

Ship Biofouling Drag Penalty Prediction with the Wind-shade Roughness Model

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ABSTRACT

Global shipping significantly contributes to greenhouse gas emissions and incurs substantial economic costs. Some of this results from increased drag due to hull fouling. Accurately predicting these drag penalties is crucial for environmental sustainability and economic efficiency. While existing models based solely on surface statistics have limited applicability, a recent wind-shade roughness model by Meneveau *et al.* (2024) offers a promising alternative by incorporating both surface topography and flow physics.

This study investigates the potential of the wind-shade roughness model to improve biofouling drag penalty predictions. We utilize truncated cone hydrodynamic drag results from Womack *et al.* (2022) as a proxy for ship hull barnacle fouling. Fig 1 shows a comparison of the truncated cone experimental data and wind-shade model results over a range of roughness planform densities. Additionally, a process similar to Monty *et al.* (2016) will be used to predict the increase in hydrodynamic drag for a mid-sized naval surface ship. By comparing the model predictions to experimental data, we aim to:

biofouling penalties.

1. Evaluate the accuracy and applicability of the wind-shade roughness model for predicting
2. Quantify the ship drag penalty associated with biofouling using both experimental and model-based results.
3. Identify areas for improvement in the wind-shade roughness model to enhance its predictive capabilities.

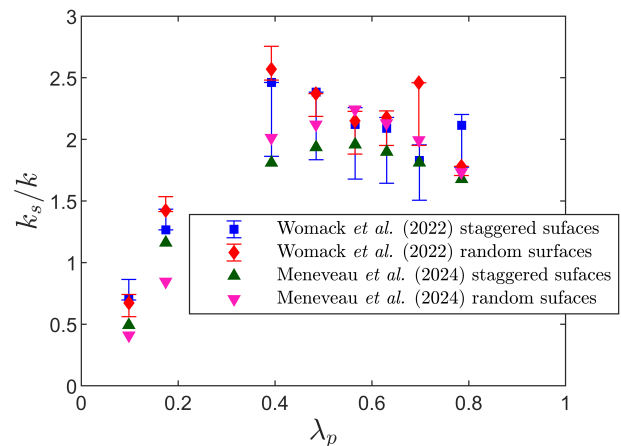


Figure 1: Equivalent sandgrain roughness, k_s , normalized by roughness height, $k = 3.15$ mm, for all planform densities, λ_p . See Womack *et al.* (2022) Fig 9 for plot data not included here.

1. Evaluate the accuracy and applicability of the wind-shade roughness model for predicting

References

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