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Aerodynamic Design of F1 and Normal Cars and Their Effect on Performance

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Abstract

Aerodynamics is a branch of dynamics concerned with studying the motion of air, particularly when it interacts with the solid object. Aerodynamic is a subfield of fluid dynamics and gas dynamics, with much theory shared between them. In this paper we are presenting the different forces acting on a car (drag force, lift force).the measurement of forces (computational fluid dynamics CFD and wind tunnel testing WTT). On the basis of forces and measurement the comparison has been done over Hindustan ambassador, Lamborghini Aventador LP 700-4 and the F1 car. The design of FORMULA1 is explained in this paper.

After detailed observation and tests performed we obtained that F1 car has most aerodynamic of all the vehicles. The design is made in such a way that it cuts through the air with ease and channelize the air flowing over it to the rear wings. This results in a highly reduced drag and lift force acting on the car body. It in turn, generates more amount of down force making the car stable at high speeds. It is the pinnacle of racing technology. On the other hand, the Lamborghini Aventedor LP 700-4, is a full on super car. It was designed to give speed and performancein a coupe car. thus the body had to be designed such that there is minimum air resistance at high speed and proper cornering stability as well as drivability.

1. Introduction

Automotive aerodynamics is the study of the aerodynamics of road vehicles. The main goals of which are reducing drag and wind noise, minimizing noise emission and preventing undesired lift forces and other causes of aerodynamic instability at high speeds. For some classes of racing vehicles, it may also be important to produce down force to improve traction and thus cornering abilities. An aerodynamic car is not only capable of going fast but it also has better fuel economy.

1.1 Types of forces acting on cars

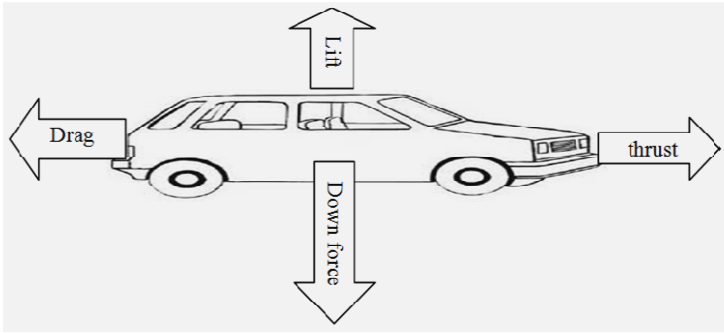

Fig. 1:-forces on car.

1.2 Forces to be measured

1. Drag force
2. Lift force
3. Thrust force
4. Down word force

Types of Drag Forces	Causes for lift forces
1) Parasitic drag	1) Angle of attack
2) Lift induced drag	2) coefficient of lift
3) Wave drag	3) limitation of deflection/turning

1.3 Test setup for Measurement of forces

Wind tunnel testing (WTT)

Fig. 2: Wind Tunnel Test Setup.

A wind tunnel is a tool used in aerodynamic research to study the effect of air moving past solid objects. In wind tunnel the test object is instrumented with a sensitive balance to measure the forces generated by air flow or the air flow may have smoke or other substance injected to make the flow lines around the object visible.

2. Procedure of testing

The model is placed in the wind tunnel for the measurement of the forces acting on it. The speed of the fan is kept at a suitable value and the process is started. Measuring of the forces acting on the car body is done by the sensors attached to it. The sensors directly feed the reading to a digital display device. If the model is a scaled down version of the original vehicle, the result must be brought to the original value for the actual sized vehicle. The speed of the wind tunnel varies from 300rpm to 3000rpm which is sufficient to simulate the air flow over the vehicle at any scale. The visualization of the air flow over the vehicle is done by smoke visualization or tuft visualization or schrillen method.

3. Cars for Testing and Comparison

Fig. 3: Indian standard car- HM Ambassador

Fig. 4: Lamborghini aventador LP 700-4

Fig. 5: The F1 Car.

4. Observations

The different observations has been made over the vehicles which is explained on the observation tables.

4.1 Observation table for formula 1 car

Table 1:-data of forces over formula 1 car

Serial No.	Speed(rpm)	H1(cm's)	H2(cm's)	Lift force(N)	Drag force(N)
1	1000	23.6	23.4	0.3	0.14
2	1200	23.7	23.3	0.4	0.23
3	1400	23.8	23.2	0.5	0.33
4	1600	23.9	23.1	0.6	0.41
5	1800	24.0	23.0	0.7	0.51
6	2000	24.1	22.9	0.8	0.63
7	2200	24.2	22.7	0.8	0.72
8	2400	24.3	22.6	0.9	0.83
9	2600	24.4	22.5	1.0	0.94

Observation table of Lamborghini aventador LP 700-4

Table 2:-data of forces over Lamborghini

Serial No.	Speed(rpm)	H1(cm's)	H2(cm's)	Lift force(N)	Drag force(N)
1	1000	23.6	23.4	0.6	0.32
2	1200	23.6	23.3	0.9	0.52
3	1400	23.7	23.2	1.1	0.65
4	1600	23.8	23.1	1.3	0.77
5	1800	23.9	23.0	1.5	0.95
6	2000	23.9	23.0	1.8	1.10
7	2200	23.9	22.9	2.0	1.15
8	2400	24.0	22.8	2.2	1.20
9	2600	24.1	22.7	2.4	1.35

Observation table of Hindustan motors ambassador

Table 3: Data of Forces Over Ambassador.

Serial No.	Speed(rpm)	H1(cm's)	H2(cm's)	Lift force(N)	Drag force(N)
1	1000	23.5	23.3	1.3	0.33
2	1200	23.6	23.3	1.7	0.46

3	1400	23.7	23.3	2.0	0.58
4	1600	23.8	23.3	2.5	0.73
5	1800	23.9	23.2	3.0	0.88
6	2000	23.9	23.1	3.7	1.12
7	2200	24.0	23.0	4.1	1.26
8	2400	24.0	22.9	4.5	1.41
9	2600	24.1	22.8	4.9	1.55

5. Results

The design of Indian ambassador car has been modified as per the standard references from Formula1 car and Lamborghini aventador LP 700-4 and had been tested in wind tunnel the result obtained are impressive which are shown below table and explained in conclusion part.

Fig. 6: Ambassador in wind tunnel test setup.

Fig. 7: Formula1 in wind tunnel test setup.

Result table for formula 1 car

Table 4:-data of forces after modification in design of formula 1 car

Serial No.	Speed(rpm)	q(cm)	V(m/s)	Fd(N)	F1(N)
1	1000	0.2	5.81	0.141	0.0186
2	1200	0.4	8.22	0.466	0.049
3	1400	0.6	10.07	1.004	0.093
4	1600	0.8	11.62	1.667	0.149
5	1800	1.0	13.00	2.586	0.217
6	2000	1.2	14.24	3.834	0.298
7	2200	1.5	15.92	5.477	0.372
8	2400	1.7	16.94	7.156	0.475
9	2600	1.9	17.91	9.058	0.590

Result table for Lamborghini aventador LP 700-4

Table 5:-data of forces after modification in design of Lamborghini

Serial No.	Speed(rpm)	q(cm)	V(m/s)	Fd(N)	F1(N)
1	1000	0.2	5.81	0.180	0.058
2	1200	0.3	7.12	0.440	0.132
3	1400	0.5	9.19	0.918	0.268
4	1600	0.7	10.87	1.523	0.445
5	1800	0.9	12.33	2.416	0.660
6	2000	0.9	12.33	2.797	0.792
7	2200	1.0	13.00	3.249	0.978
8	2400	1.2	14.24	4.069	1.290
9	2600	1.4	15.38	5.340	1.643

Result table for Hindustan motors ambassador

Table 6: Data of forces after modification in design of ambassador.

Serial No.	Speed(rpm)	q(cm)	V(m/s)	Fd(N)	F1(N)
1	1000	0.2	5.81	0.283	0.262
2	1200	0.3	7.12	0.593	0.514
3	1400	0.4	8.22	0.997	0.807
4	1600	0.5	9.19	1.569	1.261
5	1800	0.7	10.89	2.649	2.11
6	2000	0.8	11.62	2.853	2.987
7	2200	1.0	13.00	5.419	4.137
8	2400	1.2	13.62	6.667	4.995
9	2600	1.3	14.82	8.666	6.428

6. Conclusions

After detailed observations and tests performed. It was clear that F1 car was most aerodynamic of all the vehicles. The design is made in such a way that it cuts through the air with ease and channelize the air flowing over it to the rear wings. This results in a highly reduced drag and lift force acting on the car body. It in turn generates more amount of down word force making the car stable at high speeds. It is the pinnacle of racing technology.

On the other hand the Lamborghini aventadorLP 700-4 is a full on super car. It was designed to give speed and performance in a coupe car, thus the body had to be designed such that there is minimum air resistance at high speeds and proper cornering stability as well as drivability. Designing such a car demanded extensive tests and the car in production, at this point is one of the most aerodynamically stable road cars in

the world. The tests performed in a scaled down model was very much at par, showing low drag and lift force acting on it.

The common characteristic of both F1 car and Aventador were its low slung body giving them lesser ground clearance. The lining on the coupe is capable of channelizing the air flow to the rear of the car where a spoiler is provided, giving the car excellent high speed stability. The turbulence created is much less.

An aerodynamic car is not only capable of going fast but it also has better fuel economy. When relatively compared with other cars, the aventador is more fuel efficient taking into account that it is a super car. An F1 car is also fuel efficient car considering the fact that it is built for racing purpose only.

So by keeping these as references for comparison, design improvement can be done on a standard Indian car to make it more aerodynamic. This will definitely result in the car being significantly more fuel efficient as well as faster and more stable.

The present ambassador, a saloon car has a lower windshield angle. It also lacks certain features like door and roof linings that is very much useful in channeling the air to the rear of the car. A slight nose dip at the bonnet end and a more slanting rear wind screen will definitely make the car more aerodynamic, helping it to cut through the air with more ease. Lower ground clearances will lessen the lift force. Over all changes will cause lesser turbulence and make the car more stable and there will be some amount of drag and lift reduction which would finally result in the car achieving higher speed as well as better fuel efficiency.

References

[1] Wikipedia.org/wiki/Aerodynamic
[2] Wikipedia.org/wiki/Lift_ force
[3] Wikipedia.org/wiki/Wind_tunnel
[4] Wikipedia.org/wiki/Down_force
[5] www.howstuffworks.com
[6] www.formula1.com/inside_f1/understanding_the_sport/5281.html