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Cross Wind Analysis of Bike by Using CFD

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Abstract : Motorcycles have a relatively small frontal area in comparison to other motor vehicles however they are still considered to be very poor aerodynamically. Air resistance plays important role in a bike and its performance can change according to its different shapes. Bike aerodynamic drag has been extensively studied with the primary purpose of reducing drag and improving performance. Aerodynamic play a key role in bike design for stability when it is in motion. Lack of research in Motorcycle aerodynamics presents the potential for significant improvements. This research analysed the aerodynamics of Motorcycle under crosswind conditions using wind-tunnel experiments and Computational Fluid Dynamics (CFD) simulations. This project discusses not only the aerodynamic performance of a motorcycle but also how a motorcyclist and their positioning effects it. This project uses to investigate and establish the optimal position of a motorcycle.

Keywords: Crosswind, Aerodynamic, Computational Fluid Dynamics (CFD), Wind Tunnel.

1. INTRODUCTION

Crosswind effect can reduce motorcycle safety when driving on a wind-exposed locations like mountain peaks and ridgetops, bridges. As the number of long-span bridges increases throughout the world, the amount of accidents increases. This side force affects the original aerodynamic of a bike. To reduce these accidents we have to reduce yaw sensitivity and side force which is acting on a bike. Therefore have to some changes in the design of the bike like the installation of a windshield etc. this protecting motorcycle from a high windy area. Side force influences the behavior of motorcycles in windy conditions. It increases approximately linearly with yaw angle over a significant range of yaw for almost all motorcycles and the side force derivative, the gradient of side force coefficient with yaw angle, is similar for the motorcycle of a given category and size. Here we study the effect of crosswind on the lateral dynamics and control of the motorcycle by means of analysis and simulation on a computational model.



FIG.1 Crosswind Effect on Bike

2. FORCES ACTING ON BIKE

2.1 DRAG FORCE

Drag is the aerodynamic force that opposes on a motorcycles motion through the air. There are two types of drag that act against a motorcycle and motorcyclist; pressure drag and skin friction drag. These two types of drag accumulate to give the total drag.

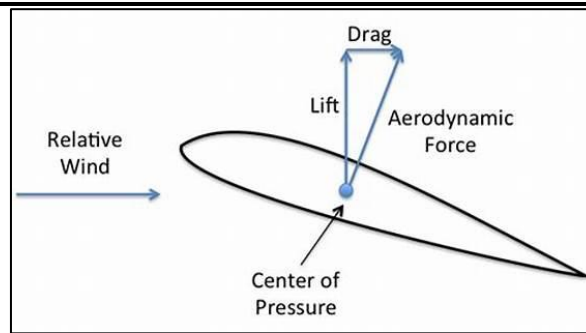


Fig.2 Aerodynamic Forces

2.2 LIFT FORCE

A fluid flowing around an object exerts a force on it. Lift is the component of this force that is perpendicular to the oncoming flow direction. It contrasts with the drag force, which is the component of the force parallel to the flow direction. Lift conventionally acts in an upward direction in order to counter the force of gravity, but it can act in any direction at right angles to the flow.

2.3 WIND VECTOR

Wind vector represent movement of mass of air on the motorbike. When air flows near ground, the speed of that wind and direction of vector is opposite of direction of air.

3. LITERATURE REVIEW

The field of Computational Sciences has significantly advanced over the past few decades. It includes a wide array of areas such as Computational Fluid Dynamics and Computer Aided Engineering. It is used in many fields such as evaluating air flows, fluid flows, predicting crash simulations, fatigue analyses, and explicit dynamics. This thesis deals with the application of Computational Fluid Dynamics techniques to obtain a real-world engineering solution for motorcycling applications. Fluid Dynamics is the science of fluid flows and their various properties. The cornerstone of computational fluid dynamics is the fundamental governing equations of fluid dynamics—the continuity, momentum, and energy equations. In simpler terms, these refer to the conservation of mass, conservation of momentum and conservation of energy. The entirety of CFD is based on these fundamental equations.

The study aims to shed light on the three fundamentals of CFD and their impact on the various approaches used over the course of the thesis experimentation. The initial section illustrates the modelling aspects of the Motorcycle body and the aerodynamic structures using CAD techniques. The CFD section includes the modelling of the test environment, meshing the domains and setting up the simulations. A separate section is dedicated to analyzing the results of the post-processing tools. The conclusions are drawn eventually from all the studies performed and results are obtained.

4. CONCLUSIONS

- Crosswind in bike driving has a considerable effect on the stability and control of the Motorcycle. Our Model simulations show that the tendency of an uncontrolled bike under the influence of crosswind is to steer into the wind. In addition, crosswind can decrease the stable forward speed range of an uncontrolled bike, and with increasing wind speed can even make an initially stable uncontrolled motorbike, unstable for all forward speeds.
- Performance of motorbike improved by the reduces side force resistance act on aerodynamic of bike or change in some design of bike. Reducing crosswind effect improves the stability of motorbike.
- Contextual conclusions for the modifications compared to non-wing models were:
 - The 0-degree model showed a small improvement in downforce & drag.
 - The 45-degree model showed massive improvements in downforce.
 - The 90-degree model showed tremendous improvements in drag (braking) force.

5. FUTURE SCOPE AND RECOMMENDATIONS

These are a few recommendations from the author for the future research on this topic.

- A study on the effects of the airfoils over the full range of attack angles.
- A study on the effects of the airfoil interference during cornering.
- A study on the effects of crashing with deployed airfoils requiring Non-Linear Explicit Dynamics simulations.
- A study on the behavior of tires and tire loads under aerodynamic forces being produced by the airfoils at various attack angles.

6. ACKNOWLEDGEMENT

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