A

Seminar on

DESIGN AND ANALYSIS OF COMPACT VEHICLE CHASSIS

By

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T.E. Mechanical Engineering

(Exam. No.:T150380828)

Guided by

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2017-2018

MIT College of Engineering, Pune

Department of Mechanical Engineering

CERTIFICATE

This is to certify that ***Mr. Amogh Borikar*** has successfully completed the seminar entitled "***Design and analysis of compact vehicle chassis***" under my supervision in partial fulfilment of second semester of third year Mechanical Engineering of Savitribai Phule Pune University for the academic year 2017-2018.

Date :

Place :

Mrs. S. A. Dhavale

Seminar Guide

External Examiner

Prof. (Dr.) S. B. Barve

Head of Department

Seal

Vision of the Institute
To empower young generation for substantial contribution to economical, technological and social development of the society.
Mission of the Institute
To be a Globally, Socially conscious institute of research and innovation with an excellence in professional education and to take up the challenges of change for benefit of the society.

Vision of the Department
To create dynamic mechanical professionals to meet global technological challenges through research & innovation for the benefit of society.
Mission of the Department
To empower young mechanical professionals through globally acceptable, effective education & industrial training with relevant research output.

ACKNOWLEDGEMENT

It gives me great pleasure to present a seminar on “Design and Analysis of Compact Vehicle Chassis". In preparing this seminar number of hands helped me directly and indirectly. Therefore it becomes my duty to express my gratitude towards them.

I am very much obliged to subject guide Mrs.S. A. Dhavale, in Mechanical Engineering Department, for helping and giving proper guidance. Her timely suggestions made it possible to complete this seminar for me. All efforts might have gone in vain without her valuable guidance.

I will fail in my duty if I won't acknowledge a great sense of gratitude to the Director Prof. (Dr.) R. V. Pujeri, Principal Prof. (Dr.) A. S. Hiwale, Head of mechanical engineering Prof. (Dr.) S.B. Barve and the entire staff members in Mechanical Engineering Department for their cooperation.

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TE Mechanical

Roll No: 3155016

Exam No:T150380828

ABSTRACT

This seminar gives an overview of design and analysis of compact vehicle chassis, it's material selection, design considerations, actual CAD modelling, analysis using different design parameters, iterative designing and implementation. Considering the recent trends in motorsports industry, a new type of compact vehicle is designed. The material selection process comparing different types of materials available in market is done to ensure the good strength for the vehicle.

The vehicle is modelled by using Solidworks 2016 version. Special attention is given to wheelbase and trackwidth. The iterative analysis for the same is done to improve the vehicle strength and to reduce the weight.

As the racing industry is growing, there is a trend of compact vehicle from past 2-3 years for racing purposes on various racing tracks. This type of vehicle, which runs on small capacity engine compared to standard racing vehicles, will be useful for racing purpose.

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NOMENCLATURE

F_1, F_2, F_3, F_4	Forces
AISI	American Iron and Steel Institute
CAD	Computer Aided Design

ABBREVATIONS

No.	Number
E.g.	For Example
i.e.	That is
F.O.S	Factor of safety

1. Introduction

1.1 Objective

The basic aim is to create a compact vehicle using iterative design process using Solidworks and Ansys. Selection of material, which is best suited for the purpose plays crucial role in the design of chassis. The vehicle should be safe for driving considering front, rear and side impact as well as its torsional rigidity.

An automobile chassis is one of the fundamental unit of vehicle. It holds the drive train, the subsystems and all other components on it. It is necessarily a structural unit which carries all the loads on the vehicle. In addition, its design is important from safety point of view and damping vibrations. A chassis must be designed in such a way that it resists all shocks, twists on a vehicle effectively, and thus ensures that it does not hinder driving performance. An Important factor while designing is weight, as it is decreased so fuel consumption is decreased.

1.2 Background

There is recent trend of compact racing vehicles in motorsport industry. The objective is to design and analyse the compact vehicle chassis and to improve the design by iterative method. As the vehicle runs on smaller capacity engine, its chassis is compact i.e. in 2-D plane. The basic requirements are taken into consideration as trackwidth and wheelbase to start the designing process of the chassis of the vehicle. Material selection is done on the various properties of available materials in the market.

Besides traditional kart racing, many commercial enterprises offer karts for rent, often called "recreational" or "concession" karts. The tracks can be indoor or outdoor. Karts are rented by sessions (usually from 10 to 30 minutes). They use sturdy chassis complete with dedicated bodywork, providing driver safety. Most of these enterprises use an "Arrive and Drive" format which provides customers with all the safety gear (helmets, gloves and driver outfits) necessary, and allow them to show up anytime to race at a reasonable price, without the problem of having to own their own equipment and gear.

1.3 Design Methodology

The design methodology is required before starting the process. The Design Methodology followed for the chassis is given as follows:

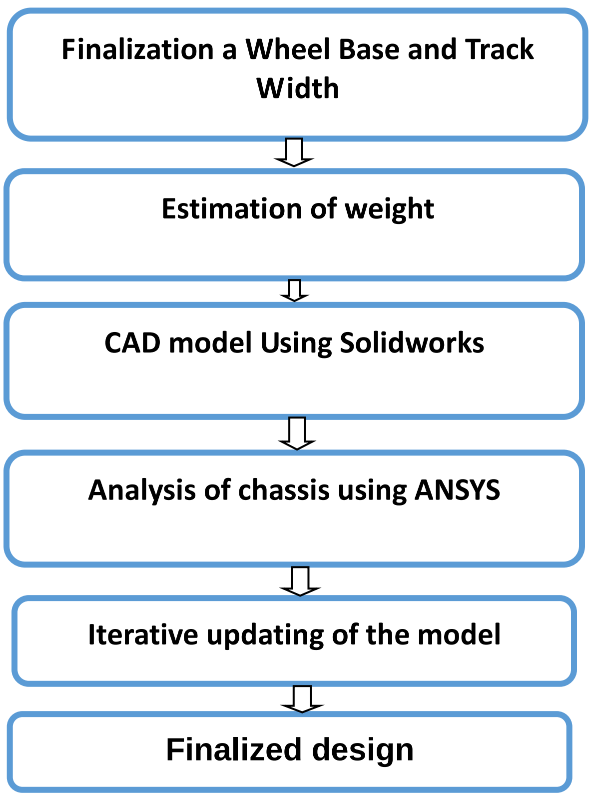


Fig 1 Design methodology of chassis design

2. Literature Survey

It is stated that, “Design safety factor, maximum stress and deflection for compact vehicle chassis is crucial for iterative designing” in “Stress Analysis if a Cross over Electric Car Chassis” by Tarsisius Kristyadi, Alexin Putra, Tito Santika, Liman Hartawan and Trinaldo (2017)

The study shows that Material selection is done according to cost, carbon content, machinability, Weldability and chassis is modelled and tested for front impact, rear impact and side impact from Design and Analysis of a Go-kart by Anjul Chauhan, Lalit Naagar, Sparsh Chavla.

Research has found that human body will pass out at loads Higher than 9 times the force of gravity and it is concluded that it is safe to consider the front impact to be 4G, rear impact to be 2G, and side impact to be 3G as per “Design and Fabrication of Race Spec Go-Kart” Simranjeet Singh, Aniket Badgujar, Pushparaj Patil, Gaurang Kadam.(2017)

Total weight of the vehicle is the sum of weights of components on vehicles such as driver, engine, weight of chassis, transmission system, steering system, braking system, battery etc. as seen in “Modelling and structural analysis of a go-kart vehicle chassis frame” by K. Chinnamaddaiah, Y. Lakshmipathi, P. Ravikanth Raju, Subramanyam B

Static loading analysis on the chassis that is analyzing the effect of driver and engine weight over chassis is done to understand and iterate the design as per the research in “Static analysis of Go-Kart Chassis frame by Analytical and SolidWorks Simulation” studied by N. R. Patil, Ravichandra R. Kulkarni, Bhushan R. Mane, Suhil H. Malve.(2016)

3. Design and Analysis of Compact Vehicle chassis

3.1 Pre-requisites of design of chassis

At the beginning, wheelbase and trackwidth is to be determined for a vehicle. Let the wheelbase be W, Rear trackwidth (centre to centre rear wheel distance) be T_r , Front track width (centre to centre front wheel distance) be T_f.

W=42 inches = 1066.8 mm

T_r=38 inches = 965.2 mm

T_f=34 inches = 863.6 mm

3.2 Material selection

The general materials used for chassis are giben in the table 2.2.

2.2 Material Comparison

Properties	**AISI 1020**	**AISI 1018**	**AISI 4130**	**AISI 4140**	**AISI 1015**
Elongation in 2in., %	15	15	74.4	25.70	18
Yield strength (MPa)	350	425	97.3	415	325
Tensile strength (MPa)	420	668	24.7	655	385
Reduction of area, %	56.0	40	70	-	40
Knoop hardness	265	145	240	219	129
Brinell hardness	121	126	217	197	111
Density(g/cc)	7.87	7.87	7.87	7.85	7.87
Poisson's ratio	0.29	0.29	0,27-0.30	0.27-0.30	0.27-0.30
Modulus of elasticity (GPa)	190-210	140	190-210	190-210	190-210
Thermal conductivity(w/mK)	25	51.9	44.5	42.6	51.9
Impact strength (izod)	125j	43	61.7	-	-

The material selected from above comparison is AISI 4130. AISI 4130 is one of the most commonly used plain carbon steel. It may be easily hardened or carburized because of its good combination of strength and ductility. AISI 4130 steel has good formability when processed by all conventional methods, as its ductility is good.

3.3 Force calculations:

As the weight of vehicle is considered to be 150 kg, i.e. 1471.5 N.

Therefore, G= 1471.5 N

1) Front Impact:

Force taken for front impact is,

F_1=4G

= 4*(1471.5)

= 5886 N

2) Rear Impact:

Force for rear impact is taken as,

F_2=2G

=2*(1471.5)

=2943 N

3)Side Impact:

Force taken for side impact is,

F3=3G

=3*(1471.5)

=4414.5N

4)Torsional Force:

Force taken for checking torsional rigidity is,

F4= 1G

= 1471.5N

These forces calculated are taken into consideration in further design iterations in analysis software i.e. Ansys. The iterations are done to obtain the design for go-kart vehicle chassis till optimum factor of safety as well as total deformation.

3.4. Basic layout of Chassis

The basic layout is drawn on Solidworks and it is analysed on Ansys. Results of the same as well as CAD is given as below:

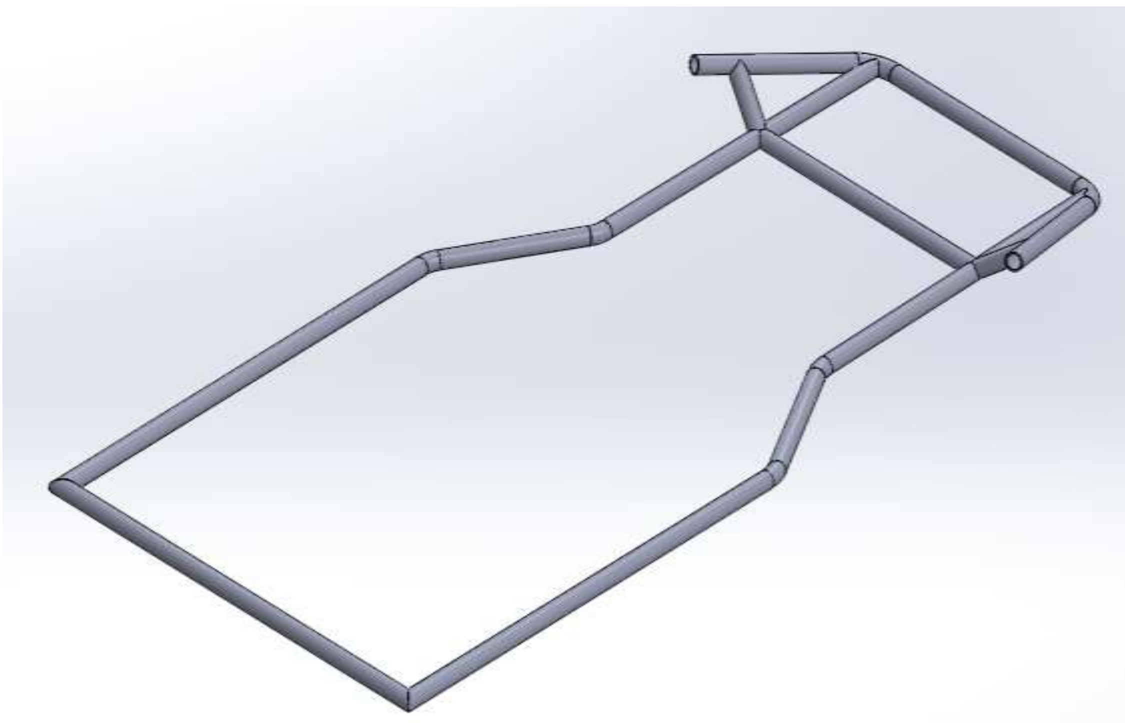
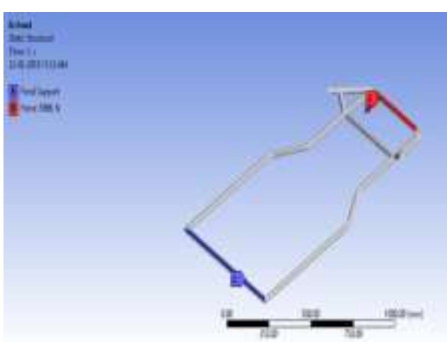
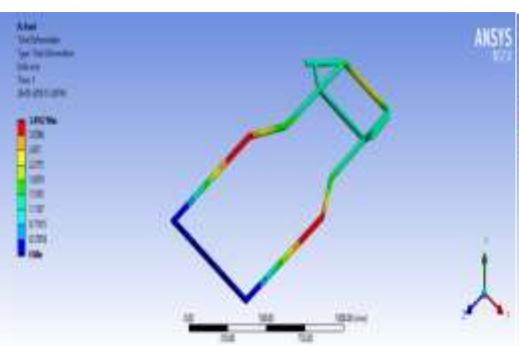


Fig 2 Basic layout





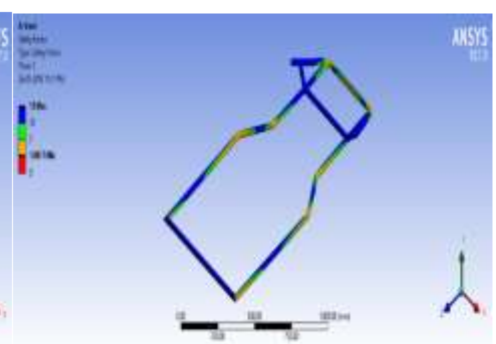


Fig.3 A

Fig 3 B

Fig 3 C

Fig 3. Analysis of chassis for basic layout for front impact
A – Front impact forces, B – Total Deformation, C – Factor of safety

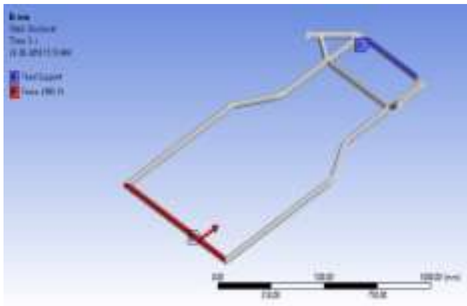


Fig 4 A

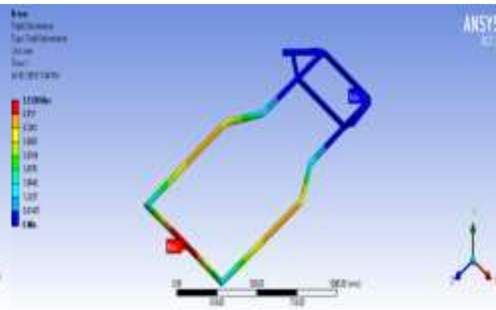


Fig 4 B

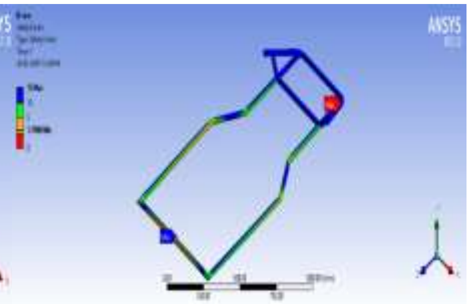


Fig 4 C

Fig 4 Analysis of chassis for basic layout for rear impact
A-Rear impact forces, B- Total deformation, C-Factor of safety

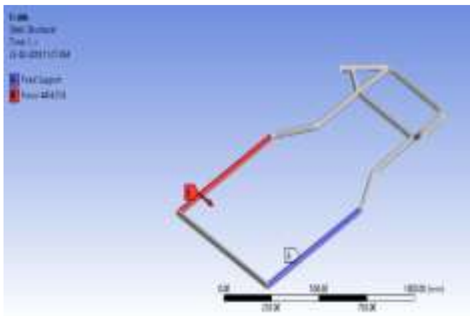


Fig 5 A

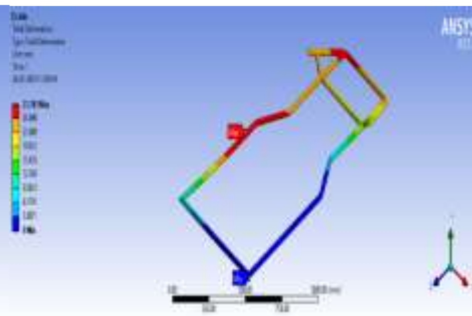


Fig 5 B

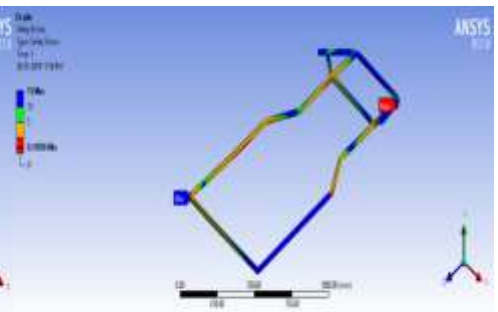


Fig 5 C

Fig 5 Analysis of chassis for basic layout for side impact
A-side impact forces, B- Total deformation, C-Factor of safety

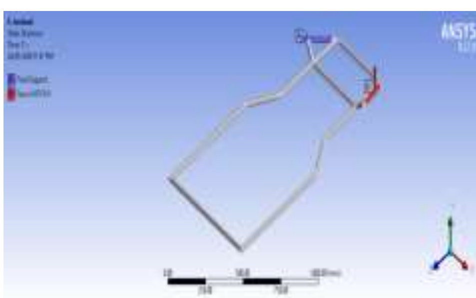


Fig 6 A

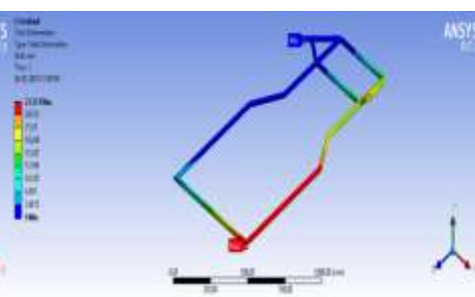


Fig 6 B

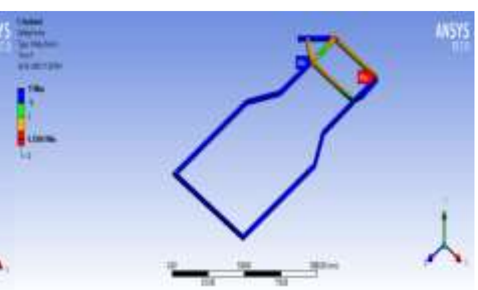


Fig 6 C

Fig 6 Analysis of chassis for basic layout for torsional rigidity
A-Torsional forces, B- Total deformation, C-Factor of safety

From this analysis, it is seen that the need of a member to sustain front impact, rear impact and side impact is required. So, members are added to the layout accordingly in the next iteration.

3.5. 1st iteration

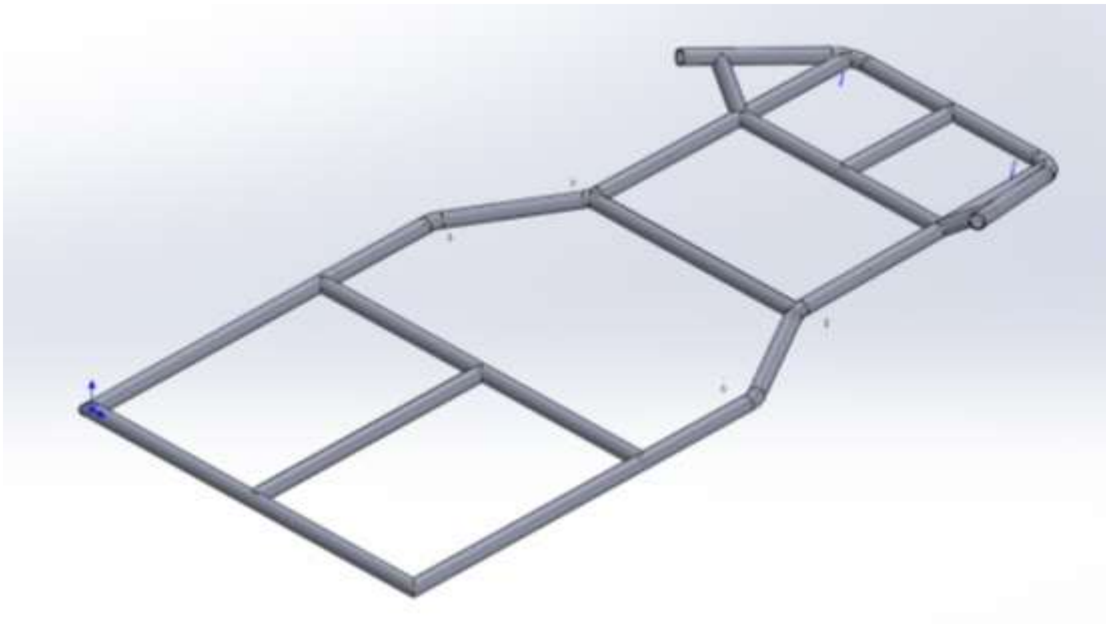


Fig 7 1ST ITERATION

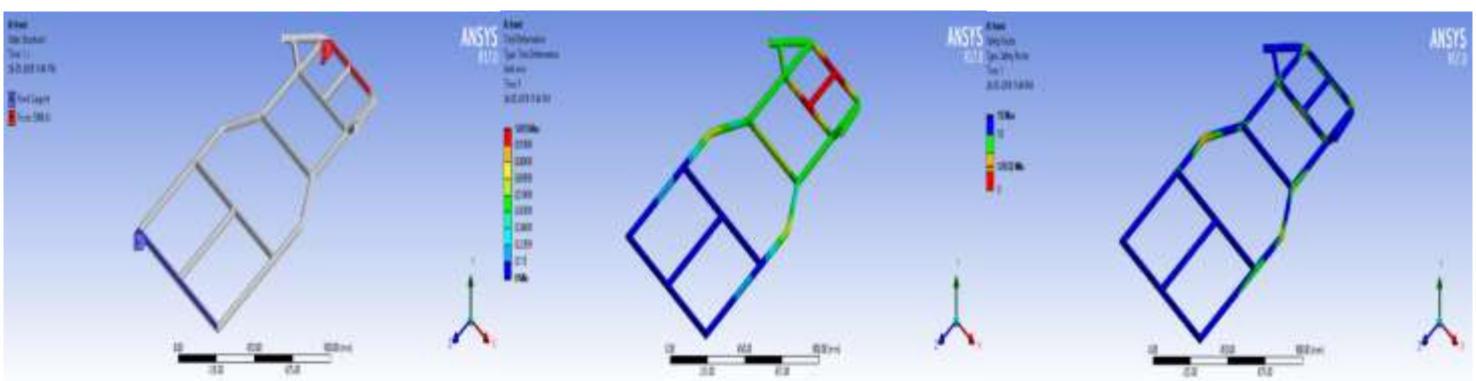


Fig 8 A

Fig 8 B

Fig 8 C

Fig 8 Analysis of chassis for 1st Iteration for front impact

A-front impact forces, B- Total deformation, C-Factor of safety

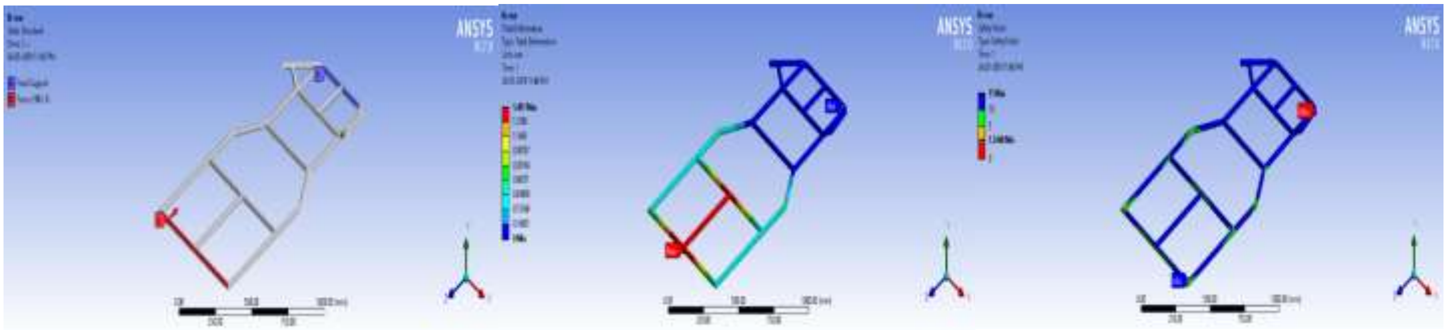


Fig 9 A Fig 9 B Fig 9 C

Fig 9 Analysis of chassis for 1st Iteration for rear impact

A-Rear impact forces, B- Total deformation, C-Factor of safety

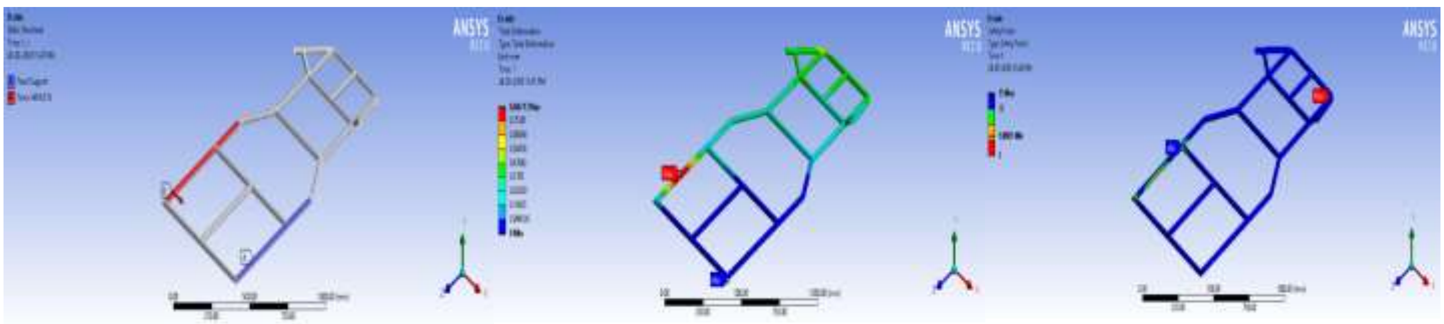


Fig 10 A Fig 10 B Fig 10 C

Fig 10 Analysis of chassis for 1st iteration for side impact

A-side impact forces, B- Total deformation, C-Factor of safety

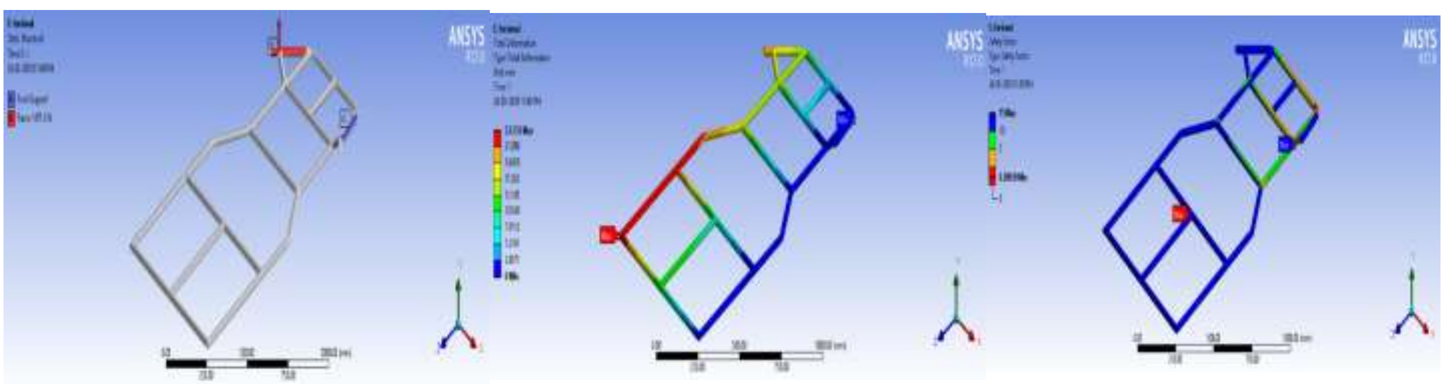


Fig 11 A Fig 11 B Fig 11 C

Fig 11 Analysis of chassis for 1st iteration for Torsional rigidity

A-torsional forces, B- Total deformation, C-Factor of safety

For engine mount and brake mount, the members are shifted according to the needs from respective mounts and analysis is done in the next iteration.

3.6. 2nd iteration

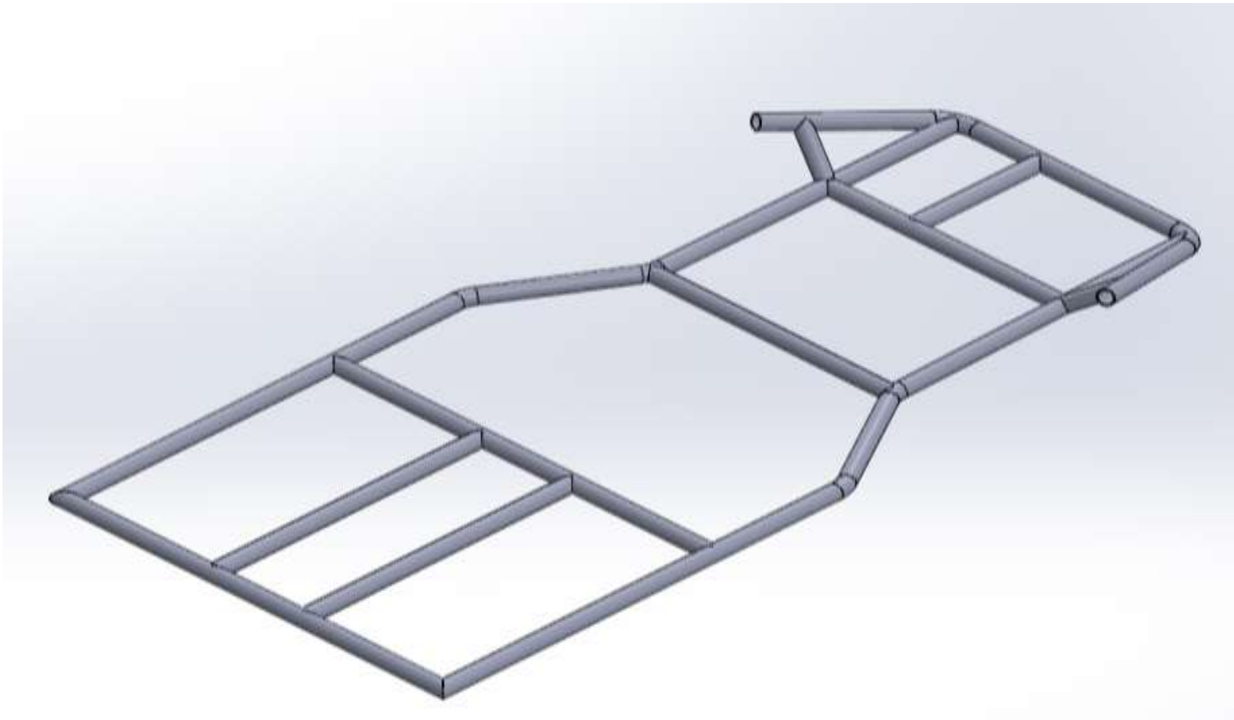
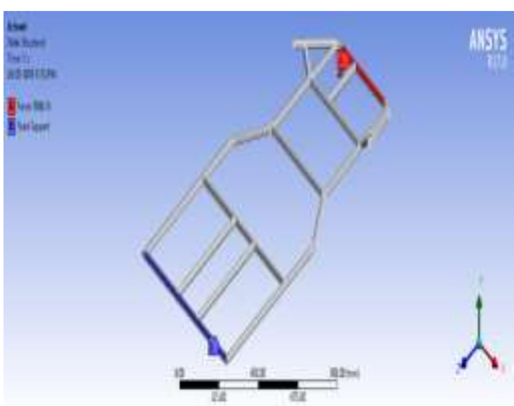
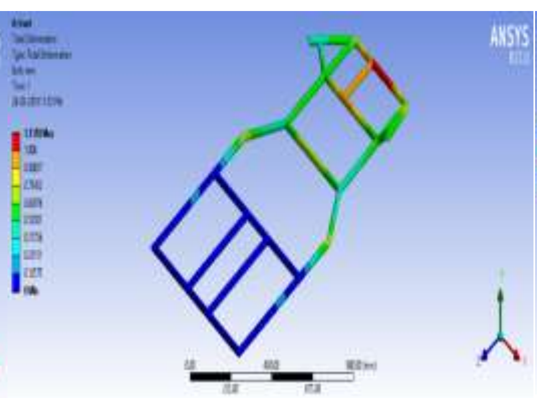


Fig 12 2ND ITERATION





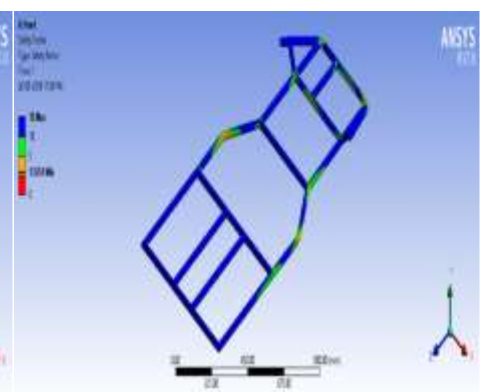


Fig 13 A

Fig 13 B

Fig 13 C

Fig 13 Analysis of chassis for 2nd Iteration for front impact

A-front impact forces, B- Total deformation, C-Factor of safety

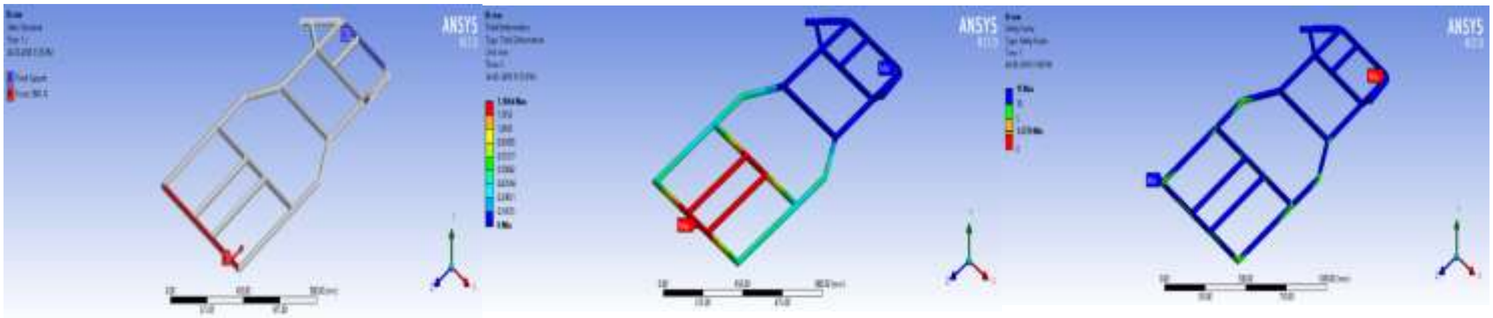


Fig 14 A

Fig 14 B

Fig 14 C

Fig 14 Analysis of chassis for 2nd Iteration for rear impact
A-rear impact forces, B- Total deformation, C-Factor of safety

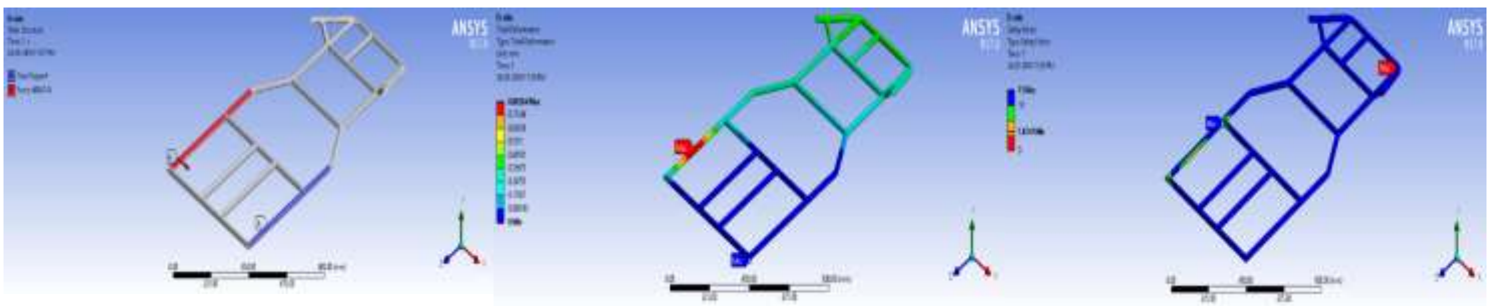


Fig 15 A

Fig 15 B

Fig 15 C

Fig 15 Analysis of chassis for 2nd Iteration for side impact
A-side impact forces, B- Total deformation, C-Factor of safety

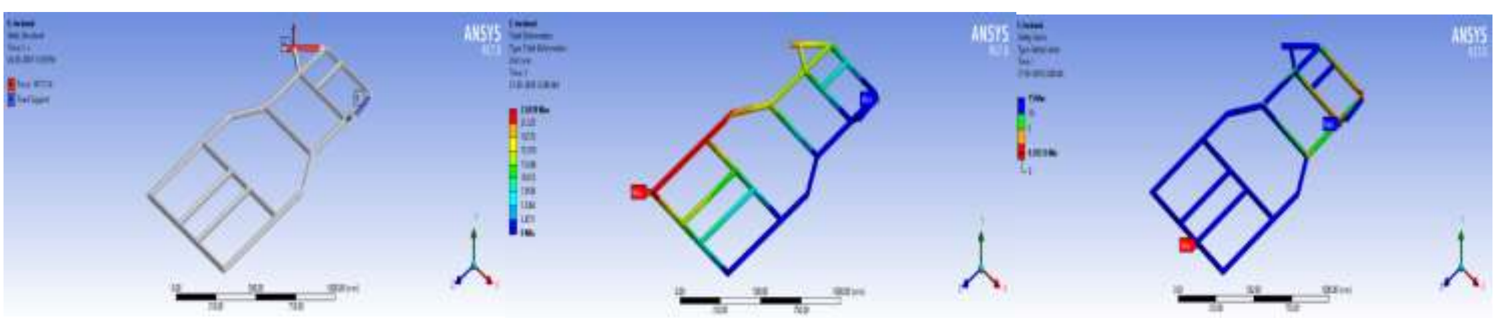


Fig 16 A

Fig 16 B

Fig 16 C

Fig 16 Analysis of chassis for 2nd Iteration for torsional rigidity
A-torsional forces, B- Total deformation, C-Factor of safety

To sustain the chassis from torsional conditions, the member is added to support the front member. According to engine mounts, the horizontal member is added, which is given in next iteration.

3.7. 3rd Iteration

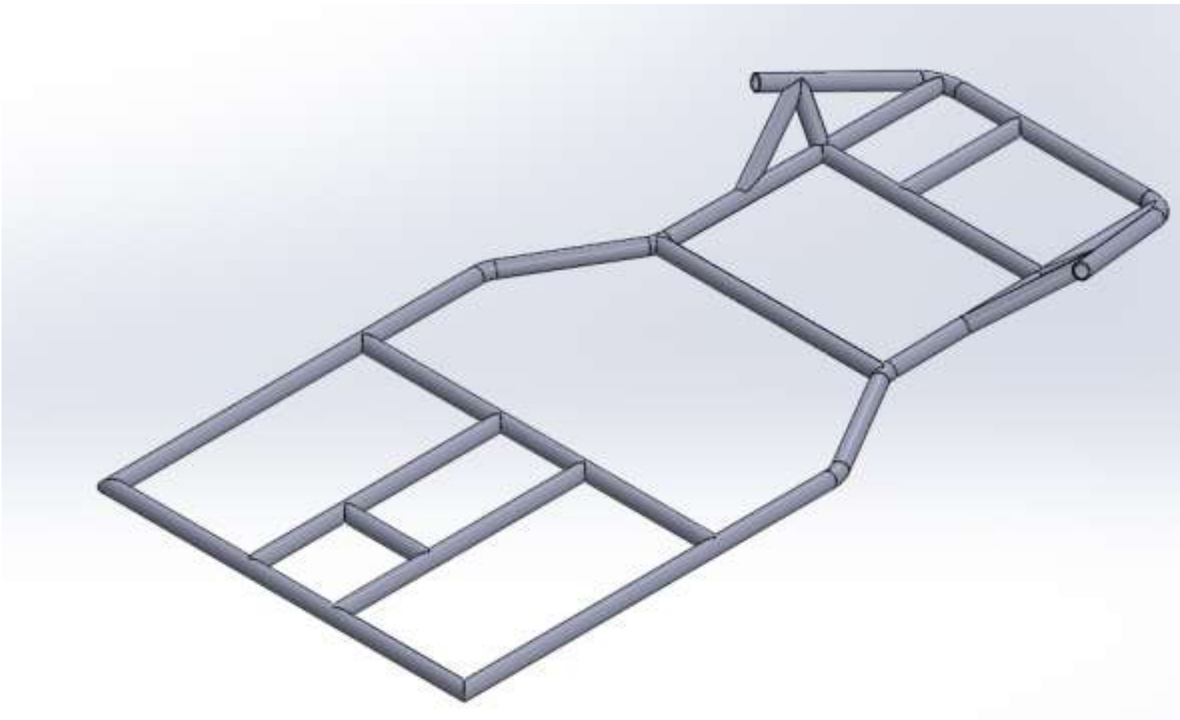


Fig 17 3RD ITERATION

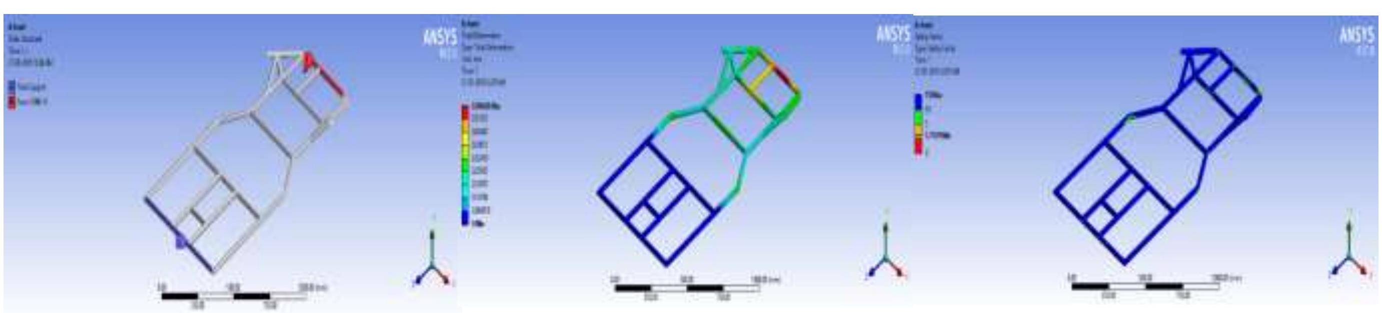


Fig 18 A

Fig 18 B

Fig C

Fig 18 Analysis of chassis for 3rd Iteration for front impact

A-front impact forces, B- Total deformation, C-Factor of safety

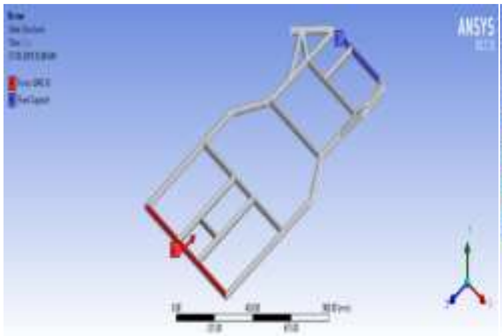


Fig 19 A

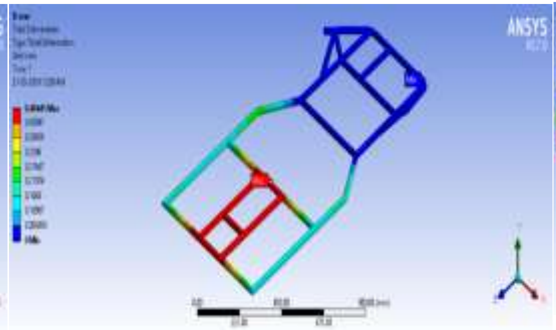


Fig 19 B

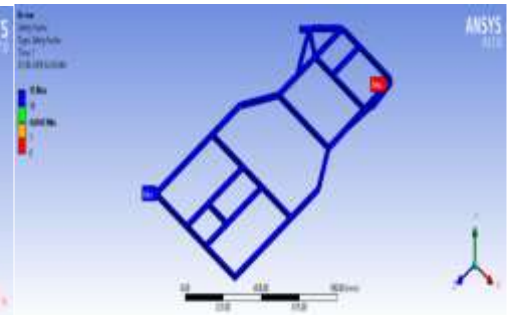


Fig 19 C

Fig 19 Analysis of chassis for 3rd Iteration for rear impact
A-rear impact forces, B- Total deformation, C-Factor of safety

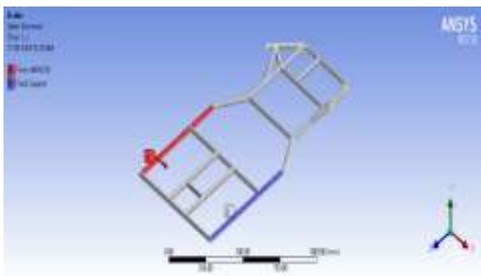


Fig 20 A

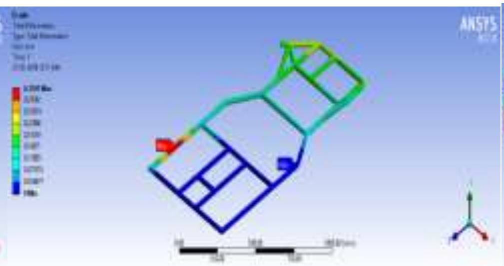


Fig 20 B

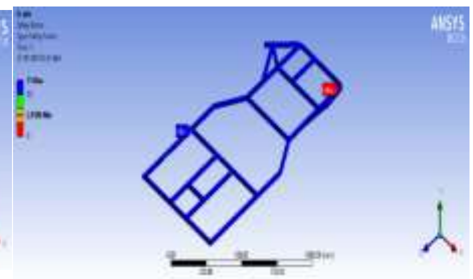


Fig 20 C

Fig 20 Analysis of chassis for 3rd Iteration for side impact
A-side impact forces, B- Total deformation, C-Factor of safety

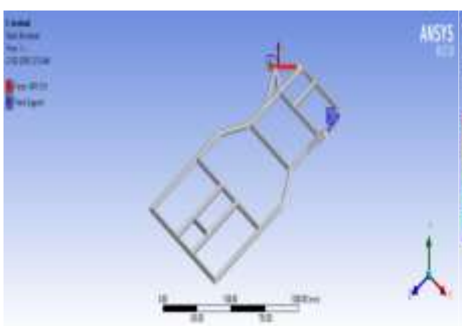


Fig 21 A

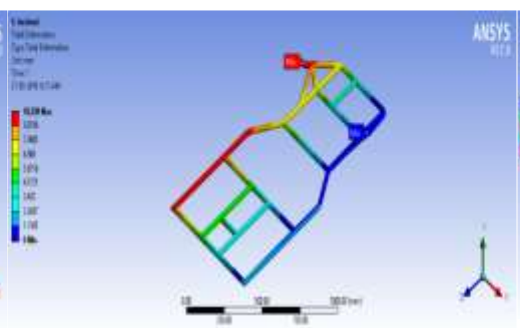


Fig 21 B

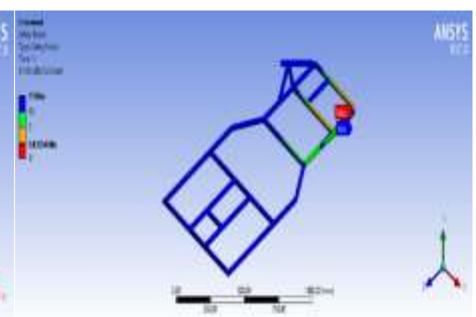


Fig 21 C

Fig 21 Analysis of chassis for 3rd Iteration for torsional rigidity
A-torsional forces, B- Total deformation, C-Factor of safety

As all the results are optimum as well as all the mounting requirements are satisfied, this chassis design is finalised.

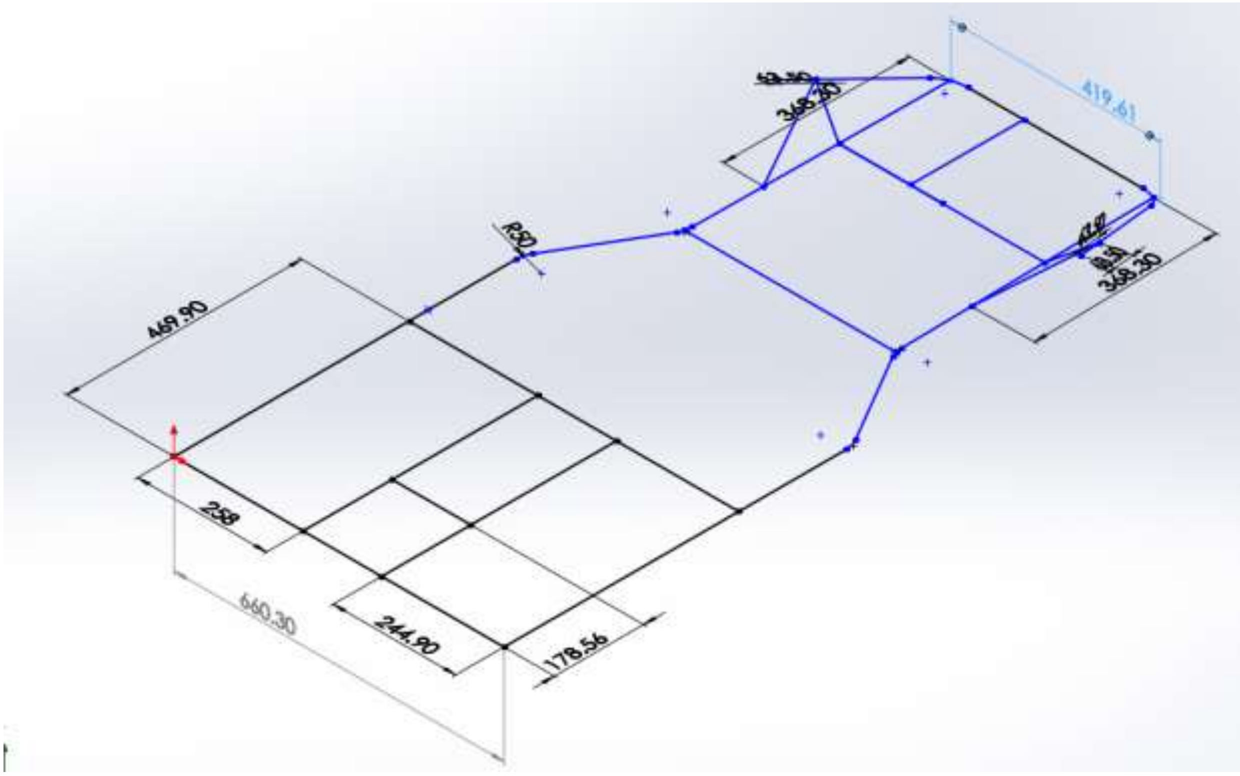


Fig 22 Dimensions of final CAD

4. Conclusion:

Basic Layout: It is seen that the need of a member to sustain front impact, rear impact and side impact is required. So, members are added to the layout accordingly.

1st Iteration: For engine mount and brake mount, the members are shifted according to the needs from respective mounts and analysis is done.

2nd Iteration: To sustain the chassis from torsional conditions, the member is added to support the front member. According to engine mounts, the horizontal member is added.

3rd Iteration: As all the results are optimum as well as all the mounting requirements are satisfied, this chassis design is finalised.

5. References:

1. Tarsisius Kristyadi, Alexin Putra, Tito Santika, Liman Hartawan, Trinaldo, *"Stress Analysis if a Cross over Electric Car Chassis"*, IOSR Journal of Mechanical and Civil Engineering, Volume 14, Issue 5 Ver. I (Sep. - Oct. 2017),PP 13-28.

2. Simranjeet Singh, Aniket Badgujar, Pushparaj Patil, Gaurang Kadam, *"Design and Fabrication of Race Spec Go-Kart"*, American Journal of Engineering Research (AJER), Volume-5, Issue-6, 48-53.

3. K. Chinnamaddaiah, Y. Lakshmipathi, P. Ravikanth Raju, Subramanyam B, *"Modelling and structural analysis of a go-kart vehicle chassis frame"*, International Journal of Mechanical Engineering and Technology (IJMET), Volume 8, Issue 6, June 2017, pp. 305–311.

4. N. R. Patil, Ravichandra R. Kulkarni, Bhushan R. Mane, Suhil H. Malve, *"Static analysis of Go-Kart Chassis frame by Analytical and SolidWorks Simulation"*, International Journal of Scientific Engineering and Technology, Volume No.3 Issue No.5, pp : 661-663.

5. Anjul Chauhan, Lalit Naagar, Sparsh Chavla, *"Design and Analysis of a Go-kart"*, International Journal of Aerospace and Mechanical Engineering, Volume 3 – No.5, September 2016.