The Dynamics of a Ship Nominal Wake in Head Waves

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ABSTRACT

Accurate capturing of ship wake at the propeller disk is crucial for designing efficient propellers and, at the same time, avoiding erosion and noise caused by cavitation over the blade. Propeller designers often use measured or computed wake data from calm water to design propeller blades. However, calm water is a scarce scenario in an actual voyage where waves and the waves induced motions can significantly impact the flow dynamics into the propeller.

In this study, the dynamics of the hull wake in waves is investigated using Computation Fluid Dynamics in different head wave conditions for a displacement vessel with a large block coefficient, where the bilge vortices are of significant importance. It is shown that the contraction and expansion of the boundary layer caused by the hull motions alter the flow into the propeller. Moreover, the bilge vortices are also influenced by the hull motions, which all together result in a complex dynamic flow into the propeller disk. In order to analyse the evolution of coherent spatiotemporal structures of the flow and identify the main contributors to the flow dynamics, Dynamic Mode Decomposition (DMD) [1], a data-driven dimensionality reduction algorithm, is used.

The modes extracted from DMD are also used to reconstruct the dynamic wake and create a reduced-order model. Due to the significant computational cost of simulations in waves [2], reduced-order models can be of great interest in conjunction with optimization algorithms or control system developments.

REFERENCES

[1] Schmid, P., (2010). Dynamic mode decomposition of numerical and experimental data. Journal of Fluid Mechanics, 656: 5–28.

[2] Irannezhad, M., Eslamdoost, A., Bensow, R.E., (2019). *Numerical investigation of a large diameter propeller emergence risk for a vessel in waves*. Proceedings of the 8th International Conference on Computational Methods in Marine Engineering (MARINE), Gothenburg, Sweden. pp. 634–645.