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Efficiency Enhancement of Racing Cars Using Aerofoil

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Abstract

In design of a racing car inside a given class, a number of parameters such as vehicle weight, engine power, and aerodynamics shape have to be optimized in context to attain highest performance. Aerodynamics is the most important out of these parameters. The test matrix was chosen to cover the effects of changing major variables of flap plane form, endplate plane form, angle of attack, flap deflection, and Reynolds number at a ground clearance of 9.906 cm (0.3). Low-Speed Wind Tunnel to quantify the performance and flow field effects of two-element open-wheel-race-car front wing configurations. Four distinct configurations were tested in- and out-of-ground effect and at various speeds (Reynolds numbers), angles of attack, and flap positions. From parametric CFD simulations on F-1 car attached with add-on devices, there is a considerable amount of drag and lift force reduction besides streamlining the airflow across the car. The best possible configuration for all add-on devices, i.e. front and rear wings, nose wing, barge board, roof spoiler and wheel scallops, are derived from CFD simulations. The combination of all these add-on devices with the most appropriate configurations is suggested to incorporate for F1 race car to improve aerodynamic performance.

Keywords: *Efficiency, Racing Cars, Aerofoil.*

Introduction

The way the shape of an object affects the flow of air over, around or under it. Race car designs can manipulate the motion of air around the cars through aerodynamics. A ground effect results from an aerodynamic design on the underside of a race car, which creates a vacuum.

Race car performance depends on elements such as the engine, tires, suspension, road, aerodynamics, and of course the driver. In recent years, however, vehicle aerodynamics gained increased attention, mainly due to the utilization of the negative lift down force principle, yielding several important performance improvements. This review briefly explains the significance of the aerodynamic downforce and how it improves race car performance.CFD simulation on the modified F1 race car with add-on devices has been carried out for different speeds. Aerodynamic performances like lift force, drag force and their co-efficient are evaluated for different configurations of add-on devices for different speeds. These include: computational fluid dynamics modeling (CFD), wind tunnel research, and in-world vehicle testing.

Previous studies of race-car aerodynamics ranging from full-car wind-tunnel tests, numerical investigations, and combined experimental and numerical studies have shown that the effect of small changes in parameters on a race car can have significant effects on aerodynamic performance. Hurst [1] shows that a 1-deg change in wheel camber, a seemingly unimportant aerodynamic variable, can change down force by up to 2%. Katz [2] demonstrates through the use of a panel method that the addition of a front and rear wing to an open-wheel race car can change a lifting body to one that produces a large amount of down force.

Experimental Apparatus

The wind tunnel uses to test the wing go after an open-circuit plan. It has a do well run speed of 22.10 m /s (48 kmph), a compression ratio no greater than 4:1, and a test chamber with dimensions 30.8 cm x 48.62 cm x 37.42 cm. The wind tunnel was planned and constructed on the design given by Mr. David, a previous physics student of USA as his design is used as the standard data for the research purpose now a day. Reynolds number of approximately 4.9 x 1 06/m.

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Figure 3.8: Open circuit wind tunnel

α °	C_D
0	0.00184 ±0.00005
10	0.00219 ±0.00005
15	0.00207 ±0.00005
20	0.00449 ±0.00005
25	0.00553 ±0.00005
30	0.00633 ±0.00005
35	0.00679 ±0.00005
40	0.00714 ±0.00005

With this setup in place, an existing Lab view program scheming the angle of the holdup could now be used to manage the angle of attack of an airfoil model mount upright in the wind tunnel. The support motor was forbidden by the computer lab throughout a standard nine-pin serial port.

Computational Fluid Dynamic

Computational fluid dynamics (CFD) is extensively used in the racing industry to predict the down force and drag race cars would experience at high velocities . CFD provides numerical solutions to the governing equations of fluid dynamics throughout the desired flow region. It allows for complex problems to be solved without losing the integrity of the problem due to over-simplification. It is this ability to solve large problems that makes CFD an excellent tool for the automotive industry. CFD allows engineers to examine the airflow over an automobile or a particular part such as a wing or hood, and see the aerodynamic effect of changing the geometry of any particular area of the vehicle.

Graphical editing of the geometric parameters such as flap position, size, angle etc. Such an interactive design tool was key to performing trade studies to assess the relative importance of the different design variables in maximizing the lift while satisfying the constraints.

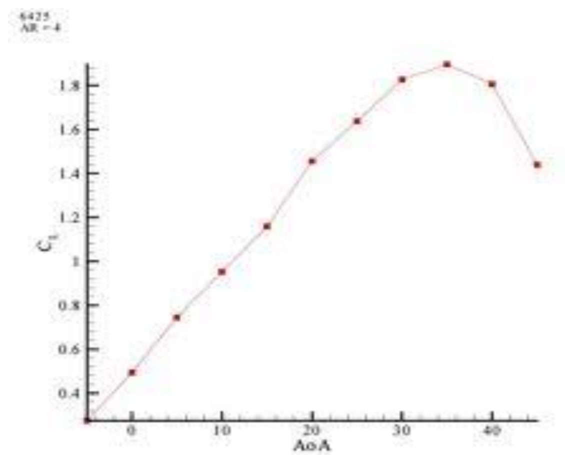

Figure 1: Lift coefficients vs. angle of attack

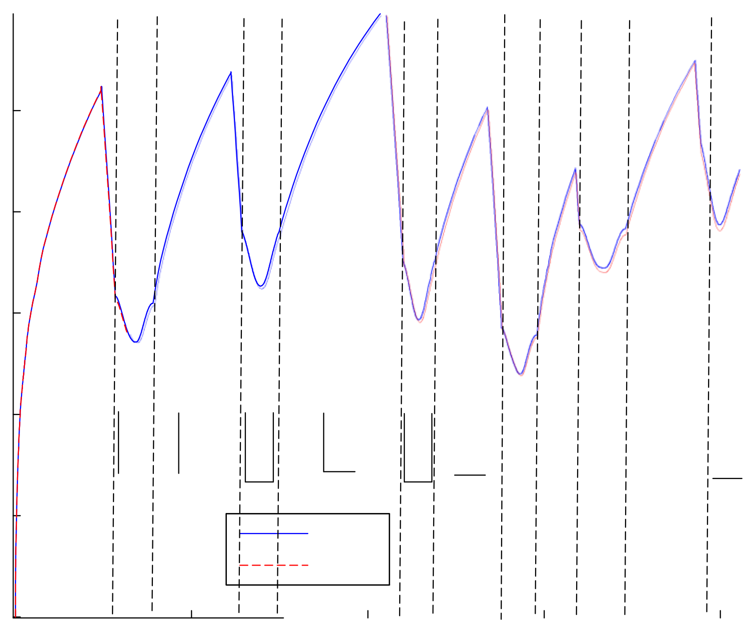

Figure 2: Drag coefficient vs. angle of attack

Table 2: Drag Coefficient for various angles of attack

α °	CL
0	-0.00020 ± 0.0010
10	0.00708 ± 0.0010
15	0.01180 ± 0.0010
20	0.03023 ± 0.0010
25	0.03023 ± 0.0010
30	0.03418 ± 0.0010
35	0.03637 ± 0.0010
40	0.03418 ± 0.0010

It is apparent from the outcome report above that the calculated data does not concur with the prediction of the computational model. This dissimilarity can be credited to a variety of factor. One is wind tunnel test flow, in wind tunnel there is streamlined flow but in actual practice there is turbulent flow. The second situation of information analyzed is that comparative to the drag coefficient (αD) versus diverse angles of attack. Like the wing down force coefficient (αL), the drag coefficient is one more significant constraint for racing car engineers to conclude as a role of the wing angle of attack, as it permit them to conclude that how much additional acceleration/deceleration is desirable (via improved engine power or by operation close gear ratios in the show) to defeat a confident drag force, which is shaped as an critical by produce of setting the car wing to attain a given necessary down force for a challenging race.

Conclusion

After having all this data of study and experiments, I conclude on the point that we have to make the aerofoil wings for a racing car at the an angle of incidence 38^0 and the base of the aerofoil should be of the width range started from the 50 mm to 150 mm and the upper portion of aerofoil should in range of 170 mm to 250 mm, and is complete hollow from inside to get the maximum efficiency in order to get the maximum drag force and appropriate down force for the best performance on the racing track providing max torque and developing less frictional force, braking effects and tom win the race.

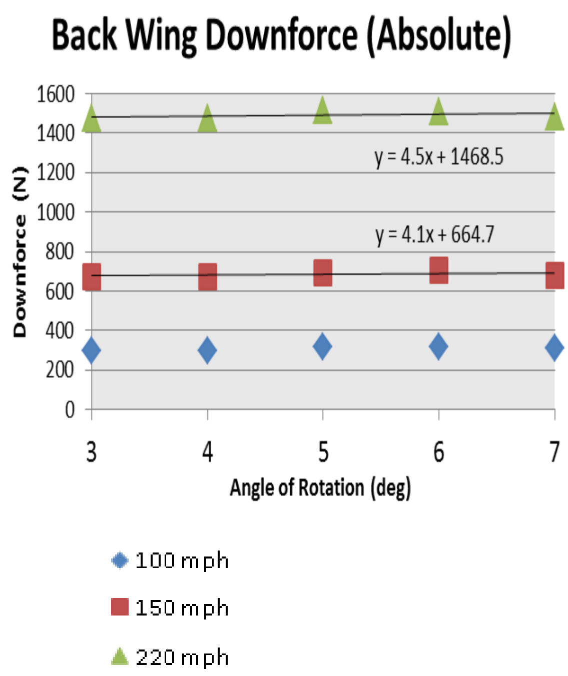

Figure 3(a)

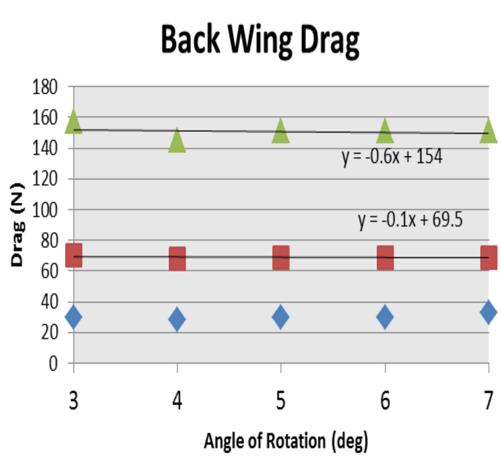

Figure 3(b)

Rear Wing simulation results. It is evident that the Rear Wing is insensitive to changes in its angular orientation both in terms of down force and drag.

We conclude from this data that efficiency increase by 15-16% with aerofoil design on 38 degree. This is satisfied with complete hollow wings structure.

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