Fluid-structure interaction during ship slamming

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Abstract

During the operation of ships in harsh environmental conditions the ship structure is subjected to large loading due to excitation of large waves that are of the same size of the vessel, as well as to localized loading that occurs when the shell plating re-enters the water with a vanishingly small contact angle between the body and the water surface. This second type of extreme loading occurs over very small space and time scales, and the magnitude of the forcing depends non-linearly on the environmental conditions such as impact velocity and effective deadrise angle.

Ships are designed with consideration for impact loading, but the methods are crude and leave designers with little confidence that the resulting structures are prepared for the loading that they see in service. A model problem that represents a simplified slamming event is the impact of an elastic wedge upon a calm-free surface. This problem has been studied numerically and experimentally [1-3].

In the present work, we use the OpenFOAM CFD library to predict the hydrodynamic forcing on the relevant geometry of the ship during a slamming event. We use the commercial FEA software ABAQUS to perform modal extraction of a wet structural model of the ship. We then couple the results from the two programs using our own research tools to predict the structural response in the time domain.

In our presentation, we will give an overview of our simulation method and process, and show results for several validation cases and compare with theoretical and experimental results from the literature [1-3]. Also, we will show an application of our method to the case of stern slamming of the JHSS vessel. We will pay particular attention to how we have incorporated the OpenFOAM library into our analysis process.

References

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