Experimental Aerodynamic Analysis of Automobile Vehicle

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***Abstract*— The aerodynamic characteristics directly affect the stability, driving characteristics, safety, operation, and oil consumption of automobile. This paper will describe aerodynamic performance of sedan car by wind tunnel approach. The aerodynamic drag force and pressure distribution at longitudinal section acting over the car body is determine by conducting the wind tunnel test. The experimental investigations will be performed on an open circuit section type wind tunnel having 30 cm × 30 cm ×100 cm test section , on a geometrically similar ,reduced scale (1:20) Maruti Esteem car wooden model is use and results like drag force , pressure distribution , wake region will investigated for aerodynamic analysis.**

***Key Words*— Aerodynamic, Wind Tunnel, Sedan, Drag Force**

I. INTRODUCTION

To save energy and to protect the global environment, fuel consumption reduction is primary concern of automotive development. In vehicle body development, reduction of drag is essential for improving fuel consumption and driving performance, and if an aero- dynamically refined body is also aesthetically attractive, it will contribute much to increase the vehicle's appeal to potential customers.[14]

Airflow over a vehicle determines the drag forces, which in turn affects the car's performance and efficiency. I will design the testing equipment to measure both the vertical and horizontal components of air resistance on a model car. Down force, the vertical component, is simply negative lift. When a car goes faster and faster the weight of the car changes due to air resistance. Depending on the direction (upward or downward) this is called either lift or down force, respectively. I will also measure the horizontal component, the drag of the model cars. Drag is the amount of force that the air is pushing on the car at a certain speed. In other words, it is the amount of resistance the air imposes on the car in a horizontal direction. For a vehicle to maintain its speed it must overcome friction. The most important source of friction at high speeds is air resistance. If air resistance can be minimized, the car will be more efficient because less energy is lost to friction. Today, with increasing energy costs, efficiency is finally receiving the attention it deserves. If a car can cut through the air with little resistance, it will get better gas mileage. The automotive industry is accordingly devoting more attention and resources to the aerodynamics of their vehicles. I will hopefully be able to apply the skills that I learn modifying and testing the wind tunnel to my work later in life.[2]

II. EXPERIMENTAL INVESTIGATION

Experimental Model

For experimental analysis,Maruti Esteem car scaled down wooden model is made with 1:20 ratio. In order to measure the surface pressure variation in a longitudinal section of the geometry, a line of pressure tapings are to be made on the model structure. For measuring the various aerodynamic force acting over the surface of the scaled model, 3mm drill is done on it, and 2.5mm copper tube is attached in hole. The test model is reduced to a geometric shape by neglecting wheels gap, mirror, etc to isolate the performance from any other aerodynamic influences.

Fig.1: Car model with pressure tapping

Experiment Set-up

Experimental work is done at SVIT, Vasad (Aeronautical department), and Experimentally, tests is carried out in an open circuit suction type wind tunnel (30cm x 30cm x 100 cm) with a glass window meant for visual observation of flow phenomenon. A variable speed DC motor employed varies air velocities (5-25 m/s). A provision for traversing Pitot tube in horizontal direction was created specially to meet with specific requirement of suggested experimentation methodology.

Experimental investigations in wind tunnel Tests will be conducted on a geometrically similar, reduced scale (1:20) wooden model, differing from actual car only in size and simulating dynamically similar flow situations.

Fig.2: Experimental setup

Fig.3: Test Section

In this approach, the model instrumented with pressure tapings along the centerline, over its profile, will be tested at different air velocities. The pressure distribution is calculated by equation.

$$P = \rho g h$$

Where, ρ = density of air
g = acceleration of gravity
h = height of manometer

Fig.4: Multitude manometer setup

Fig.5: digital panels for lift and drag

Here also digital panel available to measure lift and drag force over model is shown in tne above figure

Experimental Procedure

The experimental procedure is as follows - Wind tunnel is Started within range of speed (5 m/s-25 m/s) it is run at particular speed for 5-10 minutes to get uniform flow and the wind tunnel test section speed is adjusted and then after data is acquired. Air speed is measured by digital anemometer. On the Model surface in longitudinal section pressure distribution reading measuring by multitude manometer at different air velocity. But here for air velocity 22.8m/sec reading is given below table:

Table.1: Pressure distribution on the car at different taped point

Taped points	1	2	3	4	5	6	7	8	9	10
h mm	49	16	6	12.5	-69	-21	-46	-20.5	-17	-18
Pressure	482	164	58	123	-679	-209	-448	-203	-168	-177

III. EXPERIMENTAL RESULTS

Pressure distribution on the longitudinal section mean at the tapped point pressure and drag force results is shown in below table. Taped point shown in the below wooden model

Fig.6: Car model with pressure tapping

Pressure Distribution at Different Taped Point

Model of car has different taped point on longitudinal section at this different taped point the Pressure distribution for different air velocity is given below

Table.2: Pressure distribution for different velocity at different taped point

Pressure Distribution (Pa)		**Velocity(M/S)**			
		17	**20**	**22.8**	**25**
Taped Point	**1**	276	375	482	511
	2	108	112	164	258
	3	-27	32	58	76
	4	-54	79	123	165
	5	-279	-425	-679	-733
	6	-123	-187	-209	-346
	7	-226	-334	-448	-498
	8	-137	-146	-203	-237
	9	-79	-98	-168	-163
	10	-64	-91	-177	-189

Drag Force

Drag force reading is taken from the digital panel of lift and drag. This reading given below table:

Table.3 Drag force for different air speed

VELOCITY (MM)	17	20	22.8	25
DRAGE FORCE (N)	0.37	0.73	1.01	1.23

IV. CONCLUSIONS

From the results of the wind tunnel like pressure distribution and drag force for different air velocity conclude that high pressure zone in the front of radiator part of model and this pressure increase with velocity increases. Also, the drag force is increase with increase air velocity. Negative pressure create at the back side of car is increase with increase air velocity this indicate the suction in back side of car which creates wake region at the rear end of the vehicle

REFERENCES

[1] Bhagirath Zala, Dr. Pravin P. Rathod, Arvind S. Sorthiya, Aerodynamic performance assessment of sedan and hatchback car by experimental method and simulation by computational fluid dynamics, Journal of Engineering Research and Studies E-ISSN0976-7916 JERS/Vol. III/ Issue I/January-March, 2012/91-95

[2] Bhavini Bijlani, Pravin P. Rathod, Arvind S. Sorthiya, Experimental Investigation of Aerodynamic Forces on Sedan, Fastback and Square-Back Car by simulation in CFD, International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 2, February 2013346

[3] Kurian Jory, Satheesh ,Computational drag analysis in the underbody for a sedan type car model
[4] Manan Desai, S.A Channiwala, H. J Nagarserth, Experimental and Computational Aerodynamic Investigations of a Car, ISSN: 1790-5087 Issue 4, Volume 3, October 2008.
[5] Sathish Kumar K, Enhancement of Aerodynamic Characteristics In Automobiles , 978-1-4673-6150-7/13/$31.00 ©2013 IEEE
[6] GAO Guang - Jun ,Optimization Research on Aerodynamic Figure of the Box Car under Cross Wind Key Laboratory of Traffic Safety on the Track, Ministry of Education
[7] Korean Jury& Satheesha, computational drag analysis in the underbody for a sedan type car model, journal of information knowledge and research in mechanical engineering ISSN 0975 – 668X| Nov 10 To Oct 11 | Volume – 01, Issue – 02.
[8] Debojyoti Mitra, Design Optimization of Ground Clearance of Domestic Cars, International Journal of Engineering Science and Technology Vol. 2 (7), 2010, 2678-2680
[9] FAN Yue - Zhen ,Simulation of Noise on Moving Automobile by Using CFD Method, Institute of Technology, Beijing Forestry University Beijing
[10] Philippe Planquart, integration of CFD and Experimental Results at VKI in Low- Speed Aerodynamic Design International Symposium on Integrating CFD and Experiments in Aerodynamics ,20-21 June 2007 U.S.
[11] C.J. Baker, N.D. Humphreys ,Assessment of the adequacy of various wind tunnel techniques to obtain aerodynamic data for ground vehicles in cross wind ,Journal of Wind Engineering and Industrial Aerodynamics, 60 (1996) p .49-68
[12] Mahmoud Khaled, HichamElHage, FabienHarambat, HassanPeerhossaini, Some innovative concepts for car drag reduction, Journal of Wind Engineering and Industrial Aerodynamics 107–108 (2012) p. 36–47
[13] Fluied mechanics by R.K.Rajput
[14] Md. Hasan Ali1, Mohammad Mashud2, Abdullah Al Bari2 and Muhammad Misbah-Ul Islam2, Aerodynamic Drag Reduction Of A Car By Vortex Generation , International Journal Of Mechanical Engineering ISSN : 2277-7059 Volume 2 Issue 1