Underwater Radiated Noise Comparison between Low and High Fidelity Methods

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ABSTRACT

The capability of accurately predicting the underwater noise radiated by propellers, in the near and far field, is very important for both naval and civilian vessels, for different, equally relevant, reasons. As a consequence, especially in the past decade, the development of methods and tools for the prediction of propeller Underwater Radiated Noise (URN) has been the focus of extensive academic and industrial research.

From the point of view of the propeller designers, making accurate URN predictions while limiting as much as possible the computational effort required by the URN assessment is a key aspect, especially in the early design phases, when time is of the essence and a number of design alternatives need to be comparatively evaluated in a limited time frame. It is therefore very important to have different methods and tools available, of increasing degree of fidelity, and choose, for each design phase, the approach that provides the best compromise between accuracy and computational time.

In this paper, a comparison is proposed between a Low-Fidelity method and a High-Fidelity method for the prediction of the noise radiated by the tip vortex of a naval propeller in conditions close to cavitation inception in the vortex. Cavitation inception causes a relevant increase in the URN levels, which makes the study of this condition particularly important in the propeller design process.

The proposed Low-Fidelity methodology is based on the combination of a Boundary Element Method (BEM) and semi-empirical acoustic models and has been developed and validated within the Cooperative Research Ships (CRS), with an active involvement of the authors of this paper. The High-Fidelity methodology is based on using RANSE for the simulation of the near-field propeller behaviour and a combination of DES and the acoustic analogy (Ffowcs Williams-Hawkings) for the computation of the noise radiated in the far-field.

Both the non-cavitating condition before inception and the cavitating condition immediately after inception will be analysed by comparing far field noise spectra. For the near field analysis, the noise sources will be assessed through comparing the pressure pulses induced by the propeller on the hull and the flow field fluctuations between the brackets.

Reference

J. Bosschers. A Semi-Empirical Method to Predict Broadband Hull Pressure Fluctuations and Underwater Radiated Noise by Cavitating Tip Vortices. Fifth International Symposium on Marine Propulsors smp'17, Espoo, Finland, June 2017

E. Firenze, F. Valdenazzi. A method to predict underwater noise from cavitating propellers. OCEANS 2015, Genova, 18-21 May 2015

S. Iannello, C. Testa. An Overview on the use of the FFowcs Williams-Hawkings equation for the hydroacoustic analysis of marine propellers. VIII International Conference on Computational Methods in Marine Engineering, MARINE 2019

M. Ge, U. Svennberg, R. E. Bensow. Investigations on prediction of ship noise using the FWH acoustic analogy with incompressible flow input. Ocean Engineering 257 (2022) 111531

J. Baltazar, B. Schuiling, D Rijpkema. Propeller Performance Prediction in an Artificially Generated Wake Field Using RANSE. 22nd Numerical Towing Tank Symposium, Tomar, Portugal, 2019.