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Analytical Investigation Of Vortex Generators In Light Weighted Vehicles Using Cfd Analysis

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ABSTRACT

In the modern day design of vehicles, especially in the automobile industry involves a great deal of aerodynamic design study to analyze the airflow. The aerodynamic drag force adversely affects the forward motion of the vehicle, which in turn reduces the efficiency. If the vehicle is redesigned to optimize the aerodynamic forces, it could produce better results but requires a huge capital to change the complete design. Most of the research thesis on drag reduction has proved that the effective way of controlling the flow at the rear end of the vehicle has been achieved by using the vortex generators (VGs).

Here in this thesis we are going to use these vortex generators for the sedan modeled light weighed compact cars with various profiled designs and CFD will be carried out for the prediction.

INTRODUCTION

A vortex generator is a device which is used to control the aerodynamic for the vehicles; it is present on the top surface of the vehicle. Generally these are been used in aerodynamic vehicles such as aircrafts and for cars. When the airfoil is in motion relative with the air, the vortex generator creates an vortex, which by removing the part of the slow moving boundary layer in contact with the airfoil surfaces delays local flow separation and aerodynamic stalling, thereby improving the effectiveness of the wings as flaps, elevators and rudders.

Vortex generators are mostly used to delay the flow of air separation which is travelling on the surface of the object. These are used on the external surfaces of the vehicle. These are commonly in rectangular or triangular in shape. These will be placed obliquely, so that they can acquire the angle of attack with respect to the air flowed on the vortex which creates an energy drawing on the tip moving outside in to the boundary layer in contact with the surface.

LITERATURE SURVEY

1. Mohan Jagadeesh Kumar M, Anoop Dubey, Shashank Chheniya, Amar Jadhav, Effect of Vortex generators on Aerodynamics of a Car: CFD Analysis

Abstract- Flow separation at the vehicle‘s rear end is the major cause of an aerodynamic drag in a car. In order to delay the flow separation at the rear, bump-shaped vortex generators at the roof end of a car are tested in this paper for two different types of car models Sedan and

Hatchback. The aerodynamic analysis is carried out using GAMBIT and FLUENT for Sedan and Hatchback models. Vortex Generators are found to be not very sensitive for the designing parameters. CFD analysis confirms that the use of Vortex Generators reduces both the drag and lift coefficients.
Keywords – Vortex generators, Aerodynamics, Drag, Lift, Flow separation, CFD

2. G.Vasantha Kumar, K.Sathiya Narayanan, S.K.Aravindhkumar, S.KishoreKumar, Comparative Analysis of Various Vortex Generators for a NACA 0012 Aerofoil

Abstract: The Comparative analysis of various shapes of vortex generator is the main objective that is carried out in this paper. Here we had taken different shapes like rectangle, triangle, and gothic shapes for the comparative analysis and results based on different angle of attack at 0° and 10°. This detailed study is carried out on the NACA 0012 symmetric airfoil. The main causes of aerodynamic drag is the separation of flow near the aerodynamic object‘s rear end. To control the flow separation we place a device known as vortex generator. A vortex generator is an aerodynamic device, it removes the slow moving boundary layer by energizing the slow moving layer and modifies the flow around the surfaces affecting boundary layer and controlling the flow separation. From the above mentioned shapes, we determine the drag force values and drag coefficient values to find the best result of various Vortex Generator. Various Shapes, which is designed by Computer Aided Design in CATIA V5 software. Drag Force values can be obtained by using output of CFX. Besides that, CFX simulation results of streamline flow at the rear end of NACA 0012 is also obtained. Boundary conditions are given to the Ansys analysis at the inlet and outlet as a default domain. Models are analyzed in two different angles for comparing the best shape at the given condition at different angle of attack. Comparison of drag coefficient values of the Various Shapes of vortex generator is done and the most efficient shape is give in this comparative analysis study.
Keywords: Boundary layer, Flow separation, vortex generator, Drag force and Drag coefficient

Theoretical Calculations

Drag Force is calculated by using formulae:

$$D = \frac{1}{2}\rho A V^2$$

Where D is Drag Force
P= Density of air
A= Area of Cross section
V= velocity
For Profile 1; Length =1.4 m
Width=0.1m
Area= 0.14 m

Velocity= 27.7 m/sec

Density of air= 1.22 kg/m^3

D= ½ X 1.22 X 0.14 X27.7^2

65.52 N

DESIGN AND ANALYSIS OF VORTEX GENERATORS

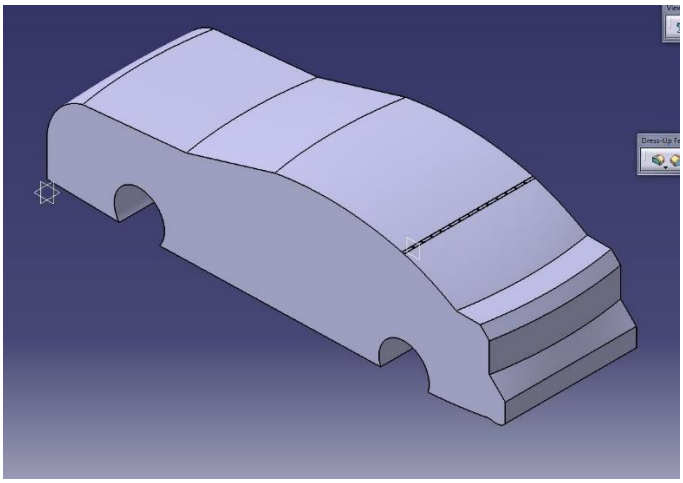

Fig shows the VG on the car

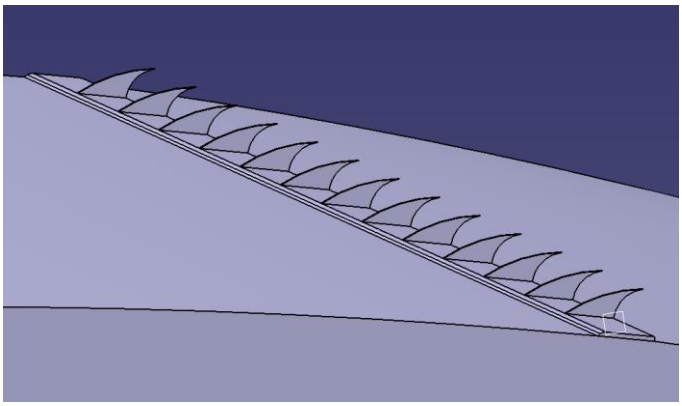

Fig shows the model of the vortex generator

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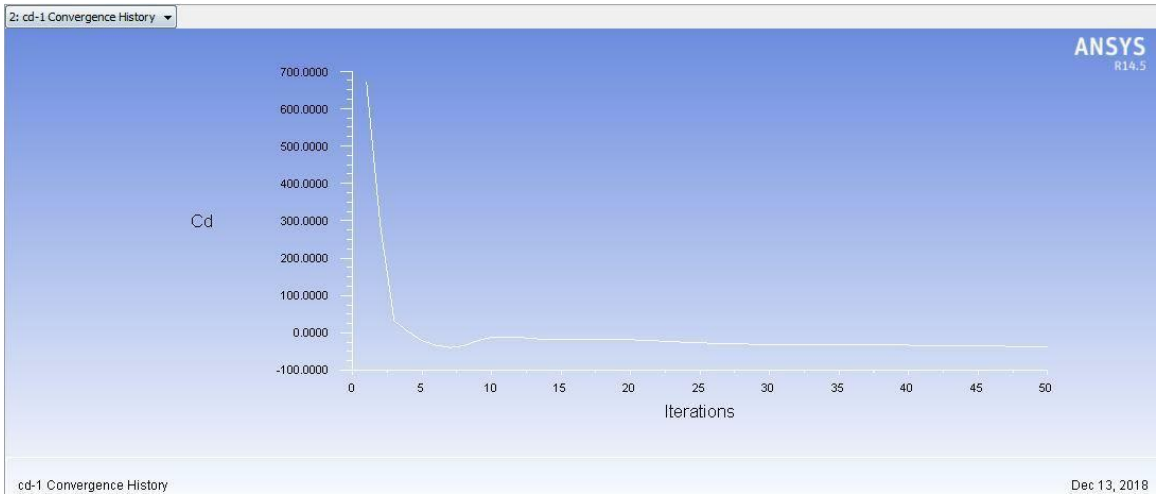

Fig shows the convergence graph

The below figure spots the result, counters of the pressure distribution from minimum to maximum

As if we see the contours here the maximum pressure is spotted at the roof of the vehicle and even at the placement of the vortex generator.

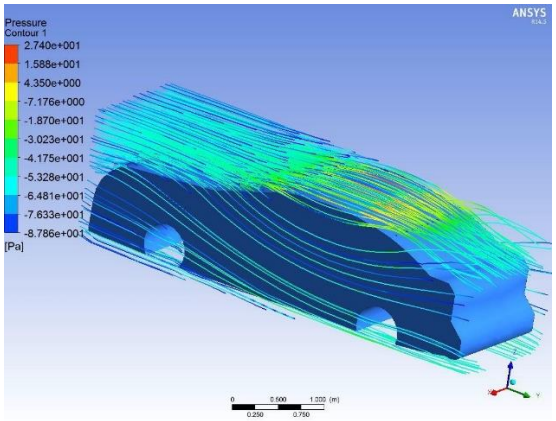

Fig shows the contours of pressure distribution

The below figure spots the result, counters of the stress distribution from minimum to maximum

As if we see the contours here the maximum stress is spotted at the roof of the vehicle and even at the placement of the vortex generator.

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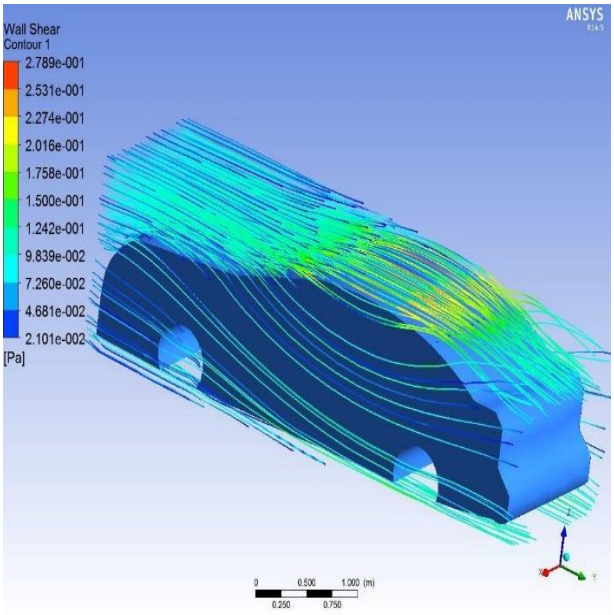

Fig shows the stress distribution

The below figure spots the result, counters of the KE distribution from minimum to maximum
As if we see the contours here the maximum KE is spotted at the roof of the vehicle and even at the placement of the vortex generator.

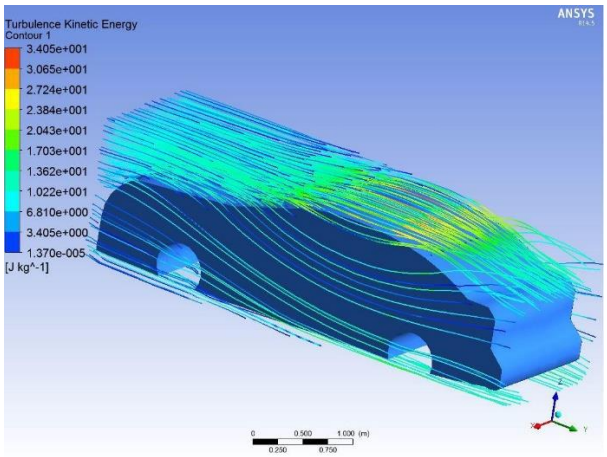

Fig shows the turbulence of kinetic energy

The below figure spots the result, counters of the velocity distribution from minimum to maximum
As if we see the contours here the maximum velocity is spotted at the roof of the vehicle and even at the placement of the vortex generator.

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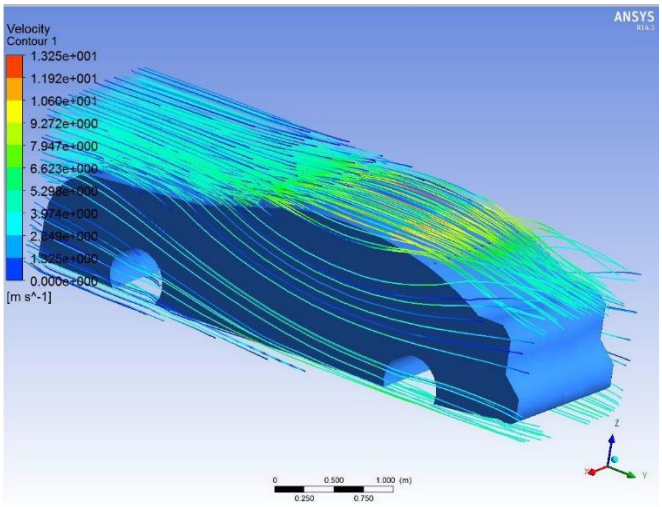

Fig shows the velocity distribution

Model 2

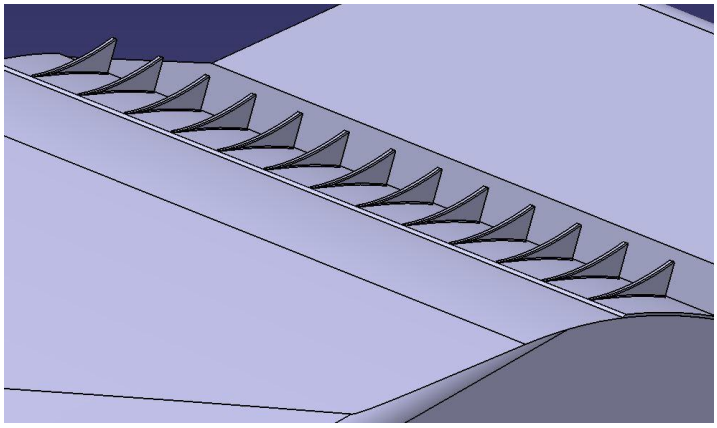

Fig shows the model of the vortex generator

Model 3

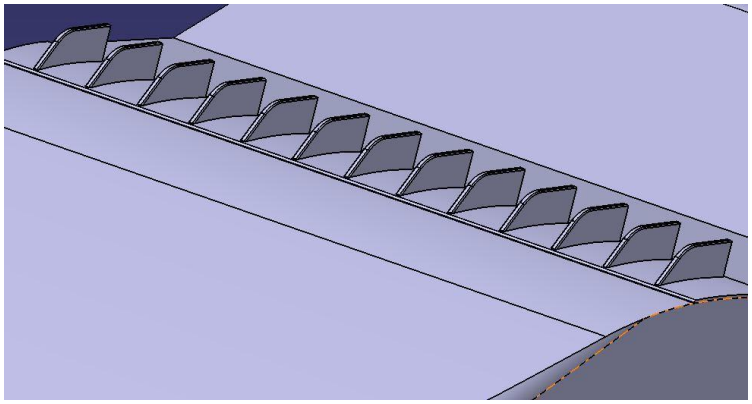

Fig shows the model of the vortex generator

RESULTS COMPARISON

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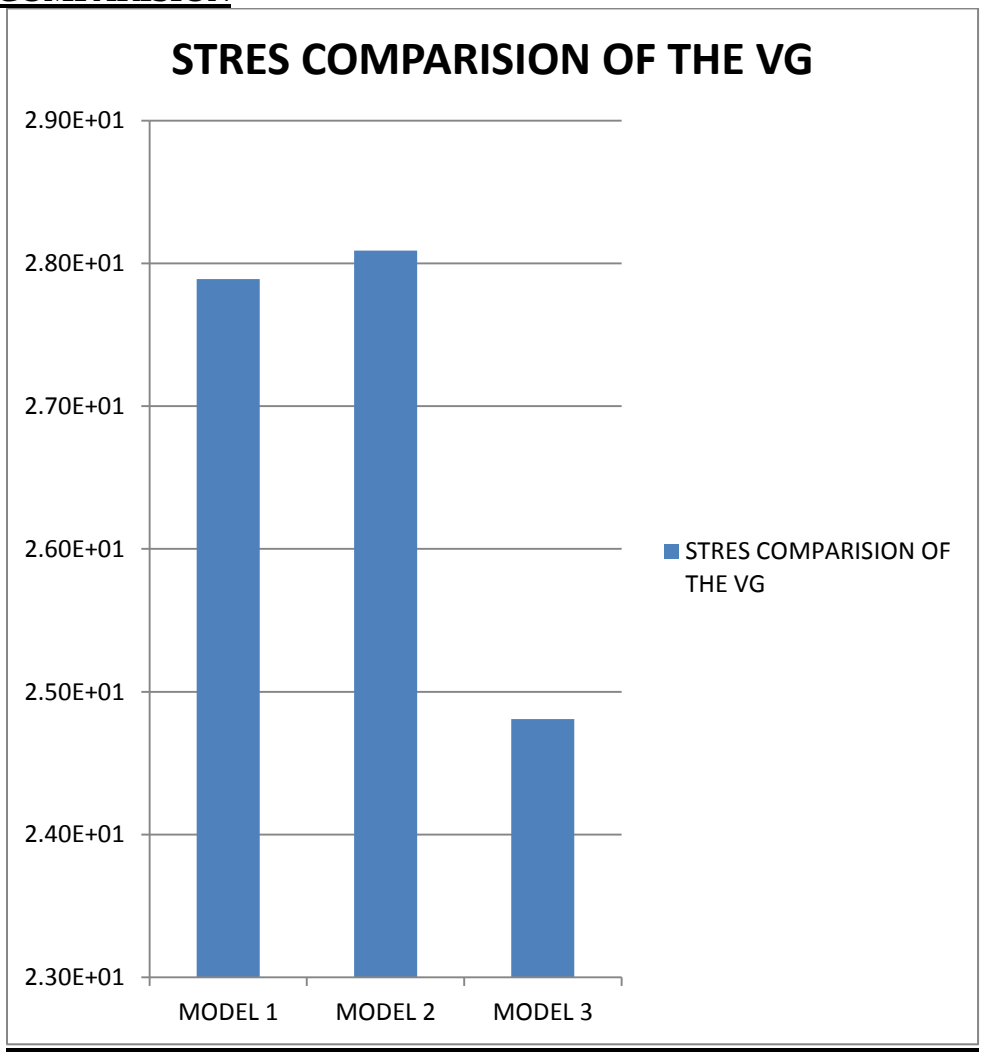
Tabular Comparison

	STRESS	K.E	VELOCITY
MODEL 1	27.89	34.05	13.25
MODEL 2	28.09	7.066	13.22
MODEL 3	24.81	266.6	162.2

Table: Tabular comparison for stress, kinetic energy and velocity

GRAPHICAL COMPARISION

STRESS COMPARISION



COMPARISION OF TURBULENCE KINETIC ENERGY

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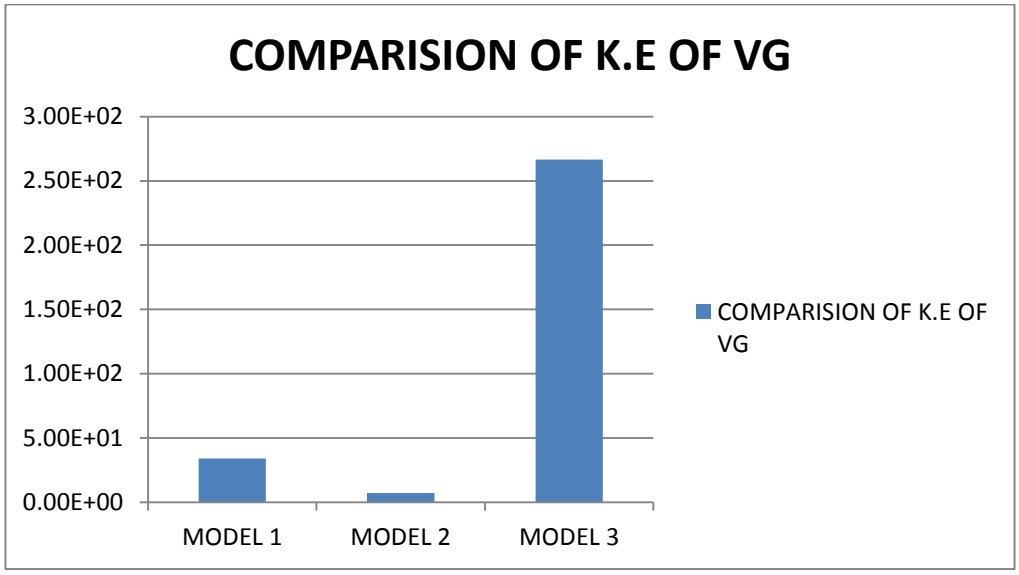
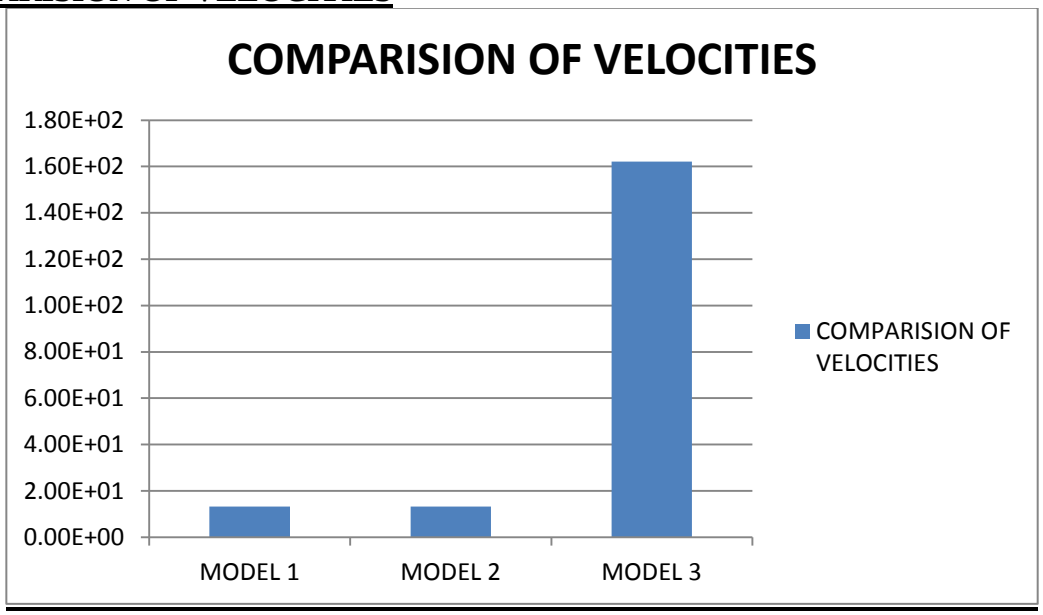


COMPARISION OF VELOCITIES



CONCLUSION

Here in this thesis we are going to use these vortex generators for the sedan modeled light weighed compact cars with various profiled designs and CFD will be carried out for the prediction.

As if we verify the project analysis results in the graphical format, here the pressure on the front bodies is same in both the models and there is not any change, as if we verify the stress and the velocities on the vehicle, there we can clearly observe that the air should flow with the higher velocities and the stress on the vehicle should be low and when we compare the velocities in the

graphical format, here we can conclude that the model 3 has the higher velocity values than the model 1 &2 and even in terms of pressure and stress the model 3 satisfies the boundary conditions, so here we can conclude that according to the drag and lift of the vehicle forces also model 3 is the suggestible for the better safety and free aerodynamic flow of air

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