Nonlinear wave interactions with fixed and floating bodies leading to unexpected wave impacts

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Abstract

This thesis deals with the nonlinear interaction of water waves with fixed and floating bodies. The case of a two-dimensional fixed surface body is first investigated using a newly developed linear and second-order boundary element model, the fully nonlinear model of Hague & Swan (2009) and new experimental observations. In this case, second-order freely propagating harmonics arising due to the wave-structure interaction are identified and quantified. Subsequently, a two-dimensional floating body is investigated, undergoing one or two motion modes, and comparisons with the fixed body case are made. These observations confirm that the wave-vessel interactions again lead to the generation of freely propagating nonlinear wave harmonics and that the magnitude of these components varies significantly for bodies with different hydrodynamic properties. Building on the physical understanding achieved from the two-dimensional study, the case of a three-dimensional floating body is considered. This concerns the interaction with both regular waves, propagating at varying angles of wave incidence, and directional wave groups. In both cases the effects of wave-vessel interactions on the surface profile are identified. Finally, it is shown that the nonlinear wave-vessel interactions identified previously can, after interacting with the incoming wave field, lead to unexpected wave impacts on the vessel. As a result, it is concluded that the occurrence of wave impacts, particularly on the side shell of a vessel, cannot be assessed on the basis of the incident waves alone.