Master thesis and internship[BR]- Master's Thesis : Aerodynamic optimization of an aileron of a racing car[BR]- Stage d'insertion professionnelle

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Aerodynamic optimization of an aileron of a racing car

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On a race car, aerodynamics has determined consequences on the performance on each circuit. The downforce contributes to a better tire performance on the corners, whereas a reduction of the drag makes possible to reach higher maximum velocities and to reduce the fuel consumption. One of the most common devices used to improve the downforce is the aileron. Nevertheless, the downforce generated comes together with a rise on the drag, leading to a need of a wide study to have a compromise between the two effects.

In this thesis, the aileron of the Fun Cup Evo 3 race car is studied to optimize its position regarding the angle of attack. This study is conducted by means of wind tunnel experiments on the wing isolated and numerical simulations of the 2D profile of the wing. In addition, the deflection of the flow upstream of the aileron generated by the car is determined with a wind tunnel experiment performed on a scale model of the car. The vertical deflection obtained, which varies spanwise, is used by the application of the Prandtl lifting line theory to estimate the performance of the aileron on real conditions. Finally, the results of these experiments are used to select three angles of attack that optimized the performance for different situations: maximum downforce-to-drag ratio, α between $-19°$ and $-9°$; maximum downforce, $\alpha = -23°$; and minimum drag, $\alpha = 7°$.

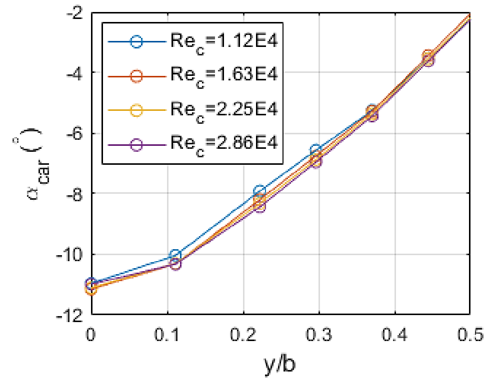

Figure 1. Deflexion of the flow induced by the car along the span for different Reynold numbers.

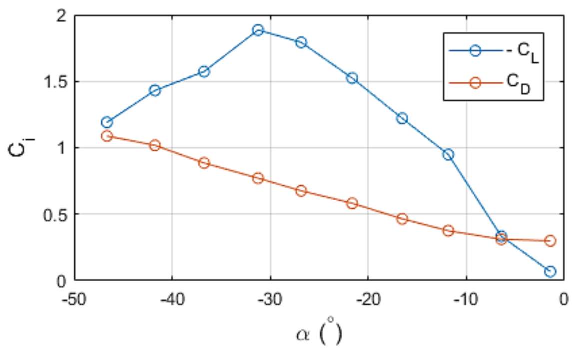

Figure 2. Variation of the negative lift and drag coefficients with the angle of attack obtained with wind tunnel force experiment for $U_\infty = 30\ m/s$.

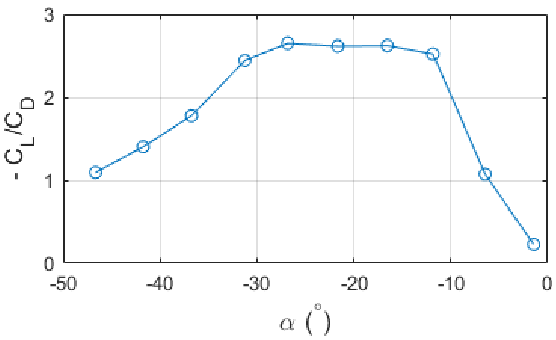

Figure 3. Variation of the ratio of downforce to drag obtained with wind tunnel force experiment.

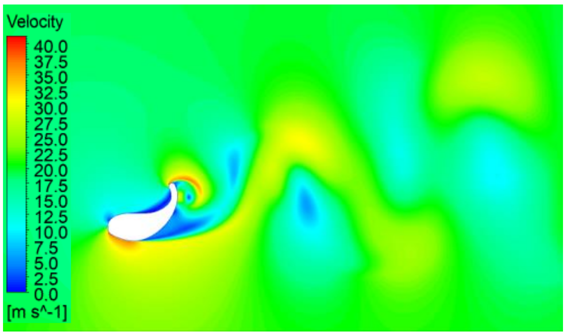

Figure 4. Velocity field in a particular time instance obtained with the numerical model SST $k-\omega$ at $\alpha = -30.5°$ and $U_\infty = 20\ m/s$.

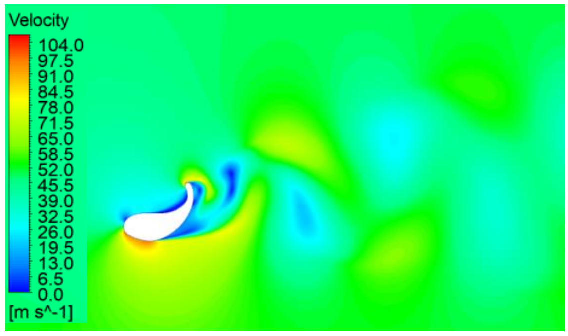

Figure 5. Velocity field in a particular time instance obtained with the numerical model SST $k-\omega$ at $\alpha = -30.5°$ and $U_\infty = 50\ m/s$.

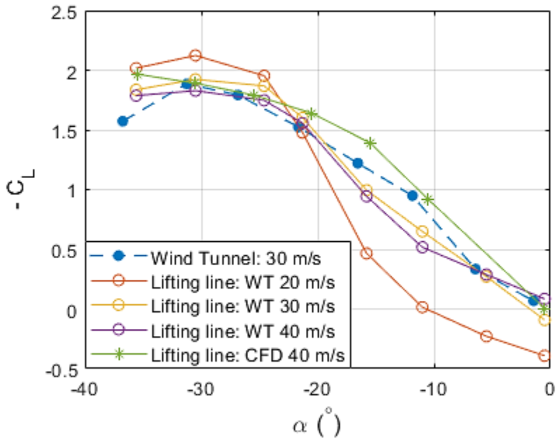

Figure 6. Comparison of the evolution of negative lift coefficient with α of all the results of the aileron isolated

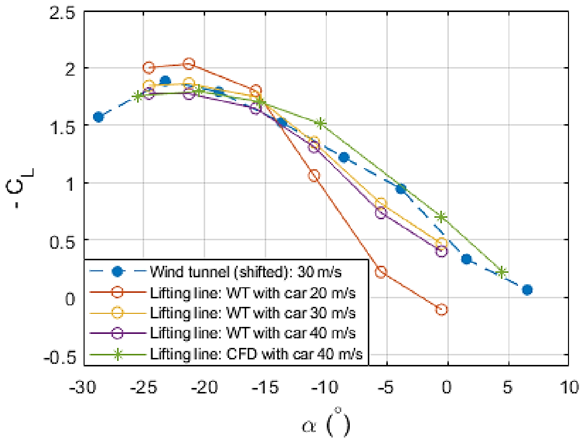

Figure 7. Comparison of the evolution of the negative lift coefficient with α of all the results of the aileron affected by the car.

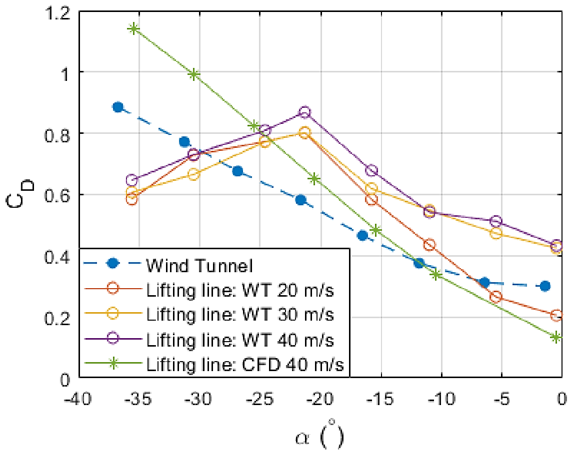

Figure 8. Comparison of the evolution of drag coefficient with α of all the results of the aileron isolated

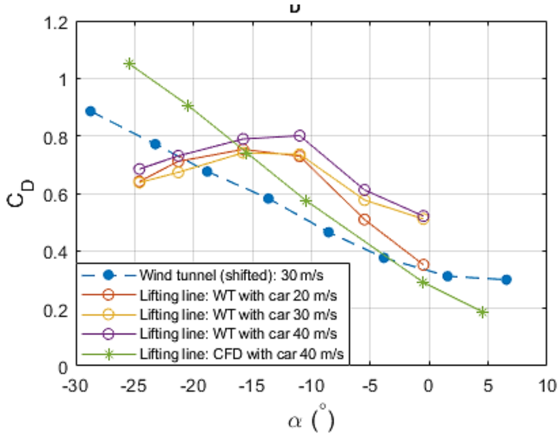

Figure 9. Comparison of the evolution of the drag coefficient with α of all the results of the aileron affected by the car

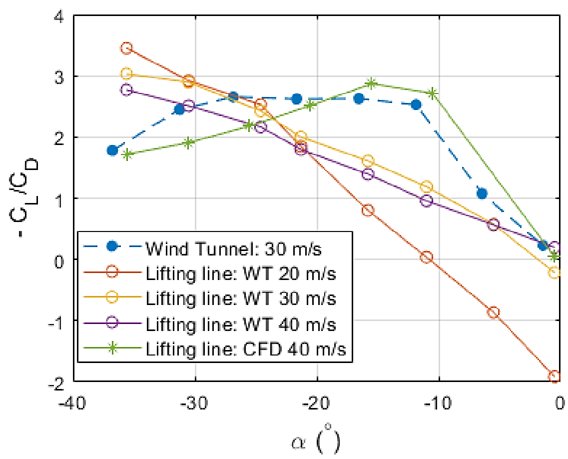

Figure 10. Comparison of the evolution of the ratio of negative lift coefficient to drag coefficient with α of all the results of the aileron isolated

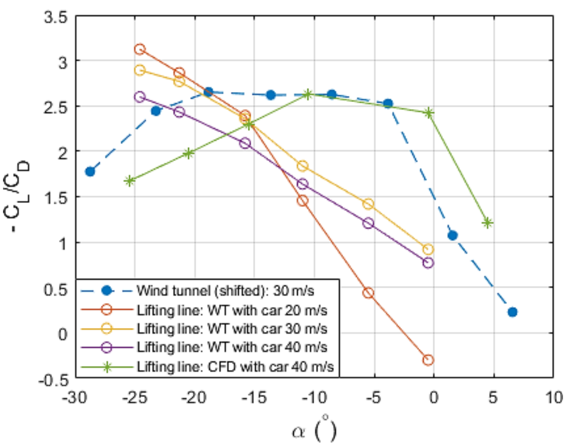

Figure 11. Comparison of the evolution of the ratio of negative lift coefficient to drag coefficient with α of all the results of the aileron affected by the car