Assessing High Performance Yachts' Hydrofoil Deformations
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ABSTRACT

In recent years, hydrofoils have been playing an important part in the performance of sailing boats. Indeed, whether they allow the boat to leave the Archimedian mode to fly above the water or simply provide more righting moment to the boat, their presence can lead to big gains in ship maximal speed.

Due to the high speed they operate under, these appendages often bend and twist under the hydrodynamic loads they are under. These deformations then lead to modifications of the forces applied on the foil, and to new deformations, thus resulting in a two-way coupling between fluid and structure effects. In this scope, naval architects need to include these models in their calculation to assess and compare the performance of their foil designs.

As of now, the fluid-structure interaction is handled through a modal approach [1]. This method is already implemented in FINE/Marine's solver ISIS-CFD, therefore no coupling with a structure solver is needed, which saves up CPU-time. To compute body's deformations, this approach requires an input file that contains mode frequencies and the associated deformation amplitudes of the structure, which are usually obtained through modal analysis in a third-party FEA code. The fluid solver then uses this data to perform the coupling, computing the deformation of the structure by a linear combination of the structure eigenmodes. However, this approach cannot take into account geometrical non-linearities, which can be critical for some foils, as IMOCA's 6-meter-length-foils can bend up to one meter in certain sailing conditions.

This approach is combined with the methods for hydrofoil fluid simulation within ISIS-CFD, including the sock-mesh approach with multi-surface and flux-component Hessian (MS-FCH) adaptive grid refinement [2]. To validate this approach, simulations using the NACRA 17 foil will first be performed, in order to compare numerical results to experiments performed by SSPA [3]. Results of simulations performed on an IMOCA equipped with foils, are also presented.

REFERENCES

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