Computation of Ship Manoeuvring in Irregular Waves with CFD

MARINE 2023

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ABSTRACT

The design of a ship requires the understanding of how it will manoeuvre in waves. Designs strike a balance between the efficiency of smaller installed power and appendages with the concern that it will remain seaworthy and controllable in the various ocean wave and current conditions that it will meet in its lifetime. The manoeuvrability of a ship depends on complicated flow of waves, flow over the smooth (or rough) surface of the hull, and the flow into and around the rudders, propellers, and any other control surfaces. Computational fluid dynamics holds the promise to accurately predict full-scale-Reynolds number ship manoeuvrability, yet the cost and complexity of the simulation prevents wide-scale adoption of the simulation-based technology. The primary cost drivers are the need to resolve the transient flow into the control surfaces, the resolution of the boundary layers for the prediction of smooth-surface separation, and the need to evolve the ocean waves and ship-generated waves.

In this paper a novel method for the calculation of the KCS (KRISO Container Ship) manoeuvring in an irregular wave field will be studied. The simulation relies on a finite-volume method for the URANS equations. The air-water interface is determined with a VOF method that employs adaptive-mesh refinement. The method uses a new data-driven propeller and rudder model [1,2] to predict the forces over the control surfaces that are represented as a body-force zone in the flow domain. A unique aspect of the method is the way in which the side force on the propellers and rudders is determined through training the model on high-resolution sliding mesh simulations at a range of flow conditions.

The paper will present a range of validation problems for the KCS including self-propulsion and turning circle. The new results will be the prediction of the KCS turning in irregular seas. An ensemble of random-wave conditions will be simulated to determine the distribution of turning circle parameters.

REFERENCES

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