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Formula Student Car: Design, Analysis and Lap Time Simulation

Authors : Rachit Ahuja, Ayush Chugh

Abstract : Aerodynamic forces and moments, as well as tire-road forces largely affects the maneuverability of the vehicle. Car manufacturers are largely fascinated and influenced by various aerodynamic improvements made in formula cars. There is constant effort of applying these aerodynamic improvements in road vehicles. In motor racing, the key differentiating factor in a high performance car is its ability to maintain highest possible acceleration in appropriate direction. One of the main areas of concern in motor racing is balance of aerodynamic forces and stream line the flow of air across the body of the vehicle. At present, formula racing cars are regulated by stringent FIA norms, there are constrains for dimensions of the vehicle, engine capacity etc. So one of the fields in which there is a large scope of improvement is aerodynamics of the vehicle. In this project work, an attempt has been made to design a formula- student (FS) car, improve its aerodynamic characteristics through steady state CFD simulations and simultaneously calculate its lap time. Initially, a CAD model of a formula student car is made using SOLIDWORKS as per the given dimensions and a steady-state external air-flow simulation is performed on the baseline model of the formula student car without any add on device to evaluate and analyze the air-flow pattern around the car and aerodynamic forces using FLUENT Solver. A detailed survey on different add-on devices used in racing application like: - front wing, diffuser, shark pin, T- wing etc. is made and geometric model of these add-on devices are created. These add-on devices are assembled with the baseline model. Steady state CFD simulations are done on the modified car to evaluate the aerodynamic effects of these add-on devices on the car. Later comparison of lap time simulation of the formula student car with and without the add-on devices is done with the help of MATLAB. Aerodynamic performances like: - lift, drag and their coefficients are evaluated for different configuration and design of the add-on devices at different speed of the vehicle. From parametric CFD simulations on formula student 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 of these add-on devices is obtained from these CFD simulations and also use of these add-on devices have shown an improvement in performance of the car which can be compared by various lap time simulations of the car.

Keywords : aerodynamic performance, front wing, laptime simulation, t-wing
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