an airport, ferry pier or other artificial construction. Also, the plate can be a model of a huge ice field. VLFP have a mat-like dynamic behaviour which can be described by the plate equation. Their horizontal dimensions are about several kilometers by several hundred meters while their thickness and draft are in order of several meters. Therefore, it is possible to consider the platform as a thin plate, using standard theory.

The plate floats on the surface of ideal, incompressible water with finite depth. There is no space between the plate and the water. We consider several geometrical sketches of the plate of finite dimensions (circle, ring) or with one infinite dimension (strip, multiple strips). The wavelength is smaller than the width of the plate. The solution for the plate deflection is derived using Green's function and is found to fulfill an integro-differential equation.

The plate deflection is represented as a series of exponential, Bessel or Hankel functions, multiplied by corresponding coefficients. Green's function obeys boundary conditions at the free surface and a radiation condition. It includes a Bessel function, extended to a series by Graf's addition theorem if needed. There are two dispersion relations for the problem, in the plate region and in open water.

From the integro-differential equation, supplemented with free edge conditions, we derive a set of equations to determine the plate deflection. For the cases when a gap exists between the plates (multiple strips) or inside the plate (ring), results for inner free surface of the water are also obtained. With this approach, the reflection and transmission of incoming waves can be described as well.

So, an exact analytical solution has been obtained for the deflection of a thin elastic plate of various shapes and dimensions, floating at the free surface of water. We obtain numerical results for all discussed forms of the plate. Details of the approach and obtained numerical results will be presented, compared and discussed at the conference.