Several leaps forward for CFD simulations of hydrofoils

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ABSTRACT

Hydrofoils unleashed the speed of sailing boats since the last two America's cup editions. They are able to lift the boat out of the water to drastically reduce its resistance and as such, they became an essential part of the design. Traditionally investigated using CFD, they are submitted to hundreds of angles, speeds and draughts combinations, usually imposed by the user from a data matrix. The result matrix is then directly used to feed a VPP, or needs further interpolation to analyse foil efficiency at a prescribed lift.

This paper proposes a combined use of specific developments to address in a convenient manner the configurations involving hydrofoils. First of all, in this approach, the lift and side forces are not an output of the simulation anymore but an input. The hydrofoil position (rake and sideslip angle) is dynamically adapted to find an equilibrium and reach the desired forces at a given speed through a quasi-static approach [1]. No need for further interpolation, the flow field is directly solved for the desired lift and sideforce. The deformation of the foil is then simultaneously taken into account through a quasi-static modal approach to reach the global dynamic equilibrium [2].

The motion and the deformation of the foil are critical for the mesh deformation, especially since the foil operates in the vicinity of the free surface, which requires a high-quality fine mesh to be captured correctly. Hence, to ensure both the mesh quality around the hydrofoil and in the far field,, a body-fitted mesh around the hydrofoil is inserted into a larger background mesh by the overset technique. Thus, the deformation and vertical displacement of the hydrofoil can be applied to the hydrofoil mesh only. The overset technique is combined with adaptive grid refinement, which is used to ensure both the accurate free surface capturing and the mesh continuity at the interpolation zone of the overlapping grids.

REFERENCES

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[2] Mouton, L., et al. Towards unsteady approach for future flutter calculations. *Journal of Sailing Technology* 7 (2018).