Analysis of Four Wheel Steer Electronic Vehicle Using FEA Method

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Abstract:-we are moving towards the future development, then we are to improve our technology. The next step towards the technical development is in automotive sector.This is possible by creativity, designing and innovation of young automobile enthusiast. The sinologist of computer aided design (CAD) modelling software and that type of related technology has been promoted the development the software for the chassis modelling. It deliberates the final effect of the outputs model, which is consist in numerical data and graphical elements of the model. This rundown the simulation time and enables the betterment process to shown by successful final results. This paper presents an electronic car chassis design by using the commercial design software package, finite element analysis (FEA). The design of the chassis with satisfying stiffness and strength is the ambition of this research paper. The material used is as mild steel AISI 1018 with 360 MPa of yield strength and 420 MPa of ultimate strength. The result shown by the worrisome point of stresses and displacement created in the middle of the side members in all loading conditions, maximum stresses created in below the yield stress.

Keywords:-Computer Aided Design, Chassis Modelling, Finite Elemental Analysis, Mild Steel AISI 1018, and Stress.

I. INTRODUCTION

Technical embarkation in electronic car design, we will create a considerable prohibition in the future in reducing radiation. Electronic drive vehicles are designing an appealing instead to combustion engine cars with increases fuel prices rise. In electronic cars, efficiency of energy usage is very intrinsic. In an electronic car to perform to have sufficient structure, it must have a stiffframe for the electronic car chassis frame. Forasmuch as electronic car's weight is two side in between the front and rear suspension, frame stiffness is absolutely these points where it is not easily bend. For the electronic car, stiffness is also very intrinsic. The safety requirements the chassis structure in itself should be givenas torsional and bending stiffness as well as direct supporting guide for the front suspension and steering system mounting points. Electronic car chassis designing and fabrication involves trade-offs. There is no one perfect design. The conspicuous consideration is that the car ought not be too heavy. This will make it easy for the motor to push a low weight electronic car than a big and also heavy one [1].

Four wheel steer is a system developed in automotive sector for the impactful turning of the vehicle and to increase the manoeuvrability. In an exemplary front wheel steering system the rear wheels do not turn in the direction of the curve and thus bridle on the capability of the steer car. In four wheel steer system the rear wheels turn with the front wheels thus increasing the capability of the vehicle. The way of steering the rear wheels related to the front wheels depends on the operating conditions. At low speed wheel movement is specific, so that rear wheels are steered in the opposite direction to that of front wheels. At high speed, when steering adjustments are tenuous, the front wheels and the rear wheels turn in the same direction. In city driving conditions the vehicle with higher wheelbase and track width face problems of turning as the space is narrow, the same problem is faced in low speed corner[2]. In this study, an attempt is made to design an electronic car chassis that would reduce the weight and provide high strength and high stiffness and easy to design and manufactured.

II. CHASSIS

The electronic car chassis frame such as various automotive parts as engine,steering, tires, brakes, axle assemblies etc. The chassis is apprehend to most emphasis component of the automotive sector. The more fatal element that gives stability and strength to the vehicle under different conditions. The electronic chassis frames supplyflexibility and strength to the car. The brawnof automobile, to its supporting chassis frame to the body of an engine and assemblies are connected to each other. Automotive chassis is considered as luminous structures of an automobile. It is usually make them of a mild steel AISI 1018 material of the frame. The electronic car chassis is frequently made of composite plastics or light sheet metal. Automotive chassis helps to keep an automobile stiff, rigid

and unbending. Automotive chassis undertake to nether levels of sound and vibrations [3].
The Automotive chassis has two main goals.
• Hold the weight of the components.
• To rigidly fix the suspension components together when moving.
Designing of the electronic car chassis is important part while consisting and developing the any car. It consists of several following parts:

- *Stiffness:* the electronic car chassis should stiffness is also possible to withstand torsion. When defining the handled qualities of the electronic car, the effective methods of adjusting the amount of over-steer and under-steer are the adjustment of roll stiffness. When up growingof front roll stiffness then down growing rear roll stiffness, both rear tires are must be equal weighted than the front tires. This makes tuning more difficult, and in extreme cases, impossible.
- *Weight:* weight should be minimized as soon as possible. Just as important as weight, is mass moment of inertia. An electronic car with a lesser mass moment of inertia will be able to turn and run to start more quickly. In according to rundown mass moment of inertia, all weight on the chassis is pushed as soon as possible towards the direction ofthe centred vehicle.
- *Tubular Space Frame chassis:* Tubular space frame chassis is structure which is manufactured by the welding of various steel pipes. Such chassis gives maximum rigidity in all directions reducing chances of failure. Manufacturing of such type of chassis is time consuming and can't be robotize. High performance cars like All Ferrari Before the, Jaguar XJ220, 360M, Lamborghini Diablo, F1 and Caterham cars. Considering various parameters, rigidity requirement and availability of resources, the project car is manufacture by Tubular Space frame Chassis.

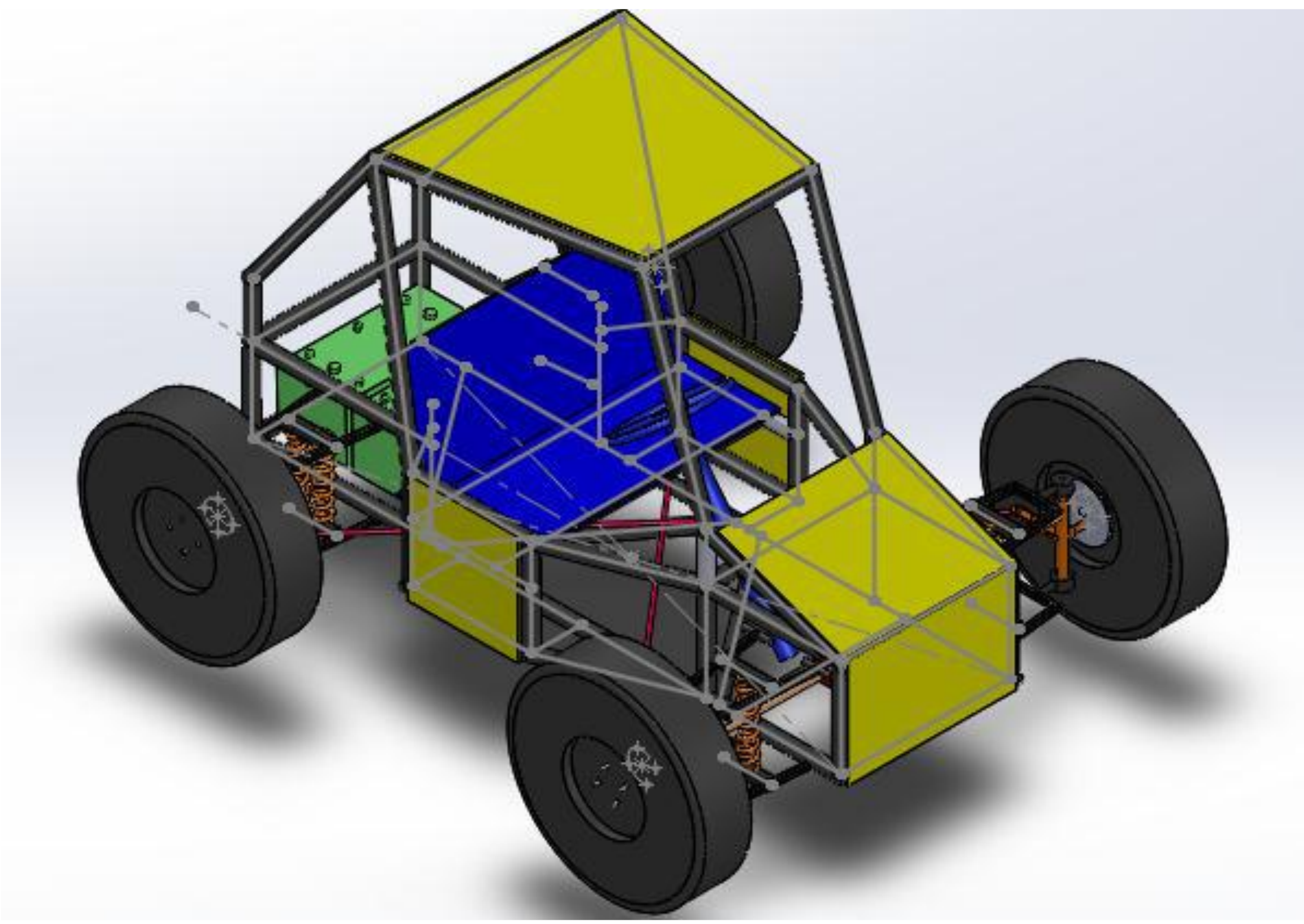

Fig.1: Tubular Space Frame Chassis

III. CHASSIS DESIGN METHODOLOGY

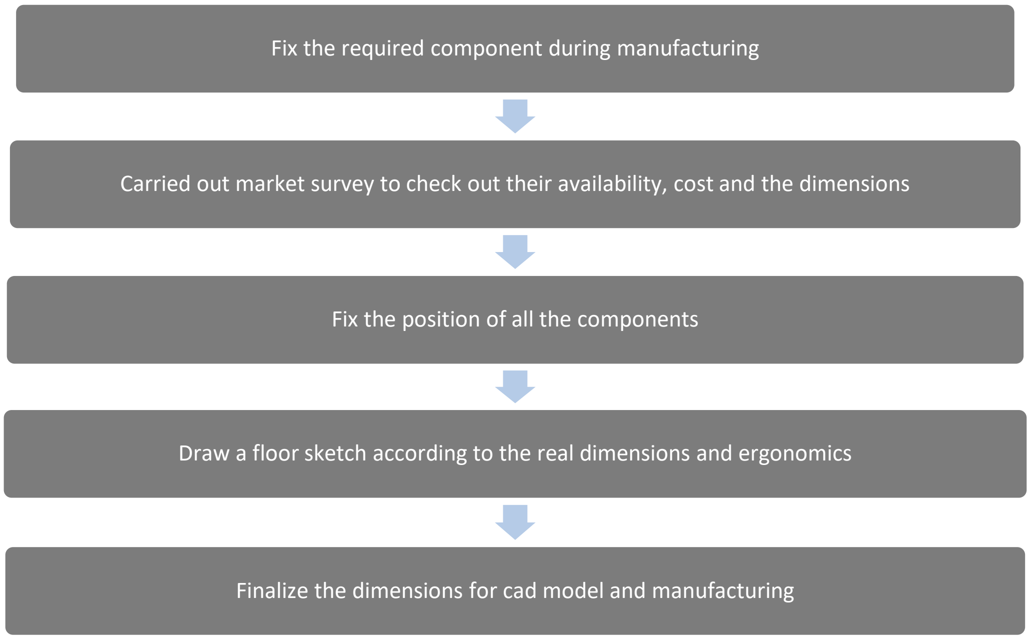

Fig.2: Flow Chart of Design

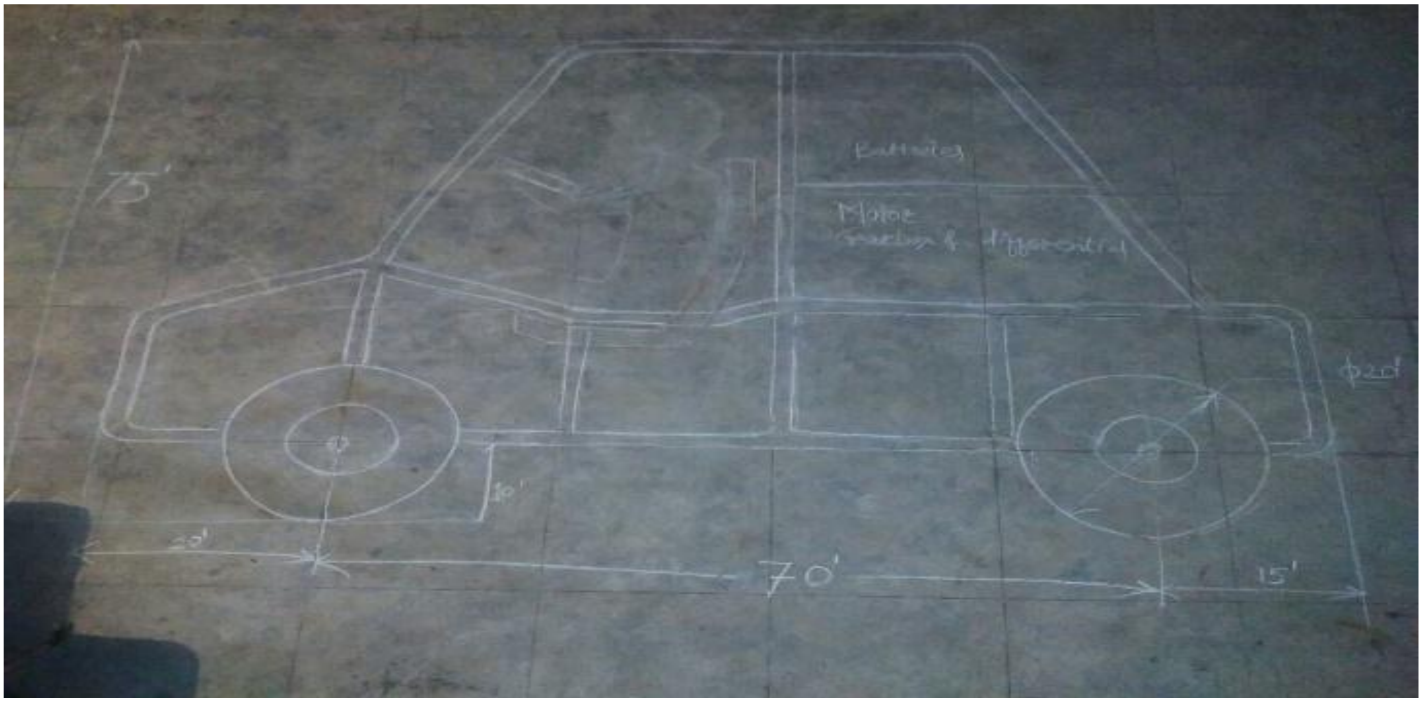

Fig.3: Primary sketch

IV. MATERIAL SELECTION

The chassis undergoes different types of forces during movement, it has to stay entire without yielding, and it should be rigid to absorb vibrations and also it should oppose high temperatures. The material property of the electronic car chassis is important criterion while designing and manufacturing of the electronic car chassis. A tubular space frame chassis was defineover a monologue chassis contempt being heavier because, its manufacturing is cost more effective requires simple tools and damages to the electronic car chassis can be easily repair. The very commonly used materials for making the tabular space frame chassis is SAE-AISI 1018 [4].

Mechanical properties	**Value**	**Unit**
Density	9.8	g/cc
Young’s modulus	210	Gpa
Poisson ratio	0.3	-
Elongation at break	19	%
Brinell Hardness	120	-
Strength to weight ratio at yield	**360**	**Mpa**
Ultimate strength	**420**	**Mpa**
Thermal conductivity Ambient	50	W-m/k
Specific Heat Capacity conventional	370	J/kg-K

Table 1: Material Properties of Mild Steel AISI 1018

The CAD model of chassis is designed by using SOLIDWORKS software. This model includes all the detailed drawing of chassis.

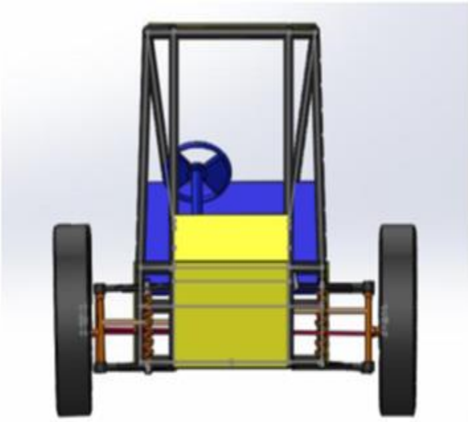

Fig.4: Front View

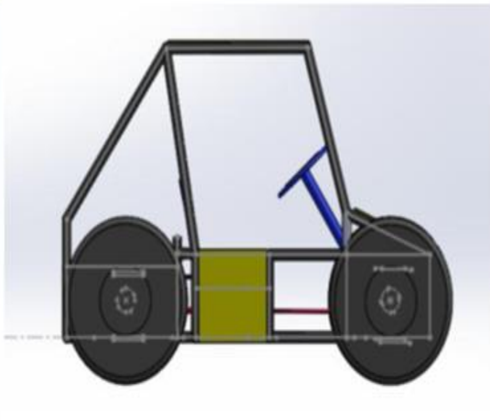

Fig.5: Side View

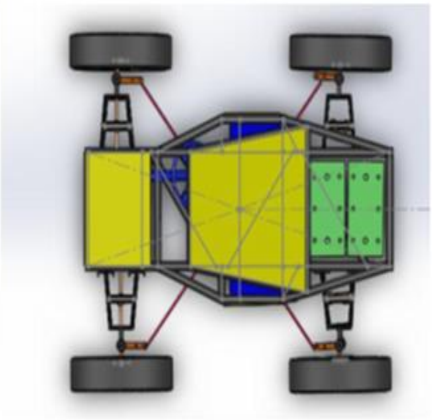

Fig.6: Top View

Parameters	Respected values
Overall length	85 inches
Overall width	53 inches
Wheelbase	56 inches
Track width	48 inches
Height	63 inches
Ground clearance	7 inches
Overall weight	350kg
Steel pipe dimensions	OD = 30 mm ID = 27.5mm

Table 2: Overall Specifications

V. ANALYSIS

Analysis was conducted use of a finite element analysis FEA on ANSYS 15 software. To take away to carry finite element analysis of the electronic car chassis design of chassis is imported on the computer stresses are calculated by simulating four different inducedindividual load cases. The load cases is simulated were front impact, side impact, rear impact and torsional impact.

The electronic car chassis is analysis for individualize conditions like front impact, rear impact, side impact and torsional impact with main focus on the driver‘s safety and after some iteration in design the best suitable design optimization is chosen.

VI. IMPORT MODEL AND MESHING

In software first step in pre-processing is to import chassis structural and input is to given material properties then mesh generation is created. After the boundary conditions are applied on the chassis model. This process is done by ANSYS software. Conducted to the stress analysis and mesh was developed for the chassis. The tetrahedral elements is used for 3D structural domain. The mesh consisted of 776053 nodesand 481010 element and element size 10 mm[5]. The meshing of structural domains has been shown in Fig.7 & Fig.8.

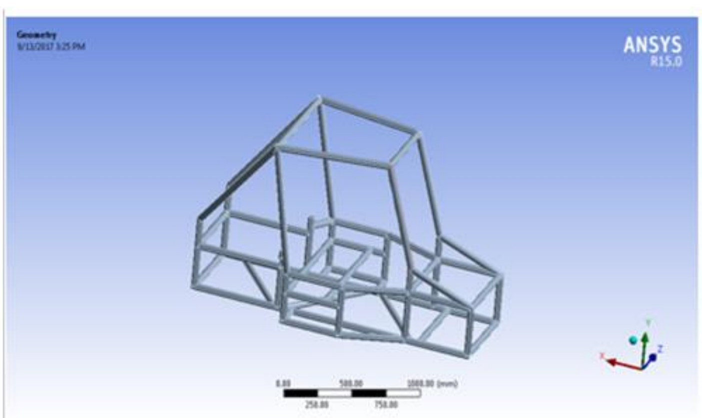

Fig.7: Import Model

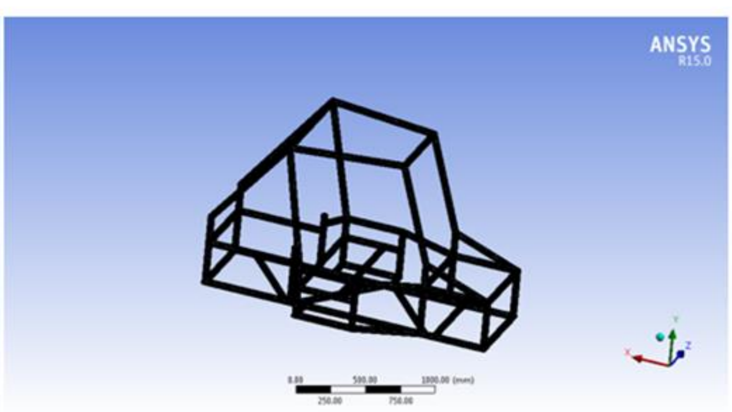

Fig. 8: Meshing

VII. BOUNDARY CONDITIONS

A. Impact Analysis

The Impact forces consider to calculated by using according to Newton's second law which is states that the force acting on a chassis is equal to the product of mass and acceleration of the chassis [6].

Change in momentum = m.vfinal - m.vinitial = F x Δt

m = mass of the vehicle with driver

vfinal (vf) = final velocity of the vehicle (0 m/s)

vinitial (vi) = initial velocity of the vehicle (16.38 m/s; the most critical case assumed)

F = impact force on the vehicle

Δt = time of collision = 0.2s (In automobile industries crash pulse is assumed to be between 0.15 to 0.20, hence we estimate the value of 0.18s)

Force = mass X acceleration

Force = rate of change of momentum

Impulse = Force X time = change in momentum

= mass X change in velocity

B. Front Impact

The front impact, engine and driver load was given at respective points. The suspensions mounting points and the rear wheels position kept fixed. Front impact is calculate for an optimum speed of 60 kmph. From impulse momentum equation, 4g force has been calculated. The load is apply on front end of the chassis because application of forces at one end, while constrain the other, results in a more conservatives approach of analysis. Time of impact considered is 0.2 seconds as per industrial standards.

F X t = m X (vi –vf)

F X0.2 = 350 (16.38 – 0)

F = 22.93 KN

C. Rear Impact

The force was calculated as similar to front impact for speed of 60 kmph. The value of 4g force has been calculated. Load is apply on at rear end of the chassis while constrain the front end axle mounting point. Time of impact considered is 0.2 seconds as per industrial standards.

F X t = m X(vi –vf)

F X 0.2 = 350 (16.38 – 0)

F = 22.93 KN

D. Side Impact

The most probable condition of an impact from the side would be with the vehicle already in motion. So it was assumed that neither the vehicle would be a fixed object. For the side impact the velocity of vehicle is taken 30 kmph and time of impact considered is 0.2 seconds as per industrial standards.

F X t = m X (vi –vf)

F X 0.2 =350 (8.19 – 0)

F = 11.46 KN

E. Torsional Impact

The force was calculated as similar to side impact for the electronic car speed of 60 kmph. The value of 2g force has been calculated. Load was applied at both front end of the chassis in the opposite direction while constraining rear end mounting point. Time of impact considered is 0.2 seconds as per industrial standards.

F Xt = m X (vi –vf)

F X0.2 =350(8.19 – 0)

F = 11.46 KN

Type of Load	Description
Front Impact Load	Force applied on: Front side of frame. Fixed Positions: Rear suspension points. load on each node as 22.93 KN.
Rear Impact Load	Force applied on: Rear side. Fixed Positions: front axle mounting. load on each node as 22.93 KN.
Side Impact Load	Force applied on: chassis both side end but horizontal toward the centre direction. load on each node as 11.46 KN.
Torsional Impact Load	Force applied on: Both front end in opposite direction. Fixed Positions: bottom rear end. load on each node as 11.46 KN.

Table 3: Boundary Conditions

On the base of the applied boundary condition is calculated by the loads in each case of the tabular space frame chassis, the following results are obtained after the analysis shown in Table 4 below:

Type of Load	Maximum Force (KN)	Maximum Equivalent Stress (MPa)	Maximum Displacement(mm)	Minimum Factor of Safety
Front Impact Load	22.93	76.46	01.31	03.26
Rear Impact Load	22.93	103.36	01.06	02.41
Side Impact Load	11.46	18.80	01.59	13.29
Torsional Impact Load	11.46	54.94	00.88	04.55

Table 4: Final Results of the Impact Analysis after Finite Element Analysis

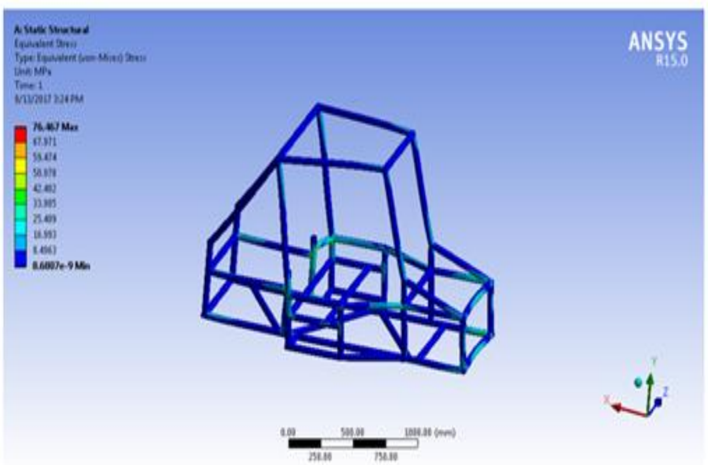

Fig.9: Stresses in the Car during the Front Impact

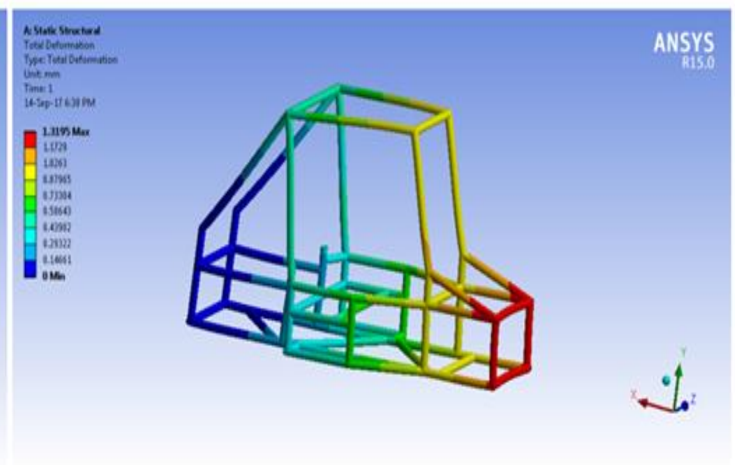

Fig. 10: Displacement in the Car during Front Impact

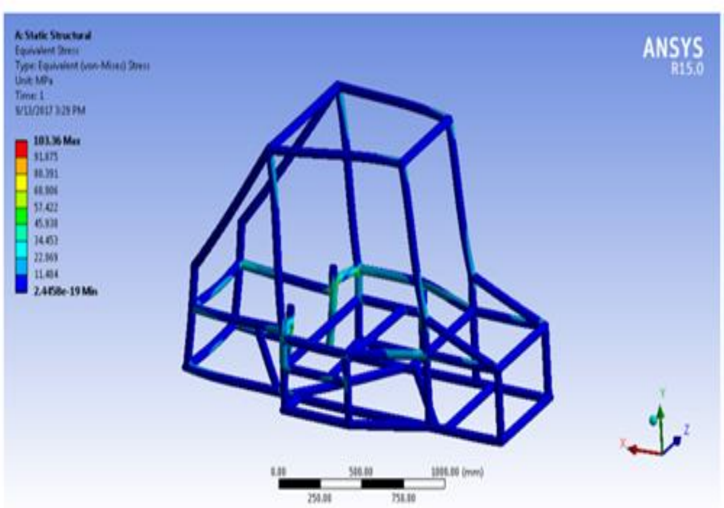

Fig. 11: Stresses in the Car during the Rear Impact

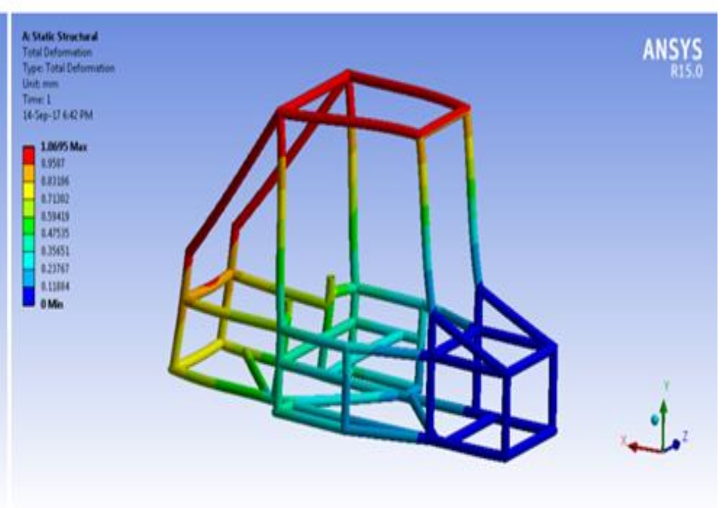

Fig. 12: Displacement in the Car during Rear Impact

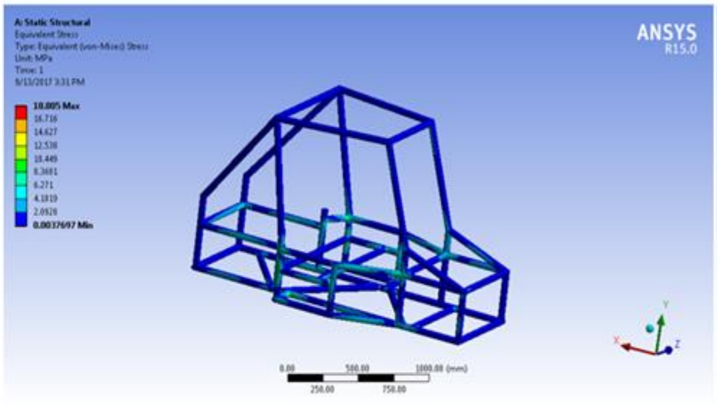

Fig. 13: Stresses in the Car during the Side Impact

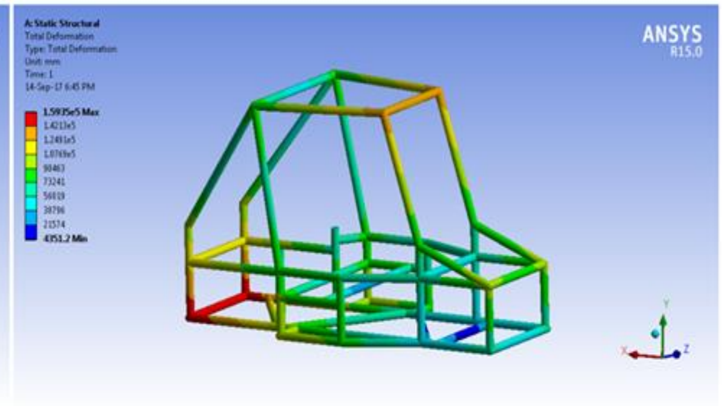

Fig. 14: Displacement in the Car during the Side Impact

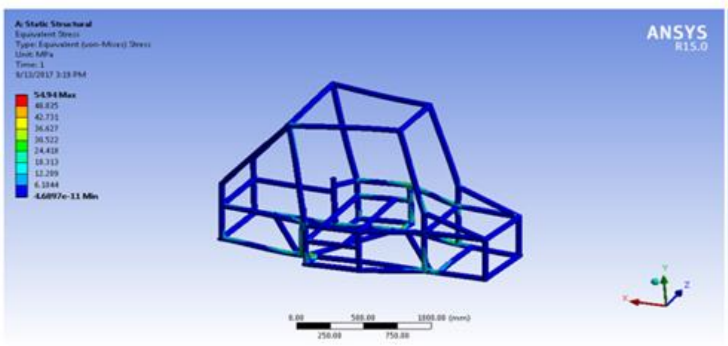

Fig. 15: Stresses in the Car during the Torsional Impact

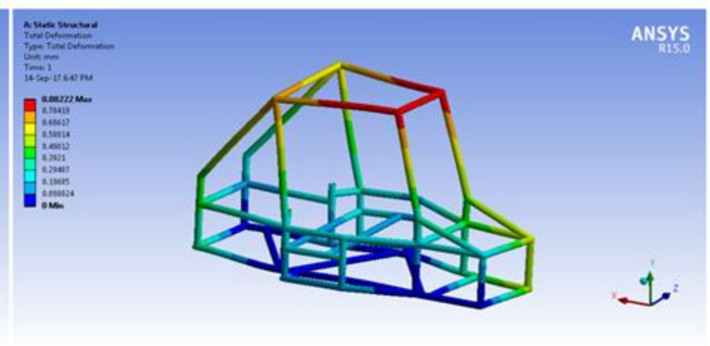

Fig. 16: Displacement in the Car during the Torsional Impact

VIII. CONCLUSION

- The maximum stresses, displacement and factor of safety of the car have been determined by loading thevehicle under various types of impacts.
- After completing all the analysisprocess we conclude that, SAE-AISI 1018 material having Strength to weight ratio at yield stress are 360MPa and Ultimate strength 420MPaand maximum equivalent stress developed in electronic car areFront Impact Load is 76.46 MPa, Rear Impact Load is 103.36 MPa, Side Impact Load is 18.80 MPaand Torsional Impact Load is 54.94 MPa. So electronic car Chassisdesign is safe.

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