A RESEARCH INTO AND THE DESIGNING OF THE 'IDEAL' HYDROFOILS FOR A LASER

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Introduction

Hydrofoiling is the concept of lifting a vessel partially or completely out of the water, reducing its resistance in the water and therefore reducing the thrust needed to maintain a constant velocity. This means a hydrofoiling ship may either reach much higher speeds with the same thrust or reach the same speed with much less thrust. The latter causes the environmental importance of hydrofoiling. Large container ships can be fitted with resistance reducing hydrofoils, which currently lead to a fuel reduction of about 14 per cent (Hull Vane Bv, 2014). If such a foil is fitted on one of the largest ships in the world, this leads to a reduction in emission that is similar to that of millions of cars. This is one of the reasons why hydrofoils are becoming more and more important and research into hydrofoils such as ours is of great value for the future.

In sailing, hydrofoils are becoming increasingly popular because of the high speeds and the smooth ride. The boats that join in competitions, which generally have the best equipment available, often have them. For the laser, a small sailing boat, one set of hydrofoils was already available, designed and produced by Glide Free Foils. This set was designed for starting foilers, focusing on ease of use. In our research and design, our goal was to achieve optimal performance, for example a high lift/drag ratio, which means our hydrofoils will perform better, but require more experience to use. This makes this project innovative: never before has anyone designed hydrofoils for a laser with optimal performance as primary focus. In addition, the outcome of the conducted research in order to form the design may contribute to research on hydrofoiling in the future.

Experimental Setup

Our research was conducted with the Computational Fluid Dynamics simulation software XFLR5, which is an extension of XFoil, made by Mark Drela from MIT, and gives the results that the Navier-Stokes equations would by dividing the foil in different panels. The Reynolds number, Mach number and NCrit were calculated and altered in order to simulate in water at the right velocity. The effects of different parameters of the wing profile, such as thickness and camber, on the performance of a hydrofoil were investigated extensively and by reviewing these results and inflicting our design choices onto them, the 'ideal' wing profiles in 2D and subsequently the 'ideal' 3D-shape was formed. 'Ideal' in this case means best meeting our design choices, which we formed at the start of our research.

Results

The chord length of both the lifting and stabilising foil is four times smaller at the tips than in the middle, which leads to a reduction of the induced drag. The lifting foil's wing profile is the NACA 7311 (figure 1), it's span is 1.2 m and it's chord length is 0.24 m in the middle and 0.060 m at the tips. The stabilising foil's wing profile is the NACA 0011 (figure 2), it's span is 0.50 m, it's chord length is 0.10 m in the middle and 0.025 m at the tips and it stands under a permanent angle of 6.725 degrees. At take-off, the lifting foil is under an angle of attack of 5.5 degrees, which becomes 8.5 degrees during take-off, because the front of the boat lifts out of the water first.

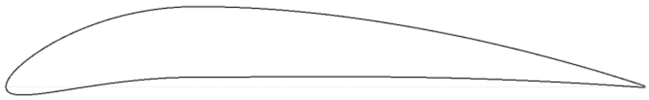

Figure 1 - Wing profile of the lifting foil (NACA 7311)

Figure 2 - Wing profile of the stabilising foil (NACA 0011)

The simulations show that a laser with these foils will start to take off at 2.1 m/s, which means it rises from the water at a 30 per cent lower speed than the existing foils for the laser.

Conclusion

According to our simulations, the design we have presented above will perform much better than the existing foils for the laser when they are handled by someone who has more experience and is therefore able to operate within smaller margins.

Since simulations can never be more than a prediction of reality, it would be best if our design was also tested in real life to confirm the outcome of our research and our predictions. For this purpose, we are now building our design, sponsored by Feadship, Glide Free Foils, International Paint, Damen Shipyards Group and Zeilschool Waterland.

Once our design has been thoroughly tested in real life, further research could look into developing the design to enhance its performance even further or designing 'ideal' hydrofoils for different circumstances, such as very high wind speeds.

References

1. Hull Vane Bv (2014). *Hull Vane - Fuel Saving Foils*. Consulted on 30 december 2017, https://www.youtube.com/watch?v=4Npm5FXnOLE