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Testing and Analysis of Spherical and Aerodynamic Helmet in open Circuit Low Speed Wind Tunnel

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***Abstract*— The main aim of the helmet is to provide the safety and protection for riders from head injury. The shape, size and design play important role in aerodynamic drag. The drag force resistance the helmet against the neck portion and create unstable effect which cause neck pain. This paper discusses a testing and analysis of model of motorcycle helmets. Two types of helmets spherical and aerodynamic shape are used for analysis. These models of helmet were tested in a wind tunnel. The open circuit low speed wind tunnel was used to measure pressure at a range of wind speeds (5m/s, 7.5m/s and 10m/s) and different pitch angle (0°, 15° and 30°). The pressure was calculated. I am tried to adding some modification for batter performance of helmet. After the complete the experiment model works properly and I found all solution. The experiment is very helpful to improvement of helmet and aerodynamic work. It is definitely very useful for primary research.**

Key Words: ***Helmet, Aerodynamic, Spherical, Drag Force, Wind Tunnel.***

I. INTRODUCTION

Two wheeler or bike is the most common mode of transportation. The two wheeler accidents are increase for the last two decades. Motorcyclist is less protected against road accident that the users of some other vehicles. Helmet is used as the main head protection gear for a long time. Helmet is used for the rider to protect from varies head injuries during such accident. Motorcycle helmet is widely used between motorcyclists, being required in almost all countries due to motorcycle standards. For this the design of a good helmet should be necessary part. The shape of the helmet should be analyzed very properly various test like drag force. The drag resistance presses the helmet against the neck portion of rider which cause neck pain. An aerodynamic shape of helmet can be able to reduce the drag.

II. DESIGN OF HELMET

My research topic is design two types of helmets (Spherical and Aerodynamic) and testing in open circuit low speed wind tunnel. In the research my first work is design the helmets. I create a ratio of design helmets. The special part of my project is reducing drag.

There are two primary ways to reduce drag:

(A). Minimize drag coefficient and helmet's frontal area; and

(B). Streamline their shape.

(A). Minimize drag coefficient and Helmet Frontal Area

Drag coefficient is a measure of the shape of an object and how smoothly air flows around it. In order to reduce aerodynamic drag we have require to measure aerodynamic drag. To see why this is so, we can visit the formula for drag in which aerodynamic drag force (F_D) can be expressed:

$$F_D = \frac{1}{2}\rho C_D A.V^2 \quad (1)$$

F_D= drag force (N)

C_D= drag coefficient

ρ = air density

V= velocity

A= frontal area of the helmet

In this formula, there are only two factors that we can change: the drag coefficient and the frontal area. Air density is affected by air temperature, pressure and humidity—three factors outside of our control. Velocity is the ultimate goal of the cyclist [1].

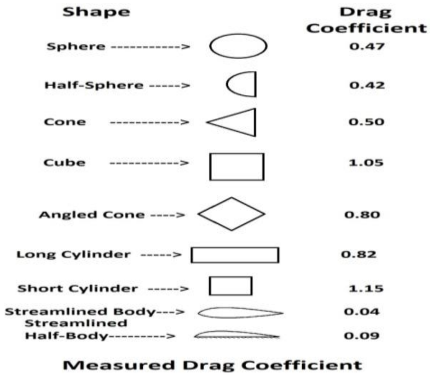

Figure 1. Measured Drag Coefficient

(B). Streamline their shape

We can reduce their drag coefficient by streamlining their shape. Non-streamlined objects leave large, low-pressure wakes behind them with a high coefficient of drag. Streamlined objects leave smaller wakes behind them and thus have lower drag coefficients and lower overall levels of drag. The following diagram shows how less streamlined objects leave larger, turbulent low-pressure wakes [2].

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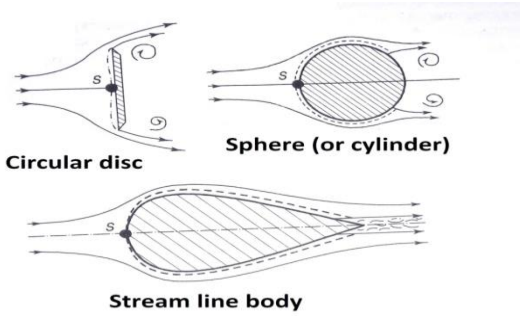


Figure 2. Wake-formation

III. TESTING OF HELMETS

In aerodynamic research a wind tunnel is used for study the effects of air moving past solid objects. The wind tunnel is very useful for automobiles. In the wind tunnel five important sections are include. First is honeycomb section for the proper distribution of air flow. It is inlet way of air. Second is construction chamber, third is testing chamber, fourth is diffuser section and last is Motor and fan for outlet of air.

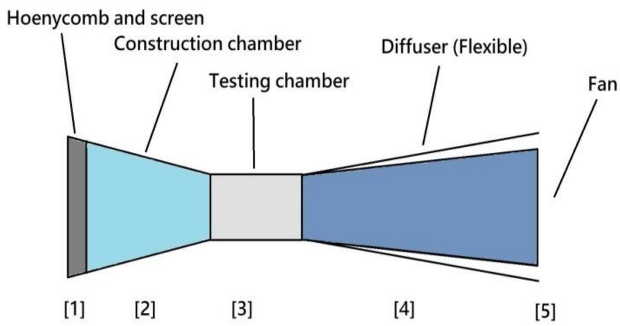


Figure 3. Wind Tunnel Diagram

The main work of the system is improves the design according to aerodynamic shape. The mean of aerodynamic research is reduced the drag force and lift forces for batter performance of the parts. Wind tunnel is used to resolve the design parameter. Testing chamber is very important area of wind tunnel. In this area we are testing the part of automobile or mechanical design. The shape is depending on the size of wind tunnel test chamber. If the testing chamber is short then we use prototype model and if the testing chamber is big then we use the scaling process [3].


Figure 4. Taking reading in Wind Tunnel


Figure 5. Honeycomb and Screens


Figure 6. Construction chamber


Figure 7. Diffuser

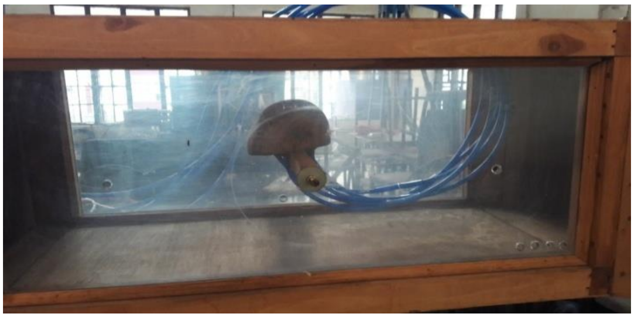


Figure 8. Spherical Helmet in Test Chamber

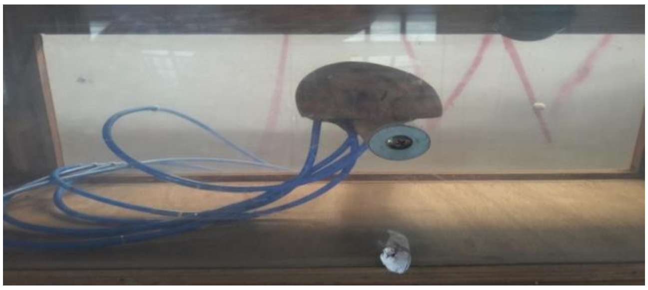


Figure 9. Aerodynamic Helmet in Test Chamber

Figure 10. Pressure point in Model

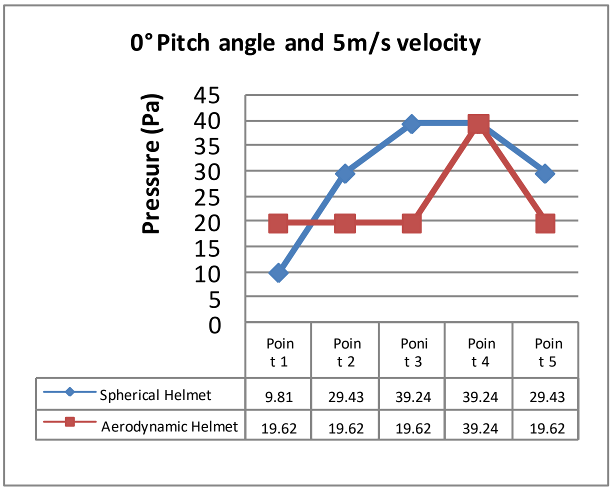
The pressure distributions around the test object have been measured by drilling some small holes along the airflow way and using multi-tube monometers to measure the pressure at each hole. Pressure distributions on a test model may also be determined by performing a wake survey in either a single Pitot tube is used to obtain multiple reading downstream of the test object. A multiple-tube monometer is mounted downstream and all its reading is taken.

IV. RESULT AND DISCUSSION

In the testing process we use two type helmet models. The object is made of timber. We set the object in different angle and noted the reading. This process is repeated many times according to research. After the testing object I have noted all readings carefully. Air velocity through the test section is determined by anemometer. Pressure readings on helmet test model determine by multi tube manometer and all its readings are taken. After completing the reading process we analysis the data and show the result according to research studies.

Case A -Pressure Analysis of Spherical Helmet and Aerodynamic Helmet at 0° Pitch Angle and 5 m/s velocity

Condition- Both Helmet sets at 0° pitch angle in the test section and fined the effect at 5m/s velocity.

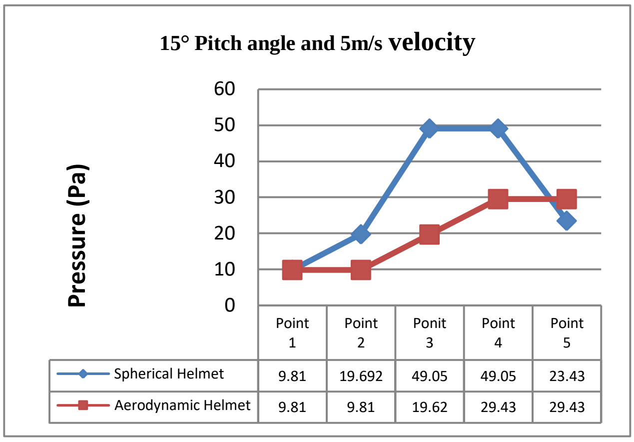


Graph1. At 0° Pitch angle and 5m/s velocity

The 0° pitch angle create pressure on helmets but pressure on helmet is different at different point and curve obtain is not smooth. At 5m/s spherical helmet pressure curve is smooth. In aerodynamic helmet pressure curve at point1, point2 and point3 not change.

Case B - Pressure Analysis of Spherical Helmet and Aerodynamic Helmet at 15° Pitch Angle and 5 m/s velocity

Condition- Both Helmet sets at 15° pitch angle in the test section and fined the effect at 5m/s velocity.

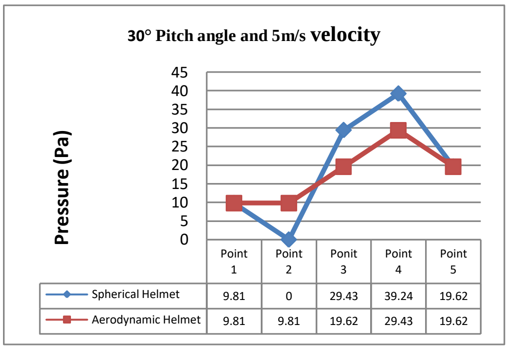


Graph2. At 15° Pitch angle and 5m/s velocity

The 15° pitch angle creates pressure on helmets but pressure on helmet is different at different point and curve obtain quite smooth. At 5m/s aerodynamic helmet pressure curve is smooth. Here aerodynamic helmet gives best result.

Case C - Pressure Analysis of Spherical Helmet and Aerodynamic Helmet at 30° Pitch Angle and 5 m/s velocity

Condition- Both Helmet sets at 30° pitch angle in the test section and fined the effect at 5m/s velocity.

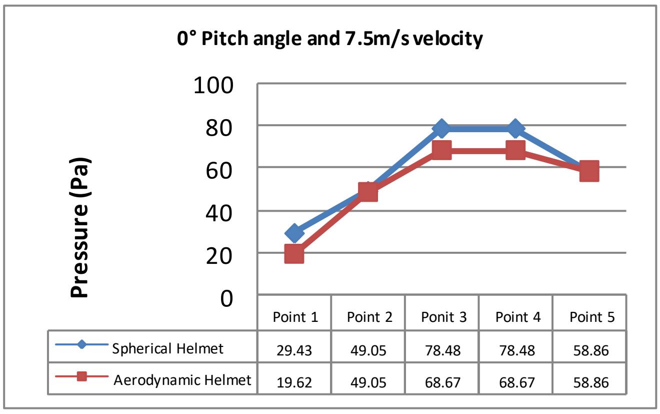


Graph3. At 30° Pitch angle and 5m/s velocity

The 30° pitch angle create pressure on helmets but pressure on helmet is different at different point and curve obtain is not smooth. At 5m/s spherical helmet pressure curve is not smooth and pressure curve at point2 change. In aerodynamic helmet pressure curve is smooth and gives good result.

Case D -Pressure Analysis of Spherical Helmet and Aerodynamic Helmet at 0° Pitch Angle and 7.5 m/s velocity

Condition- Both Helmet sets at 0° pitch angle in the test section and fined the effect at 5m/s velocity.



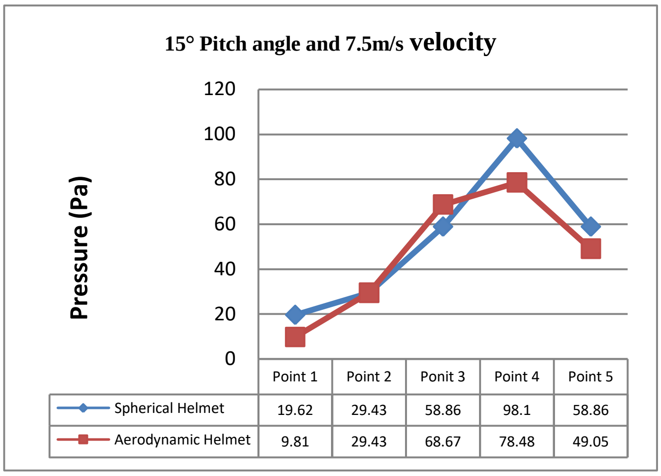
	Point 1	Point 2	Point 3	Point 4	Point 5
Spherical Helmet	29.43	49.05	78.48	78.48	58.86
Aerodynamic Helmet	19.62	49.05	68.67	68.67	58.86

Graph4. At 0° Pitch angle and 7.5m/s velocity

The 0° pitch angle creates pressure on helmets but pressure on helmet is different at different point but curve is smooth. At 7.5m/s spherical helmet pressure curve is also smooth. In both helmet pressures curve at point2 same. Here aerodynamic helmet give good result.

Case E - Pressure Analysis of Spherical Helmet and Aerodynamic Helmet at 15° Pitch Angle and 7.5 m/s velocity

Condition- Both Helmet sets at 15° pitch angle in the test section and fined the effect at 7.5m/s velocity.



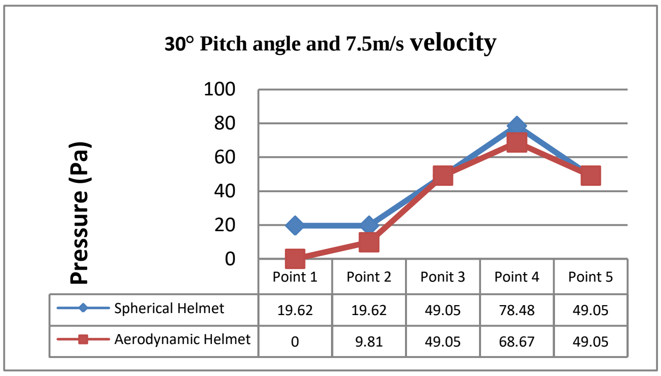
	Point 1	Point 2	Point 3	Point 4	Point 5
Spherical Helmet	19.62	29.43	58.86	98.1	58.86
Aerodynamic Helmet	9.81	29.43	68.67	78.48	49.05

Graph5. At 15° Pitch angle and 7.5m/s velocity

The 15° pitch angle create pressure on helmets but pressure on helmet is different at different point and curve obtain is not smooth. At 7.5m/s spherical helmet and aerodynamic helmet pressure curve at point1, point3 and point4 are changed.

Case F - Pressure Analysis of Spherical Helmet and Aerodynamic Helmet at 30° Pitch Angle and 7.5 m/s velocity

Condition- Both Helmet sets at 30° pitch angle in the test section and fined the effect at 7.5m/s velocity.



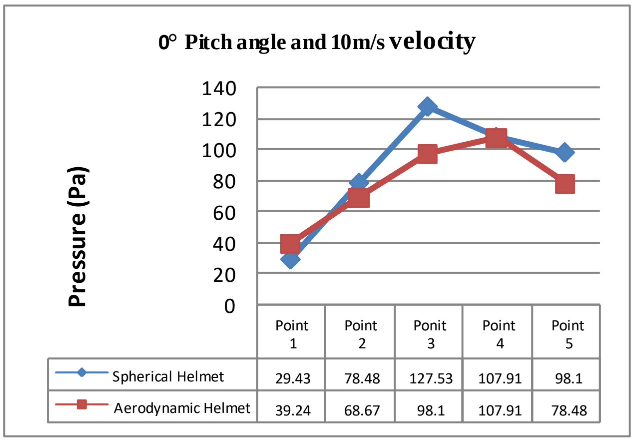
	Point 1	Point 2	Point 3	Point 4	Point 5
Spherical Helmet	19.62	19.62	49.05	78.48	49.05
Aerodynamic Helmet	0	9.81	49.05	68.67	49.05

Graph6. At 30° Pitch angle and 7.5m/s velocity

The 30° pitch angle creates pressure on helmets but pressure on helmet is different at different point but curve is smooth. At 7.5m/s spherical helmet pressure curve is also smooth. In both helmet pressures curve at point3 same. Here aerodynamic helmet give good result.

Case G -Pressure Analysis of Spherical Helmet and Aerodynamic Helmet at 0° Pitch Angle and 10 m/s velocity

Condition- Both Helmet sets at 0° pitch angle in the test section and fined the effect at 10m/s velocity.



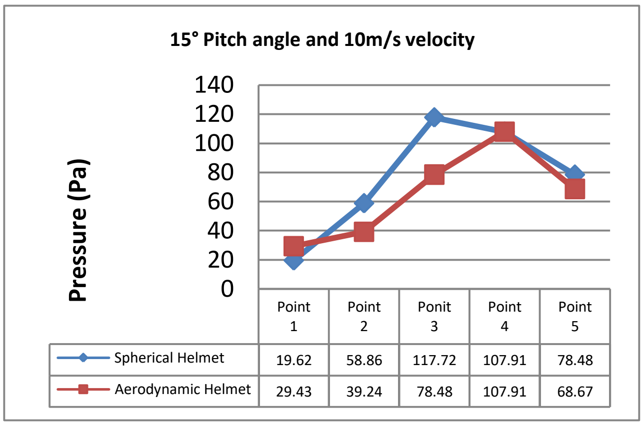
	Point 1	Point 2	Point 3	Point 4	Point 5
Spherical Helmet	29.43	78.48	127.53	107.91	98.1
Aerodynamic Helmet	39.24	68.67	98.1	107.91	78.48

Graph7. At 0° Pitch angle and 10m/s velocity

The 0° pitch angle create pressure on helmets but pressure on helmet is different at different point and curve obtain is not smooth. At 10m/s spherical helmet and aerodynamic helmet pressure curve at point1, point4, point3 and point5 are changed and curve not smooth.

Case H - Pressure Analysis of Spherical Helmet and Aerodynamic Helmet at 15° Pitch Angle and 10 m/s velocity

Condition- Both Helmet sets at 15° pitch angle in the test section and fined the effect at 10m/s velocity.



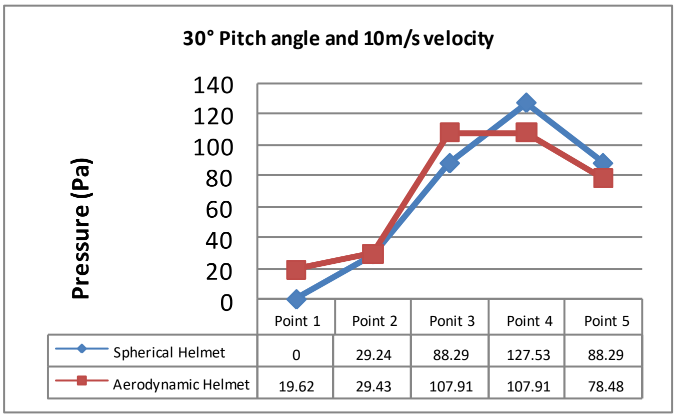
	Point 1	Point 2	Ponit 3	Point 4	Point 5
Spherical Helmet	19.62	58.86	117.72	107.91	78.48
Aerodynamic Helmet	29.43	39.24	78.48	107.91	68.67

Graph8. At 15° Pitch angle and 10m/s velocity

The 15° pitch angle create pressure on helmets but pressure on helmet is different at different point and curve obtain is not smooth. At 10m/s spherical helmet pressure curve is not smooth and pressure curve at point2 and point3 changes. In aerodynamic helmet gives high value at point1 and pressure curve is not smooth but batter than spherical helmet.

Case I - Pressure Analysis of Spherical Helmet and Aerodynamic Helmet at 30° Pitch Angle and 5 m/s velocity

Condition- Both Helmet sets at 30° pitch angle in the test section and fined the effect at 10m/s velocity.



	Point 1	Point 2	Ponit 3	Point 4	Point 5
Spherical Helmet	0	29.24	88.29	127.53	88.29
Aerodynamic Helmet	19.62	29.43	107.91	107.91	78.48

Graph9. At 30° Pitch angle and 10m/s velocity

The 30° pitch angle creates pressure on helmets but pressure on helmet is different at different point but curve is not smooth. At 10m/s both helmet pressures curve at point2 same. At point1 and point3 aerodynamic helmet pressure is high.

V. CONCLUSION

My research topic is testing and analysis of Spherical and Aerodynamic Helmet in Low speed open circuit wind tunnel. Two types of helmet, spherical and aerodynamic shape are used for analysis. My effort is to fulfill all areas. I have note all readings carefully. The pressure was calculated and comparison has been made on the basis of pressure gradient.
The 0° pitch angle create pressure on helmets but pressure on helmet is different at different point and curve obtain is not smooth. At 5m/s spherical helmet pressure curve is smooth. In aerodynamic helmet pressure curve at point1, point2 and point3 not change. The 15° pitch angle creates pressure on helmets but pressure on helmet is different at different point and curve obtain quite smooth. At 5m/s aerodynamic helmet pressure curve is smooth. Here aerodynamic helmet gives best result. The 30° pitch angle create pressure on helmets but pressure on helmet is different at different point and curve obtain is not smooth. At 5m/s spherical helmet pressure curve is not smooth and pressure curve at point2 change. In aerodynamic helmet pressure curve is smooth and gives good result. The 0° pitch angle creates pressure on helmets but pressure on helmet is different at different point but curve is smooth. At 7.5m/s spherical helmet pressure curve is also smooth. In both helmet pressures curve at point2 same. Here aerodynamic helmet give good result. The 15° pitch angle create pressure on helmets but pressure on helmet is different at different point and curve obtain is not smooth. At 7.5m/s spherical helmet and aerodynamic helmet pressure curve at point1, point3 and point4 are changed. The 30° pitch angle creates pressure on helmets but pressure on helmet is different at different point but curve is smooth. At 7.5m/s spherical helmet pressure curve is also smooth. In both helmet pressures curve at point3 same. Here aerodynamic helmet give good result. The 0° pitch angle create pressure on helmets but pressure on helmet is different at different point and curve obtain is not smooth. At 10m/s spherical helmet and aerodynamic helmet pressure curve at point1, point4, point3 and point5 are changed and curve not smooth. The 15° pitch angle create pressure on helmets but pressure on helmet is different at different point and curve obtain is not smooth. At 10m/s spherical helmet pressure curve is not smooth and pressure curve at point2 and point3 changes. In aerodynamic helmet gives high value at point1 and pressure curve is not smooth but batter than spherical helmet. The 30° pitch angle creates pressure on helmets but pressure on helmet is different at different point but curve is not smooth. At 10m/s both helmet pressures curve at point2 same. At point1 and point3 aerodynamic helmet pressure is high. Overall it shows that the performance of aerodynamic helmet is better than spherical helmet.

VI. FUTURE WORK

I am tried to adding some modification for batter performance of helmet. After the complete the experiment model works properly and I found all solution. The experiment is very helpful to improvement of helmet and aerodynamic work. It is definitely very useful for primary research.

VII. ACKNOWLEDGEMENT

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REFERENCES

[1] V. C. Sathish Gandhi, R. Kumaravelan, S. Ramesh, M. Venkatesan, M. Siva Rama Krishnan "An Aerodynamic Design and Analysis of Motor Cycle Helmet with Anti-Glare Visor" World Academy zzof Science, Engineering and Technology, International Journal of Mechanical and Mechatronics Engineering Vol:8, No:3, 2014

[2] M. N. Abdullah, M. K. H. Muda, F. Mustapha, and M. A. Shamsudin "Aerodynamics Analysis for an Outdoor Road Cycling Helmet and Air Attack Helmet" International Journal of Materials, Mechanics and Manufacturing, Vol. 5, No. 1, February 2017

[3] Bradford W Sims M.S., Peter E Jenkins Ph.D., P.E. "AERODYNAMIC BICYCLE HELMET DESIGN USING A TRUNCATED AIRFOIL WITH TRAILING EDGE MODIFICATIONS" University of Colorado Denver, Department of Mechanical Engineering, Denver, Colorado, United States, Phone: 530-848-1300

BIOGRAPHIES

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