High-performance sailing: Fluid-Structure Interactions

Background

With the advent of foiling in the America's Cup in 2013 and the subsequent interest in foiling, the future of high-performance sailing is pending toward a large portion of foiling boats being sailed and built. The use of composite manufacturing and light-weight structures implies that significant deformations of the hydrofoils are present in all sailing scenarios, leaving the designers to investigate not only the hydrodynamic forces from the shape of the foil, but also its Fluid Structure Interaction (FSI) behaviour. The deflection and twists of the hydrofoils under fluid loads will ultimately affect the stability of the whole boat with implications in the overall speed and crew-safety.

Objective

Investigating the deformation of a high-performance sailing boat's hydrofoils and the interaction effects with the hull.

Methods and tools

In this project we will study the effects of structural deformation on hydrofoils subject to real-life sailing loads. The sailing boat's behaviour under different sailing scenario will be studied using STAR-CCM+ in presence of simplified sail model. Along with the hydrodynamic analysis of the boat, the structural deformation of the hydrofoils subject to the computed hydrodynamic forces will be studied using the inbuilt FEM solver in STAR-CCM+. Prior to these simulations, the method used for structural analysis of the hydrofoil will be validated against the experimental data obtained from a test in SSPA cavitation tunnel. Eventually, the effect of hydrofoil deformation on the stability of the sailing boat will be investigated.

Miscellaneous

The project is a continuation of an earlier MSc thesis carried out previous year and will start in January 2022. Laura Marimon Giovannetti, co-supervisour, will share her expertise with the team on high-performance sailing both from engineering and sailing perspectives.

Prerequisites

- Background in Mechanical Engineering, Naval Architecture, or similar
- Knowledge and interest in Computational Fluid Dynamics and structural analysis methods
- Sailing background is recommended but not necessary

Figure 1: Hydrofoil subject to an extreme sailing load.

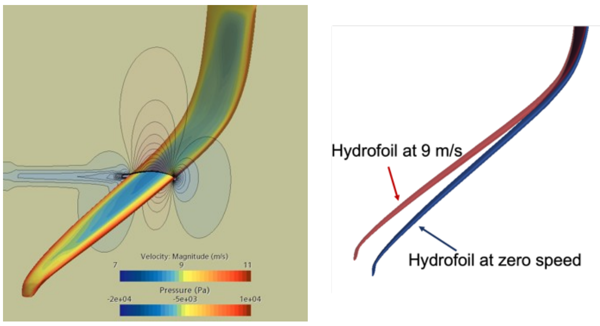

Figure 2: Hydrofoil subject to hydrodynamic loading and its ultimate deformation.

Contact

- Arash Eslamdoost, Associate Professor – arash.eslamdoost@chalmers.se – supervisor and examiner, Chalmers University of Technology
- Laura Marimon Giovannetti – Laura.Marimon@sspa.se – co-supervisor, SSPA

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