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Aerodynamic Performance of Passenger car by Experimental Method

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ABSTRACT

This paper describes experimental investigations is performed on an open circuit suction type wind tunnel with a geometrically similar, reduced scale (1:10) car model, Drag coefficient with corresponding various airspeed of car model is tabulating and plotting the graph between coefficient of drag variation with the air velocities. These provides increasing air velocity to drag force keep on increasing for considered car model , the drag coefficient of car model is reducing.

KEY WORDS: Drag coefficient, air velocity, wind tunnel, pressure coefficient,Car model.

1. INTRODUCTION

In this approach the scaled model will be tested with different velocities and the static pressure distribution is obtained at a particular position along the center line will be plotted.

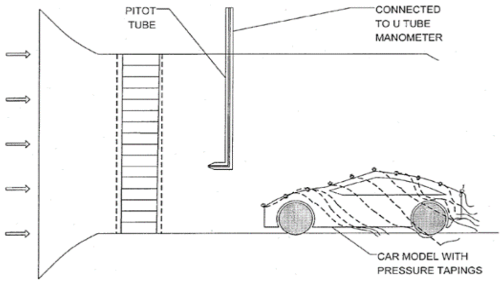

Figure.1. Scaled model

To predicting aerodynamic performance, scaled model was placed in wind tunnel test section and air was blown at different velocities. Pressures on the model are instrumented using scani valve. Its output is connected to the computer which results the data of pressure force as its input. Scani valve has sixteen probes. The probe which is from one to sixteen are connected to the model. Each pressure tubes is four feet long. The output which is the result of pressure force is tabulated below.

$$P_{avg} = \sum_{i=0}^{16} \left(\frac{Pn}{16}\right) \; n = 1,2,3,\ldots$$

$$Cd = FD/0.5\rho V^2 S$$

Drag Force (FD) = (P avg front ~ P avg rear) A
Were, Pavg: Average pressure of entire section
A: Area of test section
P: Density of air
V: Velocity of air
S: Frontal area of car

Holes for pressure tapings: Holes are drilled on the profile of the car to fix the tubes inside to measure the pressure.

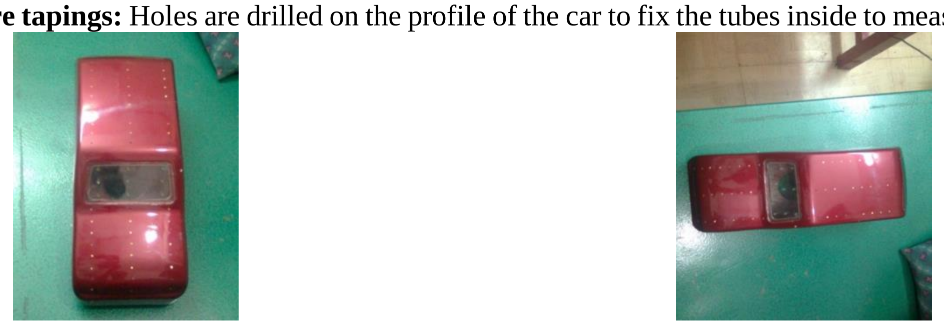

Figure.2. Pressure tapping arrangement

Number of pressure port	-	96
Port Diameter	-	2 mm
L_C	-	Center line of the car model (34 ports)
L_1	-	Left side line of the car model (31 ports)
L_2	-	Right side line of the car model (31ports)

Experimental testing of scaled model: The scaled model is located in the test section and the car model ports are connected with the pressure scanner,the scaner is connected with the computer , to find the pressure in the scanner are measured by using the Scani valve software.The measurement is carried out with the different velocities of air and the pressure values are tabulated.

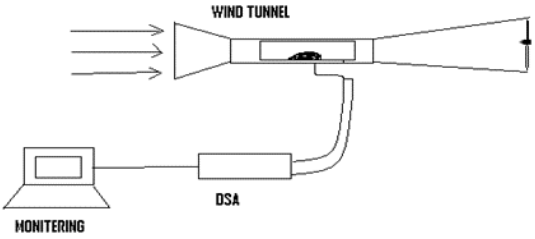

Figure.3. Line diagram of experimental set up

Figure.4. Model placed in the test section, view from the side glass

Cd calculation for car model: From this table values are interpolated and it is calculated as, Drag Force,

(FD) = ((-232.237)-(-107.937))×1.08

$$\frac{\left((-232.237)-(-107.937)\right)\times 1.08}{0.5\ \times 1.225\ \times\ 16.3^2\ \times 2.1535}$$

Cd = 0.3830

Coefficient of pressure: The coefficient of pressure is calculated by using below equation

$$Cp=\frac{P-P_\infty}{Q}$$

Where P_∞ is the reference pressure and Q is the dynamic pressure, $Q=1/2\rho V^2$

Where dynamic pressure is equal to difference between static pressure and total pressure, $P_O- P_\infty=1/2\rho v^2$

P_0 = Measured pressure N/m2

$P\infty$ = static pressure N/m2

ρ = density of air

V= wind velocity (m/s)

2. RESULT AND DISCUSSION

Pressure distribution would be low in the regions with streamlined profiles such as nose, base, windshield and rear tapered roof etc.

Table.1. Experimental values

Air Velocity In M/S	Experimental Method	
V	Cd	FD
9.6	0.2736	33.2635
13.1	0.3072	69.5476
14.6	0.3618	94.896
16.3	0.3830	134.244

Air velocity Vs drag force (V vs D): Drag coefficient and drag force of various velocity for model.

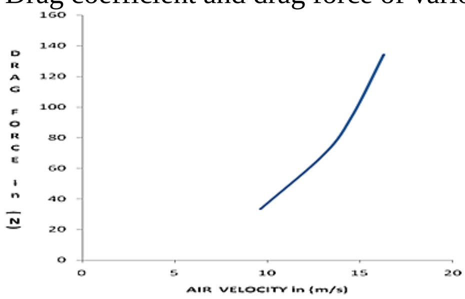

Figure.5. Drag force variation with air velocity for model

Air velocity Vs drag coefficient (V vs Cd):

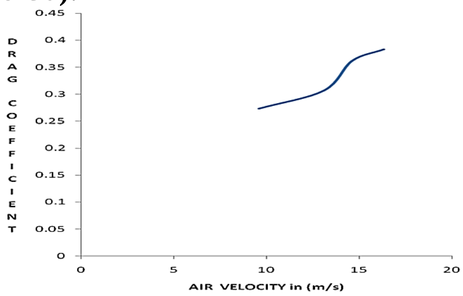

Figure.6. Drag coefficient variation with air velocity for model

Cp curve for 9.6 m/s:

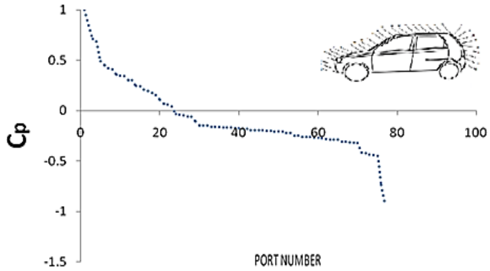

Figure.7. Mean Cp Distribution of the car model for 9.6 m/s

Cp curve for 13.1 m/s:

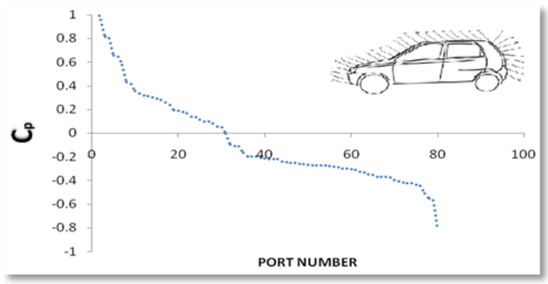

Figure.8. Mean Cp Distribution of the car model for 13.1m/s

Cp curve for 14.6 m/s:

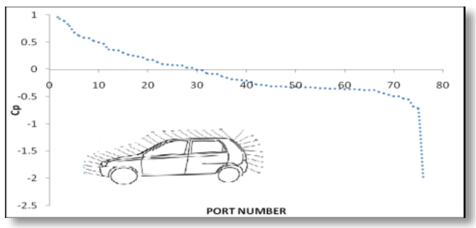

Figure.9. Mean Cp Distribution of the car model for 14.6m/s

Cp curve for 16.3m/s:

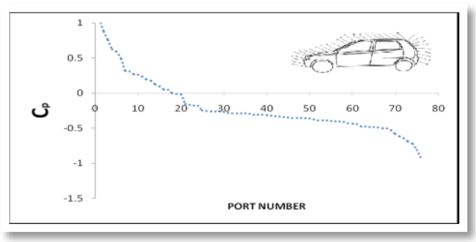

Figure.10. Mean Cp Distribution of the car model for 16.3m/s

From fig.10, shows mean cp distributions for the car model with respective air velocity. It is clearly visualized as,pressure coefficient at front region of the car is positive ie., high pressure zone and pressure co-efficient of top roof and rear side of the car region are negative zone ie., low pressure zone.

3. CONCLUSION

Experimentally drag forces and pressure distributions around the car model agree with corresponding different air velocities and car model tested at various air velocity and also evaluated coefficient of drag.Drag coefficient with corresponding various airspeed of car model was tabulated and plotted graph between coefficient of drag variation with the air velocities. These provides increasing air velocity to drag force keep on increasing for considered car model .Mean cp distribution for the car model alone normally the front face is fully exposed to incoming flow, so this region contribute high pressure directly increases drag coefficient. the region such as top roof and rear side have inclination angle of more than 12 degree, so flow get separated at roof itself. So it will create wake at the rear side.

Future work: This model could be further be improved to certain extend to make it a complete solution for any other modification such as spoiler, splitter, diffuser etc. Surface drag also be included in the model by adding the holes in the side of the car, based on the pressure values the drag can measured more accurate. By doing such modification and experiments the optimum shape of the car can be arrived. The optimum shape will reduce the drag thereby the optimum fuel efficiency can be achieved.

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