Study the Change of Aerodynamic and Comfort Parameters Due to Change in Windshield Angle on the Rider for Constant Height

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***Abstract*- The windshield is the important part of front fairing of motorcycle. The windshield design change as the motorcycle design change. It has a great impact on all over performance of motorcycle. It affects handling, comfort, aerodynamic character, comfort of rider and top of all appearance. In this present research paper the effect of change in angle of windshields is calculated in the term of obtain variation in pressure and direct velocity on rider and coefficient of drag is also calculated for motorcycle rider system by CFD.**

***Index Terms*- Motorcycle rider system (MRS), Windshield, CFD, Dynamic pressure, Coefficient of lift, Coefficient of drag.**

I .INTRODUCTION

The motorcycles for city use are common across the world. Two wheels vehicles mainly motorcycles are in large population because of affordability, efficiency and economic purposes. There are an estimated 154.3 million Two-Wheelers registered in across the world according to the statistics of international organisation of motor vehicle manufacturers 2016. The windshields are thin acrylic plastic made sheet, which is the part of the front fairing of motorcycle. Windshield is used for good appearance with reduction in aerodynamic drag and give comfort to the rider by prevent from direct air hitting to the rider. CFD numerical simulation method is a method of calculating the discrete numerical solution for the flow field around the object. The development of CFD methods and simulation enables the cheap accurate and fast development of vehicle for any environment conditions. Due to the less availability, the power consumption comfortable in laminar flow results and inefficient in dynamic calculation the wind tunnel experiment has been loss its attention towards researches(Angeletti, Sclafani, Bella, & Ubertini, 2003). The main objective of this paper to evaluate the change in pressure, velocity, coefficient of drag and lift as per changing in angle of windshield with respect to horizontal for a constant rider. Relative pressure and direct velocity has impact on rider's comfort and coefficient of drag is relates with aerodynamic nature.

II. MATERIALS AND METHODS

A. Introduction to CFD

Computational fluid dynamics or CFD is the branch of fluid mechanics, which uses numerical methods to analyze and solve the problem which involves fluid flow. Using the CFD (computational fluid dynamics) modelling, instead of wind tunnel have many advantages like, it saves our time and provides the same results at lesser expense. Wind tunnel needs much space to perform the experiments but same results can be obtained by using CFD, which does require only a computer. All CFD problems are generally based upon the Navier-Stokes equations. The general form the equation is –

$$\underbrace{\rho\left(\frac{\partial u}{\partial t}+\boldsymbol{u}.\nabla\boldsymbol{u}\right)}_{1}=\underbrace{-\nabla p}_{2}+\underbrace{\nabla.\left(\mu(\nabla\boldsymbol{u}+(\nabla\boldsymbol{u})^{T})\right)}_{3}-\underbrace{\tfrac{2}{3}\mu(\nabla.\boldsymbol{u})\mathbf{I}}_{4}+\underbrace{\mathbf{F}}_{5}$$

(Source:- Tuncer Cebeci et al., 2005)

Where u is the fluid velocity, p is the fluid pressure, ρ is the fluid density, and μ is the fluid dynamic viscosity. The different terms correspond to the inertial forces (1), pressure forces (2), viscous forces (3), and the external forces applied to the fluid (4).

B. Analysis method

The analysis of motorcycle rider system is in following steps

1. 3 Dimensional modeling and Change in windshield angle- The current work was carried out on a 3- dimensional model of motorcycle front with rider named as motorcycle rider system (see Figure 1). The modeling of motorcycle rider system as per the general motorcycle is available in Indian market. The coordinate system is XYZ, where Z in the direction of travel, Y is in the vertical direction and X is in the lateral direction. The velocity of 22.22 m/s is applied in the negative Z direction, which acts relative velocity between road and motorcycle. The length is 29 inches, height is 38 inches and width of the two wheeler front with rider is 12inches. The windshield starting angle is 0^o and ending angle has been varying from 30^o to 70^o with respect to horizontal plane.

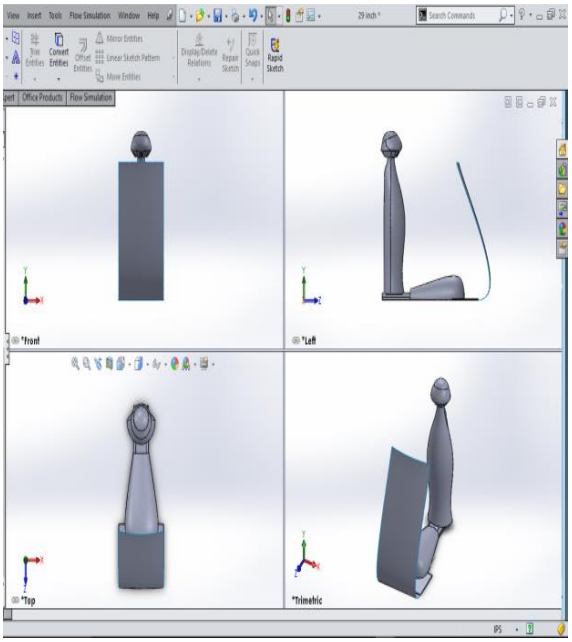

Figure 1- 3-Dimentional model of motorcycle rider system

C. Virtual Computational wind tunnel- For calculation purpose the large size computational wind tunnel is formed as per following dimension.

Table 1. Dimension of computational wind tunnel

Enclosure width	20 m
Enclosure height	10.1 m
Enclosure length	40 m
Distance between MRS and inlet	20 m
Distance between MRS and outlet	20 m
Distance between MRS and road	0.1 m
Distance between MRS and top wall	10 m
Distance between MRS and side wall	10 m

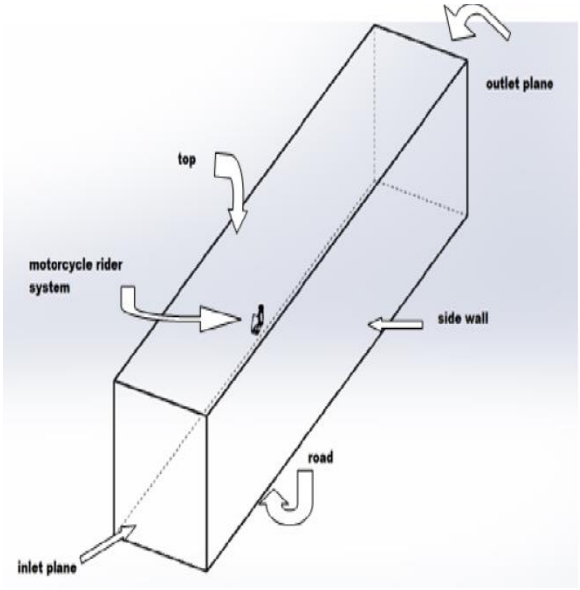

Figure 2 -Motorcycle Rider System in virtual wind tunnel

D. Calculate the parameters- In this step the 3 dimensional models has been analysis for laminar constant air flow using analysis software. The calculation is based upon pressure-velocity coupling method is used to evaluate the relative pressure, direct velocity and coefficient of drag and lift.. The inlet velocity of air at inlet is 22.22 m/s and the air density is taken $1.44 kg/m^3$.

E. Compare the results- The results are in the form of graph and images. For each change in windshield angle the relative pressure, direct velocity, coefficient of drag and lift has been calculated (Table 2).

III. RESULTS AND DISCUSSION

Table -2

sr. no	Ea	C_d	P_r	V_r
1	70	0.873	-134	9.38
2	60	0.884	-91	5.22
3	50	0.832	-131	5.24
4	40	0.809	-148	15.3
5	30	0.755	-176	12.55

As the table to shows that at angle 50 to 60 degree from vertical line the direct velocity is less on the rider. The angle below or above this range the direct velocity amount increases but coefficient of drag decreases so, while designing the motorcycle windshield the optimum values of these two parameter should be evaluated so that the performance of motorcycle can increase in the term of aerodynamic and comfort. The negative value of pressure reduction shows relative dynamic pressure with respect to reference value one atmosphere.

IV. CONCLUSION

Computational fluid dynamics software's are efficient, economic and better way to analyses the flow field around the motorcycle and motorcycle rider. The windshield design needs more attention so the overall performance of motorcycle can be increases by maintaining bond between riders.

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