Proceedings of the 8th World Congress on Momentum, Heat and Mass Transfer (MHMT'23)
Lisbon, Portugal – March 26 – 28, 2023
Paper No. ENFHT 180
DOI: 10.11159/enfht23.180

Various Motorcycle Configurations And Their Influence On Aerodynamic Performance – A CFD Analysis

Krzysztof Retych[1], Krzysztof Balcerzak[1], Bartosz Potęga[1], Michał Remer [1],
[1]Warsaw University of Technology, Institute of Aeronautical and Applied Mechanics
Nowowiejska 24, 00-665 Warszawa, Poland
krzysztof.retych.stud@pw.edu.pl

Extended Abstract

In recent years, racing teams participating in series such as Moto GP, Moto 2, and Moto 3 are increasingly emphasising developing their motorcycles' aerodynamics. Every season brings new, advanced aerodynamic devices. Winglets were one of these vehicles' first new and clearly visible elements. Their objective is to provide additional downforce at the front, which should increase front wheel traction while accelerating and effectively prevent wheelies. However, they also contribute to a more significant overall drag force acting on the motorbike and, in turn, decrease top speed. Brake covers have started to appear in Moto GP motorbikes in recent seasons, although, to the authors' knowledge, no publications regarding brake covers exist as of January 2023. In addition to the aforementioned devices, the external conditions in which the motorbike moves have a major impact on its performance. It is well known that moving in the aerodynamic shadow of another vehicle during a race may significantly impact the results [1].

This paper presents research on the use of winglets [2] and wheel covers in the Perun electric motorcycle, developed and built by the Students Association for Vehicle Aerodynamics (of which the authors are members) for the Moto Student competition. Winglet configuration and geometry are based on existing racing motorbikes and competition regulations. Several brake covers geometries differing in size and angle concerning the wheel were tested. The influence of covers on the aerodynamics of a rotating wheel was studied to help understand why to introduce them and whether they can increase Perun's performance. Only the front wheel and suspension were modelled for initial brake covers analyses.

Computational fluid dynamics simulations of airflow around a Perun 3D CAD model (including the rider) moving straight and cornering were conducted. Moreover, additional test case with two motorbikes models with a rider, one after the other, was analysed. The distance between the vehicles was changed to study the effects on the aerodynamic wake and race performance. Ansys Fluent software and the k-ω SST turbulence model were used in all simulations.

Results show that adding front winglets increases downforce and drag force by around 40% and 3,4%, respectively, while moving straight. As intended, differences in high-speed cornering with a 36˚ bank angle were significantly smaller – downforce decreased by less than 0,5% and drag force increased by about 1,3%. Different rider positions and bank angles should be considered in further analyses.

It has been observed that brake covers can reduce the aerodynamic wake of the front wheel and, consequently, the shadow of the entire motorcycle. However, their impact on the drag force generated by the moving wheel is negligible. Further analysis has shown that these devices can guide the airflow attached to the lower part of the fairing. Such flow management may generate downforce and feed wing-like aerodynamic devices in front of the rear wheel recently introduced in MotoGP.

Conducted analyses also present clear benefits of moving in the aerodynamic shadow – up to 25% reduction in drag coefficient depending on the distance from the preceding vehicle. Further research should compare the obtained results with experimental studies.

References

[1] Wiński, K.; Piechna, A. "Comprehensive CFD Aerodynamic Simulation of a Sport Motorcycle", Energies, vol 15, 5920, 2022.

[2] K. Cameron. (2021, Jan 01). *What Do MotoGP Winglets Do?* [Online]. https://www.cycleworld.com/story/motorcycleracing/what-do-motogp-winglets-do/.07.05.2020