Impacts of Fin Stabilizers on The Powering, Motions and Loading of Atlantic Canadian Fishing Vessels

Abstract

Motion stabilization of ships has been a research topic for over a century, driven by the need to enhance safety, improve vessel operability, and increase onboard comfort. Among the commonly used stabilization systems, passive fins that generate lifting forces are widely deployed on fishing vessels to mitigate roll motion during fishing and navigation. However, the interaction between fin stabilizers, the hull, and wave dynamics results in discrepancies between theoretical hydrofoil-based predictions and actual dynamic drag and lift forces and turning moment, warranting further investigation.

This study aims to improve the understanding of the impact of traditional stabilizer fins on the hull resistance and motions of fishing vessels. Also addressed is the uncertainty in the environmental loads on the stabilizer fins, which can negatively impact hull structural integrity. A 1:7.5 scaled physical model of a representative fishing vessel was designed, built and utilized to examine the influence of contemporary fin designs on hull resistance and power in calm water and motions in waves. In parallel, through extensive computational fluid dynamics (CFD) simulations conducted on a full scale, the effects of fin stabilizers on hull resistance, roll motion mitigation, and loads on the fins were analyzed across a range of fin angles, ship speeds and wave conditions. The data generated from the measurements were utilized to validate the powering and motion results obtained from the CFD simulations.

The findings reveal that while stabilizer fins have a measurable impact on resistance and powering, they are highly effective in reducing roll motion. The CFD predictions are within 5% of the measured resistance and power; however, they generally underpredicted the motion reductions, which may be attributed to the difference in Reynolds number between physical model-scale measurements and CFD calculations. The CFD-predicted drag, lift, and turning moments on the fins at different operating conditions are also presented.

This study underscores the importance of selecting appropriate fin design and configurations at prevalent ship speeds to achieve optimal powering and anti-roll performance while accounting for fin–hull interactions. The results provide valuable insights into fishing vessel design and offer guidance for designing, controlling, and optimizing stabilization systems, contributing to safer and more efficient maritime operations.

Key Words: Stabilizer fins; Motion reduction, Physical modelling, Computational Fluid Dynamics, Fishing vessels, resistance and powering,