CHALMERS
UNIVERSITY OF TECHNOLOGY

[Scientific field: Fluid-structure interaction in marine applications]

FSI Analysis: Aeroelasticity of Telescopic Wing Sails for Wind-Assisted Ship Propulsion

Background and motivation

Nowadays a critical mission in transportation is to reduce greenhouse gas emissions. In the maritime transport sector, a path towards this target is the use of wind-assisted propulsion for ships. Telescopic wing sails is known as one of the powerful concepts that can be applied to large bulk transport ships in transcontinental routes. A video to introduce telescopic sails is found in the link. Previous studies have reported that ships installed with this type of sail can reduce around 20% fuel consumption, and the reduction could be further extended by optimizing routes and time plans in terms of wind and weather conditions.

It is no doubt that designing wing sails with high aerodynamic efficiency is always of interest. To date most of available findings and data that are found in the literature or public libraries are focused on aerodynamics with no consideration of sail structure deformations/vibrations, which are stimulated by transient aerodynamic pressures. However, in fact, the structural dynamics influences the flow since it leads to flow fluctuations near the walls. The aerodynamic pressures are changed as a consequence.

Objectives

The present project aims to address the fluid-structure interaction (FSI) for wing sails using both numerical simulations and wind-tunnel experiments (see more details about the WindStruc project in the link). The telescopic wing sails designed by ScandiNAOS will be studied. The strategy for optimizing the wing sail geometries will be developed.

Methods and tools

Numerical simulations: a strongly coupled FSI approach will be used to couple a solver of Computational Fluid Dynamics (CFD) with a solver of Finite Element Analysis (FEA). The solver is developed with the simulation platform of STAR-CCM+ and Abaqus. Simulations will be conducted on the cluster of National Supercomputer Center at Linköping University.

Wind tunnel tests: the scaled models of the baseline and optimized configurations will be 3D-printed. Then, the FSI of these scaled models will be measured in the low-turbulence sonic wind tunnel at Chalmers (see more details about the wind tunnel in the link).

Number of students: 1 student

Prerequisites: CFD or FEA.

Tasks

- Simulate the FSI of the baseline and several modified wing sails.
- Perform local geometry optimization to improve the aerodynamic efficiency of the wing sails.
- Validate the FSI simulation method based on wind-tunnel tests.
- Analyse and identify the key parameters and effects that dominate the FSI based on both simulations and experiments.
- Write a thesis report.

Contacts

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