



Optimization of Roof fairing angle to reduce the Aerodynamic Drag of Heavy Duty Truck.

Kalpesh Vaghela

Department of Mechanical Engineering, CSPIT,
Charotar University of Science and Technology- 388421,
Nadiad, India

Abstract Aerodynamic consideration is very important in design and manufacturing of vehicles. The motion of the vehicle takes place through a large mass of either stationary air or air in motion. The air exerts force on the auto vehicle. The force exerted by air on a moving auto vehicle has two components. (1) Drag force (2). Lift force. This paper present the optimization of aerodynamic drag force induced in heavy duty trucks. As heavy duty trucks have large frontal area, they have to face large resistance of air (drag). Generally automotive manufacturers provide roof fairing for making the flow of wind past by the body streamlined. This paper suggests the optimized angle to reduce the aerodynamic drag force which increases the fuel economy.

Keywords Aerodynamic drag, drag coefficient, pressure coefficient, wind tunnel

I. Introduction

Drag force is the force acting on the vehicle in direction of motion. It is denoted by FD. The force acting in the direction perpendicular to be direction of motion is known as lift force. The shape of the body should be designed so that lift force should be minimum^[1]. Consider an arbitrary shaped body of an automobile held stationary in a stream of air moving at uniform velocity v , experience shear force along its tangential direction and pressure force in the normal direction called friction drag force and the pressure force acting on be body is known as a pressure drag force FDP. There are following types of drag forces acting on the vehicle body profile.

- a) Profile Drag:- It depends upon the longitudinal section of the vehicle body, play the most important part. A careful choice of body profile is essential for low drag coefficient streamlines should be continues and separation of boundary layer with its attendant vortices should be avoided.
- b) Induced Force:- It is 8% of total force. It forms vertices formed at the side of the vehicle and travelling downwards from it. The vertices in turn caused by the aerodynamics lift of the vehicle body.
- c) Friction drag force:- It contributes about 10% of the aerodynamic drag and is caused by the friction force between boundary layer and the body surface.
- d) Interference drag:- It contributes 15% percent of the total drag. It includes such elements as projecting door handles, mirrors badges which projects out of the normal surface of vehicle body.
- e) Cooling and ventilation drag:- It contributes 10% of the total drag with careful attention to the design of ducting in the vehicle it should be possible to reduce this value considerably for past vehicle and in theory to use the energy given to air flow by the radiator to secure a positive forward force.

The drag can be calculated from^[2]

$$FD = C_D A \rho v^2 / 2$$

Where, C_D is coefficient of drag, A is characteristic area of the body which is the largest projected area of body on a plane perpendicular to the direction of the air, $\rho v^2 / 2$ is called the dynamic pressure of the flowing air.

II. Method & Material

The A wind tunnel is a device used to produce a rapid stream of air through a test section in which an object or series of objects is placed. The purposes of such tests are to examine the aerodynamic and/or structural effects on the object(s) in question by simulating travel through the air or wind on a structure^[3]. Wind tunnels are typically used to test aircraft, wing sections, ground vehicles, bridge structures, and buildings, all on a small scale. Such experiments can produce reliable data on how the object will perform at full scale in its environment. The wind tunnel is also a useful educational tool for studying fluid dynamics and aerodynamics.

Figure I. wind tunnel



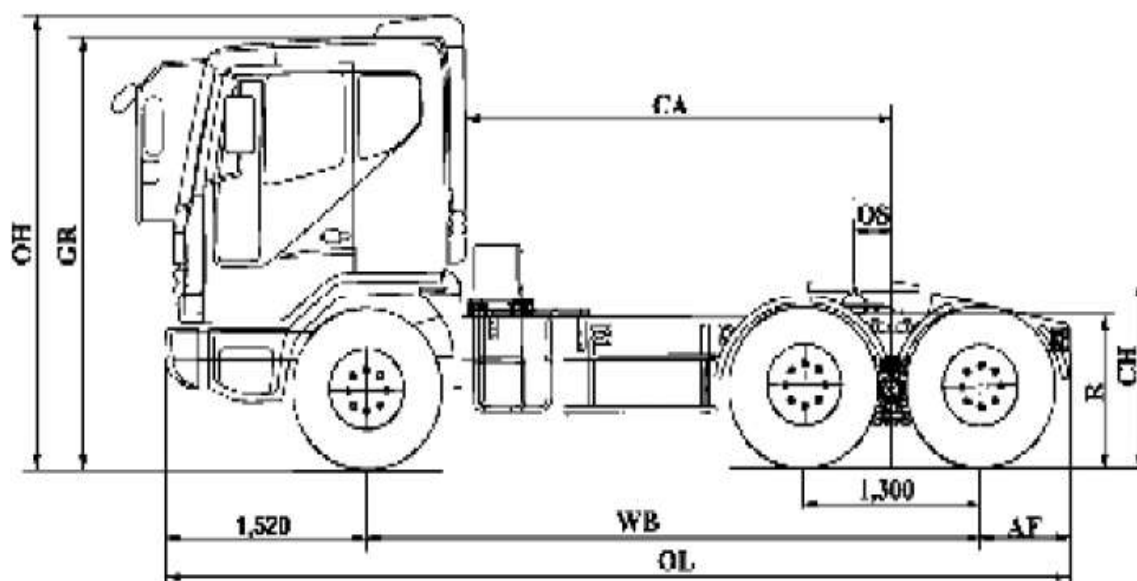
The settling chamber straightens the airflow. Uneven turbulent flows can cause unpredictable forces to be experienced and measured in the test section. The less turbulence there is, the better the wind tunnel will simulate actual flying conditions. The settling chamber usually includes a honeycomb flow straightened and wire mesh smoothing screens that produce a smooth airflow^{[4][5]}. The test section is the point where the test engineer meets the wind tunnel together with its adjacent component namely the nozzle collector and plenum. The two main types of test sections are open and closed.

Figure II. Test section of wind tunnel



A. Dimension & Prototype

Figure III. dimension of original heavy duty truck ^[6]



o DIMENSIONS (mm)	Overall	Length	OL	6,840
		Width	OW	2,490
	Tread	Height	OH	2,925
		Front	FT	2,050
		Rear	RT	1,855
	Wheelbase	WB	4,480	
	Rear axle to frame	AF	840	
	Ground to roof	GR	2,905	
	Frame-ground above bogie	R	1,065	
	Usable cab to axle	CA	3,105	
	Coupler offset	OS	270	
	Coupler height	CH	1,343	
	Min. ground clearance		270	
	Swing radius	Forward	2,430	
		Rearward	2,040	

Figure IV. Prototype for testing

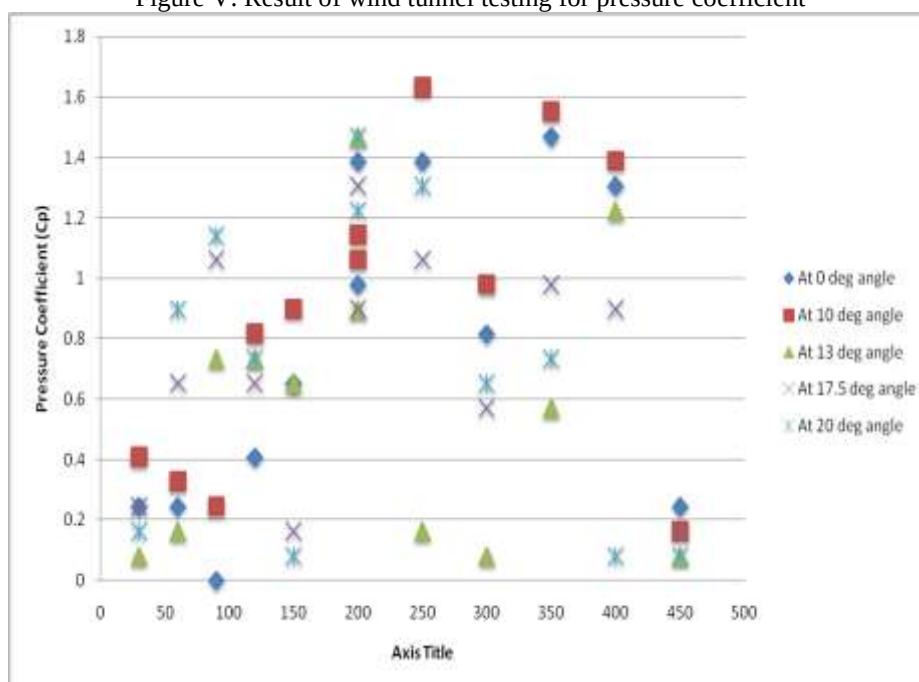


Wind tunnel test for above model with scale ratio 1:12, was carried out using roof fairing over the cab of automobile body. This fairing is placed at four different angles 10° , 13° , 17.5° and 20° ^{[7][8]}.

III. Result and Discussion

The experiment was carried out in suction type wind tunnel and pressure difference is measure at every points on the body with the help of tapings. For different roof fairing angle, variation of pressure coefficient along with the span of vehicle is shown in graph.

Figure V. Result of wind tunnel testing for pressure coefficient



VI. Conclusion

We have concluded that as the velocity of cab and trailer increases pressure at the nose of the cab is increases. The deflector angle is optimized at 17.5°, at this angle the drag reduction is more compare to 10°, 13° and 20°. After performing the experiment on the tractor trailer model in two ways, we got satisfactory and reliable related to the aerodynamic drag reduction. The drag coefficient (CD) evaluated for proposed exterior profile of the tractor trailer, comes out to be of the order of 1.15. Deflector on the cab reduces the pressure and increases the aerodynamic performance of vehicle.

VII. References

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