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DESIGN & ANALYSIS OF SUV CHASSIS AND ITS PASSENGER CABIN CAVITY

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Abstract— **In this paper, dynamic analysis of a sport utility vehicle chassis frame has been done using Ansys. Firstly CAE, (Computer Aided Engineering) is widely used in automotive and aerospace structural analysis. The results obtained from the simulations describe the reality with accuracy and cost effective. In this project a conceptual model of chassis of a Sport Utility vehicle will be designed in CATIA based on its body and will be used in ANSYS for stress-strain analysis, compression testing , equivalent stress and strain . The vehicle's passenger cabin vibrations also analyzed using the same. The crash involvement and behaviour of Sports Utility Vehicles (SUV) was analysed. Also comparisons were made with actual numbers of the car fleet of the vehicles types, so that exposure rates can be included. Accidents of vehicles in the above-described categories will also be compared with each other.**

INTRODUCTION –

The safety performance of passenger cars has been an important factor influencing consumers' purchasing decisions and government regulations. Currently, a New Car Assessment Program (NCAP) exists under the US Department of Transportation which assess the crash worthiness of new cars. The results are published as a well known one-to-five star rating system indicating the crash protection for passengers within the same weight class. The final results are easy to understand and have been a valuable index for the general public. Recently, the National Highway Traffic Safety Administration ("TSA) announced its plan to provide information about the rollover stability of vehicles in its future safety rating. One major driving force behind this new initiative is the well publicized rollover incidents of several Sports-Utility Vehicles (SW) and passenger cars (Suzuki Samurai, Isuzu Trooper, Mercedes A-class and the Mercedes/Swatch Smart car). It seems fair to say that rollover stability is becoming an important element in the vehicle safety performance.

At the moment many discussions are going on about the traffic safety aspect of SUV's, mainly about their aggressiveness. Some of their properties as size (geometry) and mass differ considerably from normal passenger cars. There is a lack of so called 'compatibility'. The worst item concerning compatibility is the height and especially the 'bumper height'. Other road-users feel threatened by SUV's because of the above mentioned differences. Accident studies for vehicle compatibility and traffic fatalities by vehicle type in the US show that the chance to get killed in a crash with a SUV, being an occupant in a passenger car is higher especially if the SUV is coming from the side. Another safety aspect is their rollover sensitivity. Research in this field show that SUVs tend to be more involved in vehicle rollover .Normally, a passenger car never rolls over.

For this study the definition of an SUV is set to: An SUV is a vehicle with a nose type front-end, a bigger geometry and an increased mass, front and rear bumper height, overall ground clearance and higher centre of gravity, in comparison to normal passenger cars. Terrain (off-road) vehicles and so called 'pickup-trucks' are also included in this definition.

Firstly the methods used for the analysis of the data are described. Next the results are presented, subdivided into national traffic accident statistics and TNO in-depth database. Finally the conclusions and the recommendations are presented.

METHODOLOGY

A database with all SUV and passenger car accidents is built from the combination of the Dutch National Traffic Accident Statistics or in the Dutch 'Verkeers-Ongevallen-Registratie' (VOR) database of 2001 until August, 2002 and the Dutch licence plate registration system (RDW-data) to identify the vehicle types in a collision.

All passenger car accidents and SUV accidents were extracted from the database. Normally all SUVs should be coded as passenger cars, however in the VOR in some cases these vehicles are also coded as 'Van' or 'Truck'; this is taken into account in the selection. The names of SUV type vehicles were selected from several internet sources and year book lists. In total approximately 120 SUV types were identified. The collision partners of the selected vehicles were found by coupling the vehicles in the VOR-database that were involved in the primary collision.

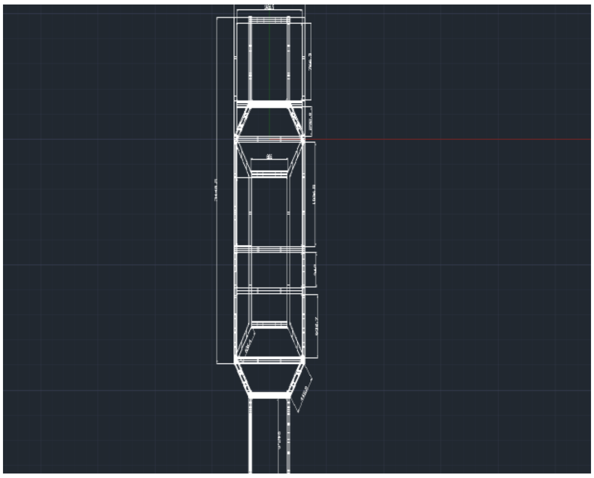
DESING OF THE SUV CHASSIS –

A finite element stress analysis need to be carried out at the failure region to determine the stress distribution and possible design improvement. Since suitable software like ProE, Catia, Solid Works, Unigraphics, etc. are normally utilized for creating the geometry of the component (3D model). The design verification can be achieved without elaborate need for prototypes at each phase saving time and effort. A final prototype for the final design review can be employed for verifying the analytical results.

CATIA-

By using catia software, design a 3d-modeeling of a sport utility vehicle chassis using different types of tool like line ,splines ,dim etc,

2D DRAFTING OF SUV CHASSIS



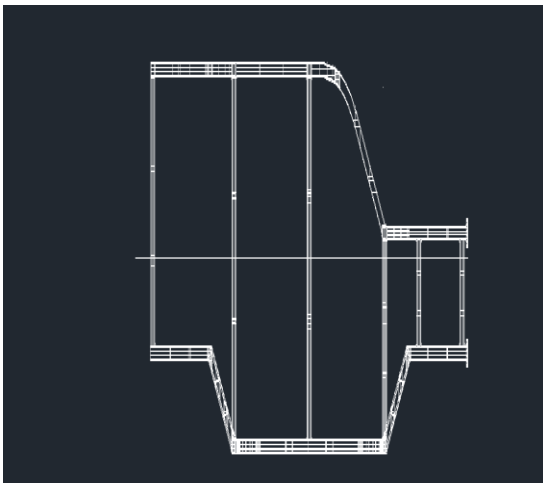


Fig : Top view of the SUV chassis

Fig : Side View of the SUV chassis

3D MODELLING OF SUV CHASSIS

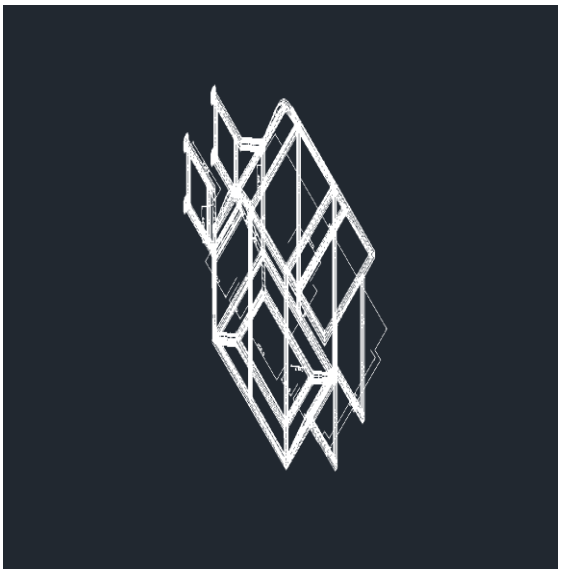


Fig: design of the SUV chassis

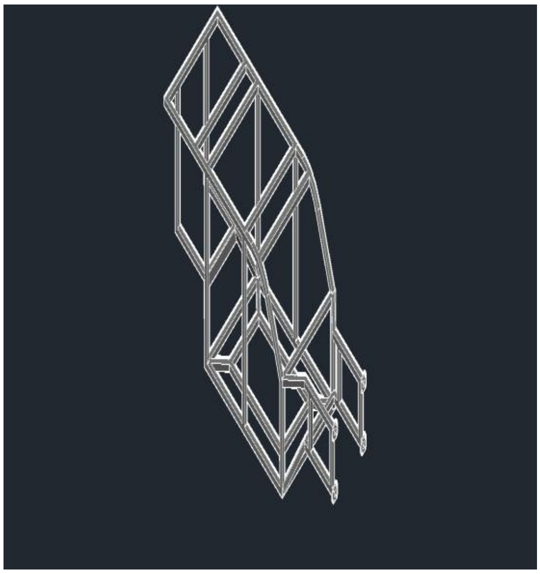


FIG :Design of a suv chassis

ANSYS-

By using ansys software ,we have to find out the deformation , equivalent stress , equivalent elastic stress and strain energy of the sport utility chassis at boundary condition .we have to applied the load at front ,rear ,bottom supports of the chassis . A user may start by defining the dimensions of an object, and then adding weight, pressure, temperature and other physical properties. Finally, the Ansys software simulates and analyzes movement, fatigue, fractures, fluid flow, temperature distribution, electromagnetic efficiency and other effects over time. Ansys also develops software for data management and backup, academic research and teaching. Ansys software is sold on an annual subscription basis.

ANALYSIS IN ANSYS-

FRONT COMPRESSIVE FORCE- 840N & 1000N

If the load is applied at the front supports and the rear is fixed in this position

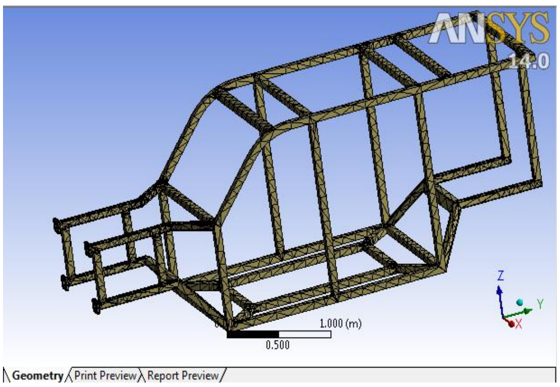


Fig : FE meshing

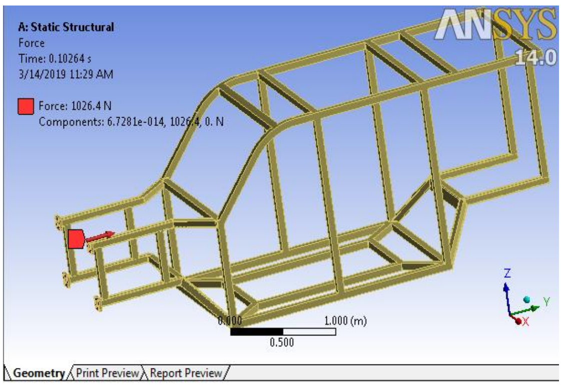


Fig : Load applied in the front chassis

REAR SUPPORT

The load is applied at the rear end and the front end is fix

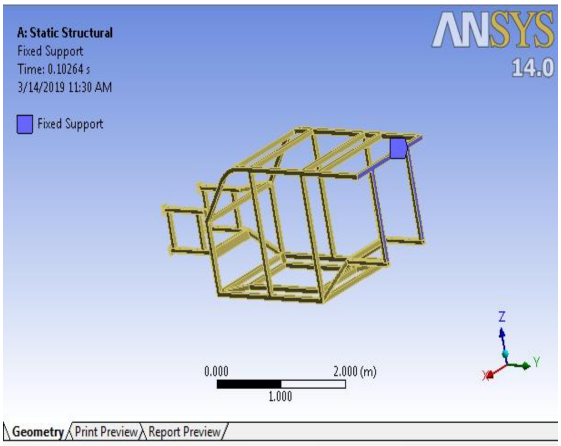


Fig : load applied at the rear sup

FRONT SUPPORT

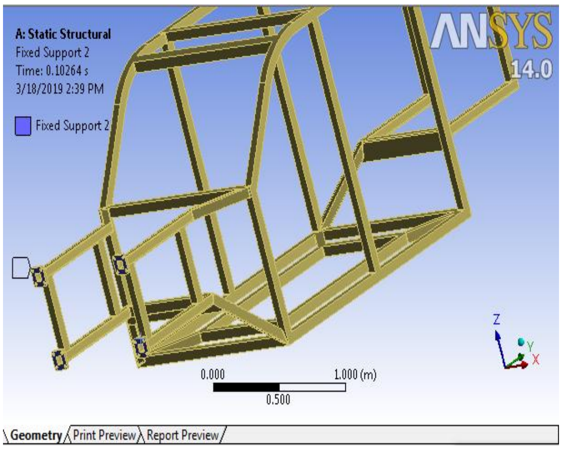


Fig :load applied at the front support of the chassis

REAR COMPRESSIVE FORCE-840N & 1000N

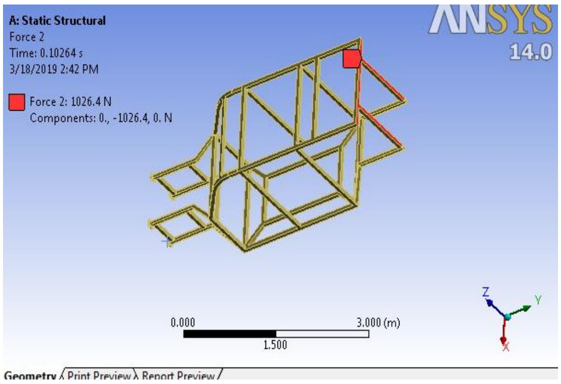


Fig : load applied at the rear end of the chassis

TOP COMPRESSIVE FORCE-840NN

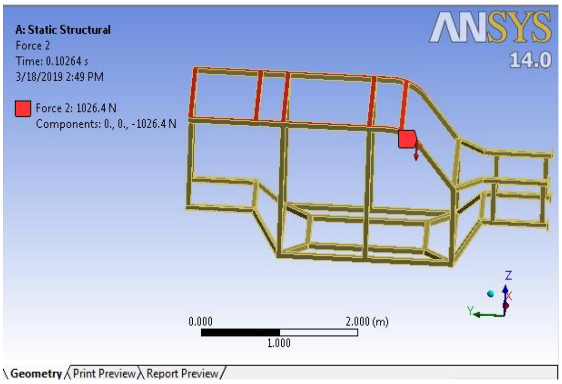


Fig : load applied at the top of the chassis

BUTTON SUPPORT

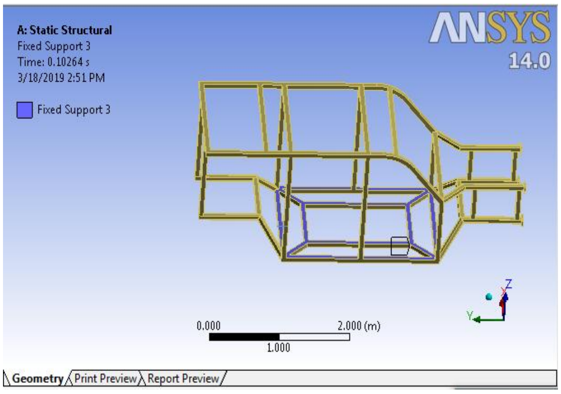


Fig : load applied at the bottom of the chassis

BOTTOM FIXED SUPPORT FOR SIMULTANEOUS FRONT & REAR COMPRESSIVE FORCE OF 1000N

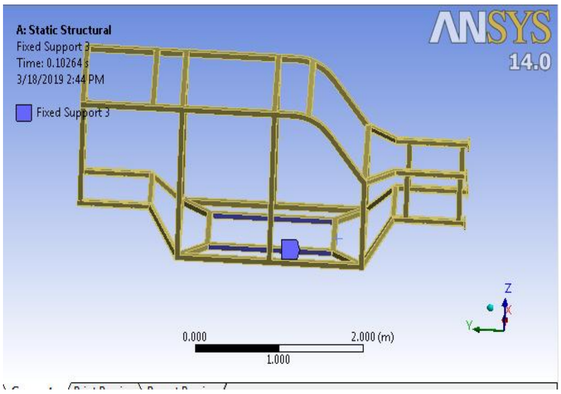


Fig : load applied at the fixed end of the bottom chassis

ANSYS POST-ANALYSIS

Material-Structural steel

Rear Compressive force -840N with front fixed Deformation

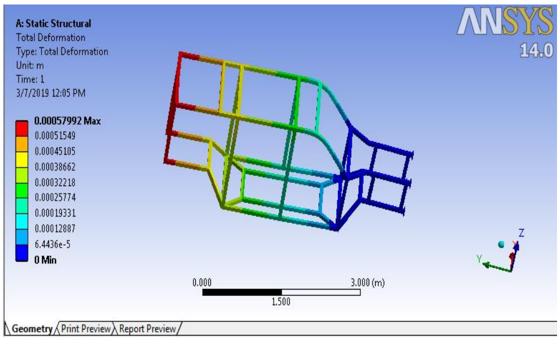
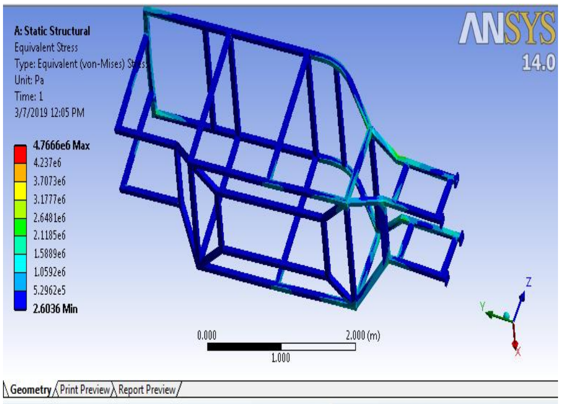


Fig : Deformation occur at the rear compressive end of the chassis

Equivalent elastic strain

A form of strain in which the distorted body returns to its original shape and size when the deforming force is removed.



Strain energy

Strain energy is defined as the energy stored in a body due to deformation. The strain energy per unit volume is known as strain energy density and the area under the stress-strain curve towards the point of deformation. When the applied force is released, the whole system returns to its original shape. It is usually denoted by U.

The strain energy formula is given as,

$U = F\delta / 2$

Where, δ = compression,

F = force applied.

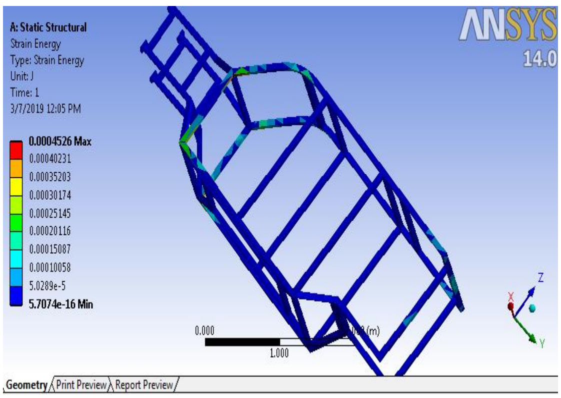


Fig :strain energy deformation

REAR COMPRESIVE FROCE -1000N WITH FRONT FIXED DEFORMATION :

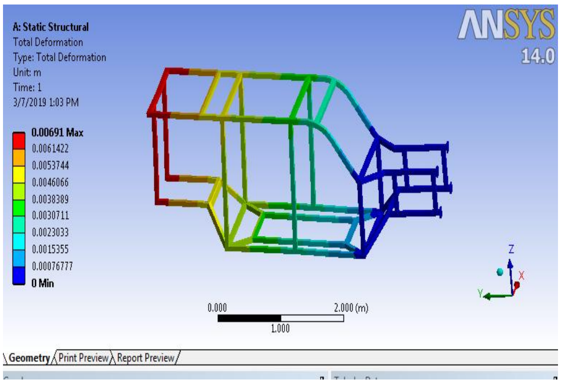


Fig : structural structure of the chassis with total deformation

EQUIVALENT ELASTIC STRAIN

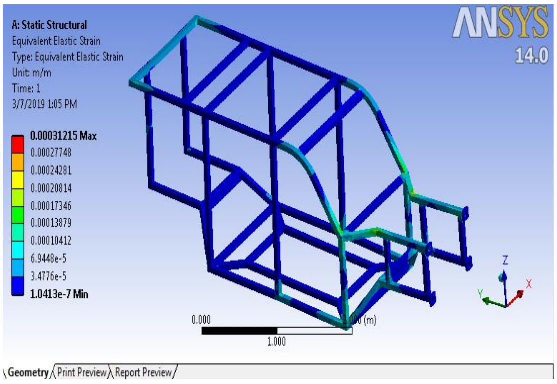


Fig: elastic strain of the suv chassis

EQUIVALENT STRESS

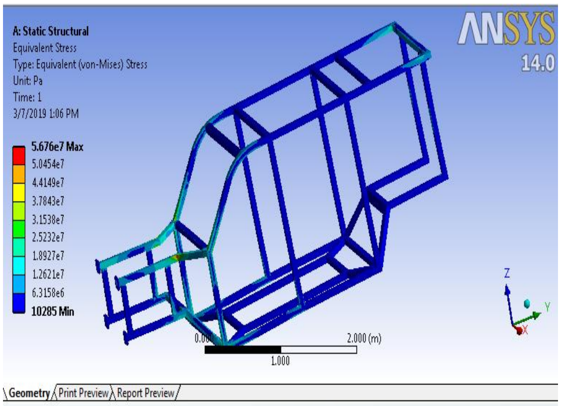


Fig : equivalent stress diagram of the svu chassis

STRAIN ENERGY

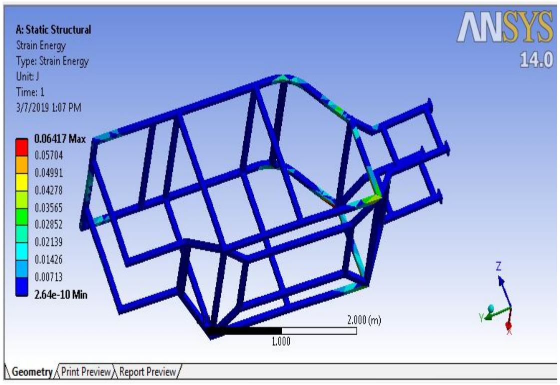
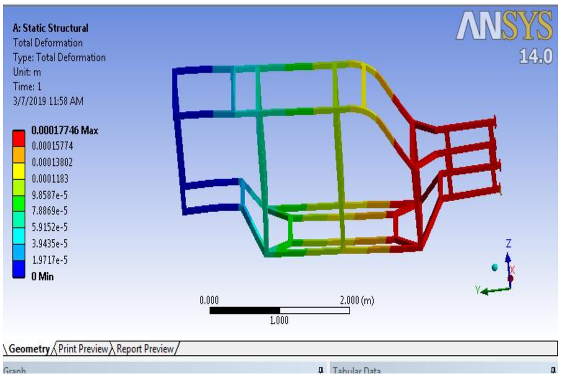
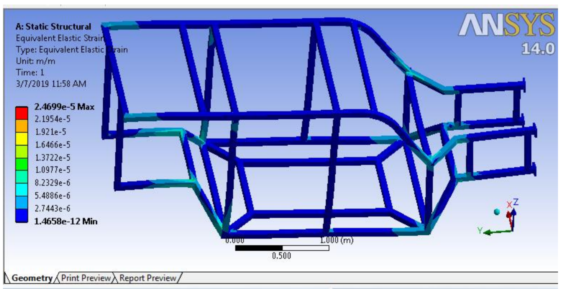


Fig :Strain energy diagram of the suv chassis

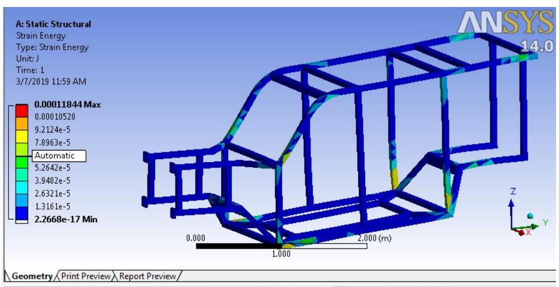
FRONT COMPRESSIVE FORCE -840N WITH REAR FIXED DEFORMATION



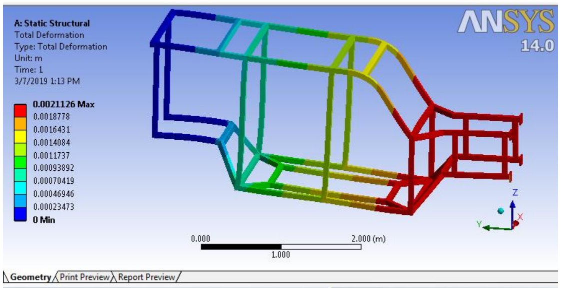
EQUIVALENT ELASTIC STRAIN



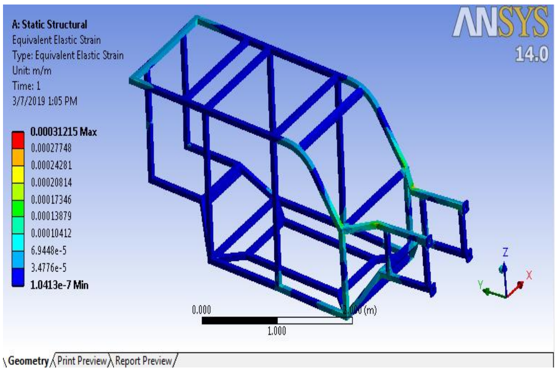
STRAIN ENERGY



FRONT COMPRESSIVE FORCE -10000N WITH REAR FIXED DEFORMATION



EQUIVALENT ELASTIC STRAIN



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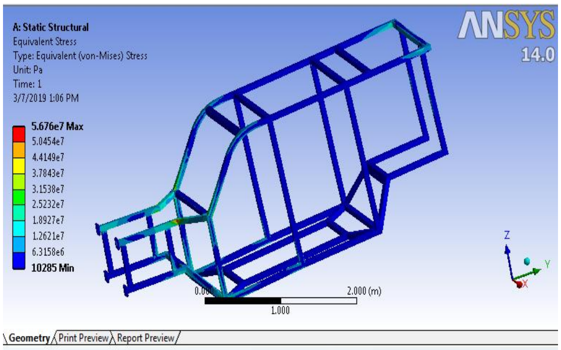
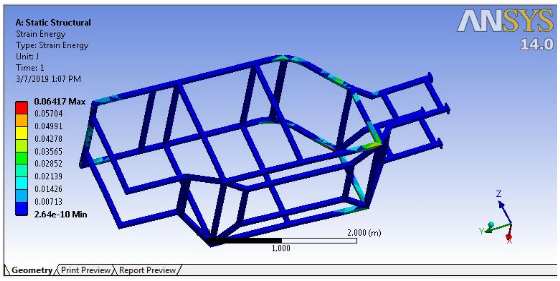
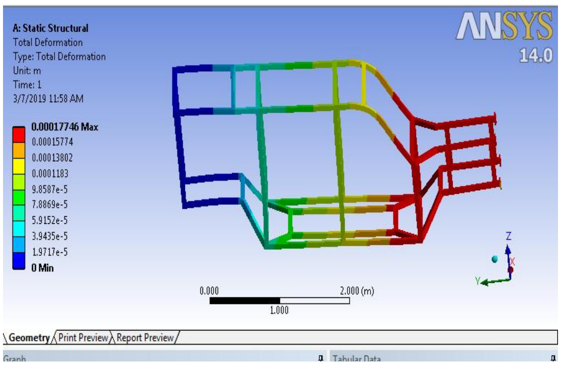


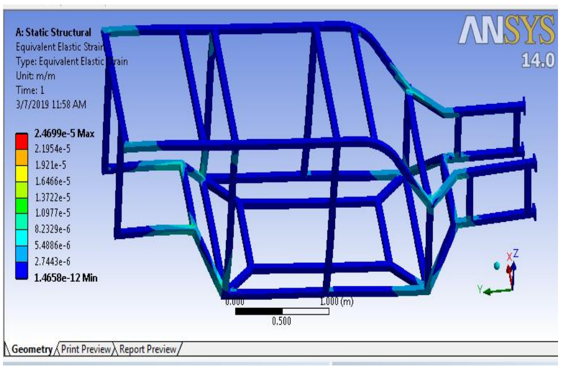
STRAIN ENERGY



FRONT COMPRESSIVE FORCE -840N WITH REAR FIXED DEFORMATION



EQUIVALENT ELASTIC STRAIN



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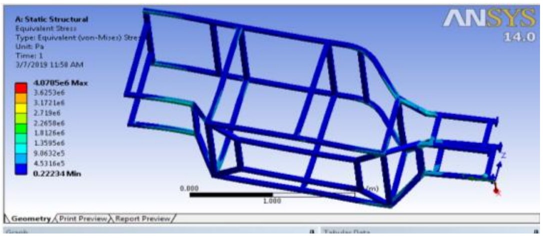
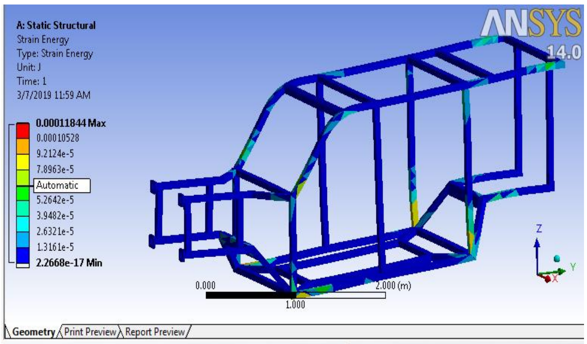
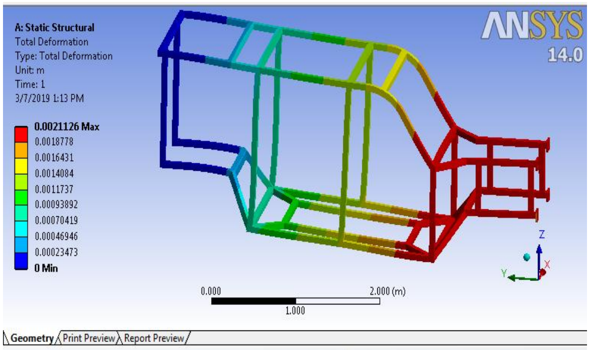


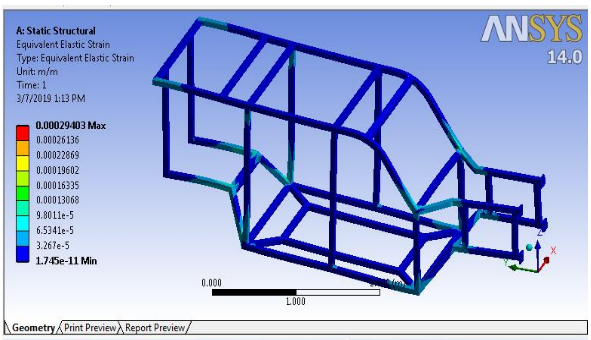
STRAIN ENERGY



FRONT COMPRESSIVE FORCE -10000N WITH REAR FIXED TOTAL DEFORMATION



EQUIVALENT ELASTIC STRAIN



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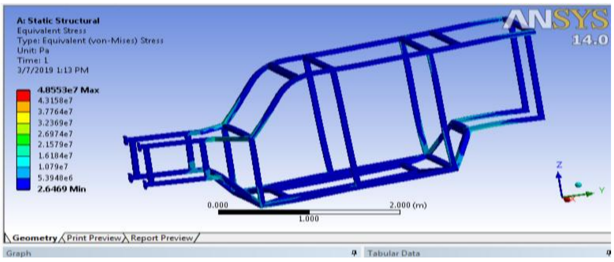

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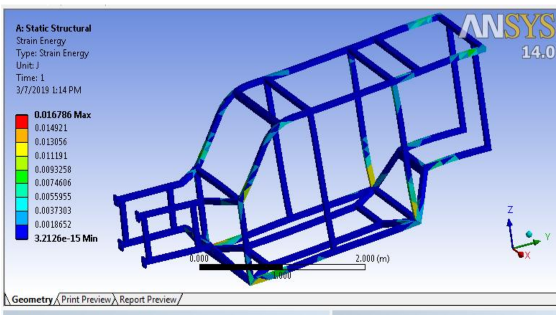
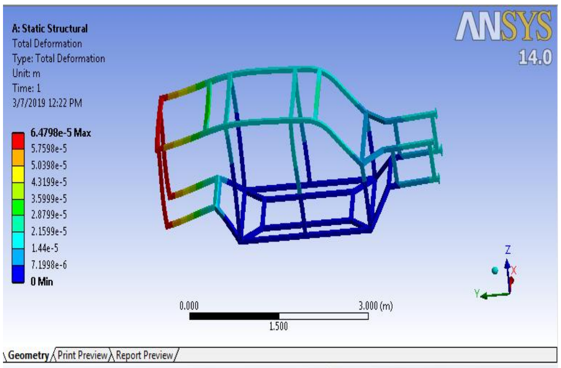
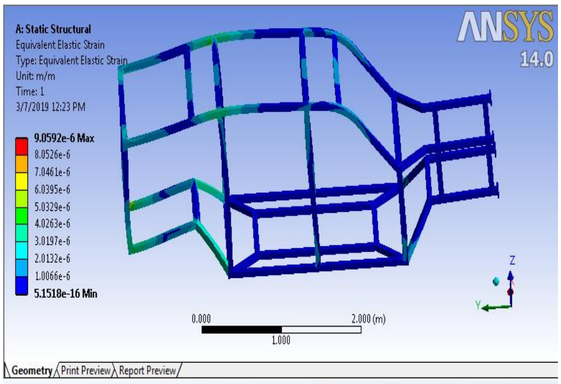


TOP COMPRESSIVE FORCE-840N TOTAL DEFORMATION



EQUIVALENT ELASTIC STRAIN



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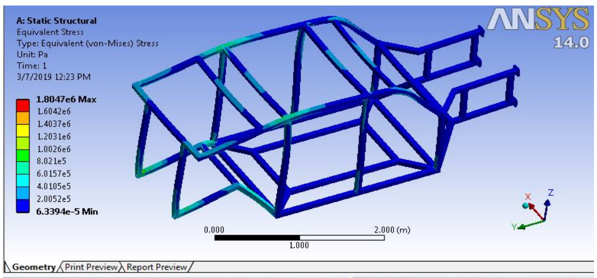
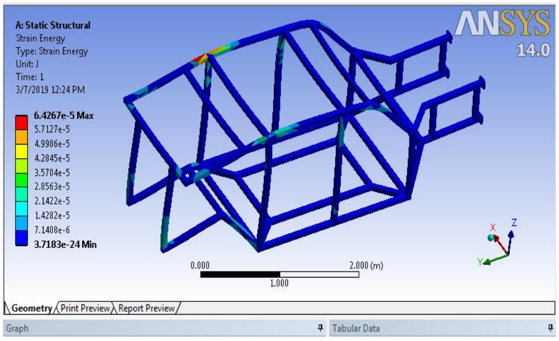
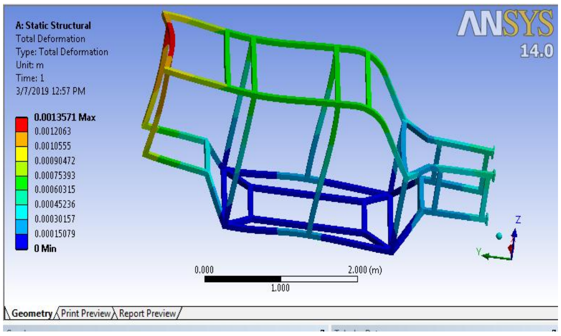


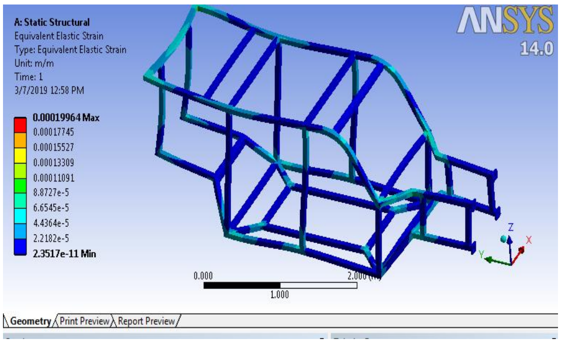
STRAIN ENERGY



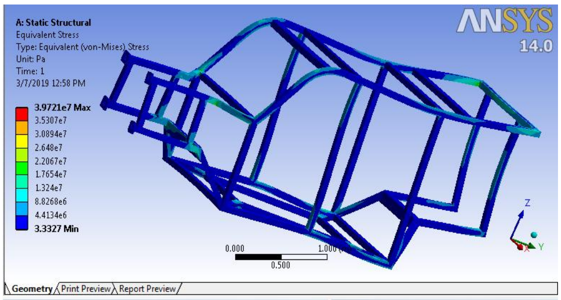
FRONT & REAR COMPRESSIVE FORCE- 10000N TOTAL DEFORMATION



EQUIVALENT ELASTIC STRAIN



EQUIVALENT STRESS



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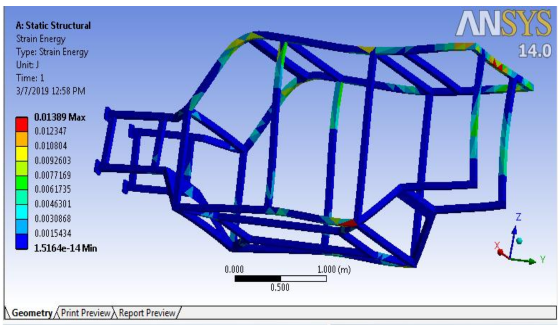

RESULTS & DISCUSSION

FORCE APPLICATION	SUPPORT	FORCE(N)	DEFORMATION(m)	EQ.EL STRAIN	EQ.STRESS (Pa)	STRAIN ENERGY(J)
REAR	FRONT	840	0.0006	2.62E-05	4.77E+06	0.0005
			0	1.94E-11	2.60E+00	5.71E-16
REAR	FRONT	10000	0.007	0.0003	5.68E+07	0.064
			0	1.04E-07	1.03E+04	2.64E-10
FRONT	REAR	840	0.0002	2.47E-05	4.08E+06	0.00012
			0	1.47E-12	2.20E-01	2.27E-17
FRONT	REAR	10000	0.0021	3.00E-04	4.86E+07	0.017
			0	1.75E-11	2.65E+00	3.21E-15
TOP	BOTTOM	840	6.48E-05	9.06E-06	1.80E+06	6.43E-05
			0	5.15E-16	6.34E-05	3.72E-24
FRONT & REAR	BOTTOM	10000	0.001	2.00E-04	3.97E+07	1.40E-02
			0	2.35E-11	3.33E+00	1.52E-14

CONCLUSION

The results in the table give respective changes in the chassis for each force and the direction and application of force. The vehicle's passenger cabin vibrations also analyzed using the same. The crash involvement and behaviour of Sports Utility Vehicles (SUV) was analysed. Also comparisons were made with actual numbers of the car fleet of the vehicles types, so that exposure rates can be included. Accidents of vehicles in the above-described categories will also be compared with each other.

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