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Investigation of hull and propeller roughness on full scale CFD predictions

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ABSTRACT

With the increasing computer power, full-scale CFD simulations are getting more attention for predicting the ship performance. Predicting the required power to achieve the contract speed at the sea trial is crucial for an efficient ship and propeller design (Quist et. al. 2023). As the number of regulations with respect to the reduction of GHG emissions is also increasing, so does the need for accurate predictions of the fuel efficiency in order to meet the targets of the maritime industry. The ITTC committee has concluded that CFD simulations can initially complement model testing and potentially replace it in the future. CFD simulations provide the opportunity to give full-scale predictions directly without any extrapolation, as required by the standard performance prediction methods used by the model basins.

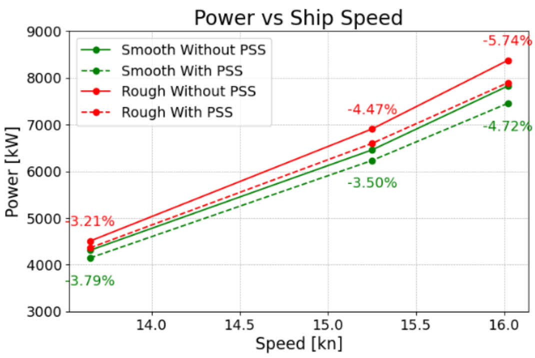

Figure 1: Power-Speed curve for a smooth and rough hull/propeller surface with and without PSS.

Hull and propeller roughness play a crucial role in the overall efficiency of a vessel, as roughness affects the flow characteristics around the hull and influences the ship's speed and power requirements. Even for a newbuild vessel, factors such as coating quality, construction tolerances, and welding characteristics introduce initial roughness that should be considered in simulations. Over time, biofouling and coating degradation further increase roughness, leading to higher frictional resistance. Therefore, it is essential to use accurate roughness functions in simulations to predict the added friction resistance and ensure optimal performance throughout the vessel's life.

Within the JORES Joint Industry Project, hull roughness measurements have been performed on a number of vessels together with sea trial measurement. This study serves as a first attempt to understand the importance of including hull and propeller roughness in CFD simulations to obtain better predictions that are in line with the full-scale measurements. An example of the impact of roughness in the required power of a self-propelled ship with and without Pre-Swirl Stator (PSS) is shown in Fig. 1. Higher power savings from the PSS (up to 1%) are shown for the rough model at higher speeds, indicating the importance of including roughness functions in the simulation, when assessing the efficiency of energy saving devices.

References

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