Ergonomic Design of an Uberhood

Thrinesh Duvvuru, Chenna Kesava Venkata Sai Krishna Lalam

***Abstract**: This paper provides an in-detail description of the design considerations, ansys analysis and theoretical data involved in the design of an ERGONOMIC UBERHOOD. The main objective of this paper is to design uberhoods with different shapes and obtain an efficient uberhood from the tested designs. In the wake of many two-wheeler accidents happening in rainy season due to the visibility factor, a hood can be placed to improve the visibility factor for the driver. Especially in two wheelers, there is lot of scope in the design in aerodynamics. The rider provides considerable unattended drag by acting as a bluff body, which can be reduced by stream lining the flow of air. Air should be provided with a hood so that it will get stream lined without reaching bluf body. Preliminary basic shapes like parabola and ellipse are chosen for designing the hood for BAJAJ AVENGER 220. SOLIDWORKS is used for modeling the hood. Based on the model, theoretical drag forces were calculated for the corresponding Reynold's number. ANSYS Fluent is used to obtain pressure contours, velocity contours, drag forces and lift forces. Theoretical drag force and the simulated drag forces are compared. The results obtained from Fluent are compared with the unhooded vehicle. There is an overall reduction in drag force for hooded vehicle when compared to the unhooded vehicle.*

Keywords: Ergonomic Uberhood, Bajaj Avenger 220. Solidworks, Ansys Fluent is used to obtain pressure contours, velocity contours, drag forces and lift forces.

I. INTRODUCTION

A. Brief Introduction on Problem:

The increase in India population from 30 crores to 130 crores since 1940s resulted in extensive fossil fuels consumption and serious environmental issues. Safety and fuel efficiency are the prime factors in the minds of Indian customer's in automobile industry. In the last three decades, with the growing concern on environmental impact and with the market demand for safety and lower fuel consumption, Owing to continuous endeavors have been made to improve efficiency in energy utilization, with almost optimized designs of other parts through aerodynamic development, performance enhancement with reducing drag forces are coming to limelight. aerodynamic development has become a standard part of the automobile design area and it is easy to foresee that this is going to happen very fast in the field of motorcycles also.

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Safety and fuel efficiency are the prime factors in the minds of Indian customer's in automobile industry. In the last three decades, with the growing concern on environmental impact and with the market demand for safety and lower fuel consumption, aerodynamic development has become a standard part of the automobile design sector. Scope for improving the fuel economy lies in reducing drag force on the motorcycle with the rider. Therefore, an attempt is made to improve both safety and fuel economy by designing an aerodynamically feasible uberhood. In this paper, uberhood is designed for the **Bajaj Avenger 220** and is exposed to flow condition in the simulation software to check the validity of the uberhood and its usefulness in reducing the drag and providing the safety.

B. Objective:

- To give a basic shape to the uberhood on the bike from where onwards shape optimization can be done.
- Compare the theoretically calculated drag force values with the ones obtained from simulation.
- Compare the drag values for the various shapes with unhooded motorcycle.

II. EXISTING SOLUTIONS TO THE PROBLEM

Many attempts were done to meet this problem partially without knowing that they are attempting this problem. Their attempts are based on the problem in hand like to find shade in summer as shown in figure 2.1&2.1. But, these types of jugaad without any scientific backup can lead to disasters, like if the relative velocity is high, then there will be sufficient lift produced which can sway the motorcycle resulting in losing the balance of motorcycle and causing accidents. In some two-wheeler models, hood is used to improve aesthetic look. But in some places jugaad has been made to improve the designs according to the problems/necessities in that places. These designs mainly focus on the problem in hand and have many shortcomings.

Fig 2.1. Modified Umbrella

Fig 2.2. Juggad Model

III. PROPOSED DESIGN SOLUTIONS

A. Detailed Design and Methodology

- Collecting the dimensions of motorcycle and the average rider dimensions. Using this, a 2-D model of the motorcycle with rider on it is modeled in Solidworks.
- Based on the above model, Confining space for uberhood can be determined.
- Designing the 2D models for various shapes in the confining space. For this, first we need to calculate the coordinates of the shapes. Using these coordinates, with the help of spline, different shapes can be modeled.
- Drag force will be calculated to every model modeled so far. These values are compared with the unhooded motorcycle model. Drag force with hood should be less than unhooded model.
- Convert the models into STEP or IGES format and then import them to ANSYS Fluent. In this Fluent, change the geometry by creating an enclosure around the body(bike). Mesh the 2-d model with proper orthogonality order and aspect ratio.
- Use the Fluent to set up the conditions of the flow, boundary and initial conditions, viscous laminar, k-epsilon equation, relative velocity of air 50 kmph, gauge pressure at inlet and outlet. Run initialization and then solve the problem.
- Obtain the various results and compare them.

Theoretical drag force values:

Table 3.2.1

HOOD MODEL	DRAG FORCE(N)
NO HOOD	1049.49
SIMPLE	423.954
ELLIPTICAL	441.428
PARABOLIC	400.868

Drag equation: F_D=1/2 ρ2 C_D A

F_D is the drag force

ρ is the density of the fluid

C_D is the drag coefficient

A is the reference area

IV. DESIGN CONSTRAINTS AND STANDARDS USED DESIGN CONSTRAINTS

- Comfort ability of the driver and pillion driver may be compromised to an extent over safety.
- Former compact shape may be missing.
- Cognitive of advanced material properties.
- Additional accessories are necessary for the success of this model.
- Space for designing the uberhood is limited to a .864*.676 (m*m) rectangle based on the height of the human and the distance from human to headlight.
- Slope of the curve at the top of the uberhood should lie between -50 and 0 degrees. The region between -50 and -90 degrees will make the flow rise resulting in increase of drag.
- Slope of the curve at the bottom of uberhood should be equal to or greater than 119.32degrees because of the continuity required for the flow to make it stream line.

Standards Used:

Table 4.2.1 Standards Used

S. No	Bajaj Avenger 220 Street Bs4 Bike	Details
1	Overall length Overall width Overall height Ground clearance Wheel base Seat height	2.177m 0.801m 1.070m 0.169m 1.490m 0.725m
2	FRONT TYRE	90/90-17’’49P
3	BACKTYRE	130/90-15’’66P
4	RIDER	Height -1.829m Inseam-0.8128m

V. ANALYSYS AND SIMULATIONS

Flow Analysis without Hood:

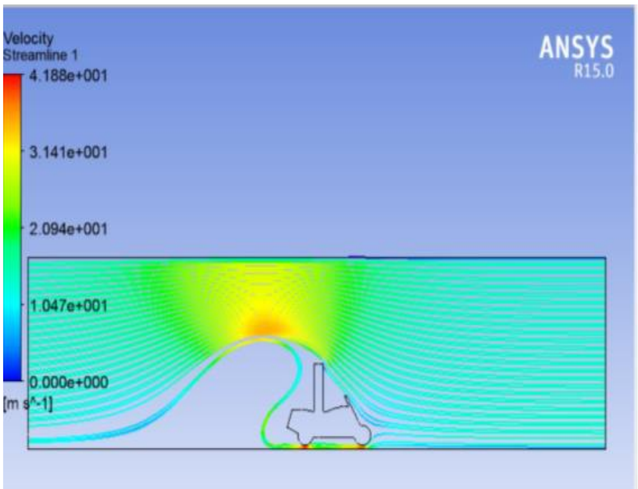

Fig 5.1.1 Velocity Streamline Plot

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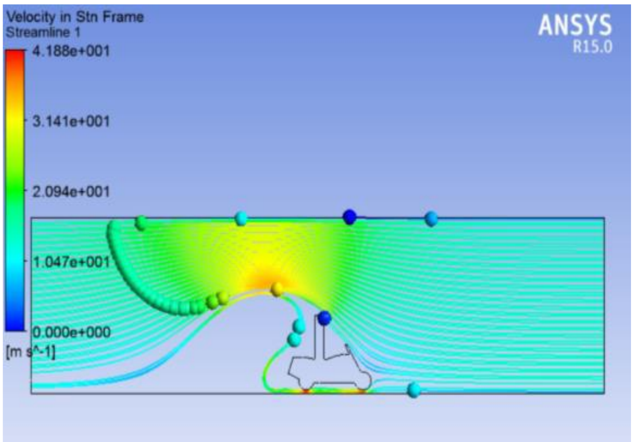

Fig 5.1.2. Particle Flow Path

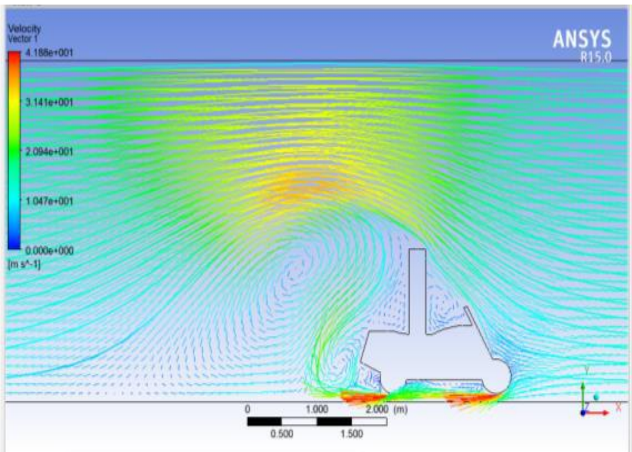

Fig 5.1.3. Velocity Vector Streamlines

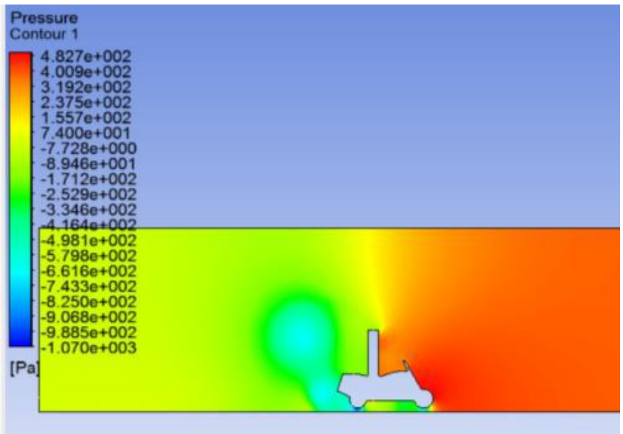

Fig 5.1.4. Pressure Contour

- From this flow analysis, the DRAG force on bike is found to be 1194.0708N and a LIFT force of 1058.6942N

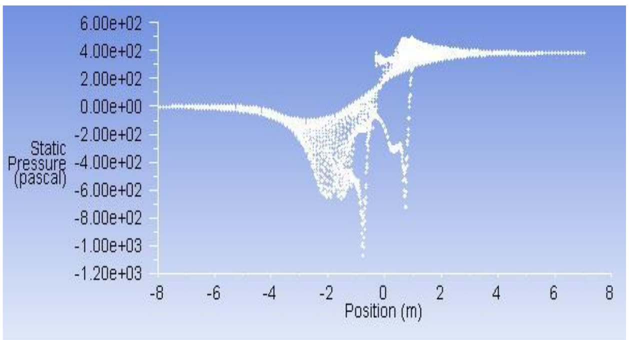

Fig 5.1.5.A Plot Between Position and Static Pressure

Flow Analysis with Hood of Simple Form:

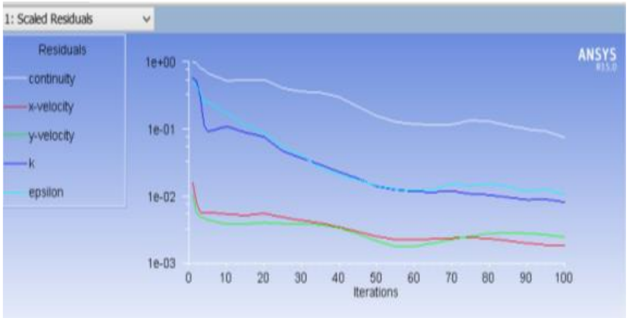

Fig 5.2.1. Scaled Residuals

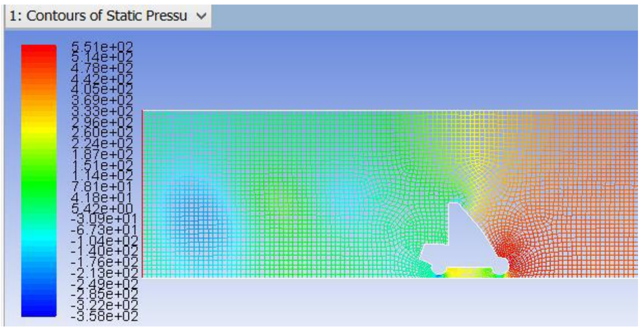

Fig 5.2.2. Contours of Static Pressure

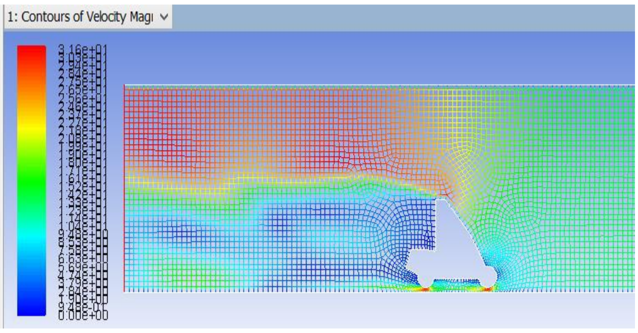

Fig5.2.3. Contours of Velocity

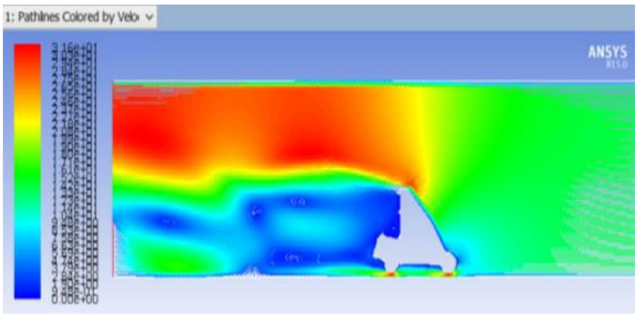

Fig 5.2.4. Velocity Path Lines

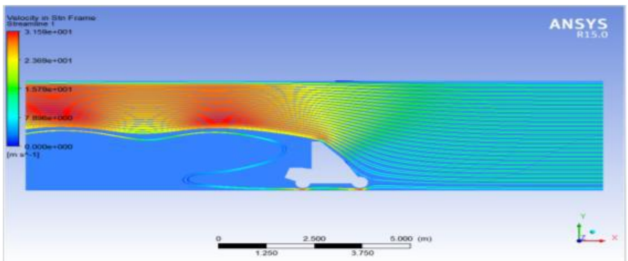

Fig5.2.5. Velocity Path Lines

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- From this flow analysis, the DRAG force on bike is found to be 451.90251N and a LIFT force of 0.64842697N

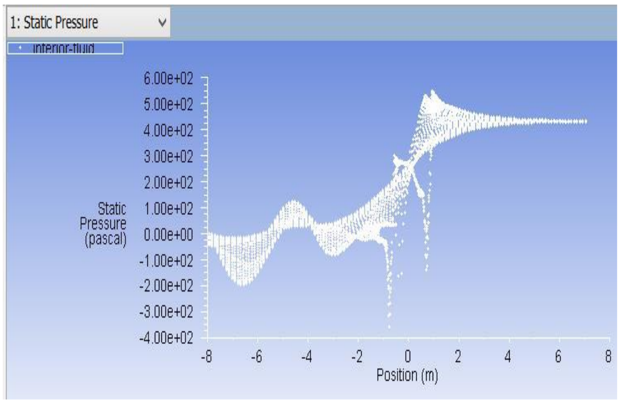

Fig 5.2.6. A Plot Between Position and Static Pressure

5.3. Flow Analysis with Hood of Elliptical Form:

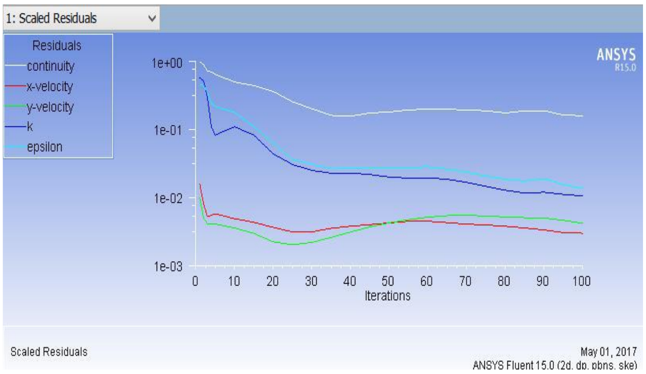

Fig5.3.1Scaled Residuals

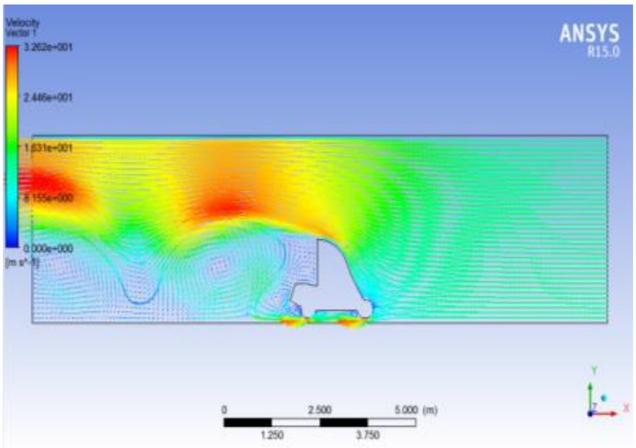

Fig 5.3.2. Velocity Vectors

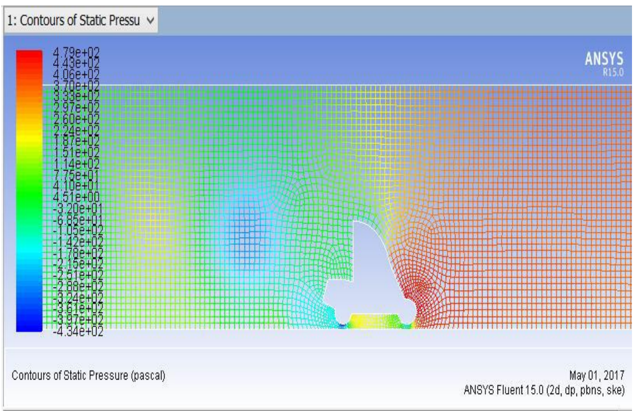

Fig5.3.3. Contours of Static Pressure

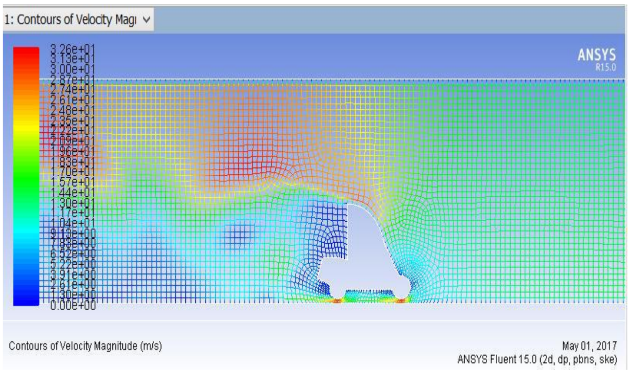

Fig5.3.4. Contours of Velocity

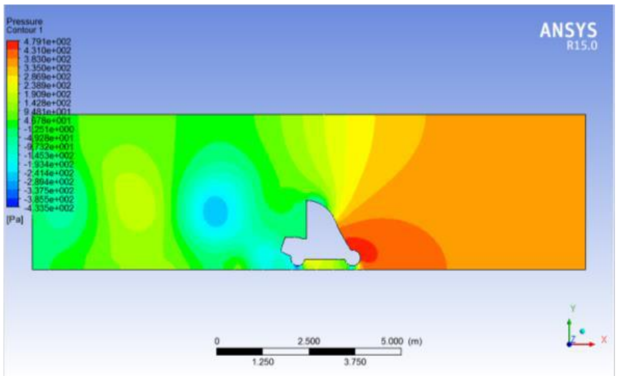

Fig 5.3.5. Contours of Pressure

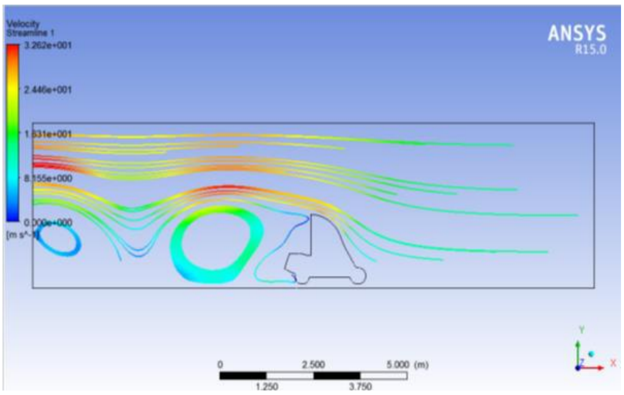

Fig5.3.6. Streamline Velocity Path

- From this flow analysis, the DRAG force on bike is found to be 510.90532N and a LIFT force of 147.252N Flow analysis with hood of parabolic form:

5.4. Flow Analysis with Hood of Parabolic Form:

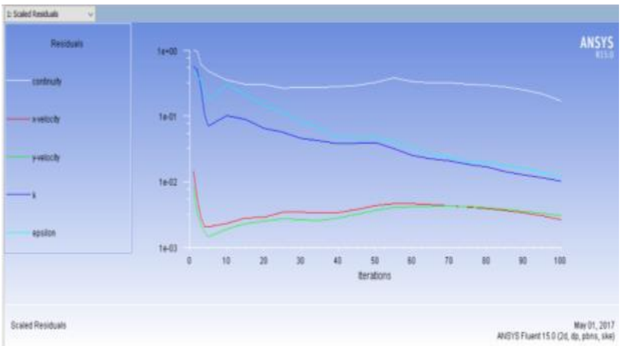

Fig 5.4.1.Scaled Residuals

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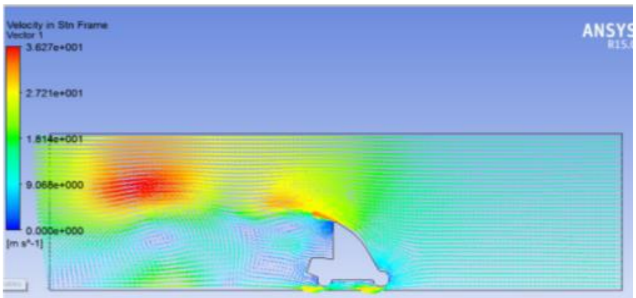

Fig 5.4.2. Velocity Vectors

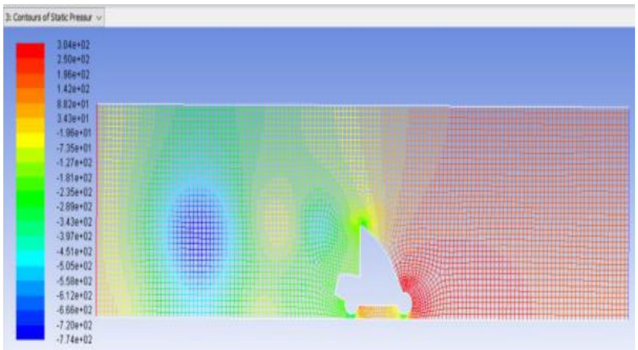

Fig 5.4.3Contours of Static Pressure

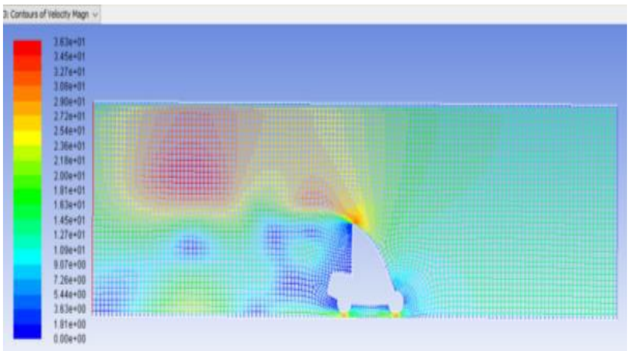

Fig 5.4.4. Contours of Velocity

- From this flow analysis the drag force on bike is found to be 405.53457N and a LIFT force of 169.63609N

Table 5.4.1. Drag Force and Lift Force Values

Hood Model	Drag Force (N)	Lift Force (N)
NO HOOD	1194.0708	1058.6942
SIMPLE	451.90251	0.64842697
ELLIPTICAL	510.90532	147.25355
PARABOLIC	405.53457	169.63609

- The flow simulation results show that the drag force on the bike drops from 1194.1N to 405.53.N.
- Approximately the drag force on the bike is reduced by three times.

VI. CONCLUSION

A significant handicap to uberhood design is the severe lack of data on the uberhood design process. The result of the current work is the first attempt in finding the aerodynamic shape of uberhood. The results show that parabolic shape is the best among the considered shapes with 66.08% to reduction in drag force on the motorcycle and can be further used in optimising the shape of uberhood. Further the lift force, produced in the models are negative which suggests that the motorcycle will be much safer when riding at high speeds by not losing contact with the road. Though uberhood looks better and ready to be equipped in the motorcycle, the better part of the effects has to be weighed with negative parts like assembly to mount uberhood and their weight. This can be scope for another discussion.

IMPACTS:

Environmental	The reduction in drag force -> Increase in fuel efficiency -> Less fuel consumption-> less emissions->Pollution control
Social	Economical
Health	Protected from moist, moist, and heat waves.
Safety	Ride is made safer through better vision

APPENDICES

Detailed Drawings and models:

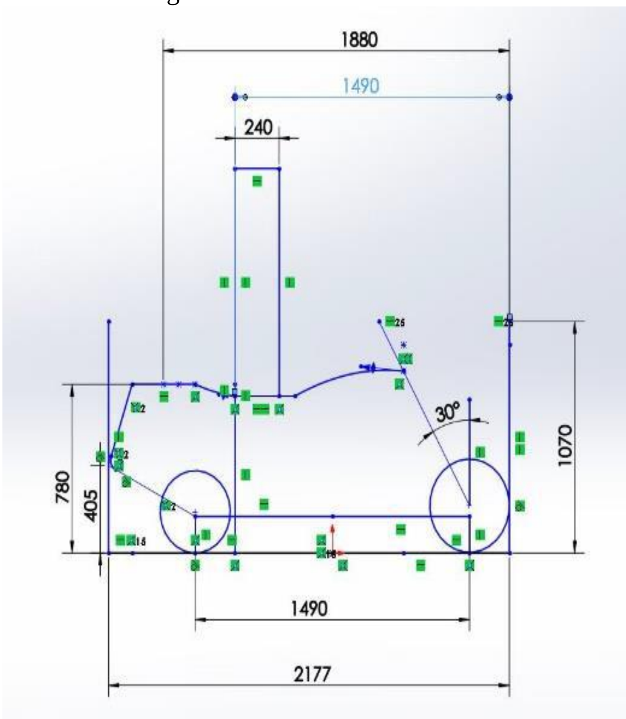

Fig8.1.1Dimensions of the Model in 2D

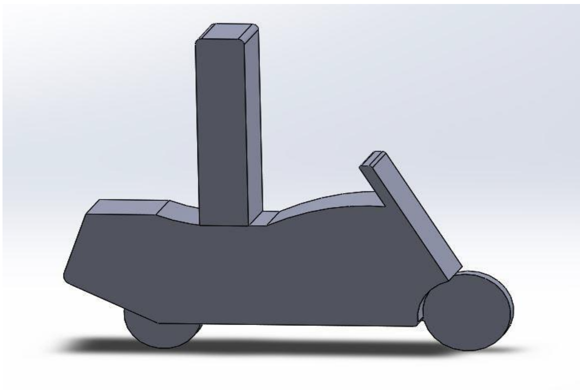

Fig 8.1.2 A 3D Model of the Posture

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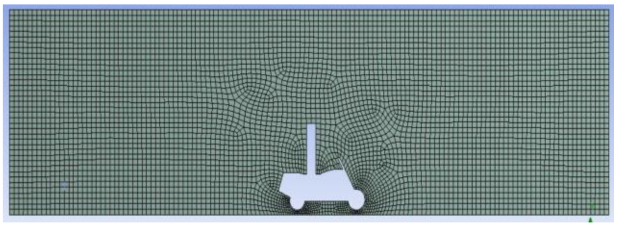

Fig 8.1.3 Mesh of the Motorbike without Hood

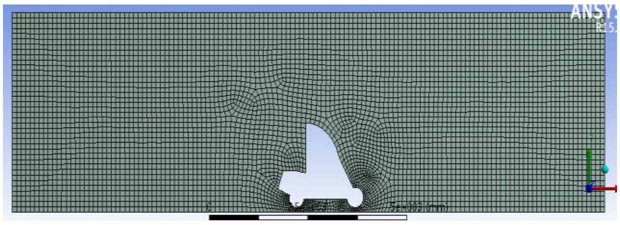

Fig 8.1.4 Mesh of the Motorbike with Elliptical Hood Model

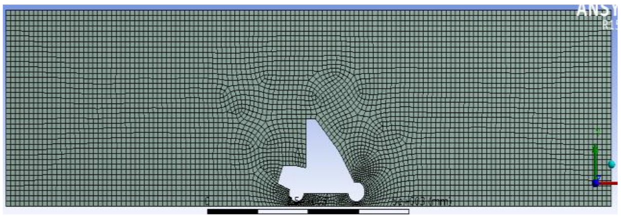

Fig 8.1.5 Mesh of the Motorbike with Simple Hood Model

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