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THE AERODYNAMIC EFFECT OF WHEEL FAIRINGS APPLIED TO A GENERIC FORMULA ONE CAR

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Abstract

A reason for the lack of overtaking in Formula One racing is often attributed to the loss of downforce for a trailing car. This is due to the car operating in a highly turbulent wake aft of a car ahead of it. A loss of downforce results in a trailing car losing control margins in corners, thus failing to overtake. Early concept images for the 2022 technical regulations suggested the use of wheel coverings or fairings over the rear wheels of the cars, in an attempt to reduce the impact downstream of a car's highly turbulent wake.

In order to ascertain the aerodynamic impact of such fairings, numerical models were employed to examine the wake structure of the car. This involved numerical wake surveys of the three-dimensional velocity components in various planes downstream of a car. A car model with no wheel fairings was tested in order to develop a baseline to which comparisons could be made. Two fairing configurations were then tested, namely a partial and full fairing. Both fairings covered part of the rear wheel tread. The partial fairing differed from the full fairing by the absence of a covering over the sidewalls of the wheels. Simulations that measured the change in drag and lift coefficient of a trailing car operating in the wake further highlighted the aerodynamic impact of the fairings. 1/6 scale wind tunnel wake surveys were conducted using a traverse system and five-hole probe to measure the three-dimensional velocity components at various planar probing locations. The data from the wind tunnel wake surveys was then compared to scale numerical models in order to provide validation to the numerical model setup. The numerical model setup was further verified by means of evaluating domain size sensitivity and mesh independence.

By analysing two-dimensional velocity contours and streamtraces, it was seen that the addition of both partial and full wheel fairings altered the wake structure. The addition of wheel fairings increase the size of low axial speed vortex cores with increased circulation to the sides of the wheels. The upwash flux towards the midplane of the car also increased due to the addition of fairings. Both these changes in wake structure would have adverse affects on downforce production for a trailing car by reducing the magnitude of the oncoming flow and decreasing the effective angle of attack of the front and rear wings. The trailing car

simulations highlighted an increase in drag coefficient and decrease in lift coefficient due to the addition of both fairing configurations.

Thus, both rear wheel fairing configurations were concluded to be ineffective in increasing the overtaking opportunities in Formula One racing. This was due to the effect of inhibiting a trailing car to follow a leading car closely because of the increase in drag and understeering in to corners due to the decrease in downforce. The traditional open-wheel configuration is thus the recommended rear wheel configuration for future car regulations.