ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL

(Approved by AICTE, recg. By Maharashtra Govt. DTE,

Affiliated to Mumbai University)

PLOT #2&3, SECTOR 16, NEAR THANA NAKA, KHANDAGAON, NEW PANVEL,NAVI MUMBAI-410206, Tel.: +91 22 27481247/48 * Website: www.aiktc.org

CERTIFICATE

This is to certify that the project entitled

"DESIGN, ANALYSIS AND FABRICATION OF A GO-KART CHASSIS"

Submitted by

KAZI SHAHEZAD FAISAL

MIRZA SHAHRUKH AJAZ

MUKRI HASSEIN ARMAN

KHAN IMRAN JAMIL

To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

Project co-guide	**Internal Examiner**	**External Examiner**
(Prof.RahulThavai)	(Prof.AslamHirani)	

Head of Department	**Principal**
(Prof. Zakir Ansari)	(Dr.AbdulRazzakHonnutagi)

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APPROVAL OF DISSERTATION

This is to certify that the thesis entitled

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(Internal Examiner) **(External Examiner)**

___________________ ___________________

Date: ___________

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

KaziShahezadFaisal(11ME28)
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MirzaShahrukhAjaz(11ME37)
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Khan Imran Jamil (11ME53)
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Date: ______________

Abstract:

TITLE:"DESIGN, ANALYSIS AND FABRICATION OFA GO-KART CHASSIS"

This report aims to model, simulate, perform the static and dynamic analysis and fabrication of a go kart chassis consisting of Circular beams. Modeling , simulations are performed using modeling software i.e. SOLIDWORKS and analysis on ANSYS. The maximum deflection is determined by performing static analysis. Computed results will be then compared to analytical calculation, to check whether the location of maximum deflection agrees well with theoretical approximation.

The chassis is designed such that it requires less material and as well as it is strong enough to withstand the various impacts on it. Strength and light weight were our basic consideration throughout the design of the chassis of the kart. Hence, AISI1018 was selected as an appropriate material for design which is a medium carbon steel with properties such as light weight, high tensile strength, high machinability, better weldability, etc.

All the impacts and stresses were calculated manually by considering the severe working conditions and then the design was analysed in the analysis software. Step by step modifications in design were made as found necessary and as analysed on the software. After the complete analysis and the approval of design by inspecting it in all the modes of failure the design was finalized and was selected to fabricate which will not fail in any extreme criteria of stresses or load induced.

Table of Contents

Chapter 1

Introduction

1.1 Introduction

The automotive chassis is tasked with holding all the components together while driving, and transferring vertical and lateral loads, caused by accelerations, on the chassis through the wheels. Most engineering students will have an understanding of forces and torques long before they read this. Some people stress full with material choice but once you are familiar with this it is the key to a good space frame. While this will make the design better it can still benefit from this more general design principles. The design section of the book will talk more about these items .

We designed a CAD model of the chassis on the 3D modelling software. Using this design software allowed the team to visualize the design in 3-D space and reduce errors in fabrication. The main criterion in chassis design was to achieve perfect balance between a spacious and ergonomic driver area with easy ingress and egress, and compact dimensions to achieve the required weight and torsional rigidity criteria. Following this criterion, the required dimensions were roughly set using a virtual template to achieve the necessary clearances in case of a rollover situation. After a series of design changes and subsequent calculations, the final chassis design was decided upon.

The design process of the vehicle is iterative and is based on various engineering and reverse engineering processes depending upon the availability, cost and other such factors.

So the design process focuses on following objectives:

- Safety
- Serviceability
- Strength
- Ruggedness
- Standardization
- Cost
- Driving Feel And Ergonomics
- Aesthetics
- Durability
- Light Weight
- High Performance

1.2 Organisation of Project Report

The rest of the project report is organized as follows. ChapterII describes the history of chassis. It also specifies the methodology of our project. Chapter III onwards the report describes the various steps involves in designing of go kart chassis.Chapter III explains about 3D cad modelling. Chapter IV describes material used for manufacturing purpose. Chapter V explains about analytical calculations which consists of static and dynamic analysis. Chapter VI gives a brief detail about vehicle specification and its cost report. Chapter VII represents the results and discussion. Chapter VIII,IX,X consist of conclusion,futurescope,gantt chart respectively.

Chapter 2

Literature Survey

Chapter 2 Literature Survey

2.1 Literature Review

A chassis consists of an internal framework that supports a man-made object in its construction and use. It is analogous to an animal's skeleton. An example of a chassis is the underpart of a motor vehicle, consisting of the frame (on which the body is mounted). If the running gear such as wheels and transmission, and sometimes even the driver's seat, are included then the assembly is described as a rolling chassis.

The chassis takes a load of the operator, engine, brake system, fuel system and steering mechanism, so chassis should have adequate strength to protect the operator in the event of an impact. The driver cabin must have the capacity to resist all the forces exerted upon it. This can be achieved either by using high strength material or better cross sections against the applied load. But the most feasible way to balance the dry mass of chassis with the optimum number of longitudinal and lateral members. The chassis must be constructed of steel tubing with minimum dimensional and strength requirements dictated by ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS).

2.2 History

Racing Go Karts have evolved over the past 50 years to become one of the most competitive forms of motor racing in united states. Kart Racing has been a stepping stone for many drivers working their way up the professional ladder in NASCAR ,FORMULA 1 and the INDY RACING LEAGUE. Drivers like TONY STEWART,DANICA PATRICK, MICHAEL SCHUMACHER and SARAH FISHER each got his or her start in this less expensive but adrenaline pumping form of motorsports racing.As a recreational activity, Karting can appeal to just about anyone. From age 5 to 75, racing Go Karts have become popular all over the world with people looking for an exciting ay of having fun. Infact, many amusement parks have added rental racing Go Karts called concession Karts that use detuned 4 stroke go kart engines for a milder experience.

Most karting historians give credit to Californian Art Ingels as the first person to build a racing go-kart, originally called a go kart. It did not takes long for this fad to catch on and go kart tracks started to pop up all across America. By the late 1950's an American company modified a two stroke chain saw motor and the McCulloch MC-10 became the first motor manufactured specially for go kart racing

2.3 Design Objectives

Design objectives of chassis are:-

- Provide full protection of the driver, by obtaining required strength and torsional rigidity, while reducing weight through diligent tubing selection
- Design for manufacturability, as well as cost reduction, to ensure both material and manufacturing costs are competitive with other Go Karts.
- Improve driver comfort by providing more lateral space in the driver compartment
- Maintain ease of serviceability by ensuring that chassis members do not interfere with other subsystems
- Deciding the cost efficiency of such in terms of large scale manufacturing.
- Calculation of stresses acting on the chassis of the vehicle under different loading conditions.
- The product can prove to be very efficient in all the aspects such as cost, drivability, maintenance, easy usage, safety etc.

Chapter 3

Project Overview

3.1 Chassis Design

The chassis is a most important aspect of a Go-Kart. The chassis of such a vehicle is either preferred to be made up of hollow pipes or Super Tubular section so as to make it light weight and shock absorbent.

Chassis design should be such that it should not be subjected to twist during sharp turns, therefore it must have sufficient tensile and elastic enough to resist effects of centrifugal forces.

3.2 Chassis Modification

- The Chassis has been modified as per the design constraints put forth in the earlier section.
- The chassis that was fabricated along with the bolting point of the engine and other accessories needed a firm base on to which the suspension system has been mounted.
- The fabricated chassis along with the mounting point was then mounted on to the base frame and thereby welded firmly to it.

3.3 Design Consideration

We used SOLIDWORKS software to design a three dimensional model of the chassis .This software allowed our team to visualize the design in 3-D space and reduce errors in fabrication. The main criterion in chassis design was to achieve perfect balance between a spacious and ergonomic driver area with easy ingress and egress, and compact dimension to achieve the required weight and torsional rigidity criteria.

After a series of design changes, with consequent finite elemental analysis using ANSYS-15 software ,the final chassis design was decided upon.

3.4 Methodology

The main objective of the study is to obtain a maximum deflection of chassis under static condition. The overall study flow chart is as in Figure 3.1

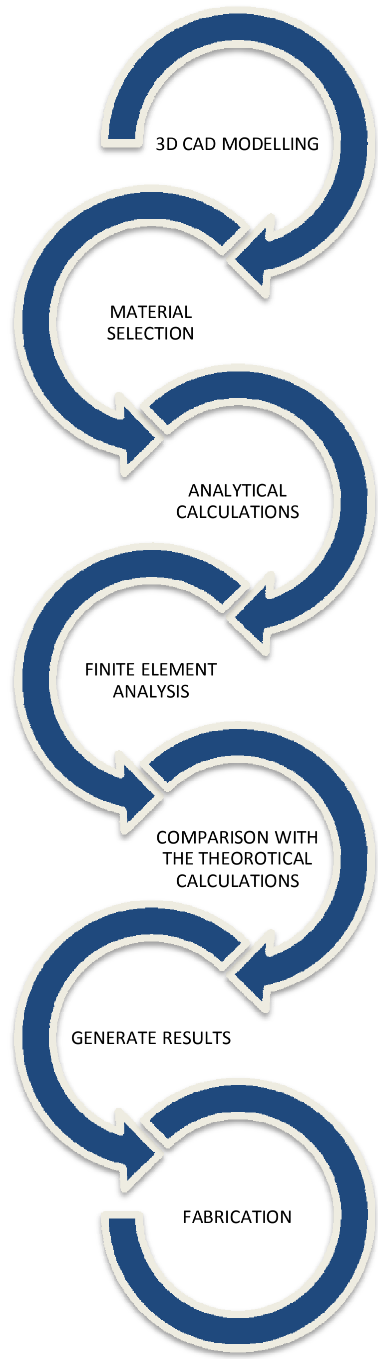


Figure 3.1:Flowchart Depicting Methodology

Chapter 4

3-D CAD MODELLING

4.13D Cad Modelling

- Computer aided design (CAD) is the use of computer systems to assist in the creation, modification, analysis or optimization of a design
- CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation and to create a database for manufacturing.
- CAD is an important industrial art extensively used in many applications including automotive and aerospace.
- Our team used a 3-d Modelling software named as SOLIDWORKS for modelling the 3-D of chassis of go-kart

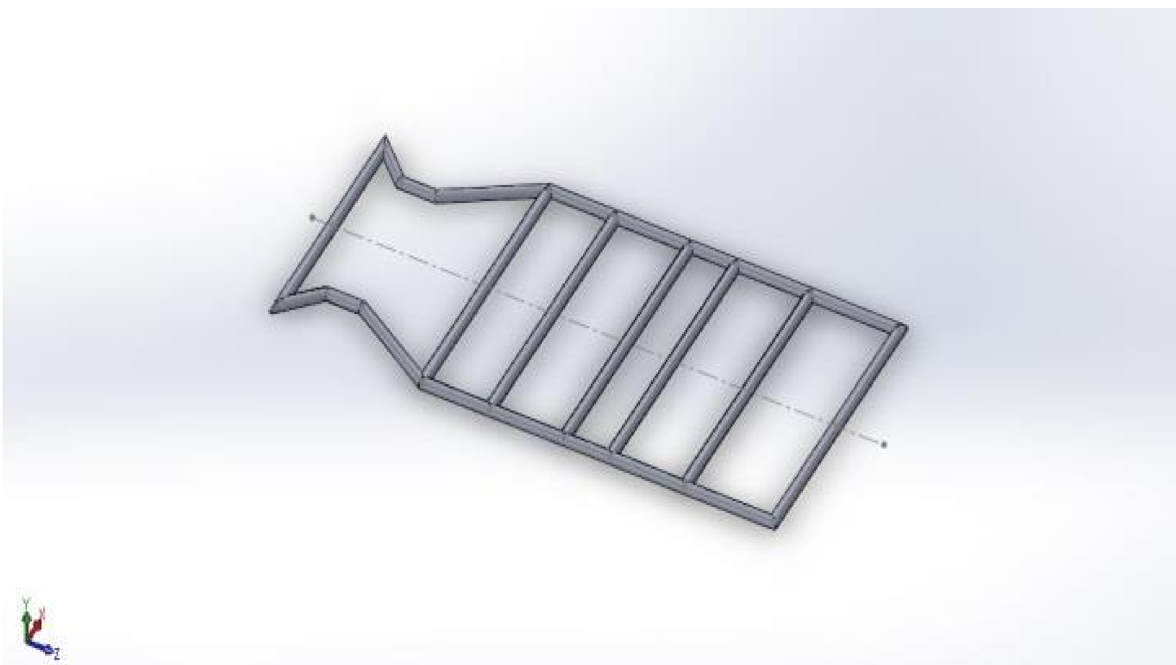


Figure 4.1 : 3D CAD Model of Gokart Chassis Frame

- 3-D modelling was done using Solid Works software as shown in Figure.2

Chapter 5

MATERIAL SELECTION

5.1 Material Selection:

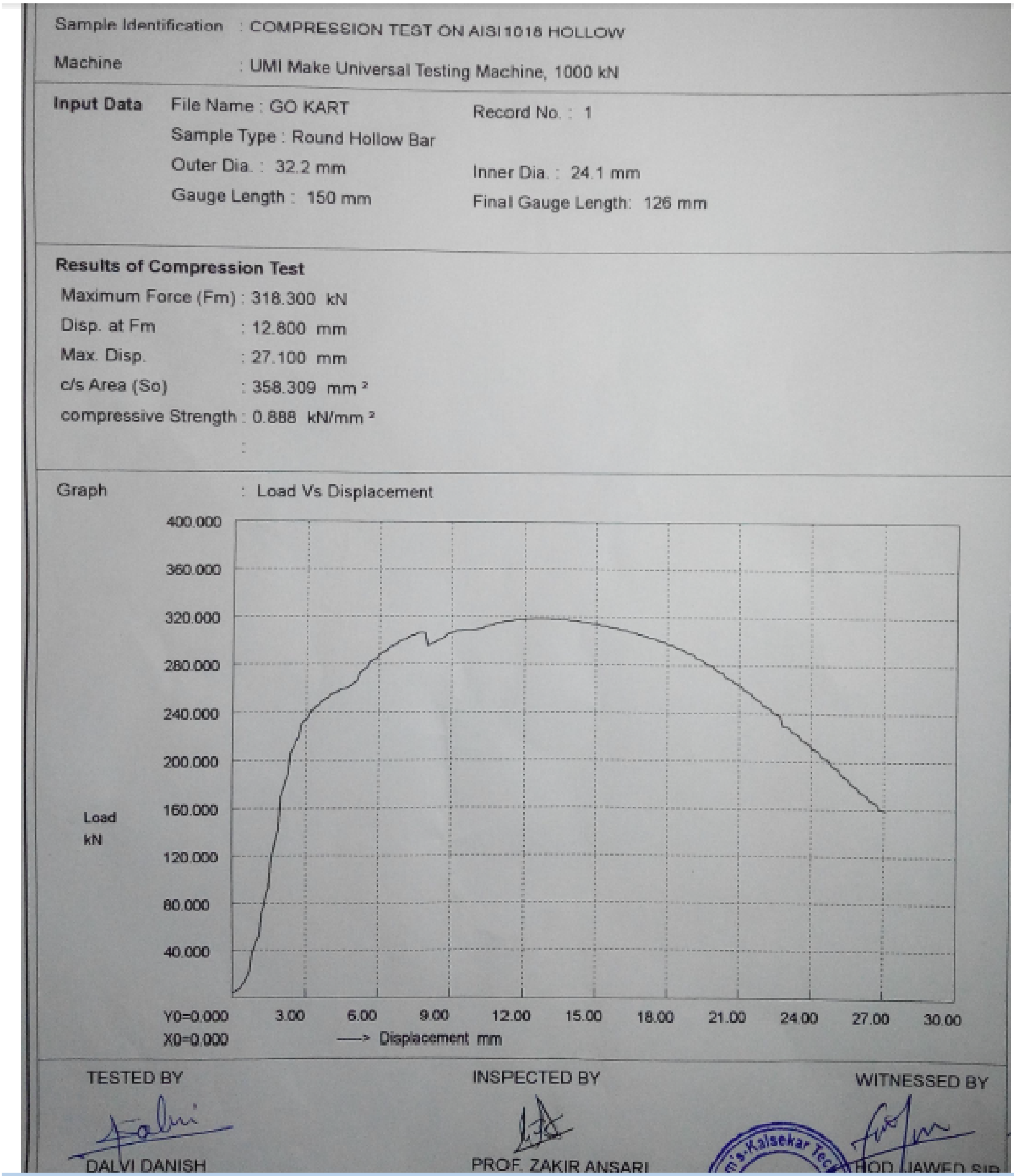
The chassis is made up of AISI-1018.This material was selected due to its good Combination ofall of the typical traits of Steel - strength, ductility, And comparative ease of machining.

The properties of the material are presented in Table. 1

Table 5.1 Material properties

PROPERTIES	VALUES
Modulus of elasticity (MPa)	200
Hardness, Brinell	**126**
Hardness, Knoop (Converted from Brinell hardness)	**145**
Hardness, Rockwell B (Converted from Brinell hardness)	**71**
Hardness, Vickers (Converted from Brinell hardness)	**131**
Tensile Strength, Ultimate	**440 MPa**
Tensile Strength, Yield	**370 MPa**
Elongation at Break (In 50 mm)	**15.0 %**
Reduction of Area	**40.0 %**
Modulus of Elasticity (Typical for steel)	**205 GPa**
Bulk Modulus (Typical for steel)	**140 GPa**
Poissons Ratio (Typical For Steel)	**0.290**
Machinability (Based on AISI 1212 steel. as 100% machinability)	**70 %**
Shear Modulus (Typical for steel)	**80.0 GPa**

5.2VariousTestings'onMaterial


Sample Identification : COMPRESSION TEST ON AISI1018 HOLLOW

Machine : UMI Make Universal Testing Machine, 1000 kN

Input Data

File Name : GO KART

Record No. : 1

Sample Type : Round Hollow Bar

Outer Dia. : 32.2 mm

Inner Dia. : 24.1 mm

Gauge Length : 150 mm

Final Gauge Length: 126 mm

Results of Compression Test

Maximum Force (Fm) : 318.300 kN

Disp. at Fm : 12.800 mm

Max. Disp. : 27.100 mm

c/s Area (So) : 358.309 mm ²

compressive Strength : 0.888 kN/mm ²

Graph : Load Vs Displacement

TESTED BY

DALVI DANISH

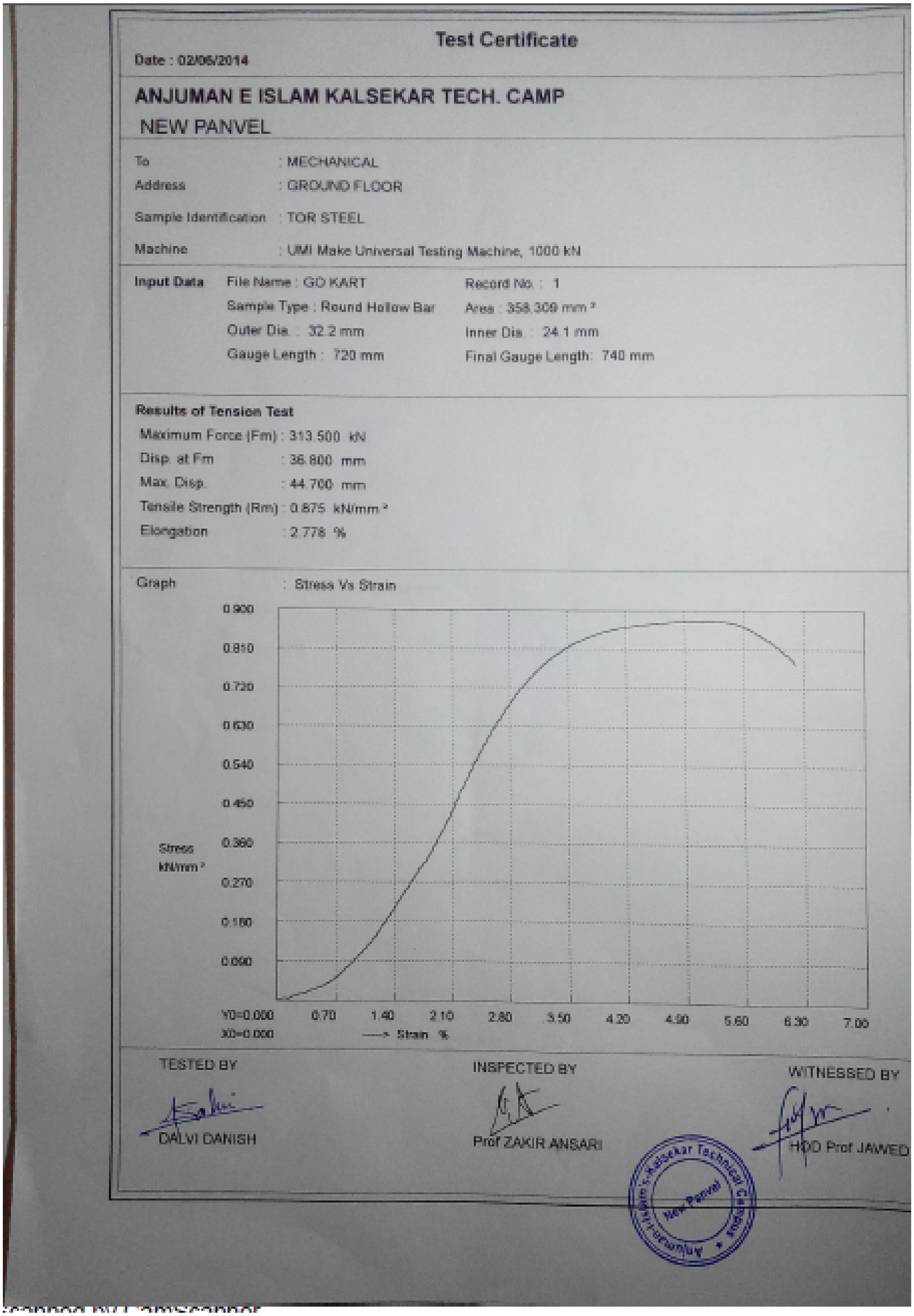
INSPECTED BY

PROF. ZAKIR ANSARI

WITNESSED BY

HOD JAWED SIR

Figure 5.1 Compression Test



Test Certificate

Date : 02/06/2014

ANJUMAN E ISLAM KALSEKAR TECH. CAMP

NEW PANVEL

To	: MECHANICAL
Address	: GROUND FLOOR
Sample Identification	: TOR STEEL
Machine	: UMI Make Universal Testing Machine, 1000 kN

Input Data

File Name : GO KART	Record No. : 1
Sample Type : Round Hollow Bar	Area : 358.309 mm ²
Outer Dia. : 32.2 mm	Inner Dia. : 24.1 mm
Gauge Length : 720 mm	Final Gauge Length: 740 mm

Results of Tension Test

Maximum Force (Fm)	: 313.500 kN
Disp. at Fm	: 36.800 mm
Max. Disp.	: 44.700 mm
Tensile Strength (Rm)	: 0.875 kN/mm ²
Elongation	: 2.778 %

Graph : Stress Vs Strain

TESTED BY DALVI DANISH

INSPECTED BY Prof ZAKIR ANSARI

WITNESSED BY HOD Prof JAWED

Figure 5.2 Tension Test

Chapter 6

ANALYTICAL CALCULATIONS

6.1 Design Of Chassis

Circular cross-section is employed for the chassis development as it helps to overcome difficulties as increment in dimension, rise in the overall weight and decrease in performance due to reduction in acceleration.

It is always preferred over other cross section become it resist the twisting effects. Circular section is selected for torsional rigidity.

The chassis needs to withstand any collision that it might be subjected to as a part of the testing process or competition. To ensure driver safety, required chassis strength, followingSTATIC and DYNAMIC impact scenarios as stated below were analysed using software to ensure the frame design will not fail.

6.1.1 Analysis of Chassis in Static Loading

The static load design of chassis involves design of car when it is at rest.

Static loads on chassis:

- Driver along with seat and accessories.
- Roll cage.
- Engine.
- Transmission system.
- Steering system.
- Fuel tank.

Load of Driver, Driver Seat and Engine were taken into consideration while load of steering system, fuel tank,etc. is low as compared to above components hence it can be neglected. Also, as chain drive transmission system is used load of transmission system can also be neglected.

6.1 .1 Analysis of Chassis in Static Loading

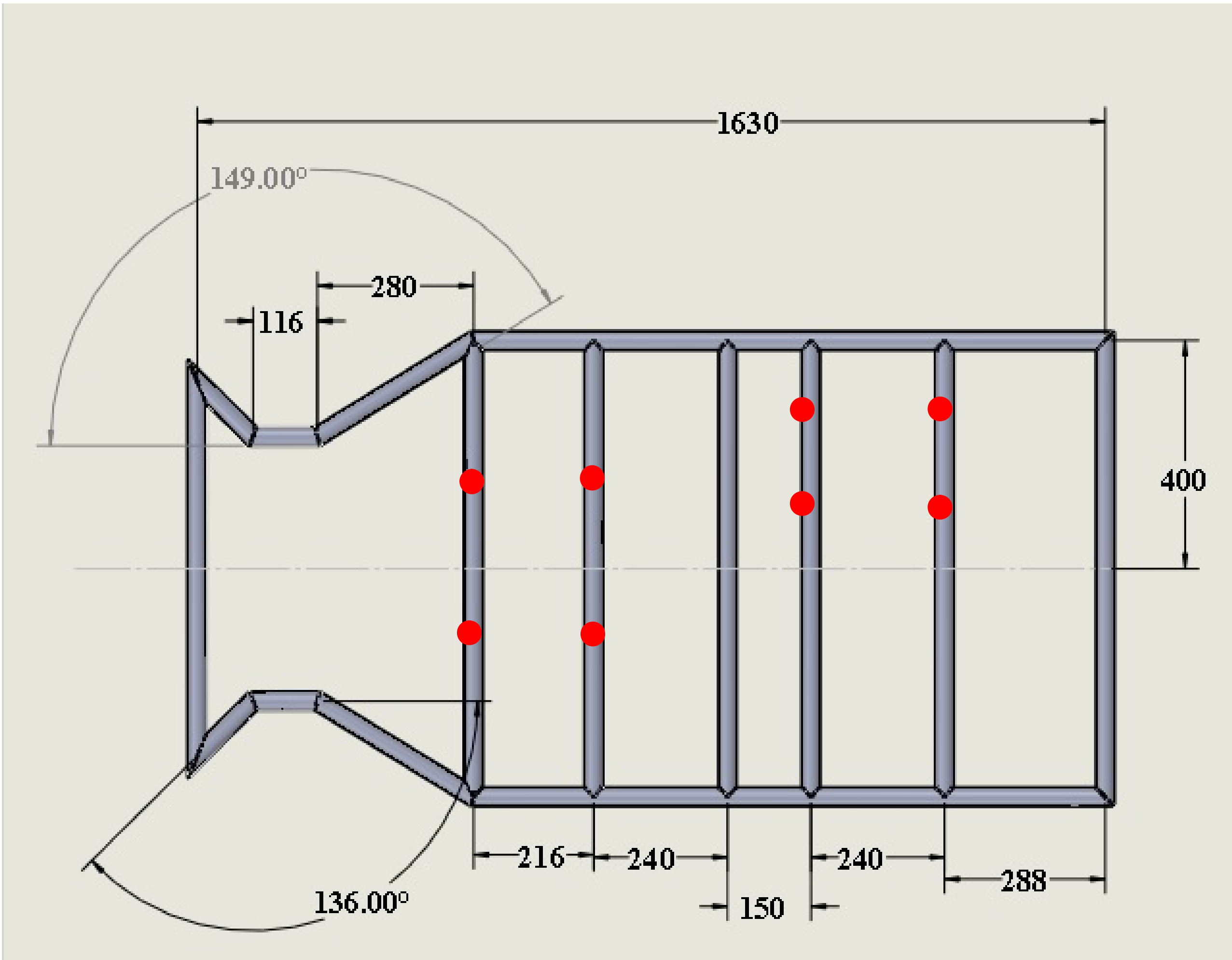


Figure 6.1 : Static Loads on Chassis

● Indicates position of static loads

6.1.1.1 Finite Element Analysis

The safety and the strength of chassis are important issues for its structure. To meet these requirements, it is essential to perform a static analysis on the chassis. Static analysis was done using finite element method as it is an effective and efficient approach. SolidWorks software was used for finite element analysis.

6.1.1.2 Meshing

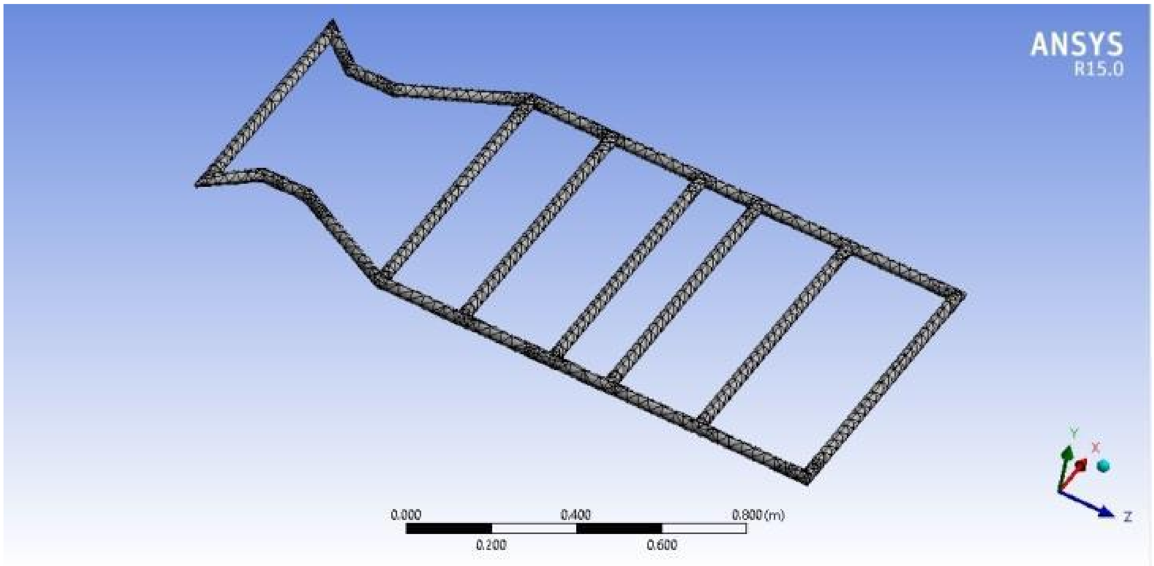


Figure 6.2 :Meshing Of Frame

6.1.1.3 Boundary conditions

Boundary conditions selected were two area of fixed point, in which one is steering knuckle joint and another is bearing on rear axle.

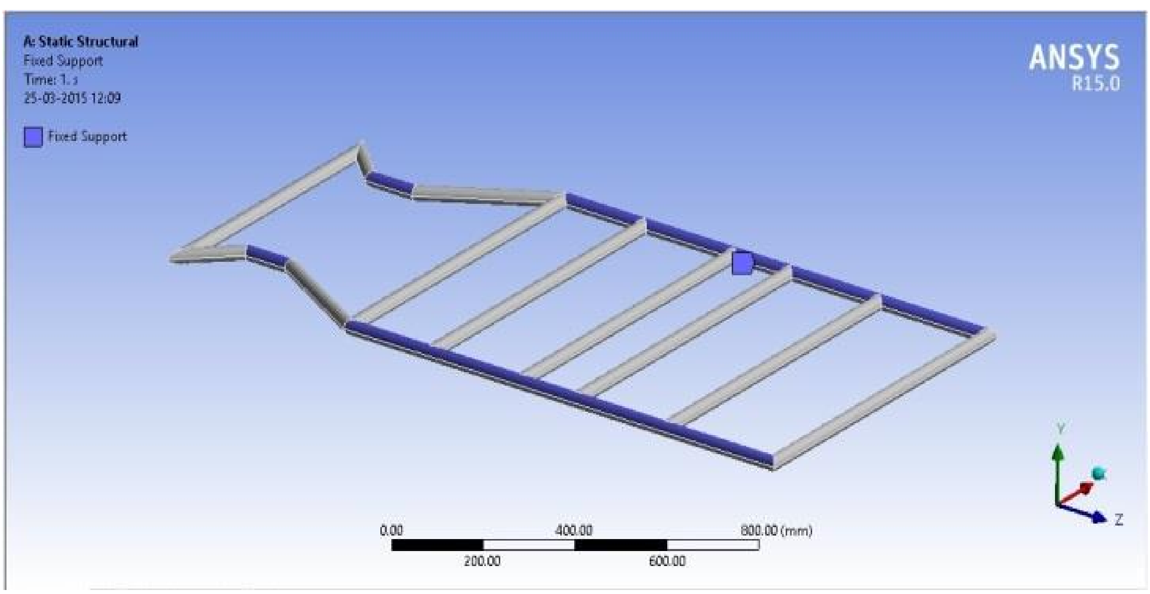


Figure 6.3 :Boundary Conditions

6.1.1.4 Loading

Figure.5 below shows the forces that have been imposed downward to the structural model. The load is distributed uniformly on member below of driver's seat and engine compartment.

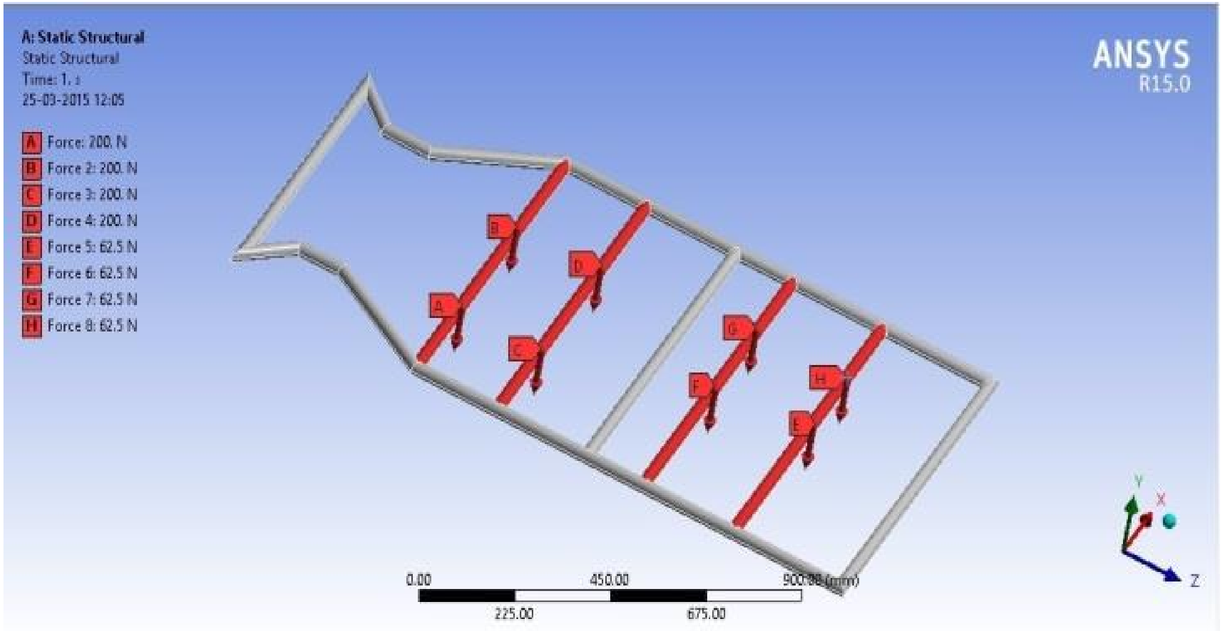


Figure.6.4:Loading Conditions

6.1.1.5 ResultsOf Static Analysis

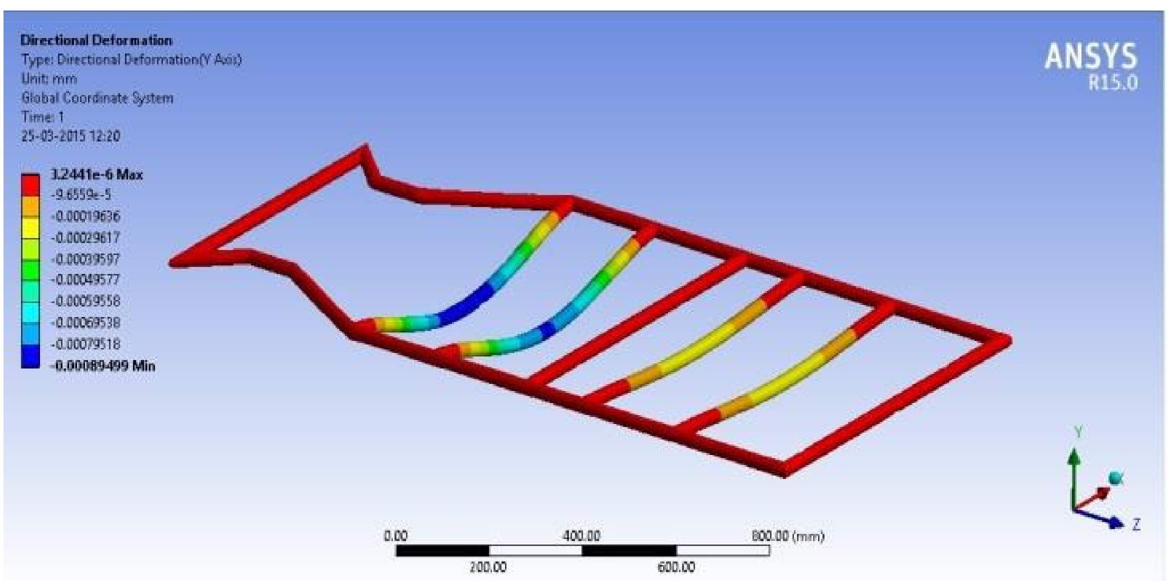


Figure.6.5: Results

Figure.6.5 shows the deflection of the model. The maximum deflection value is $3.2441x10^{-6}$mm.

The result shows, that the location of maximum deflection goes well with theoretical location but varies in magnitude aspects, from the numerical analysis

.The structure is considered under uniformly distributed load of driver seat & engine compartment foranalytical calculations.

The below equation calculates the maximum deflection which is calculated by moment area method from strength of material approach.

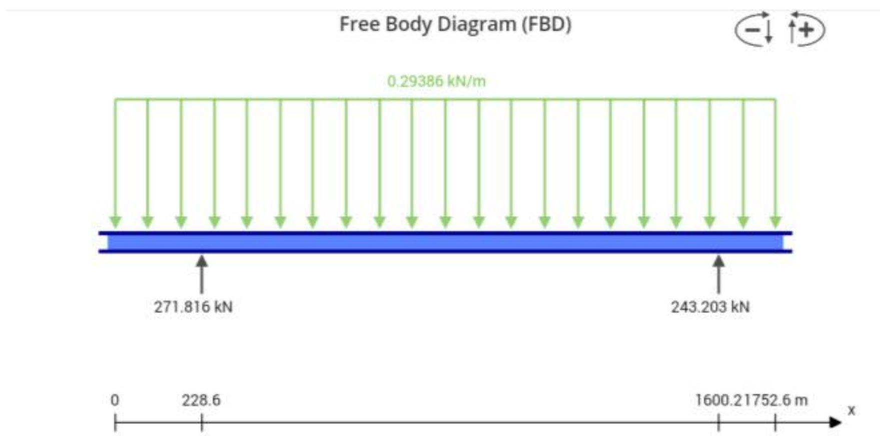


Figure.6.6: Free Body Diagram

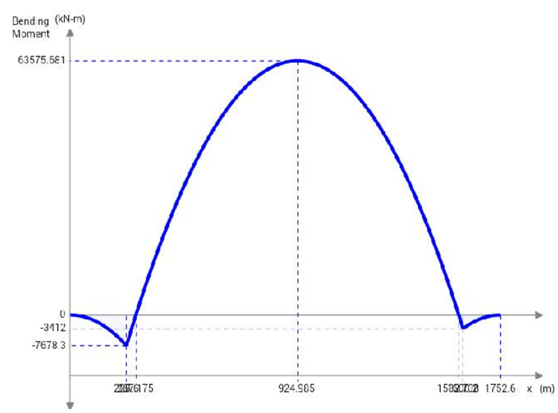


Figure.6.7: Bending Moment Diagram

$$\delta \max = \frac{moment\ of\ area\ of\ bending\ moment\ diagram}{structural\ rigidity}$$

$$= 2.092 \text{ mm}$$

As we can observe there is difference in the value of maximum deflection between numerical simulation and analytical calculation, former (numerical simulation) being greater than later (analytical calculation).

Using ANSYS software, static analysis was successfully carried out to determine maximum deflection. To countercheck these results, analytical calculations were carried out.The results of analysis shows that the location of maximum deflection agrees well with theoretical maximum

6.1.2 Analysis of chassis in dynamics :

To ensure driver safety, required chassis strength, following DYNAMIC impact scenarios as stated below were analysed using software to ensure the frame design will not fail.

1. **Front impact analysis**
2. **Rear impact analysis**
3. **Side impact analysis**
4. **Four Sided Impact Analysis**

6.1.2.1 Front Impact Analysis:

Maximum Speed of Vehicle =80 kmph = 23 m/s

Weight of Vehicle and Driver =280 kg

Impact Time (t sec) = 0.15

Equation of Motion:

$\therefore a = \frac{v-u}{t}$

$\therefore \quad = \frac{23-0}{0.15}$

a =153.33m/s²

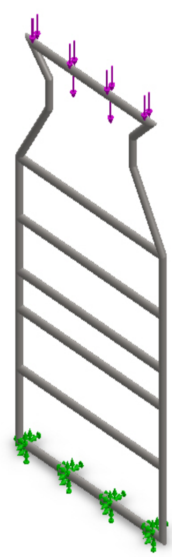
Also, Force = mass x acceleration

=280 x 153.33

=43kN

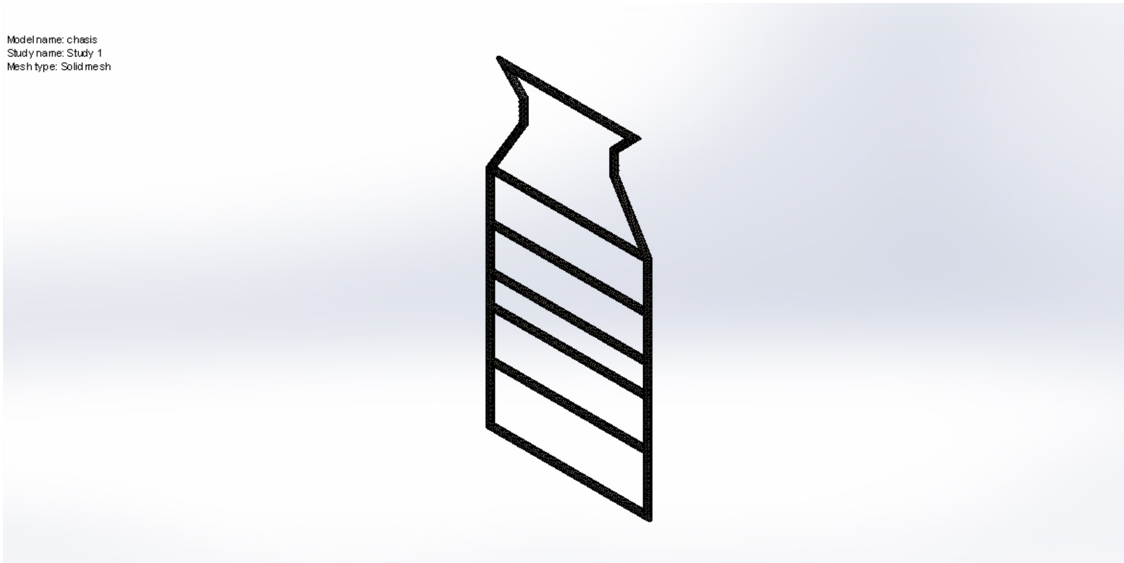
∴ Intensity of Impact Force = 43kN/mm.

Loading:



6.8 Loading on Chassis

Meshing:



6.9 Meshing on Chassis

Study Results:

Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.00111998 N/m^2 Node: 44271	7.34103e+008 N/m^2 Node: 51529

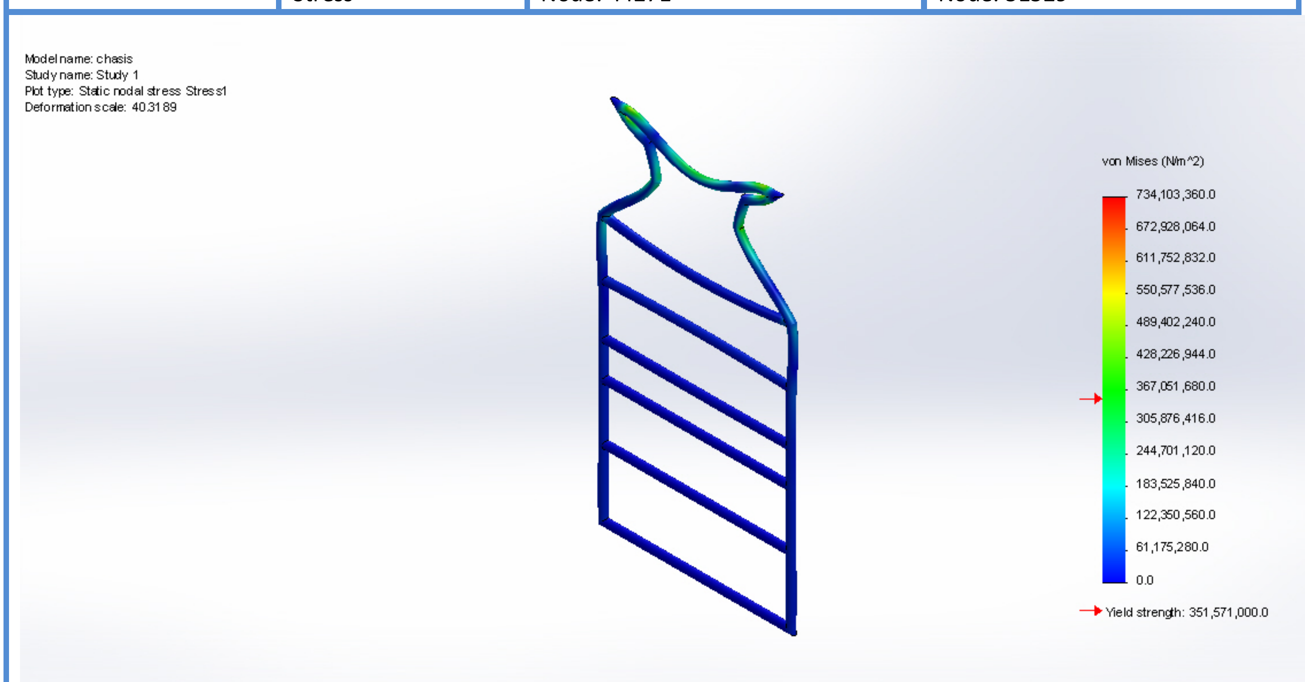


Figure 6.10 Von Messes Stress

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 3411	4.12151 mm Node: 50504

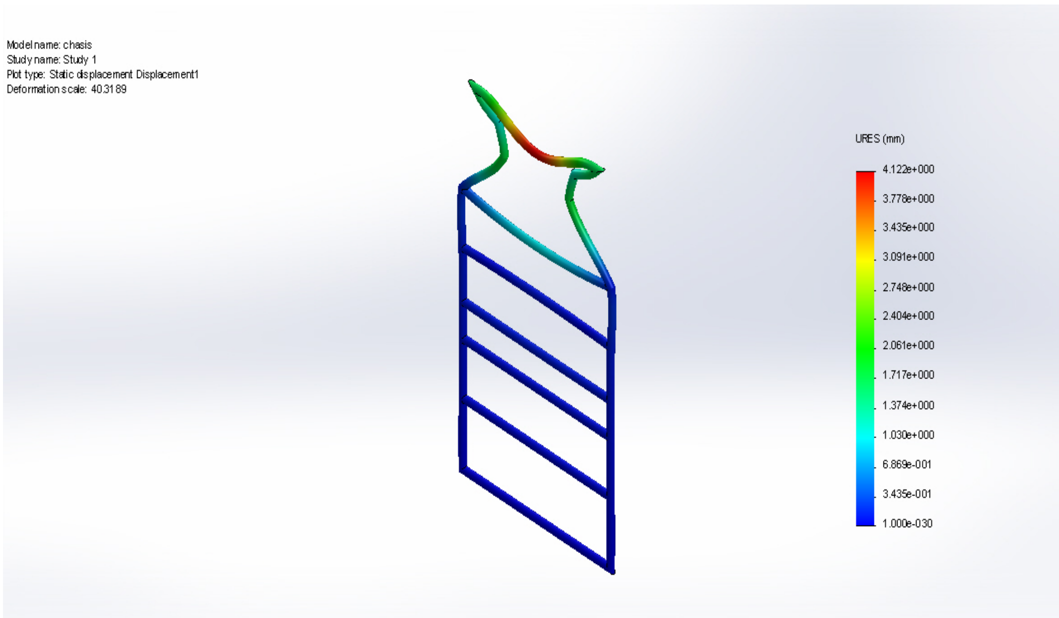


Figure 6.11 Resultant Displacement

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	3.62733e-015 Element: 5961	0.00284191 Element: 14629

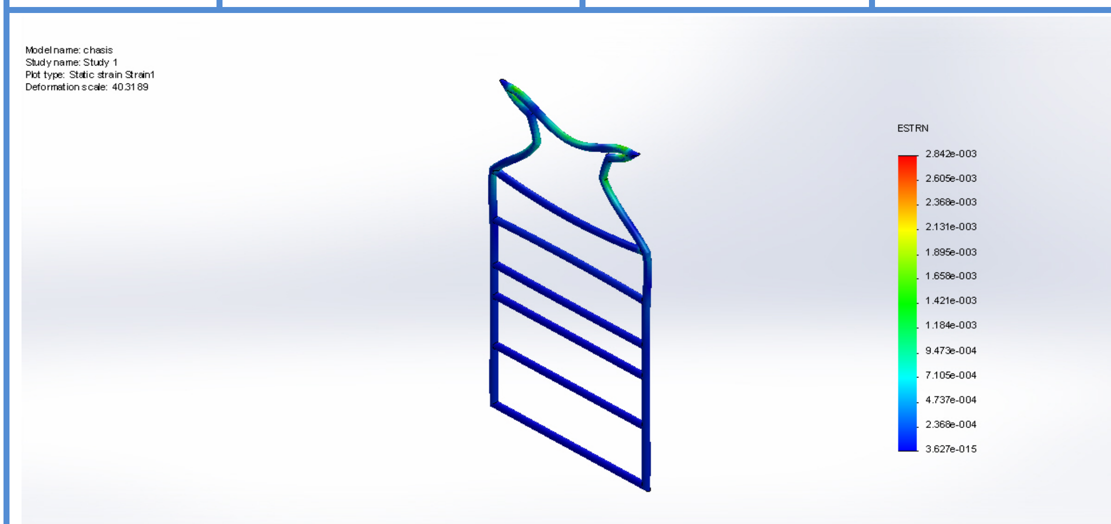


Figure 6.12 Equivalent Strain

6.1.2 Analysis of Chassis in Dynamics

Results:

- Stress

  Max Stress = 87.89 MPa (Taking Single Point Load into Consideration)

- Factor Of Safety

  Incorporated Factor Of Safety = S_{yt}/S_{max}

= 370 / 87.89

= 4.20

Hence, the chassis will be safe under front impact.

6.1.2.2 Rear Impact Analysis

Maximum Speed of Vehicle =80 kmph = 23 m/s

Weight of Vehicle and Driver =280 kg

Impact Time (t sec) = 0.15

Equation of Motion:

$\therefore a = \frac{v-u}{t}$

$\therefore \quad = \frac{23-0}{0.15}$

a =153.33m/s²

Also, Force = mass x acceleration

=280 x 153.33

=43kN

∴ Intensity of Impact Force = 43kN/mm.

Loading:

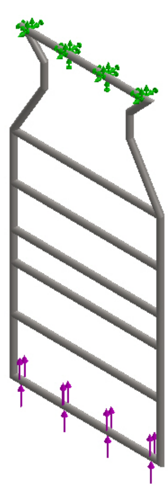
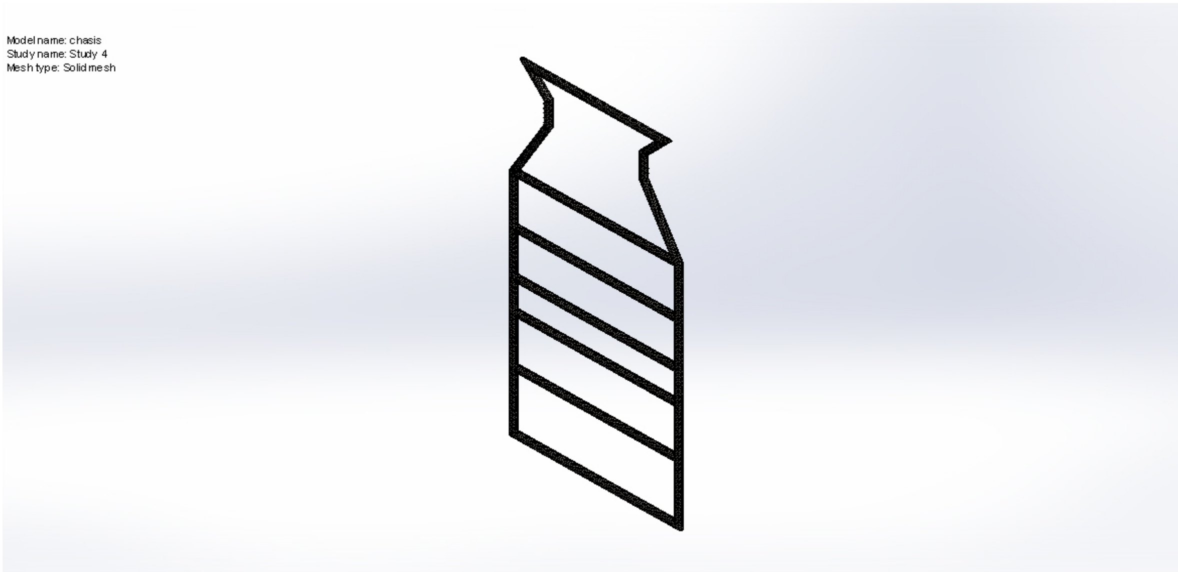


Figure 6.13 Loading on Chassis

Meshing:

Figure 6.13 Loading on Chassis



Study Results:

Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.477852 N/m^2 Node: 25614	9.78824e+008 N/m^2 Node: 40290

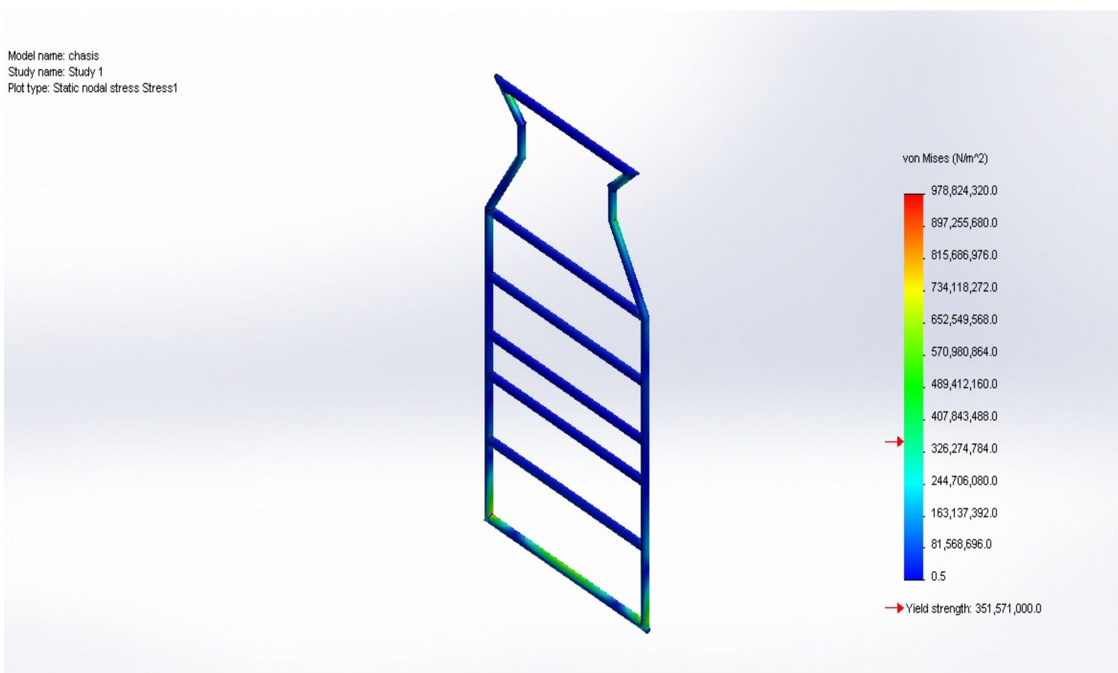


Figure 6.14 Von Mises Stress

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 2409	10.9549 mm Node: 40024

Figure 6.15 Resultant Displacement

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	3.06349e-012 Element: 30277	0.00318414 Element: 13336

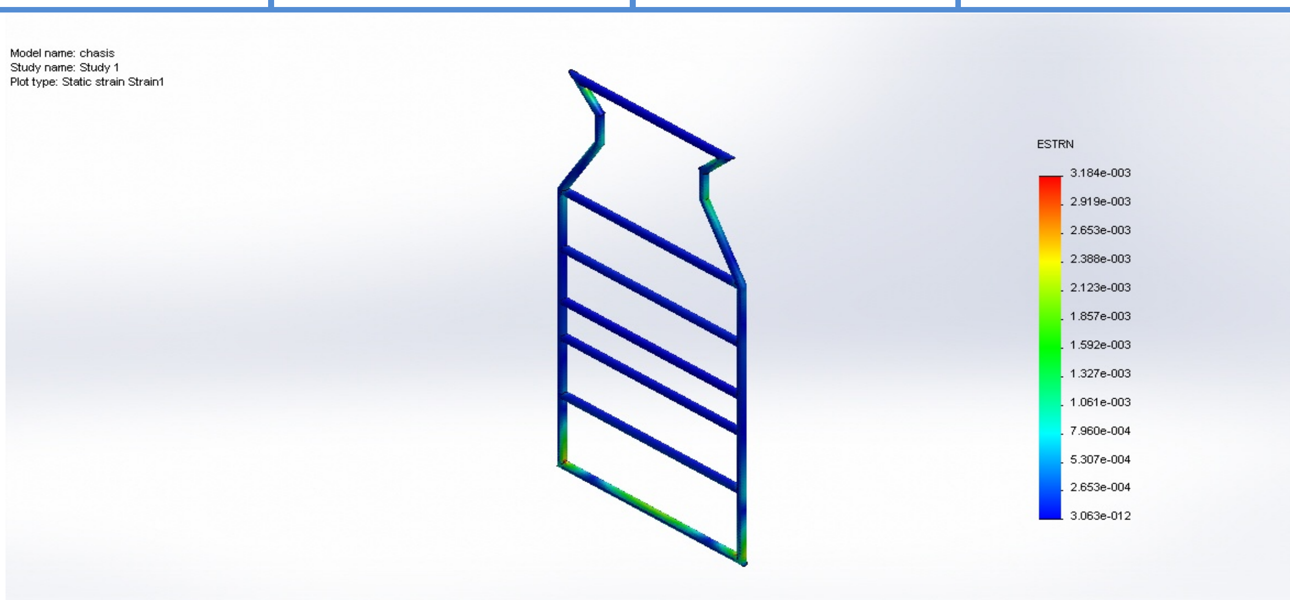


Figure 6.16Equivalent Strain

Results:

- Stress

  Max Stress = 87.89 MPa (Taking Single Point Load into Consideration)

- Factor Of Safety

  Incorporated Factor Of Safety = S_{yt}/S_{max}

= 370 / 87.89

= 4.20

Hence, the chassis will be safe under rear impact.

6.1.2.3 Side Impact Analysis

Maximum Speed of Vehicle =80 kmph = 23 m/s

Weight of Vehicle and Driver =280 kg

Impact Time (t sec) = 0.15

Equation of Motion:

$\therefore a = \frac{v-u}{t}$

$\therefore \quad = \frac{23-0}{0.15}$

a =153.33m/s²

Also, Force = mass x acceleration

=280 x 153.33

=43kN

∴ Intensity of Impact Force = 43kN/mm.

Loading

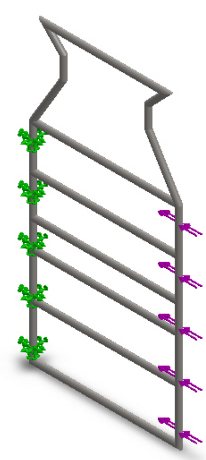


Figure 6.17 Loading on Chassis

6.1.2 Analysis of Chassis in Dynamics

Meshing:

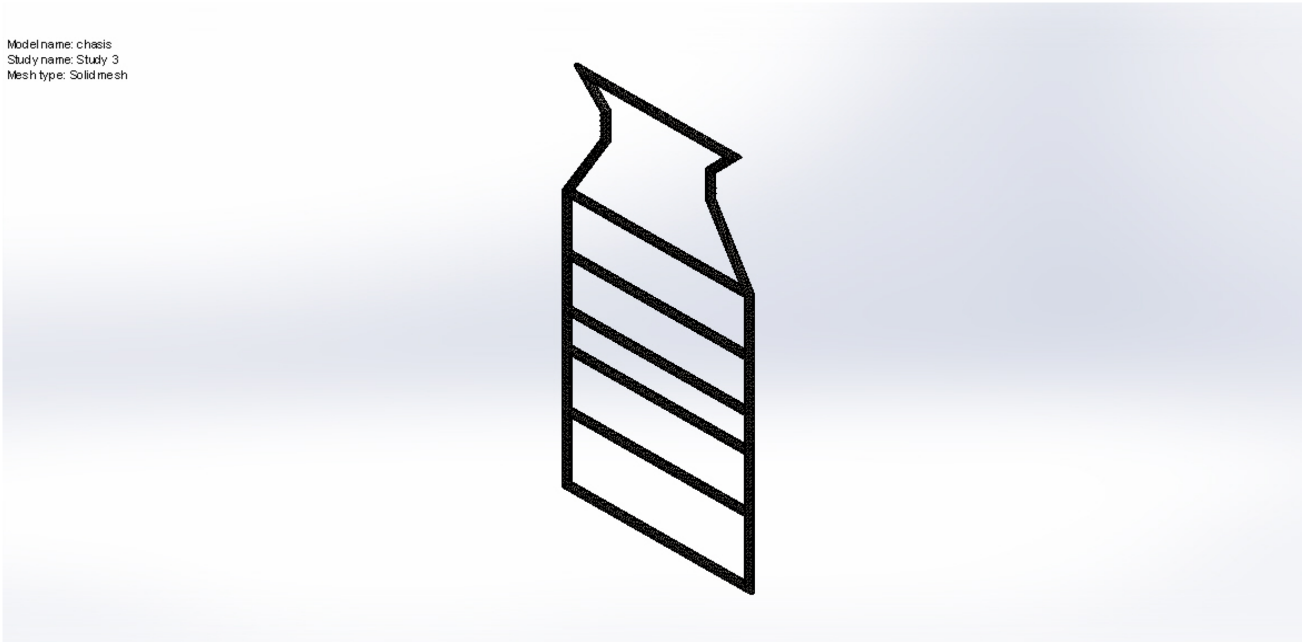


Figure 6.18 Meshing

Study Results:

Name	Type	Min	Max
Stress1	VON: von Mises Stress	49.6639 N/m^2 Node: 31747	8.50407e+007 N/m^2 Node: 38030

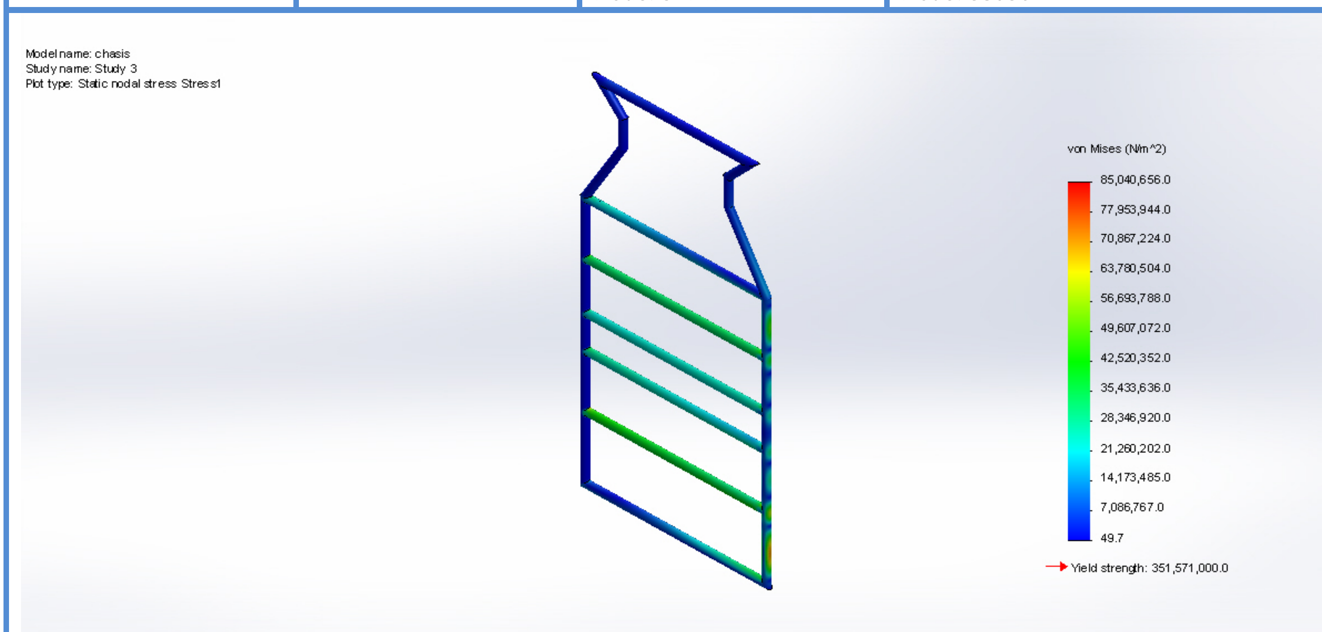


Figure 6.19von Mises Stress

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 1	0.264456 mm Node: 38126

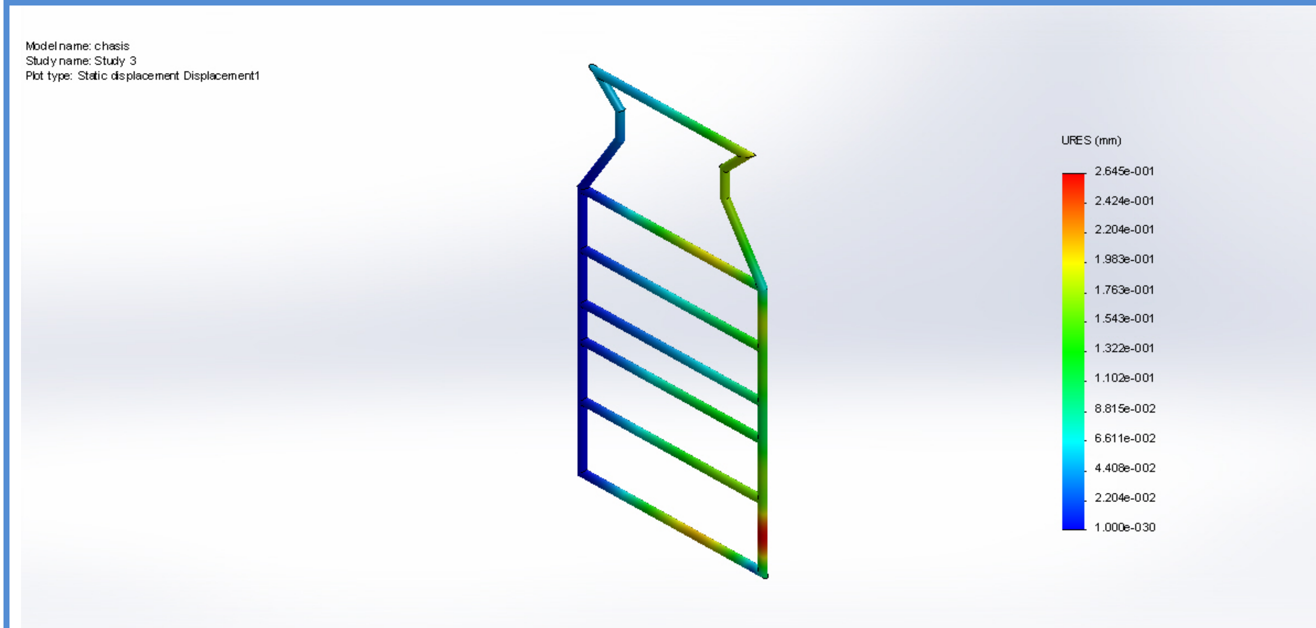


Figure 6.20Resultant Displacement

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	2.60495e-010 Element: 28624	0.000323919 Element: 13985

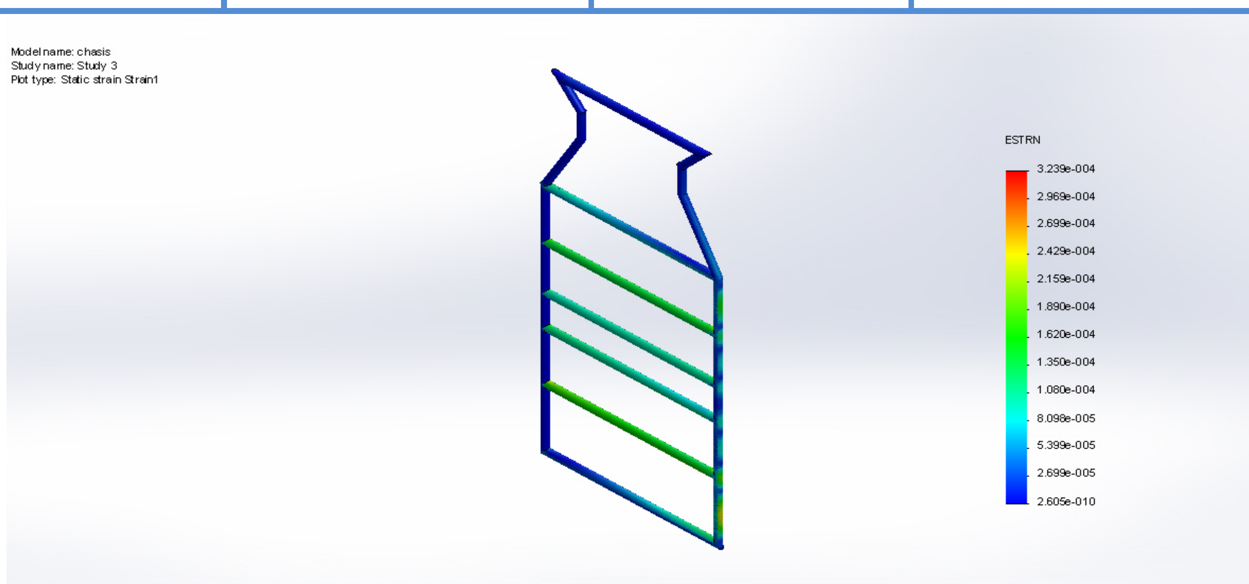


Figure 6.21Equivalent Strain

Results:

- Stress

  Max Stress = 87.89 MPa (Taking Single Point Load into Consideration)

- Factor Of Safety

  Incorporated Factor Of Safety = S_{yt}/S_{max}

= 370 / 87.89

= 4.20

Hence, the chassis will be safe under side impact.

6.1.2.4 Four Sided Impact Analysis

Loading

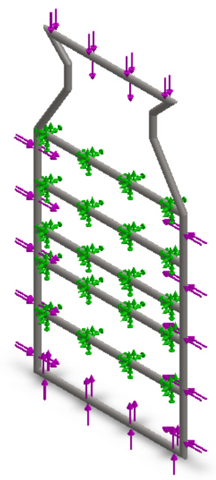


Figure 6.22 Loading on Chassis

Meshing

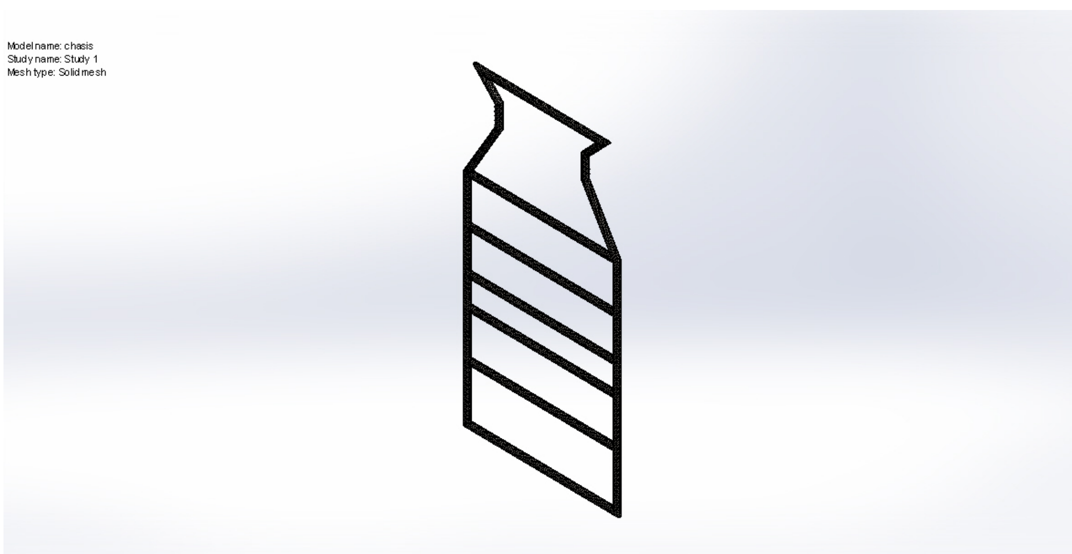


Figure 6.23 Meshing

6.1.2 Analysis of Chassis in Dynamics

Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.000498705 N/m^2 Node: 60796	1.06297e+009 N/m^2 Node: 44553

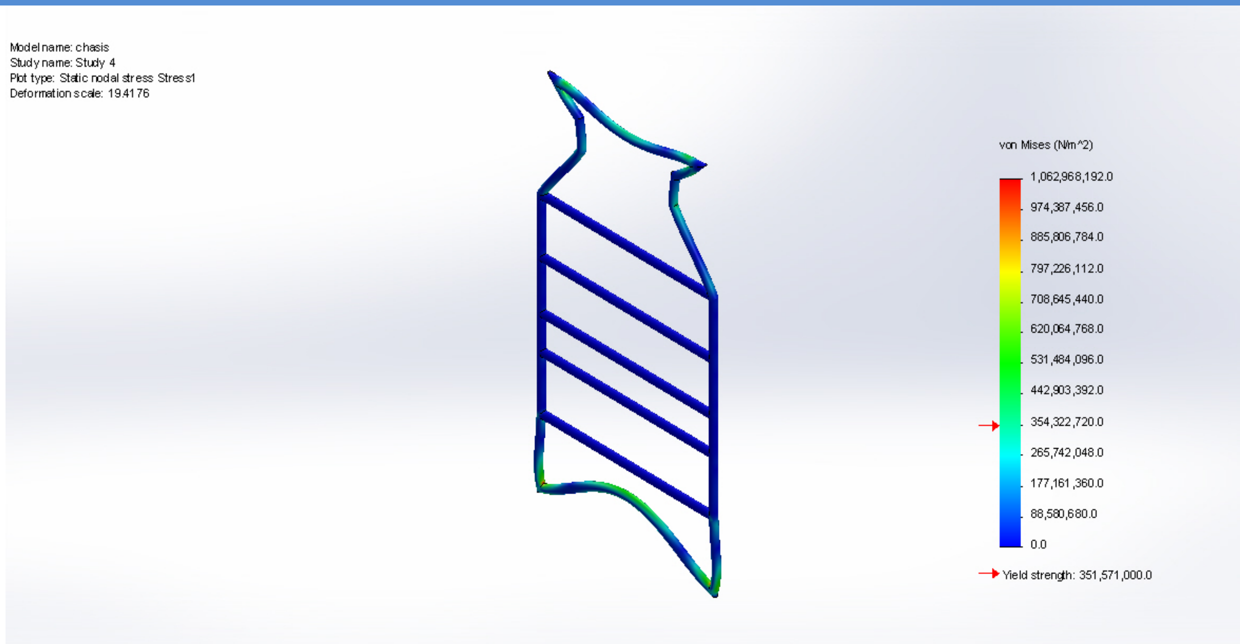


Figure 6.24 von Mises Stress

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 1	8.55795 mm Node: 3754

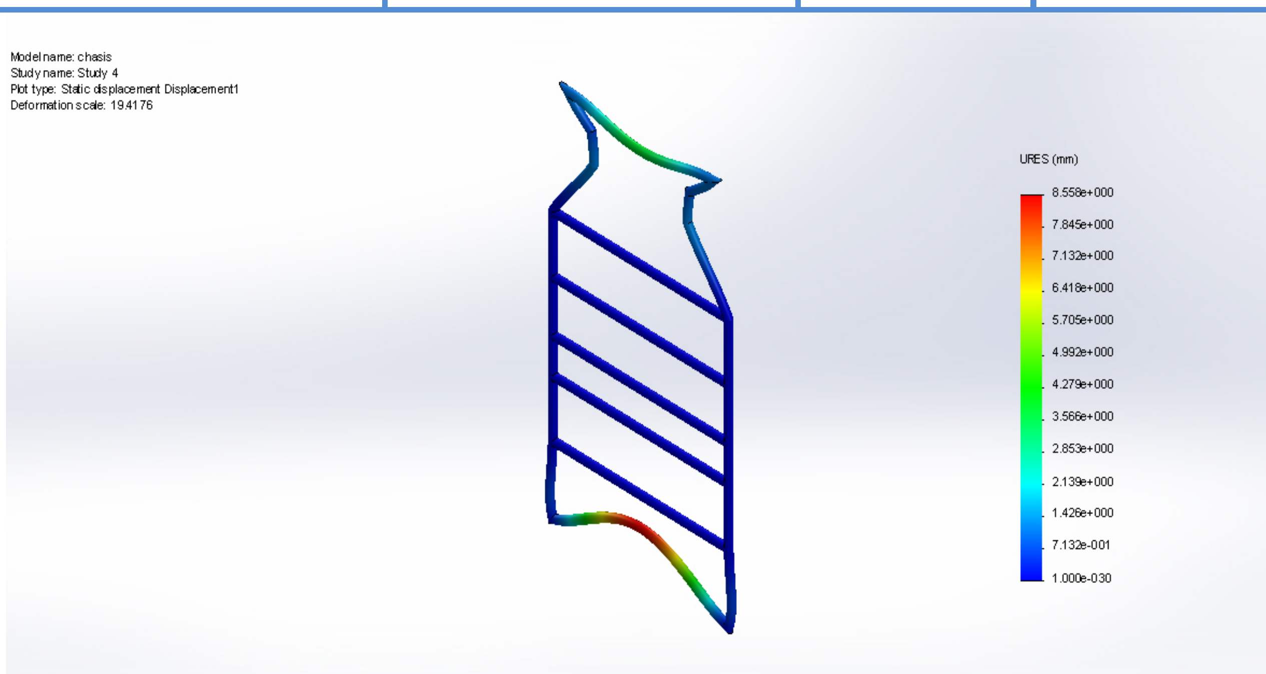


Figure 6.25 Resultant Displacement

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	1.55638e-015 Element: 36982	0.0037314 Element: 19047

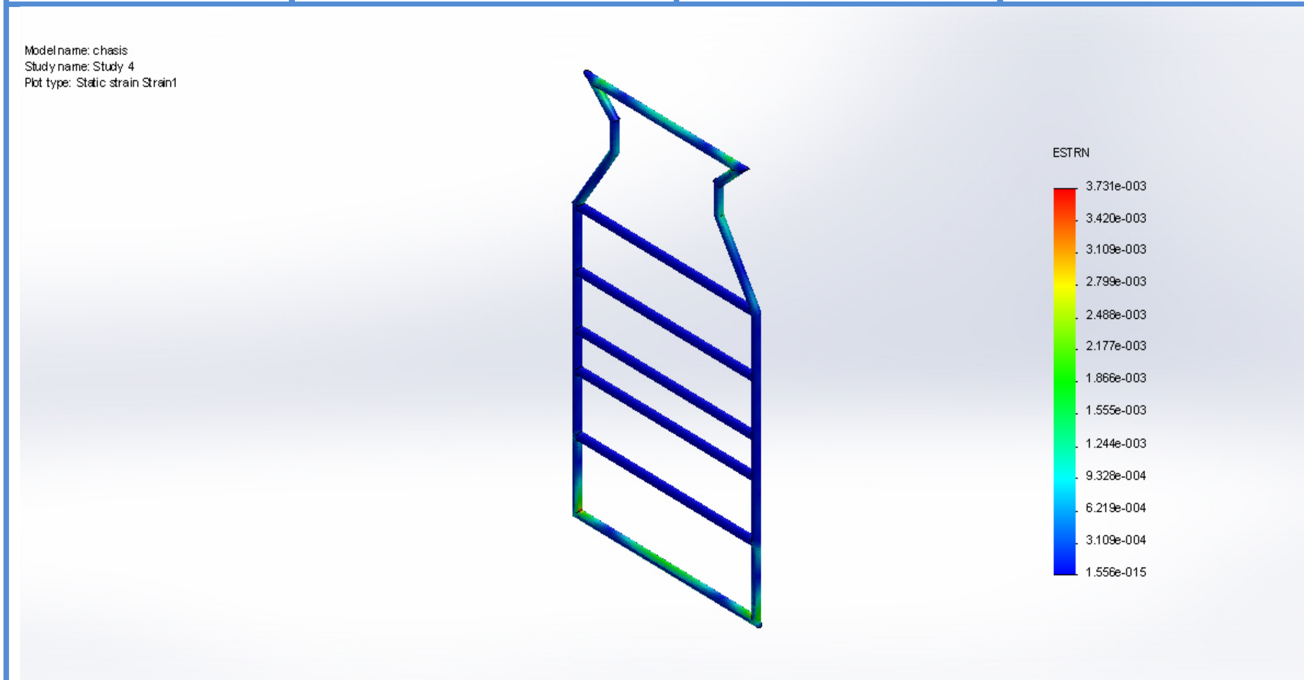


Figure 6.26Equivalent Strain

Results:

- Stress

  Max Stress = 87.89 MPa (Taking Single Point Load into Consideration)

- Factor Of Safety

  Incorporated Factor Of Safety = S_{yt}/S_{max}

= 370 / 87.89

= 4.20

Hence, the chassis will be safe under four sided impact.

Chapter 7

VEHICLE SPECIFICATIONS

7.1 Vehicle Specifications

Table 7.1 Vehicle Specifications

VEHICLE MODEL	MAKE VALUE
Wheel base	1494mm
Wheel track	920mm
Overall length	1630mm
Overall width	800mm
Maximum Speed	80 km/hr
Overall weight	< 200kg
Material	AISI 1018

Chapter 8

RESULT

AND

DISCUSSION

Chapter 8 Result & Discussion

8.1 Results And Discussion:

The key to good chassis design is that the further mass is away from the neutral axis the more ridged it will be. This one sentence is the basis of automotive chassis design

This study attempted to analyze stress on the chassis design using finite element analysis (SOLIDWORKS). This is important because the simulation data are useful for further design improvement and subsequently leads to cost effectiveness

The table below show results of all the analysis done on the chassis of Go-kart successfully:

Table 8.1 Results

Analysis	Result
Vertical Loading	Safe
Front Impact	Safe
Rear Impact	Safe
Side Impact	Safe
Four Sided Impact	Safe
Vibrational (Nodal)	Studied
Torsional	Studied

Chapter 9

Cost Report

Table 8.1 Costing of Materia

BODY FRAME PARTS	COST (Rs.)
MATERIAL (AISI 1018)	8250
WELDING RODS	350
CUTTER BLADE	200
RED OXIDE	100
PAINT & PAINTING ACCESSORIES	300

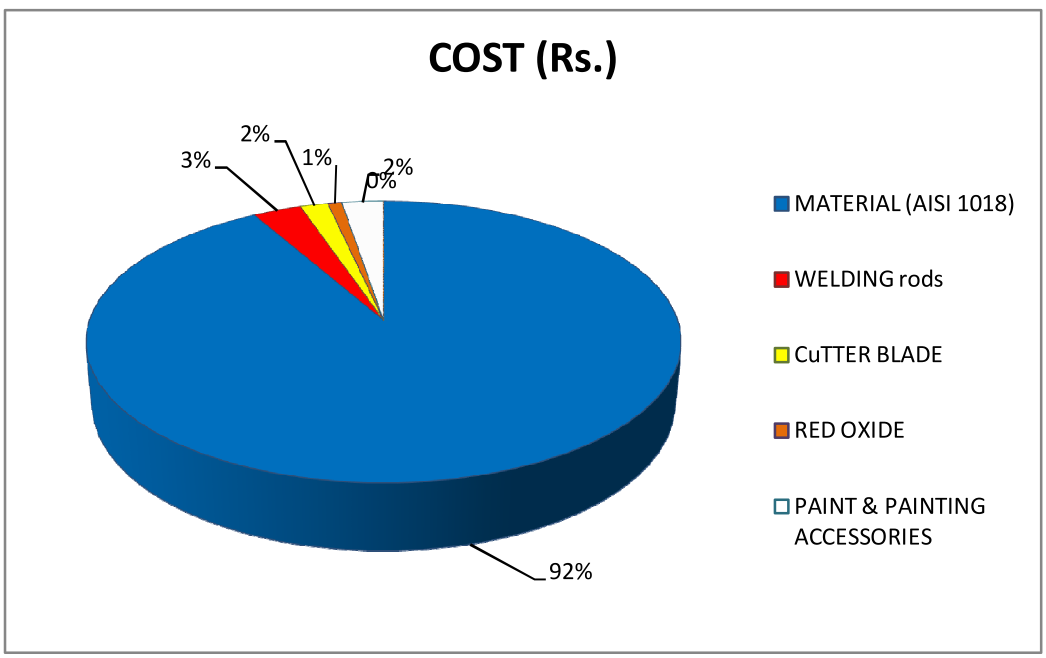


Figure 8.1 Pie Chart Representation of Cost

Chapter 9

Gannt Chart

Chapter 9 Gannt Chart

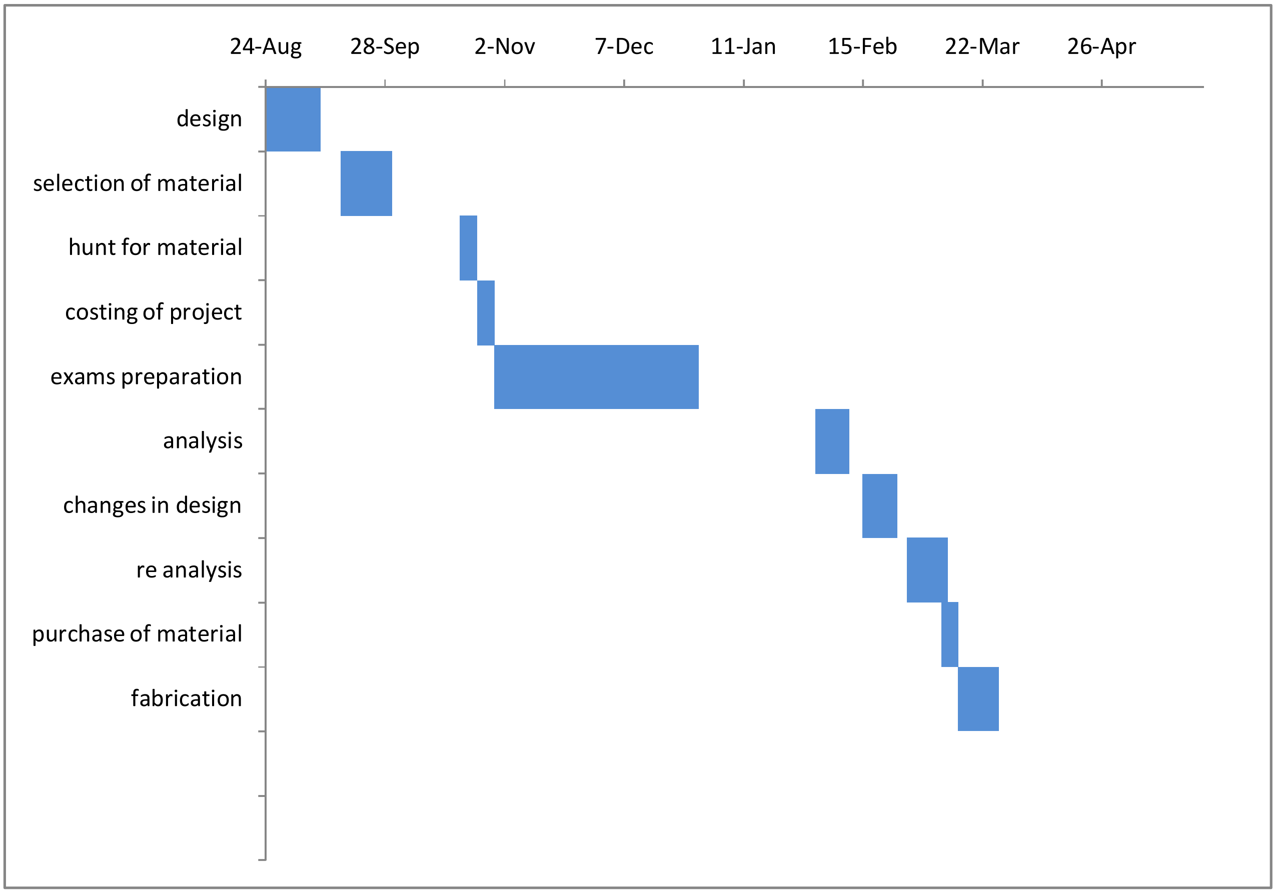


Figure 9.1 Gannt Chart

Chapter 10

CONCLUSION

Conclusion:

Static analysis using finite element method was successfully carried out to determine maximum deflection and its location on chassis structure. The results of analysis revealed that the location of maximum deflection agrees well with theoretical maximum location of simple beam. This study found out that there is discrepancy between the theoretical (2-D) and numerical (3-D SOLIDWORKS) results.

Future Scope

As of now, Go-Karts are only used for recreational purposes in India. But there are Automobile manufactures which produce high performance Go-Karts which are street legal. For example, Ariel Atom manufactured by Ariel Motor Company and KTM X-Bow manufactured by KTM. So in future, Go-Karts can be used as a people's mover, which are safer and gives high comfort.

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Publications

1) Rahul Thavai,KaziShehzaad,MirzaShahrukh,MukriArman,Khan Imran,2015, "*Static Analysis Of Go-Kart Chassis By Analytical And SolidWorksSimulation"*International Journal of Modern Engineering Research (IJMER), ISSN: 2249-6645,Vol.5,Issue no.4,April 2015,pg no. 64-68.

2) Rahul Thavai,KaziShehzaad,MirzaShahrukh,MukriArman,Khan Imran, "*Static Analysis Of Go-Kart Chassis By Analytical And SolidWorksSimulation"*ANED (American National Engineering Database),ANED-DDL(Digital Data Link) No. 02.6645/IJMER-J0504_01-64

Appendix I

Torsional Stiffness Or Torsional Rigidity Calculations

Torsional Stiffness Calculations:

Moment Arm = ½ x track width

= ½ x 920

= 460 mm

Angular Deflection = $\tan^{-1}$ [vertical deflection / moment arm]

= 1.245 deg

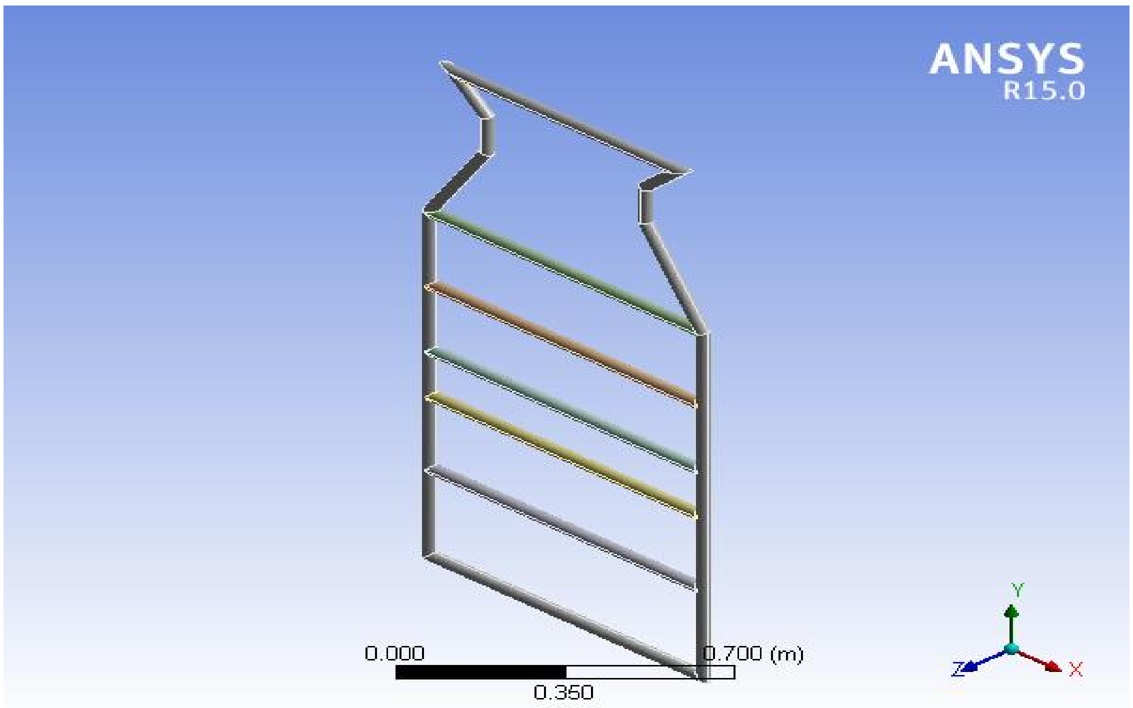
$$\frac{T}{J} = \tau / R$$

Torsional stiffness = torque/ angular deflection

= 345.3815 Nm/deg

Appendix II

Study of Modal Vibrational Analysis



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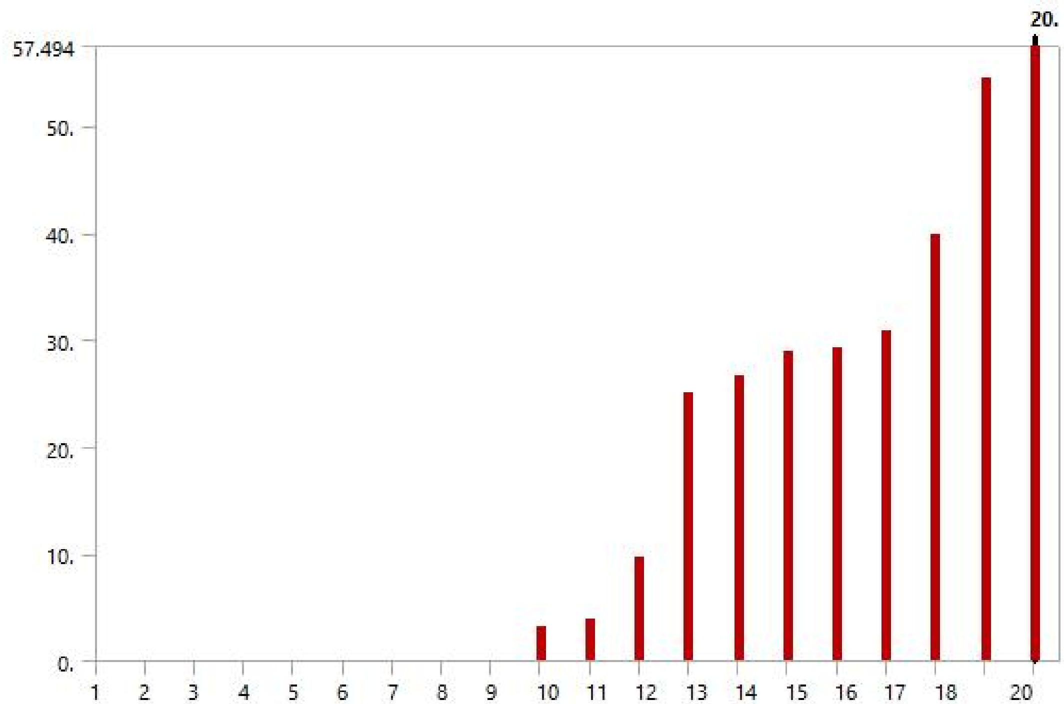
The following bar chart indicates the frequency at each calculated mode



Appendix II

The following table represents the above calculated frequency:

Mode	Frequency [Hz]
1.	0.
2.	
3.	
4.	
5.	
6.	
7.	7.622e-004
8.	1.2689e-003
9.	2.9887e-003
10.	3.2041
11.	3.8356
12.	9.6663
13.	25.061
14.	26.586
15.	28.984
16.	29.302
17.	30.819
18.	39.944
19.	54.581
20.	57.494

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