Development of a reduced order model numerical tool for the coupled hydro-elastic analysis of floating structures

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The numerical simulation of a hydro-elastic model involves the coupling between the hydrodynamics and the structural dynamics. The most common approach uses the Boundary Element Method to solve the hydrodynamics with a 3d potential flow coupled with the Finite Element Method (FEM) to solve the structural dynamics. One of the most recent works have proposed a full 3d time-domain hydro-elastic model using FEM-FEM to simulate tightly coupled problems (Servan-Camas et al. 2021)[1]. Solving the 3d hydro-elastic model is complex and requires a large computational cost. Reduced Order Models (ROMs) are mathematical simplifications of the physical high-fidelity models. They reduce considerably the time of the simulations allowing us to perform near real-time analysis.

In this work, the methodology for solving the full 3d reduced order hydro-elastic model is presented. The structural ROM is based on the modal matrix reduction technique. The structural motion equations are projected onto the orthogonal truncated base composed of the eigenvectors. The displacement field is reconstructed as a linear combination of the modal amplitudes and the eigenvectors. In order to include the hydrodynamic pressure loads, the structural ROM is integrated in the time-domain potential flow seakeeping solver SeaFEM[2]. The use of a structural ROM speeds considerably up the hydro-elastic calculations.

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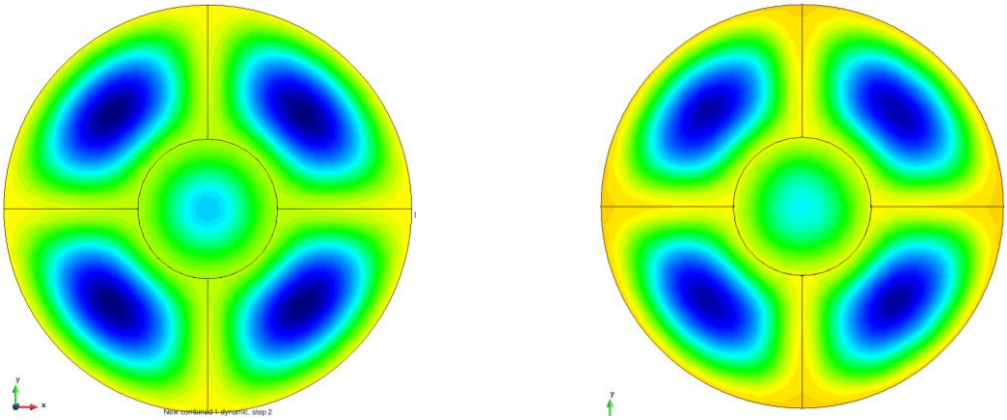

(a) (b)

Figure 1. Top view of the instantaneous vertical displacement field of a floating steel-based buoy computed with a: (a) high-fidelity 3d hydro-elastic solver, and (b) with the reduced order hydro-elastic model with the first 80 most energetic eigenmodes.

[1] (Servan-Camas et al. 2021) Servan-Camas B, Di-Capua D, Garcia-Espinosa J, Sa-Lopez D. Fully 3d ship hydroelasticity:monolithic versus partitioned strategies for tight coupling. Marine Structures 80 103098 (2021)

[2] https://www.compassis.com/compass/en/Productos/SeaFEM