Comparative Analysis of Wave Models and Motion Dynamics of a Freely Floating Barge

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Synopsis

In offshore engineering, understanding how waves interact with floating structures is key to ensuring their safety and reliable performance. Physical experiments to study these interactions can be expensive and challenging to conduct, so numerical simulations have become an effective and practical alternative. Accurate modelling of structures like pontoons under various wave conditions is essential for effective design and assessment.

This study focuses on validating the *olaFlow* solver in OpenFOAM and exploring how a pontoon-type floating structure responds dynamically to different types of waves. The simulations do not include any turbulence models. A numerical wave tank is the domain, and the multiphase Volume-of-Fluid (VOF) method is used, which includes active wave generation and absorption boundaries. The computational domain is constructed using a structured mesh generated by the *blockMesh* tool. In contrast, dynamic meshing is used to accurately capture the body's movement and its interaction with the wave. Five different wave types are tested: Stokes II, Stokes V, cnoidal, solitary, and irregular waves. To ensure the solver's accuracy, simulated surge and heave motions are compared to experimental results from the literature, showing good agreement within about ±15% error—especially for the regular waves like Stokes II and Stokes V. After validating the solver, the study looks at how the pontoon reacts to each wave type. The results show that solitary waves tend to produce stronger nonlinear effects, while irregular waves cause a broader range of wave motions, leading to more complex structural responses.

Overall, the study demonstrates that olaFlow can accurately capture the complex hydrodynamic responses of floating structures under different sea conditions. These results highlight its potential as a reliable and practical tool for both research and engineering applications in wave-structure interaction.

Keywords: Wave-structure interaction, olaFlow, floating structures, dynamic meshing