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DESIGN OPTIMIZATION OF AERODYNAMIC DRAG AT THE REAR OF GENERIC PASSENGER CAR

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***Abstract*-. In vehicle body design and development the reduction of drag is essential since the primary concern of automotive industry is fuel consumption and protection of global environment. Aerodynamic drag of a commercial vehicle is a large part of the vehicles fuel consumption and it can contribute to as much as 60% of the vehicles fuel consumption. It has been established that systematic aerodynamic study of the rear end of a vehicle can help to improve its aerodynamics since one of the main cause of aerodynamic drag is the separation of flow near the vehicle rear end. The most practical way of drag reduction at the rear end is to use an effective flow control technique. In this thesis two different models of commercially available cars are tested with two different models of vortex generators placed at 3 different locations of the rear end using simulations and the acquired results are discussed briefly in the conclusion.**

I. INTRODUCTION

A vortex generator (VG) is an aerodynamic surface, consisting of a small vane that creates a vortex. Some surfaces on an airplane can result in air flow separation from the surface or skin. A vortex generator creates a tip vortex which draws energetic, rapidly-moving air from outside the slow-moving boundary layer into contact with the aircraft skin. This keeps the flow close to the aircraft surfaces. Vortex generators can be found on many devices, but the term is most often used in aircraft design. Vortex generators are also being used in automotive vehicles. In one form they are used as in aircraft to influence the boundary layer of air flow primarily for drag reduction. Vortex generators are likely to be found the external surfaces of vehicles where flow separation is a potential problem because VGs delay flow separation. The vortex is oriented by appropriate placement of the vortex generator in order to redirect airflow in the flow field so that adverse interactions are prevented or delayed. With this mechanism, the generators act as a flow deflector.

II. CATIA MODEl

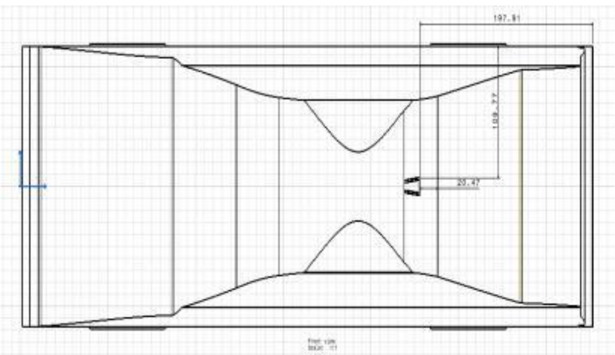


Fig: Model 1 from catia model

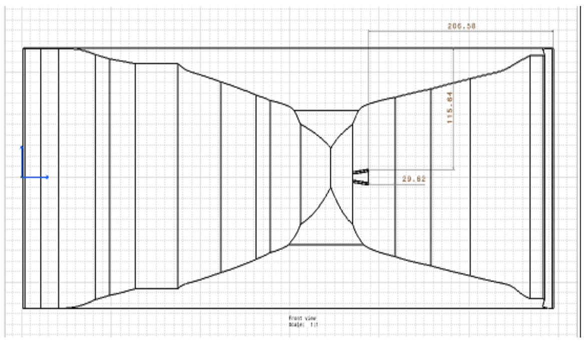
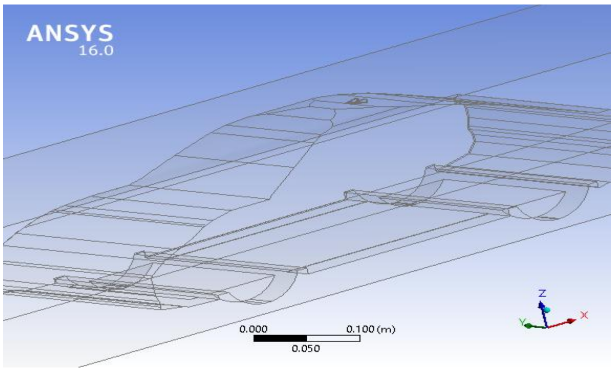


Fig: Model 2 from catia model



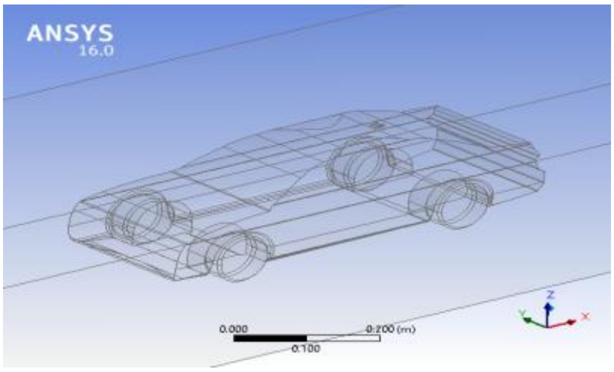
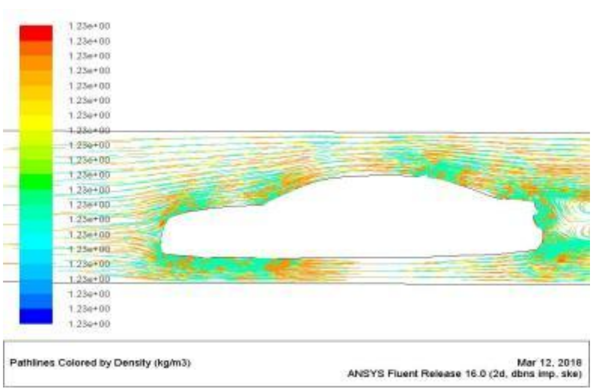


Fig: Model 1 from ansys model

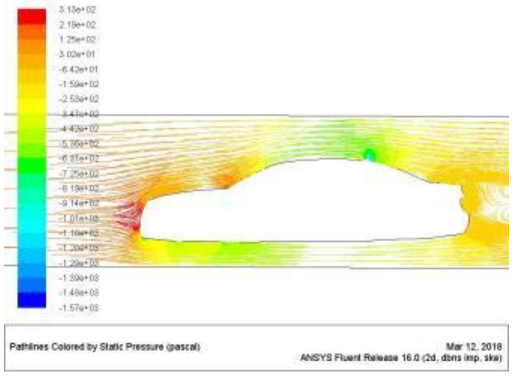
Fig: Model 2 from ansys model

III. ANALYSIS

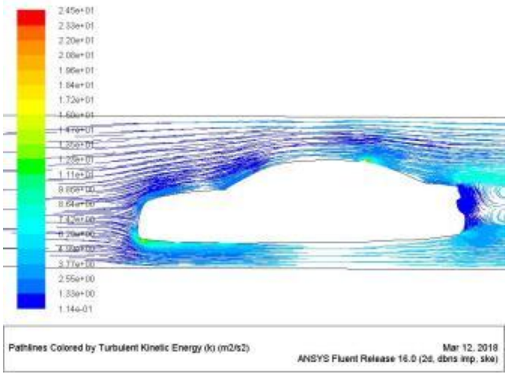
Sedan class model 1 front 60



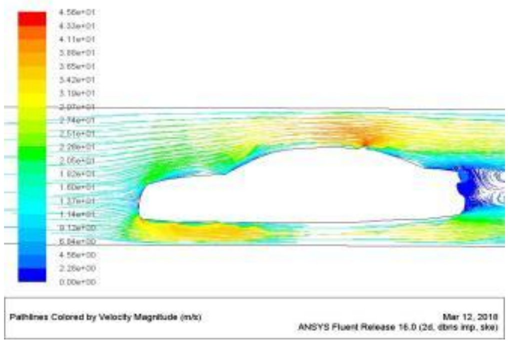
Picture showing density of sedan class model 1 front at 60kmph



Picture showing static pressure of sedan Class model 1front at 60kmph

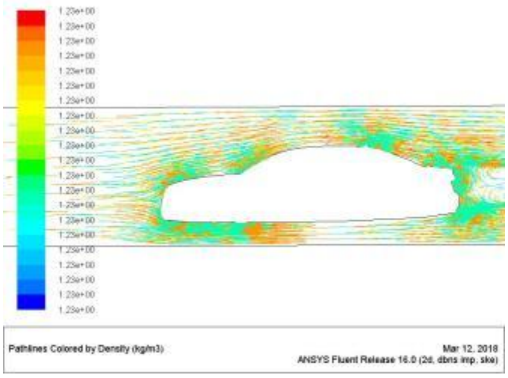


Picture showing turbulent kinetic energy of sedan Class model front at 60kmph

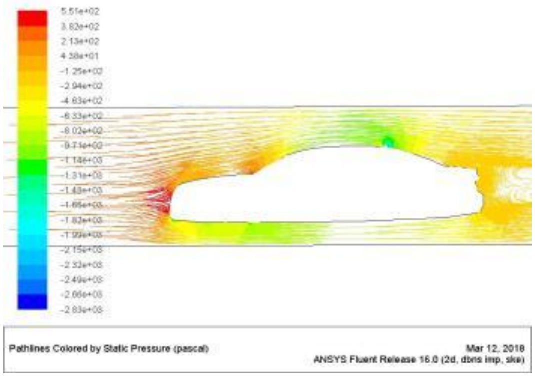


Picture showing velocity magnitude of sedan class model 1 fronts at 60kmph

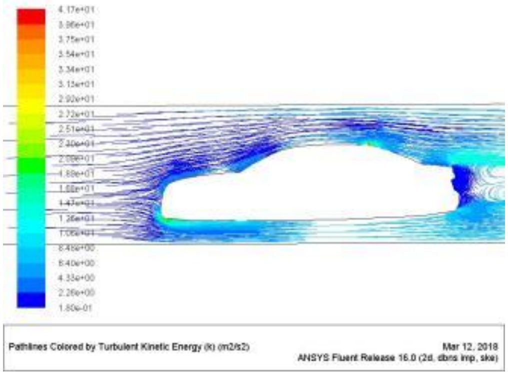
Sedan class model 1 front 80



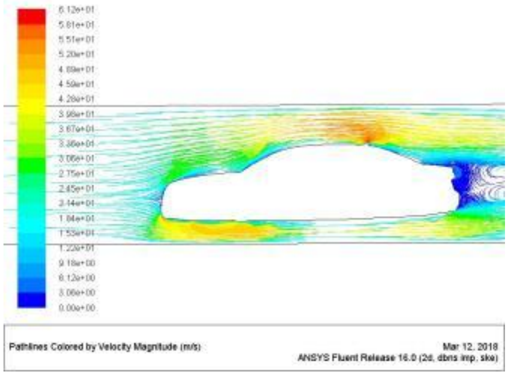
Picture showing density of sedan class model 1 front at 80kmph



Picture showing static pressure of sedan class model 1 front at 80kmph

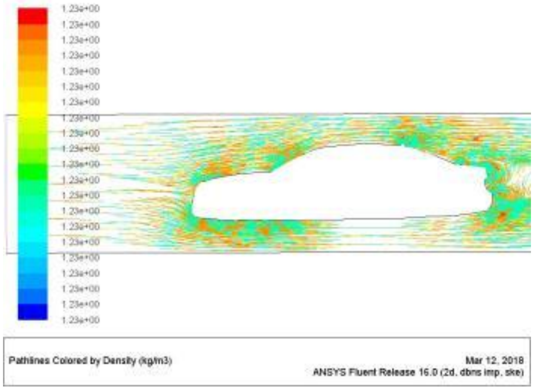


Picture showing turbulent kinetic energy of sedan class model 1 front at 80kmph

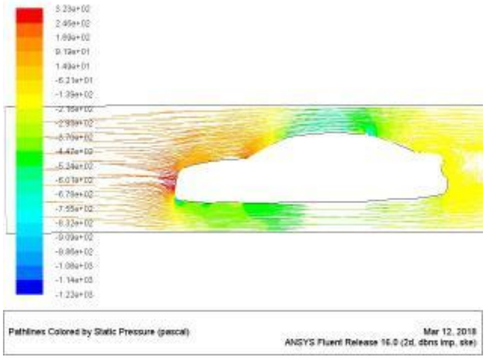


Picture showing velocity magnitude of Sedan class model 1 first at 80kmph

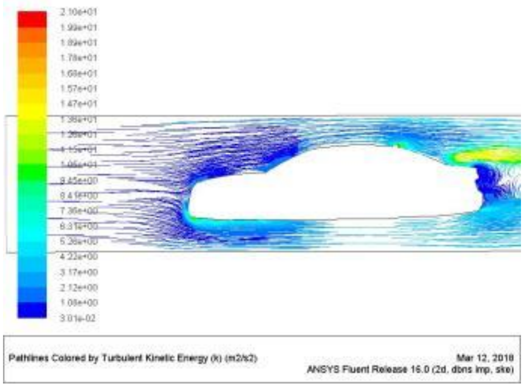
Sedan class model 1 middle 60



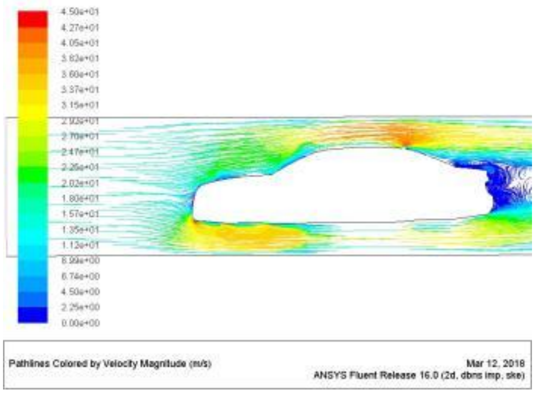
Picture showing density of sedan class model 1 mid at 60kmph



Picture showing static pressure of sedan class model1 mid at 60kmph

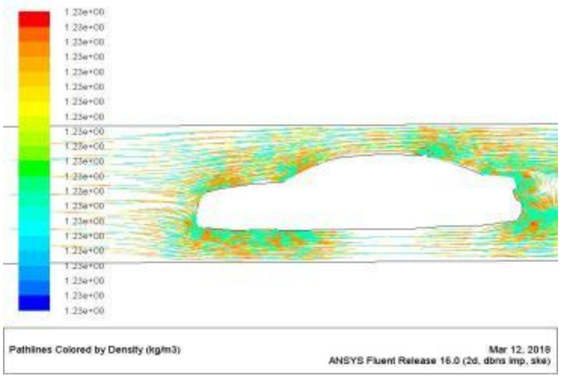


Picture showing turbulent kinetic energy of sedan class model 1 mid at 60kmph

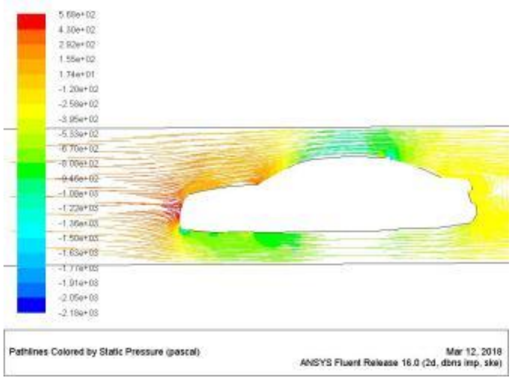


Picture showing velocity magnitude of sedan class model 1 mid at 60kmph

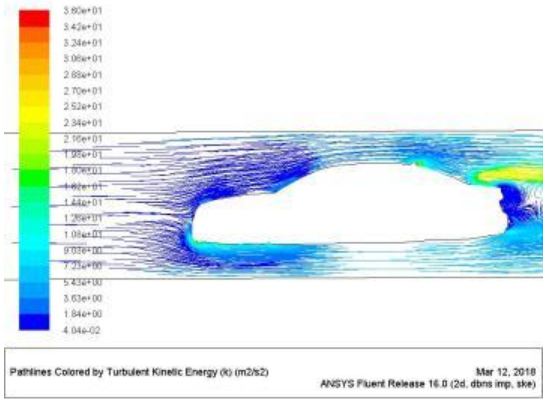
Sedan class model 1 middle 80



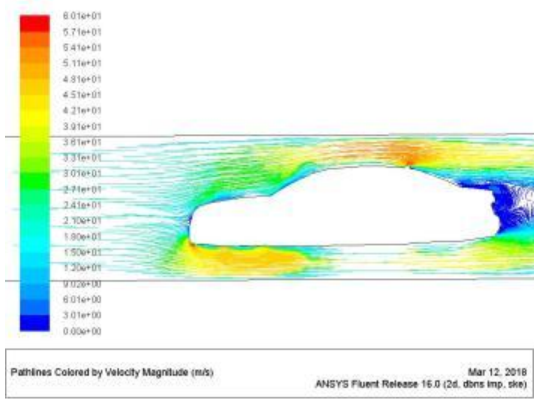
Picture showing density of sedan class model 1 mid at 80kmph



Picture showing static pressure of sedan class model 1 mid at 80kmph

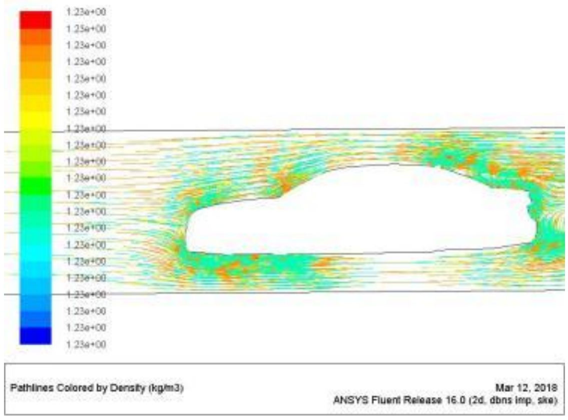


Picture showing turbulent kinetic energy of sedan class model 1 mid at 80kmph

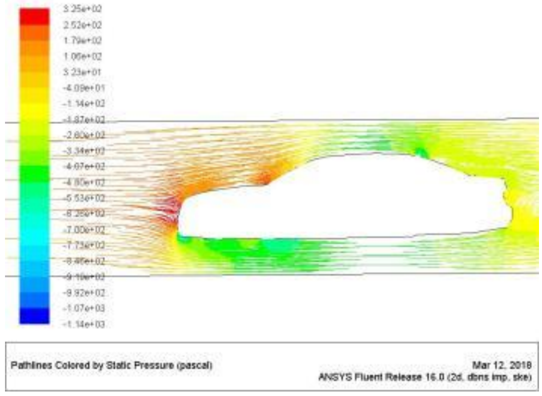


Picture showing velocity magnitude of sedan class model 1 mid at 80kmph

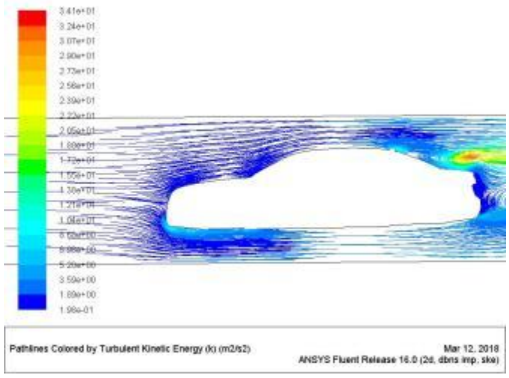
Sedan class model 1 rear 60



Picture showing density of sedan class model 1 rear at 60kmph



Picture showing static pressure of sedan class model 1 rear at 60kmph



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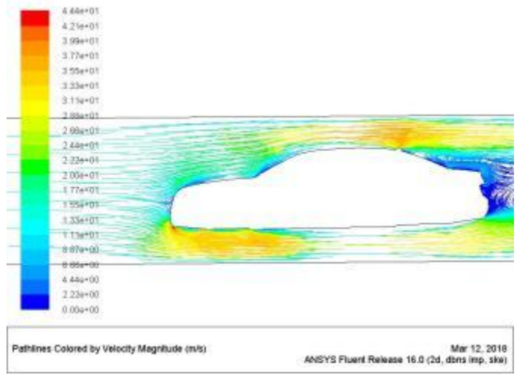
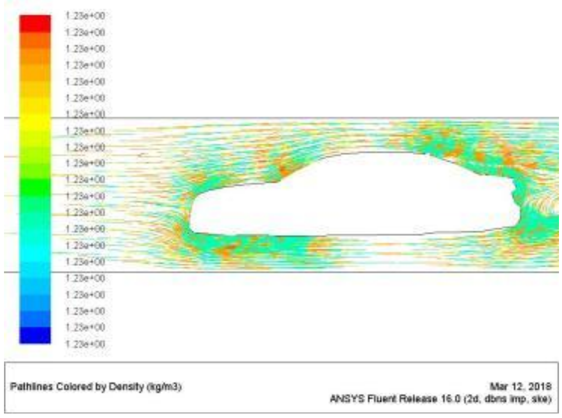


Picture showing velocity magnitude of sedan class model 1 rear at 60kmph

Sedan class model 1 rear 80



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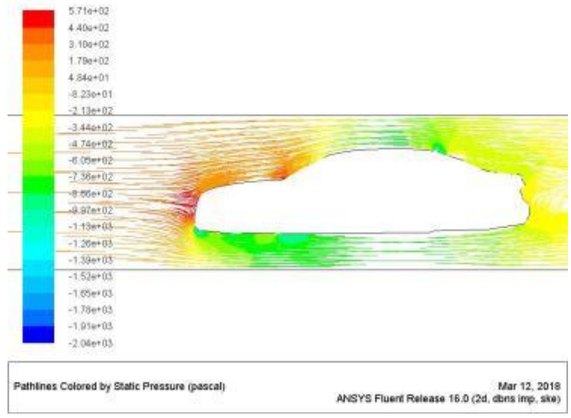
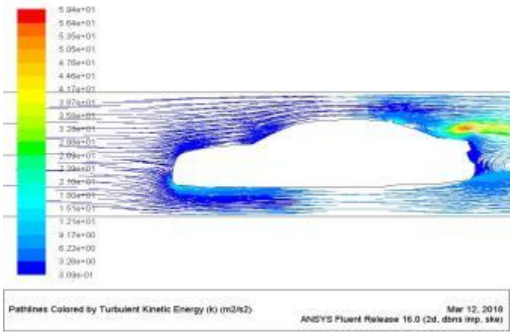


Picture showing static pressure of sedan class model 1 rear at 80kmph



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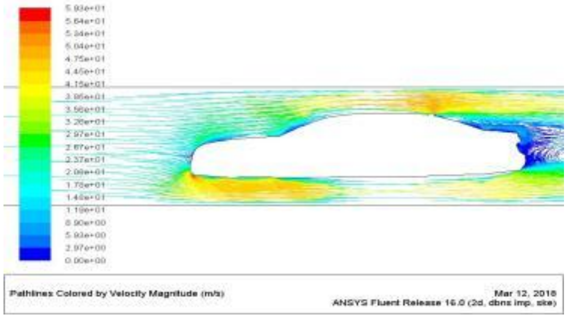
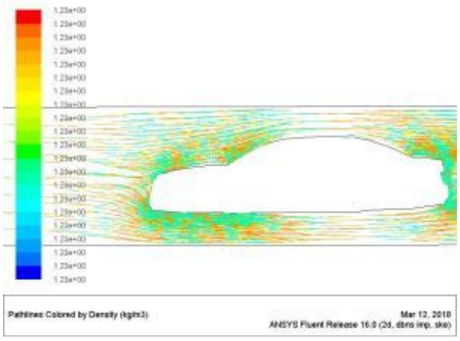


Picture showing velocity magnitude of sedan class model 1 rear at 80kmph

Hatchback model 1 front 60



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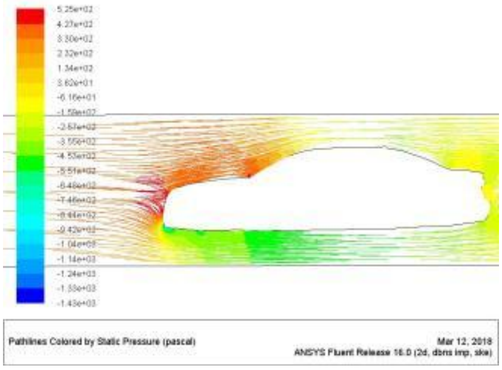

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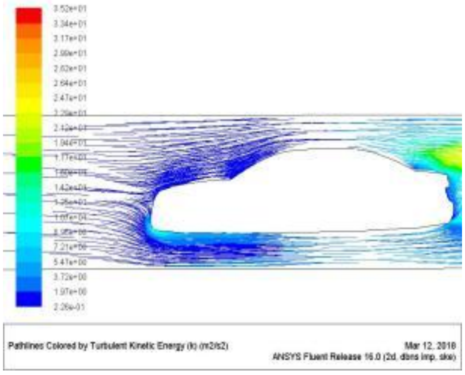
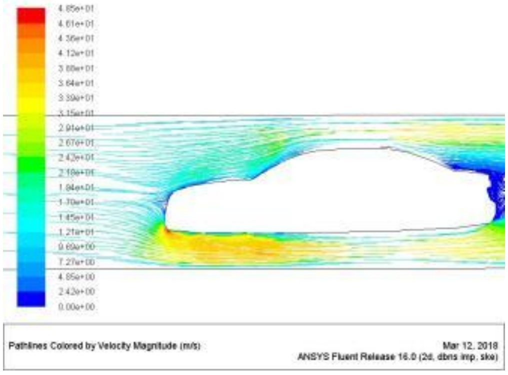
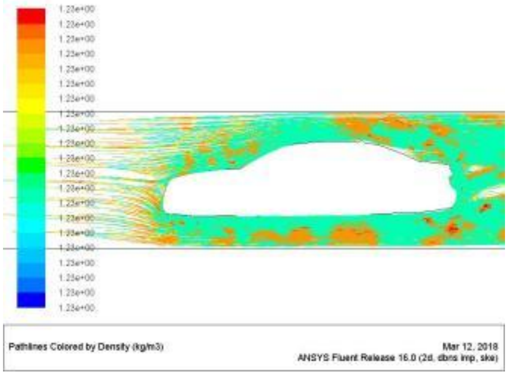


Picture showing turbulent kinetic energy of Hatch back model 1 front at 60kmph



Picture showing velocity magnitude of hatchback model 1 front at 60kmph

Hatchback model 1 front 80



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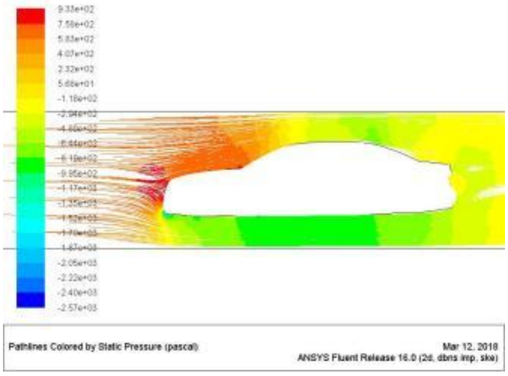

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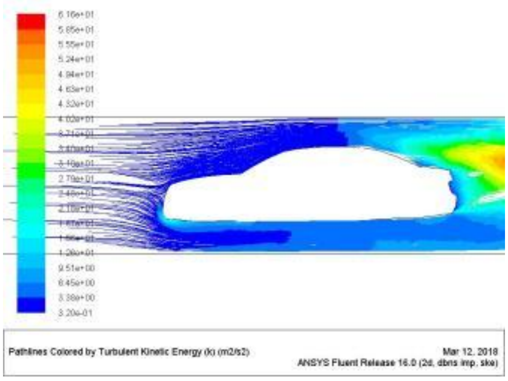
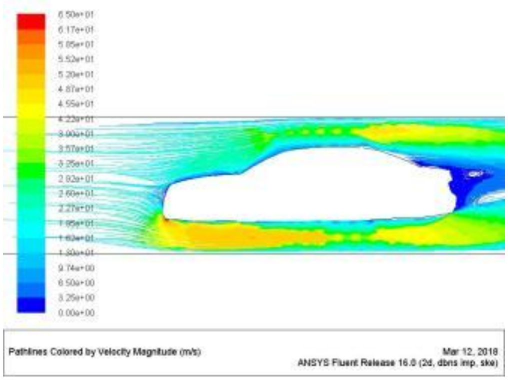
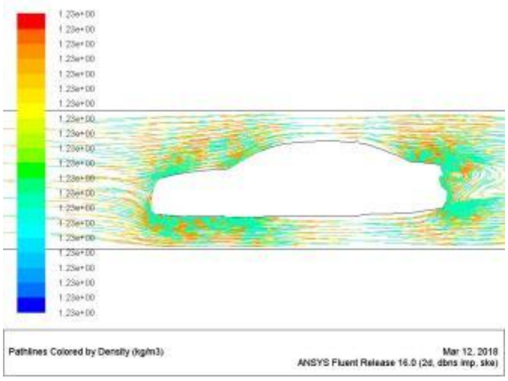


Picture showing turbulent kinetic energy of hatch back model 1 front at 80kmph

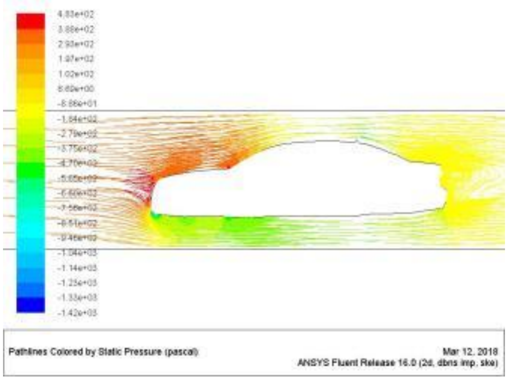


Picture showing velocity magnitude of hatchback model 1 front at 80kmph

Hatchback model 1 middle 60



Picture showing density of hatchback model 1 mid at 60kmph



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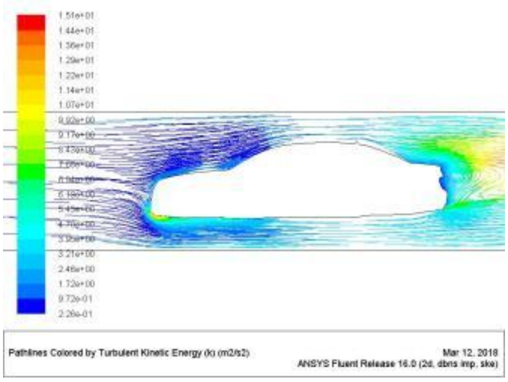

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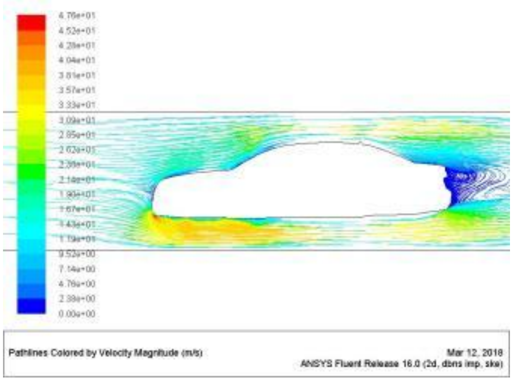
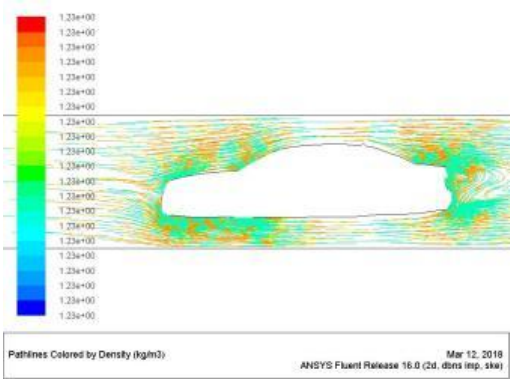
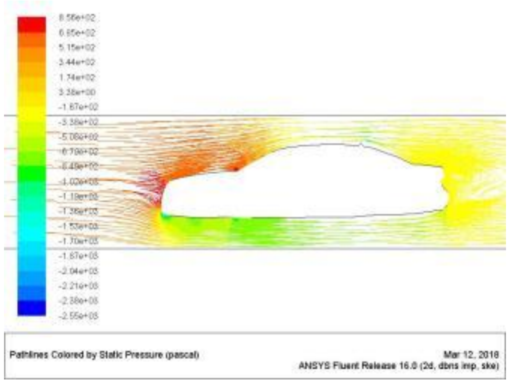


Picture showing velocity magnitude of hatch back model 1mid at 60kmph

Hatchback model 1 middle 80



Picture showing density of hatchback model 1 at 80kmph



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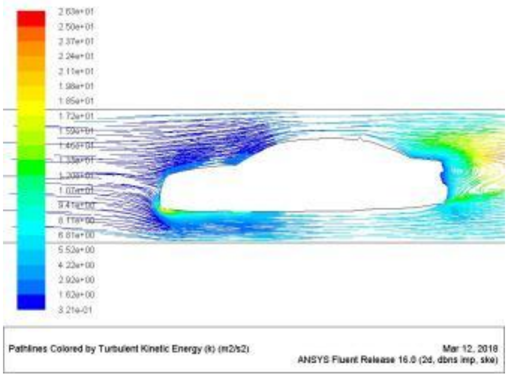
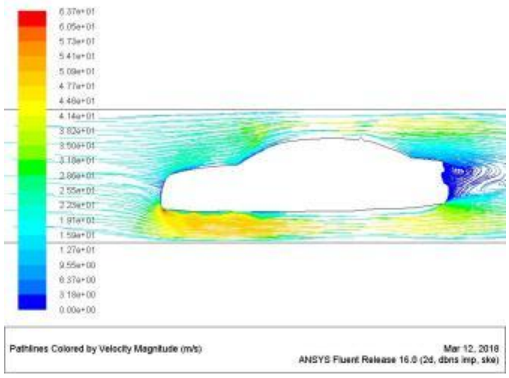
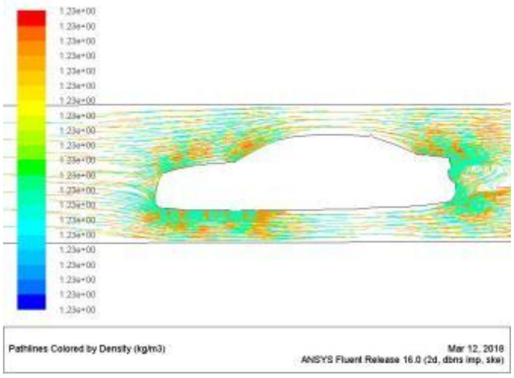


Picture showing turbulent kinetic energy of hatch back model 1 mid at 80kmph

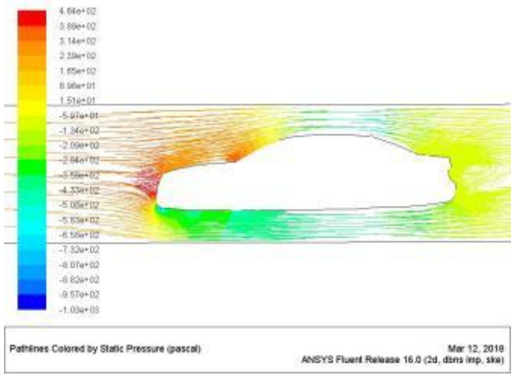


Picture showing velocity magnitude of hatchback model 1 mid at 80kmph

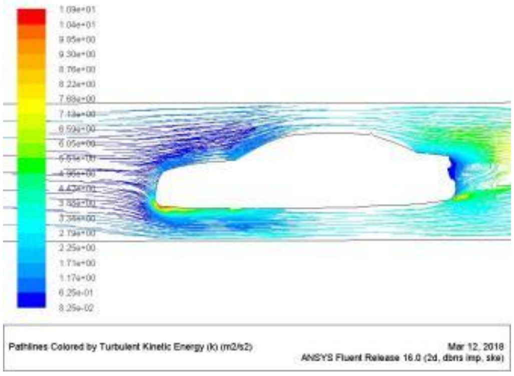
Hatchback model 1 rear 60



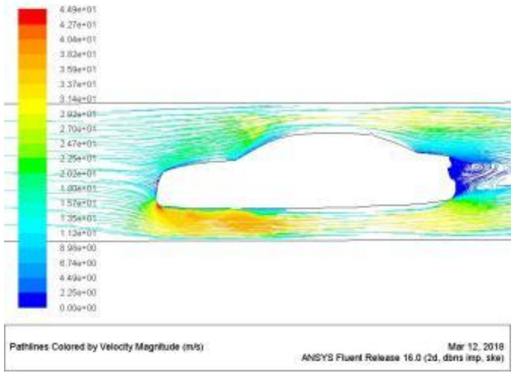
Picture showing density of hatchback model 1 rear at 60kmph



Picture showing static pressure of hatchback model 1 rear at 60 kmph

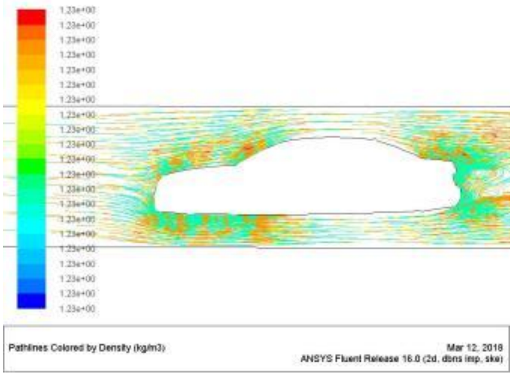


Picture showing turbulent kinetic energy of hatchback model 1 rear at 60kmph

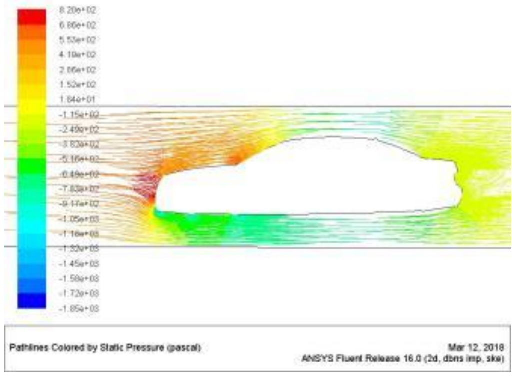


Picture showing velocity magnitude of hatchback model 1rear at 60kmph

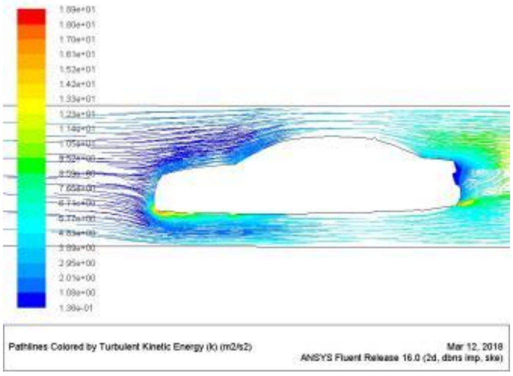
Hatchback model 1 rear 80



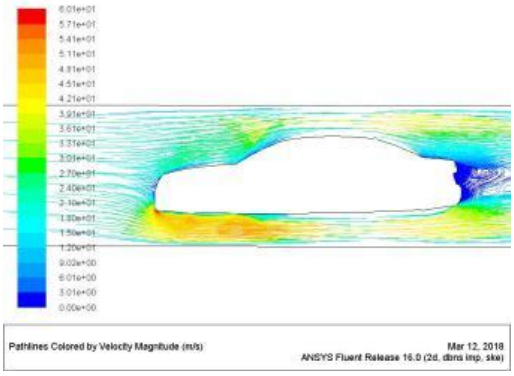
Picture showing density of hatchback model 1 rear at 80kmph



Picture showing static pressure of hatchback model1 rear at 80kmph



Picture showing turbulent kinetic energy of hatchback model 1 rear at 80kmph



Picture showing velocity magnitude of hatchback model 1 rear at 80kmph

IV. REPORT

Representing Sedan class (model 1) at 60kmph

Audi(model1)								
Audi(model1) 60kmph	Density(kg/m3)		static pressure(pascal)		turbulent kinetic energy(k)(m2/s2)		velocity magnitude(m/s)	
	Min	max	Min	Max	min	Max	Min	max
Front	1.23E+00	1.23E+00	-1.57E+03	3.13E+02	1.14E-01	2.45E+01	2.28E+00	4.56E+01
Middle	1.23E+00	1.23E+00	-1.22E+03	3.23E+02	3.01E-02	2.10E+01	2.25E+00	4.50E+01
Rear	1.23E+00	1.23E+00	-1.14E+03	3.25E+02	1.98E-01	3.41E+01	2.22E+00	4.44E+01

Representing Audi (model 1) at 80kmph

Audi(model1)								
Audi(model1) 80kmph	Density(kg/m3)		static pressure(pascal)		turbulent kinetic energy(k)(m2/s2)		velocity magnitude(m/s)	
	Min	max	Min	Max	min	Max	Min	max
Front	1.23E+00	1.23E+00	-2.83E+03	5.51E+02	1.80E-01	4.17E+01	3.06E+00	6.12E+01
middle	1.23E+00	1.23E+00	-2.18E+03	5.68E+02	4.04E-02	3.60E+01	3.01E+00	6.01E+01
Rear	1.23E+00	1.23E+00	-2.04E+03	5.71E+02	3.09E-01	5.94E+01	2.97E+00	5.93E+01

Representing hatchback (model 1) at 60kmph

hatchback (model 1)								
hatchback (model 1) 60kmph	Density(kg/m3)		static pressure(pascal)		turbulent kinetic energy(k)(m2/s2)		velocity magnitude(m/s)	
	Min	max	Min	Max	Min	Max	min	Max
Front	1.23E+00	1.23E+00	-1.43E+03	5.25E+02	2.26E-01	3.52E+01	2.42E+00	4.85E+01
middle	1.23E+00	1.23E+00	-1.42E+03	4.83E+02	2.26E-01	1.51E+01	2.38E+00	4.76E+01
Rear	1.23E+00	1.23E+00	-1.03E+03	4.64E+02	8.25E-02	1.09E+03	2.25E+00	4.49E+01

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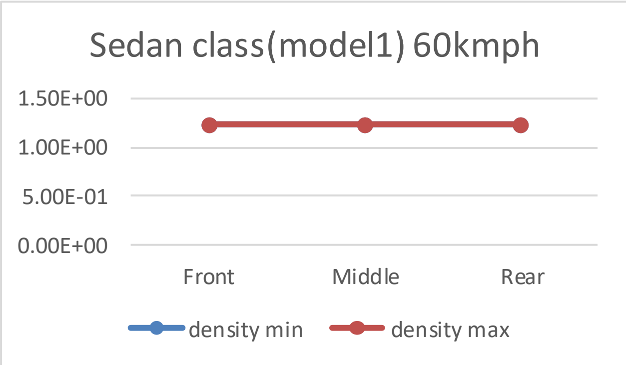
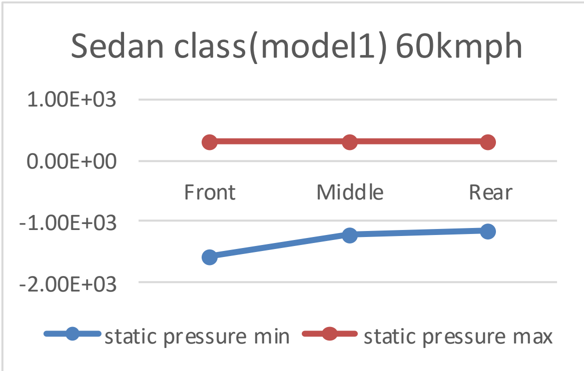
Representing hatchback **(model 1) at 80kmph**

hatchback (model 1)								
hatchback (model 1) 80kmph	Density(kg/m3)		static pressure(pascal)		turbulent kinetic energy(k)(m2/s2)		velocity magnitude(m/s)	
	Min	max	Min	Max	Min	Max	min	Max
Front	1.23E+00	1.23E+00	-2.57E+03	9.33E+02	3.20E-01	6.16E+01	3.25E+00	6.50E+01
middle	1.23E+00	1.23Es+00	-2.55E+03	8.56E+02	3.21E-01	2.63E+01	3.18E+00	6.37E+01
Rear	1.23E+00	1.23E+00	-1.85E+03	8.20E+02	1.36E-01	1.89E+01	3.01E+00	6.01E+01

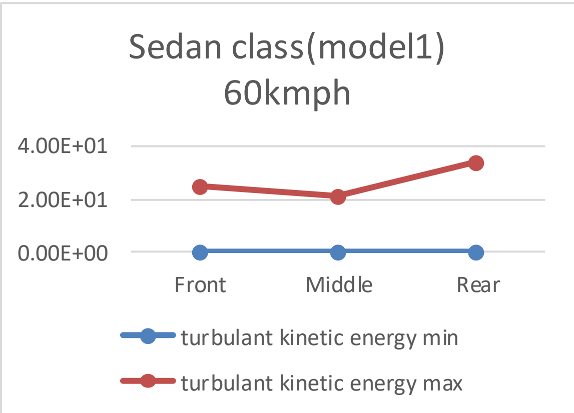
GRAPHS



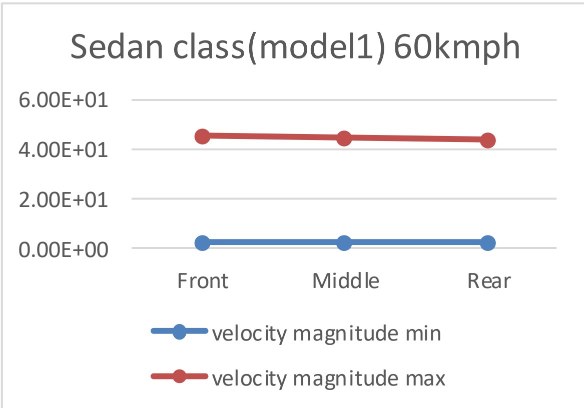
Graph showing density for sedan class model 1 at 60kmph



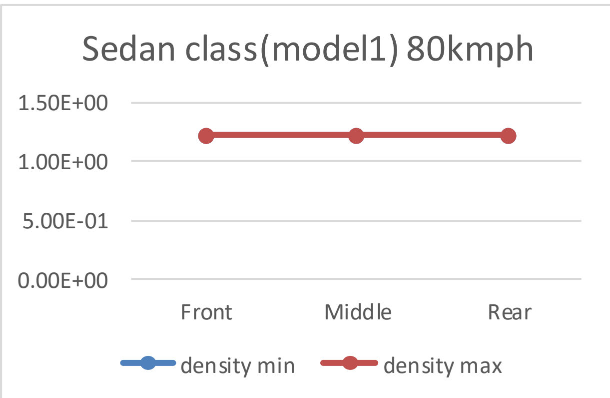
Graph showing static pressure for sedan class model1 at 60kmph



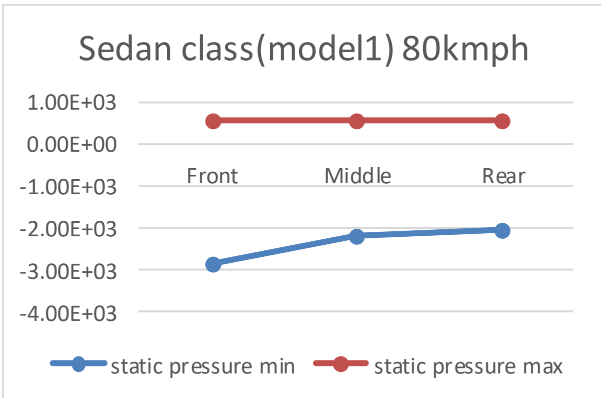
Graph showing turbulent kinetic energy for sedan class model 1 at 60kmph



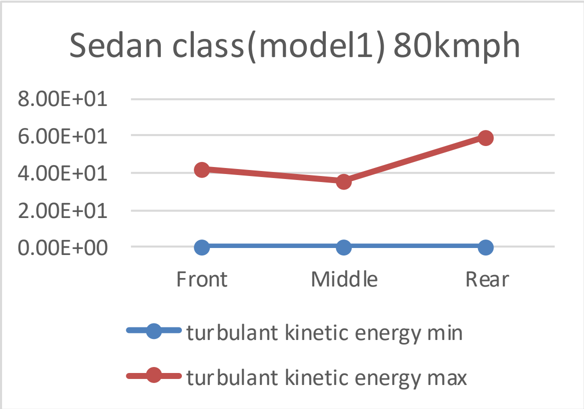
Graph showing velocity magnitude for sedan class model 1 at 60kmph



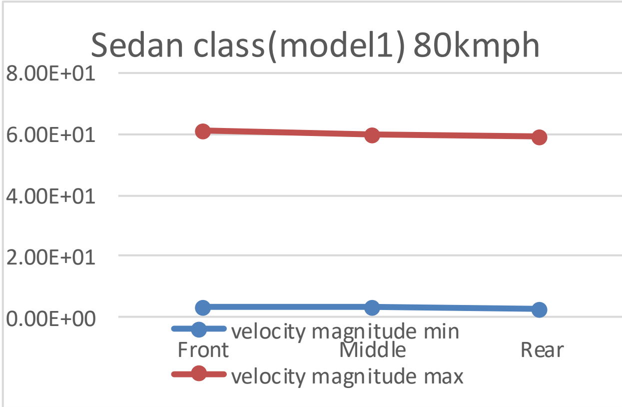
Graph showing density for sedan class model 1 at 80kmph



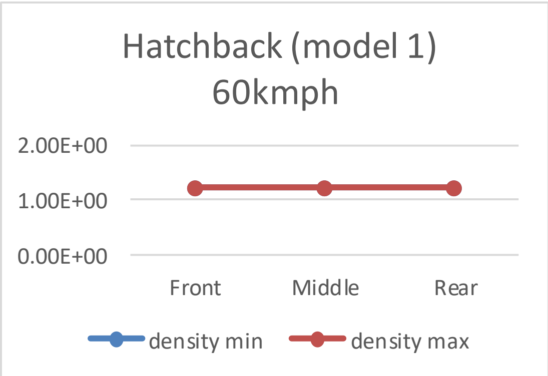
Graph showing static pressure for sedan class model 1 at 80kmph



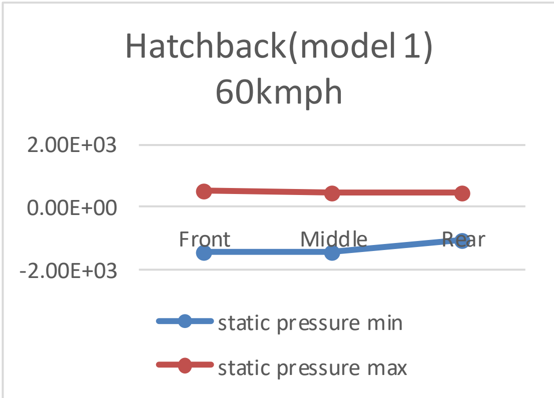
Graph showing turbulent kinetic energy for sedan class model 1 at 80kmph



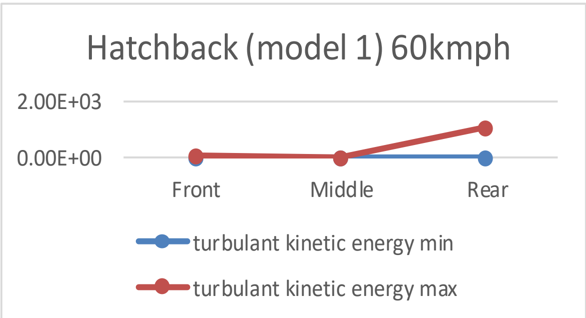
Graph showing velocity magnitude for sedan class model 1 at 80kmph



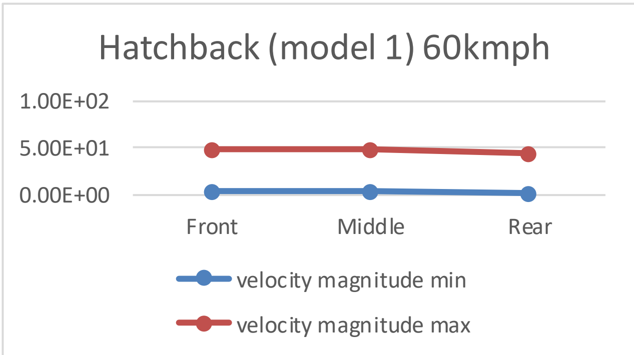
Graph showing density for hatchback model 1 at at 60kmph



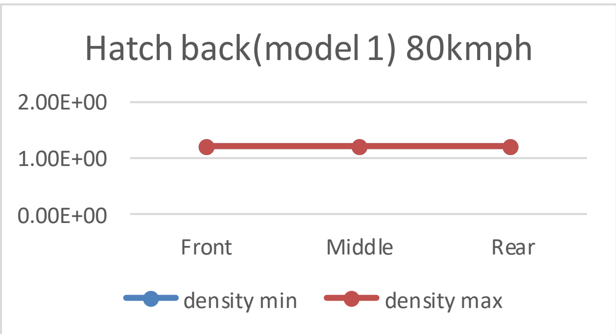
Graph showing static pressure for hatchback model 1 at 60kmph



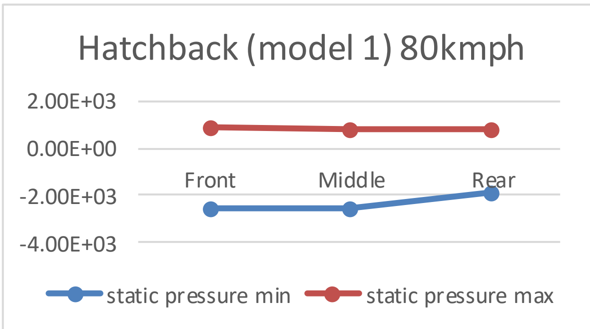
Graph showing turbulent kinetic energy for Porsche model 1 at 60kmph



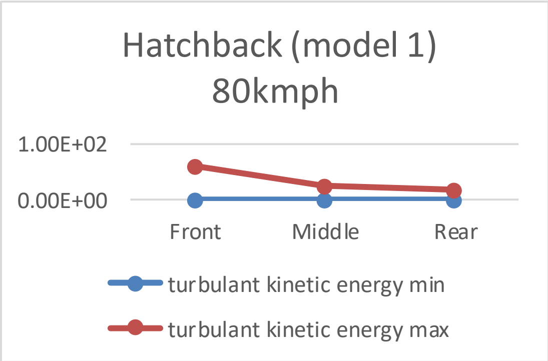
Graph showing velocity magnitude for Porsche model 1 at 60kmph

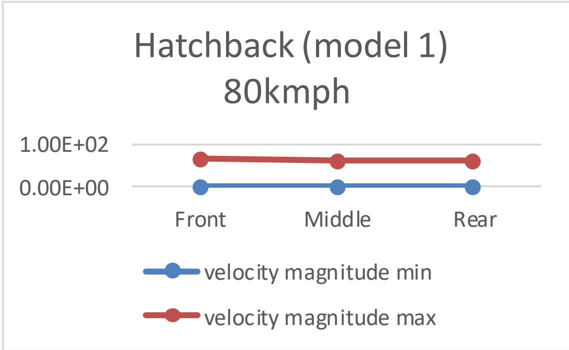


Graph showing density for hatchback model 1 at 80kmph



Graph showing static pressure for hatchback Model 80kmpn





Graph showing turbulent kinetic energy for hatchback model 1 at 80kmph

Graph showing velocity magnitude for hatchback model 1 at 80kmph

V. CONCLUSIONS

The main aim is to characterise the aerodynamic behaviour of different car models with different vortex generators at different locations, two different models of cars technically called as sedan and hatch back models are considered for this work Placement of vortex generators has a great effect on the pressures and turbulence created from the simulation results. When the vortex is placed at the end of the tail roof the pressures and turbulence created are maximum. As per low pressures at the tail end are one of the reason for poor aerodynamic performance. By placing vortex generators we can eliminate low pressures at the tail end and therefore we can improve the fuel

efficiency of the vehicle. .In case of hatch back the behaviour is entirely different maximum pressures and turbulence are occurring when the vortex generator is places at the beginning of tail roof. This behaviour of hatch back is mainly because of the absence of boot.

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