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Nonlinear Phenomena in Wave-Body Interaction: Description and Theoretical Modeling

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Abstract. At first approximation, the study of wave interaction with fixed or floating bodies is carried out within a linear frame. However nonlinear effects are numerous and they have diverse origins: mechanical nonlinearities, variation in time of the wetted part of the hull, viscous phenomena (flow separation), nonlinear free surface equations. We focus here on the latter type of nonlinearities. Two different approaches are described, both being based on potential flow theory. Practical applications are given for two basic geometries: a vertical cylinder and a vertical plate, perpendicular to the wave direction.

In the first approach, one proceeds through successive approximations, based on a perturbation series development. The first-order of approximation coincides with the linear theory. The main interest of the second-order of approximation, well mastered nowadays, is that it yields excitation loads in an enlarged frequency domain, encompassing most of the natural frequencies of the system considered. At third-order the complexity of the equations becomes dissuasive and few researchers have ventured there. We suggest that third-order (or tertiary) interactions, between incoming waves and reflected waves by the structure, can play a very important role, overlooked so far, in phenomena such as run-up or green water.

In the second approach one integrates in time and space the nonlinear equations of the initial boundary value problem, with the free surface equations being exactly satisfied. In this way one obtains numerical equivalents of the physical wave-tanks. They are briefly described and some illustrative results are given.

Key words: *Wave-body interaction, Hydrodynamics, Nonlinear.*

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