Modelling of Air Chamber Supported Floating Platforms – Coupling Free Surface Flow, Compressible Air, and Flexible Structures

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ABSTRACT

Supporting very large floating platforms by air chambers can significantly reduce the wave induced loads on the structure [1]. Traditional target applications for such platforms, like mobile offshore bases or floating airports, require high pressure in the air chambers in order to support the payload. In order to achieve the required strength to sustain the internal pressure, the bounding walls of the air chambers investigated so far [2-4] are relatively stiff. Novel target applications with lower payload requirements, like collector fields for offshore solar power, allow platform designs based on air chambers formed by highly flexible membranes. For such designs the deformation of the chamber wall is strongly coupled with the wave induced pressure variations in the air chamber.

We present a fully coupled (monolithic) finite element (FE) formulation for the problem: The water was modelled as an incompressible, inviscid fluid. Appropriate free-surface boundary conditions were introduced to model surface gravity waves. A perfectly matched layer (PML) formulation was developed to absorb radiating waves at the end or the computational domain, such that unbounded domains can be modelled. The air in the chamber was modelled as a compressible, inviscid fluid, and the structure was modelled as a linear elastic solid. Coupling conditions between fluids and structure, as well as between water and air were incorporated into the FE formulation.

Selected example problems for testing the numerical implementation are presented. The performance of the PML formulation for surface gravity waves is evaluated in terms of type of assumed damping function, layer thickness, and wave frequency. Finally, possible target applications for the developed formulation are suggested.

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