Structural Design of Go-Kart Chassis

Sonali Shukla[1] Divya Tiwari[2] Shreya Pandey[3] Sumit Mishra[4]
[1,2,3,4]Student
[1,2,3,4]Department of Mechanical Engineering
[1,2,3,4]Govt. Engineering collage Rewa, Madhya Pradesh, India

Abstract— This research paper mainly focuses on Design Analysis and Forming modelling Analysis of Light Weight Structures in Circular Beam and Solid works. A Go-Kart is Driven by a child or adult and has a steering wheel, pedals, and a seat for driver. AISI1018, which is the best material used on go kart chassis, is a medium carbon steel with high tensile strength, high machinability and provides a good balance of rigidity and ductility. It is mainly designed on CatiaV5 software and we analysed in Ansys R21.0. To check the possible structural deformation stress is applied on the structure and actual impact test is carried out and efforts are made to reduce the deformation in the structure. The design analysis for the chess piece was made in Catia V5 and it has a weight of 1.8 ounces. The Design Build of a Go Kart Many People Are Trying to Build with One1 lakh cost and we also took up the challenge of making a Go-Kart in the budget of 70 thousand. it's a dream we are for Working with the hope of making this a reality.so it's sure the project will be in high demand in the industry. The design process follows all Rules set by the 10th Go-Kart Design Challenge (GKDC) rulebook. It is one of the main systems of the go kart on which other subsystems like engine, steering and transmission systems, seat are mounted. It is one of the main systems of the go kart on which sit other subsystems such as the engine, steering and transmission systems. The forces acting on the vehicle from different directions are responsible for wear and tear in the vehicle. Hence stress arises maximum combined stress direct stress etc. using 3D Modelling software Ansys we had designed a Cad model. Which help us to visualize our Go-kart design and reduces the errors in our fabrication. Our Design is b based on following Objective: 1) Safety Strength Service availability 2) Vehicle control 3) Ruggedness Accommodation, Ergonomics & Aesthetic Durability Cost 4) High performance 5) Light weight

Keywords: GKDC, Chassis, CatiaV5, Stress, AISI1018, Analysis

I. INTRODUCTION

A go kart is a simple vehicle, specially designed for racing and has very low ground clearance compared to other vehicles. Go karts are a great outlet for those interested in racing. It was built in the late 1950s as a place for airmen to spend their free time. Art English is generally regarded as the father of karting. He made the first car in 1956 in Southern California (R1). the ordinary parts of a go kart are the engine, wheels, steering, axles and chassis, and tyres. Go kart is like F1 racing track. it Must have a go-kart chassis Stable with high torsional stiffness, and the skeleton frame made of hollow pipe and other materials. The chassis of any vehicle should be rigid, and strong enough Sustaining loads and shocks the vehicle can bear during competition While passing through the track area. it must be Designed in an ergonomic and sturdy effective manner at optimum cost Weight for track race purposes. The chassis is designed taking into account factors such as dimensional limitations wheel base, track width. height operational restrictions, regulatory issues, construction restrictions, regulatory issues, contractual requirements, financial constraints and human ergonomics as a priority. It has been designed keeping in mind factors like dimensional range, wheelbase, track width. altitude, operational restrictions, regulatory issues, construction restrictions, regulatory issues, contractual requirements, financial constraints and human ergonomics as a priority (R2). The chassis is a skeletal framework made of hollow pipes and other materials of various sizes. The frame is the base of the vehicle which supports the weight of the engine, driver, passenger and is designed in such a way that it must be securely fixed and the core strength of the chassis does not change when a load is applied. The chassis is fabricated through the use of a set Guidelines provided by ISIE through the use of modelling software solid works. The chassis is an essential design in which the student should be a material that has high strength, low Weight, economy, feasibility and availability (R3).

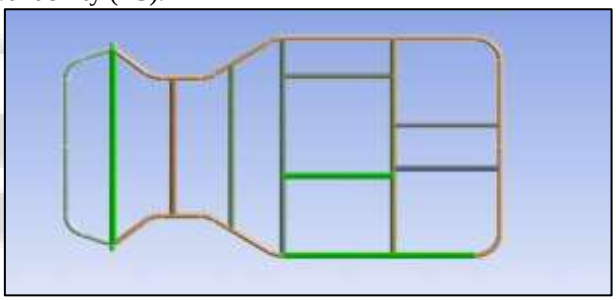


Fig. 1.1: Top view of the chassis

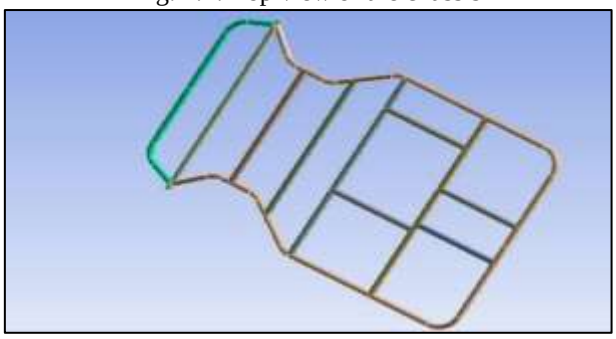


Fig. 1.2: Isometric view of the Chassis

II. REQUIRED MATERIALS

PROPERTIES	AISI1018
Density	7.9 g/cm3
Elastic young flexible gauge	210GPa

Table 2.1: Properties of AISI 1018

COMPOSITION	AISI1018
Iron (Fe)	98.8 to 99.25%
Manganese (Mn)	0.6 to 0.9%
Carbon (C)	0.15 to 0.2%
Sulphur (S)	0 to 0.050%

Phosphorus (P)	0 to 0.040%

Table 2.2: Composition of AISI 1018

The carbon content in steel is of great importance in determining hardenability, strength, machinability and weldability. property plays a key role in the construction of the entire vehicle, providing material selection for the chassis dependability, security and tolerance. Steel that contains carbon increases the hardenability of the material. aluminium alloys are costlier than steel, so steel is the best material to make a chassis(R4). the carbon content in steel is very important. Machinability to determine the hardness and strength characteristicsand plays an important role in vehicle manufacturing. the factor of safety (FOS) plays an important role; it is defined as the ratio of the ultimate yield strength of the stresses produced in the roll cage. This value of Factorof safety for the chassis should not be exceed 3 and less than 1. If the value is less than 1, it will become significant deformation before reaching the maximum stress value. If the value is more than 3, than the weightof roll cage will exceed the optimum level for whom should have to be. The vehicle is considered separately different circumstances. The components of chassis required to be welded.

The key to a good-chassis is selecting the best materials, for which we have done extensive research. Based solely on strength, weight, cost, availability, corrosion resistant and weldability were the main factors for our comparison(R5). assorted criterion were kept in mind while choosing the frame material which incorporates obtainability, cost, machinability and tensile strength.

Most automotive components and parts are made from cast iron, such as brake drums and rotors, spindles, engine blocks and many other components including fasteners. There are different types of steel for each component, which requires a different strength and characteristic from the material. The amount of carbon in steel is the most important factor in determining strength, hardenability and machining characteristics. (R6). AISI-1018 material is used in the chassis design Because of its good weldability, the relatively soft and Strong as well as good manufacturability. A good the strength material is important in the roll cage because the roll needto absorb as much energy as possible to stop the cage Roll cage material from fracturing at high influence(R7).

III. CROSS SECTION SELECTION

	Square	Circular
Bending Stress	392.93	287.19
Deflection	10.372	5.375

Table 3.1: Bending stress and deflection of square and circular – cross section of tube

IV. FRAME DESIGN

The chassis has been designed keeping in mind various factors like its cross section, pipe area, front impact force, rear impact force, torsional effect, its weight in seated position etc. the tube used in the construction of the chassis must be seamless. The minimum OD of the tube used in the chassis shall not be less than, greater than 1 inch(25.4mm). values are taken as per 10th rule book GKDC.

Calculation of Area moment of inertia, bending strength and bending stiffness:

A. AREA MOMENT OF INERTIA

I= (π/64) x (D4 – d 4)
= (π/64) × (254−194)
= 1.27x10−8 *m*4

B. BENDING STRENGTH:

Bending strength = Sy*I/C AISI 1018 Circular Section, Sy=370MPa
C=12.7mm
Hence, Bending Strength =370×1.27x10−8 /0.0127 =370 N-m

C. BENDING STIFFINESS:

Bending Stiffness =E × I AISI 1018 Circular Section, E=205GPa
Bending Stiffness=205×1.27x10-8
=2603.5 Nm-1

The chassis has to be designed in such a way that it can handle everything. The stress of force from all directions should be distributed along the pipes and this effect should flow from front to back to distribute thestress throughout the chassis. The frame of a vehicle, or the design of a structure understand the various loads acting on a structure. Main deformation modes for automotive chassis(R8).

V. DESIGN OF CHASSIS

Considering GKDC 10th Rule Book as a guide book to clear all required dimensions and constraints to manufacture the chassis, and then Designed using CATIA v5 software, wireframe workspace, model.

Fig. 5.1: Wireframe model of Chassis (Front view)

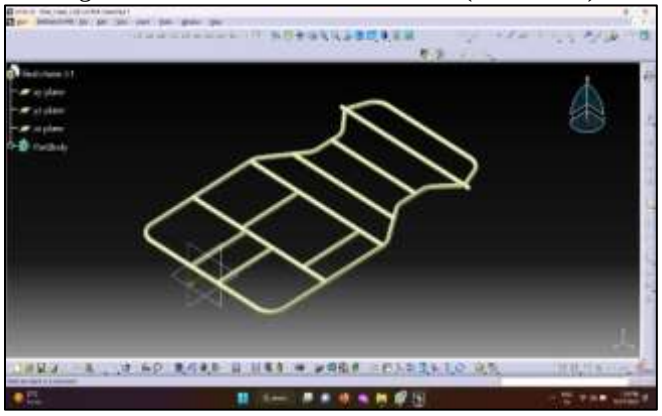


Fig. 5.2: Wireframe model of Chassis (Isometric view)

Chassis design is done using CATIA v5 software. Ideal parametric as well as pre-calculated locations. This means that the models characteristics are based on previous dimensions and will change according to any modifications to the original characteristics. With this design the parameters used in the design are also very important.

VI. METHODOLOGY

- -Creation of wireframe of the structure in CATIA v5 software.
- -Importing and cross sectioning it on Ansys R21.0 design modeler didactic.
- -Perform common model analysis to examine each weather element whether the chassis is fully connected or not.
- -Creation of meshes in mechanical modeler.
- -Calculate total after setting all analysis and frequency settings distortion.
- -Then in a stable structural workbench after applying all necessary loads and disrupts all analysis viz,
  1) Front impact analysis
  2) Rear impact analysis
  3) Side impact analysis
  4) Analysis of load at seating position
  5) Tortional impact analysis
- Then modify the wireframe CAD model to obtain the minimum distortion capable.
- The frame was meshed with beam elements for analysis in Ansys workbench, the model was automatically generated with the following specifications:
  Physical Prefer – Mechanical Relevance – 50
  Relevance Centre – Fine Smoothing – Medium
  Minimum Edge Length – 21.678mm Element Size – 4mm
  Nodes – 57241
  Elements - 57028

VII. ANALYSIS OF THE DESIGNED FRAME

A. FINITE ELEMENT ANALYSIS

This FEA software is used for analysis of an academy in our case. Whether it works the way it is designed or not. For this the cost of construction can be optimized. It's the frame based on the size of the element. Finite element analysis (FEA) is a computerized method for predicting how a product reacts to real-world forces, vibration, and other physical effects. Finite element analysis shows whether a product will break, wear out, or work the way it was designed. Here we divide the chassis into small sizes known as element and collective elements on the model from a mesh(R9). After designing chassis in Catia software, CAD model was exporting to FEA software and element model was made using Abaqus (R10). The meshed model of the chassis is shown in images below:-

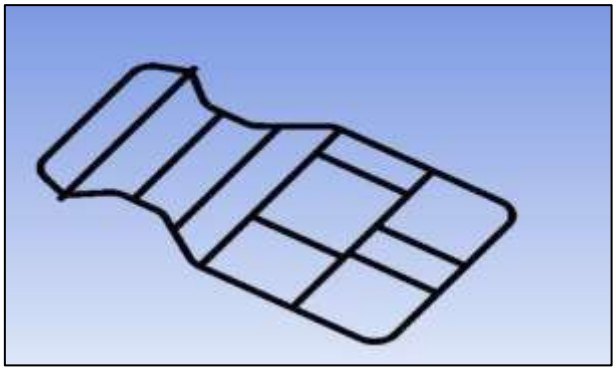


Fig. 7.1: Meshed Model of

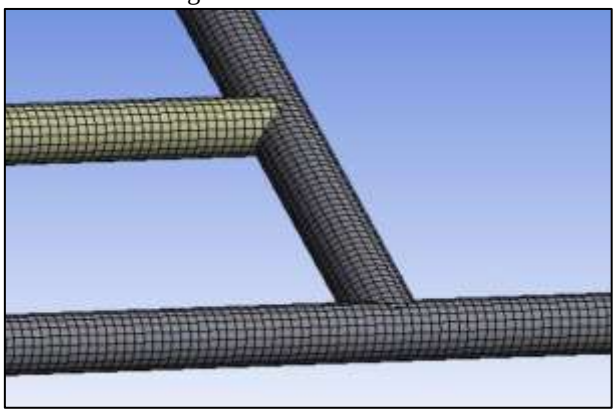


Fig.7.2: Fine Mesh of frame with 54271 nodes

Following tests were performed on the roll cage: -

- Front Impact Analysis
- Rear impact Analysis
- Side impact Analysis
- Load at Seating Position
- Torsional Impact Analysis

B. FRONT IMPACT ANALYSIS

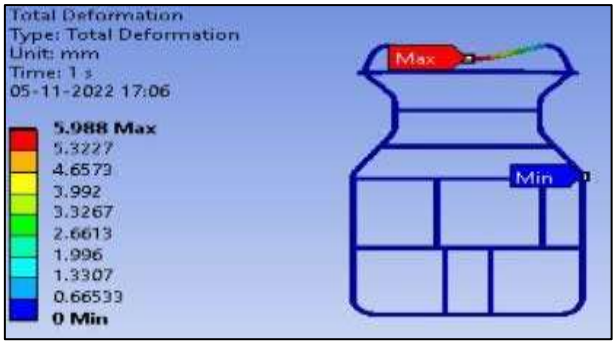


Fig.7.3. Deformation Diagram

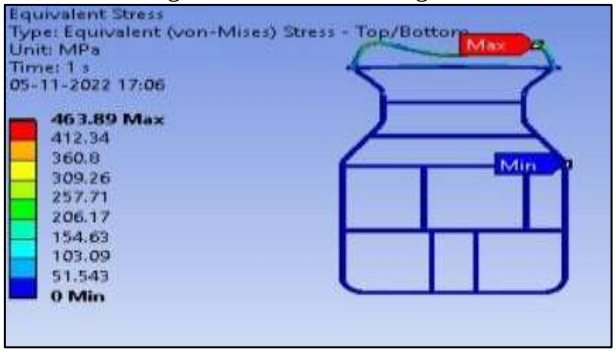


Fig.7.4 Equivalent Stress

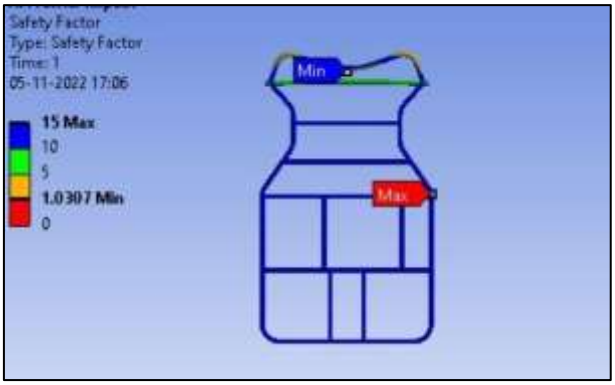


Fig. 7.5: F.O.S.

Load - 11KN
Max. Deformation - 5.98 FOS (min) - 1.03
It can be seen from the table that the maximum stress in the base member is 4.08mm on the front bumper which is acceptable. Highest joint stress was encountered at 463Mpa.

C. REAR IMPACT ANALYSIS

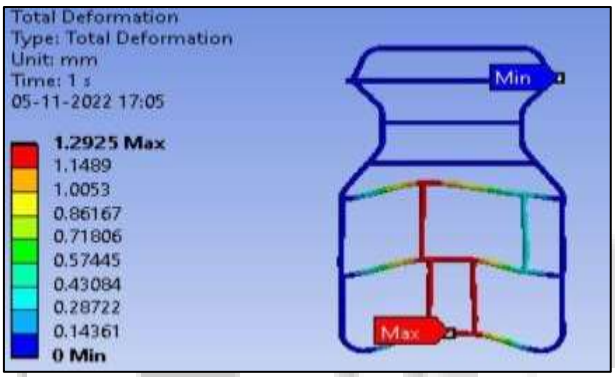


Fig. 7.6: Deformation Diagram

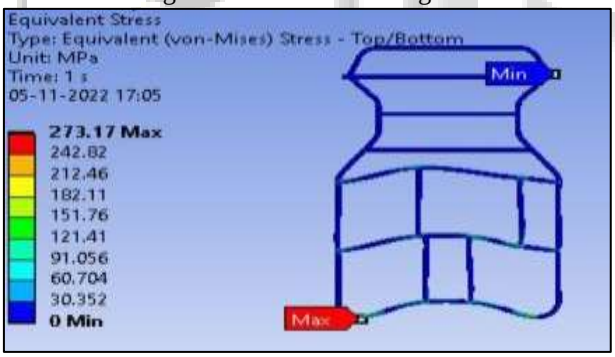


Fig. 7.7: Equivalent Stress

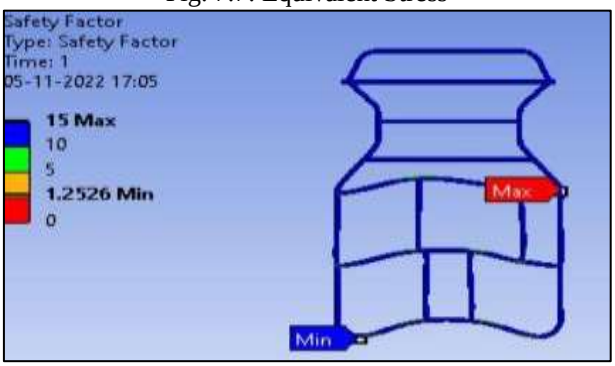


Fig. 7.8: F.O.S.

Load - 11KN
Max. Deformation - 1.29mm FOS (min) - 1.25
It can be seen from the table that the maximum stress in the base member is 1.29mm on the rear bumper which is acceptable. Highest joint stress was encountered at 273Mpa.

D. SIDE IMPACT ANALYSIS

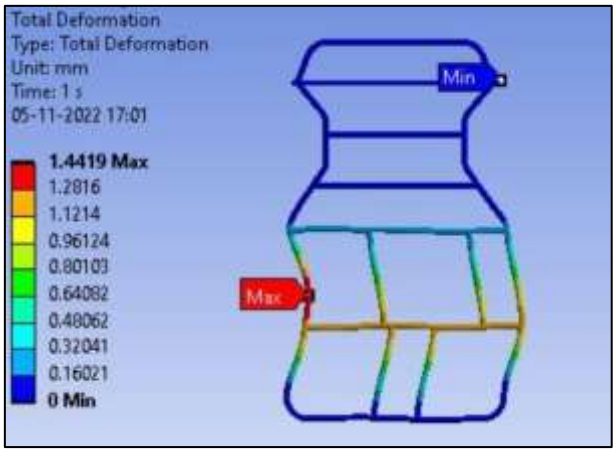


Fig. 7.9: Deformation Diagram

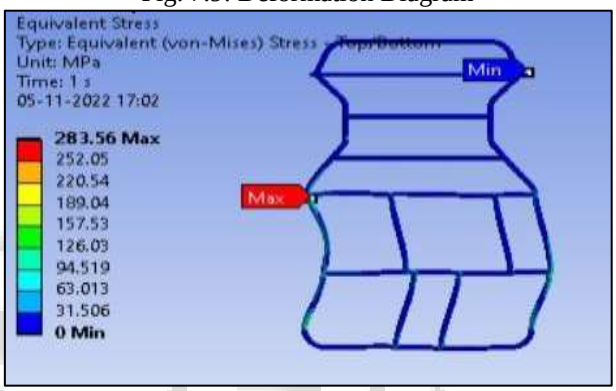


Fig. 7.10: Equivalent Stress

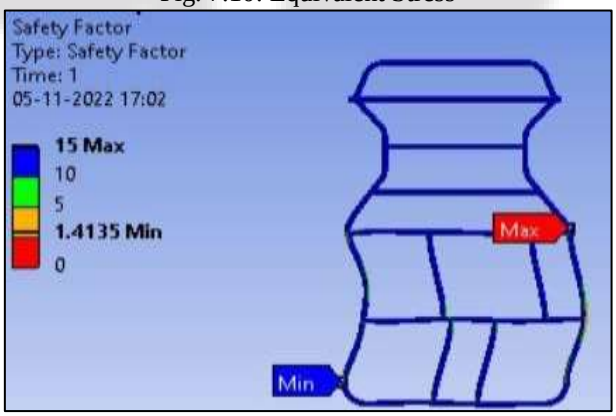


Fig. 7.11: FOS

Load – 11KN
Max. Deformation – 1.44mm FOS (mm) – 1.41
It can be seen from the table that the maximum strain in the base member is 1.44mm on the front bumper which is acceptable. Highest joint stress was encountered at 283Mpa.

E. LOAD AT SEATING POSITION

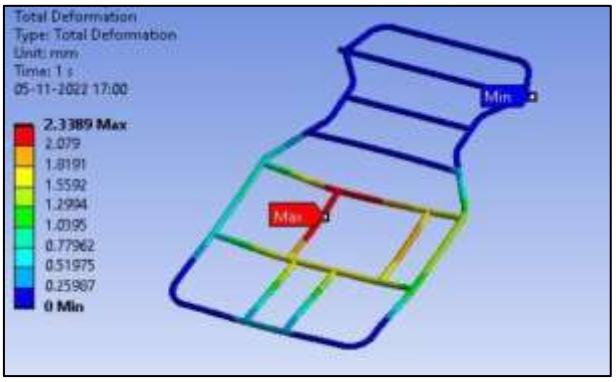


Fig. 7.12: Deformation Diagram

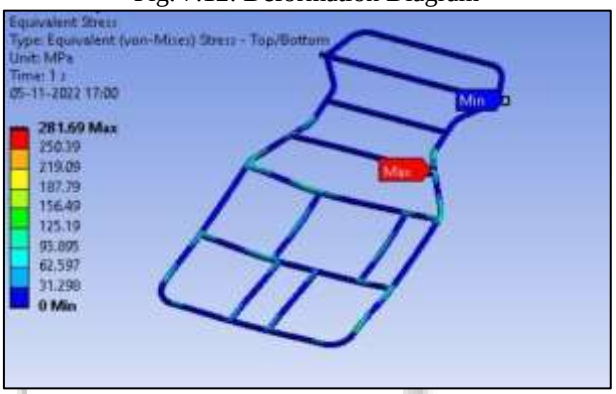


Fig. 7.13: Equivalent Stress

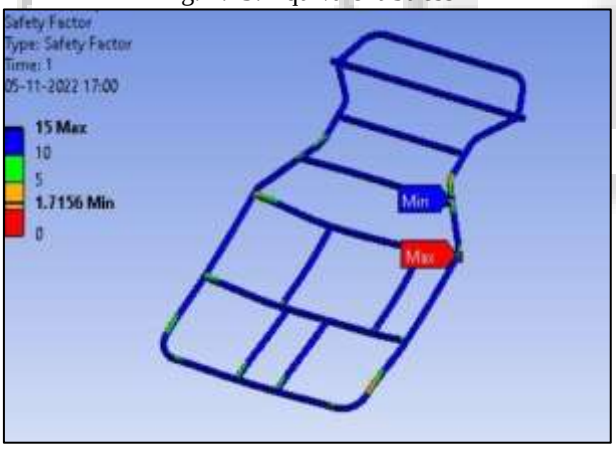


Fig. 7.14: F.O.S.

Load – 5KN
Max. Deformation – 2.3389 mm FOS (min) – 1.7
As can be seen from the table, the maximum deformation in the base member is 2.3mm on the front bumper which is acceptable. Had the highest joint stress withstand at 281Mpa.

F. TORTIONAL IMPACT ANALYSIS

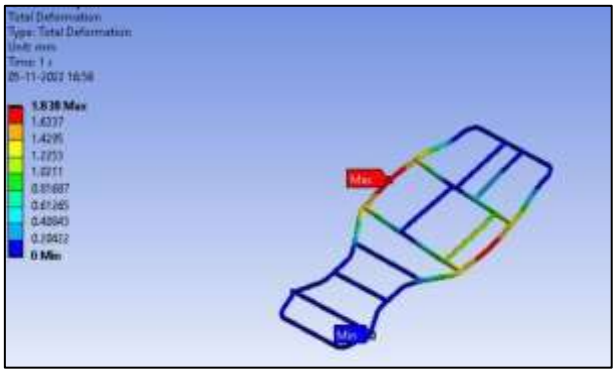


Fig. 7.15: Deformation Diagram

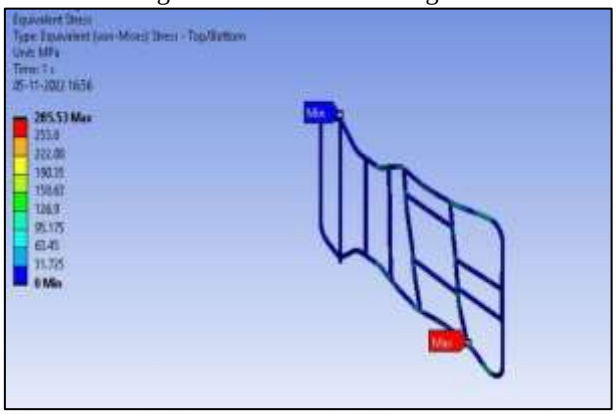


Fig. 7.16: Equivalent Stress

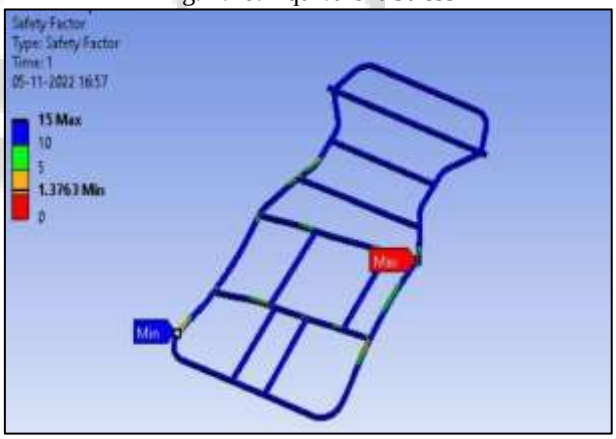
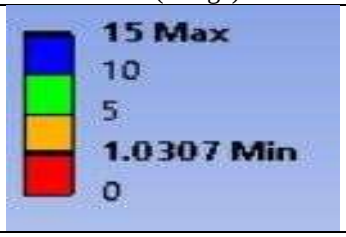
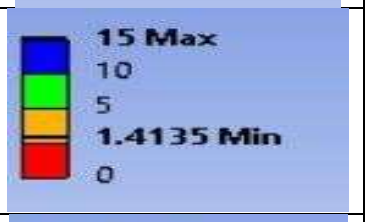


Fig. 7.17: F.O.S.

Load – 5KN x 2
Max. Deformation – 1.838 mmFOS (min) – 1.37
It can be seen from the table, maximum deformation in base member is 1.8mm which is acceptable. Thehighest combined stress was encountered at 285Mpa.

VIII. FEA-ANALYSIS RESULTS

Test Load	Max Deformation	Max Stress	FOS(min)	FOS(Range)
1. Front Impact	11KN 5.98mm	463Mpa	1.03	

2. Rear Impact	11KN 1.2925mm	273.17Mpa	1.2526	
3. Side Impact	11KN 1.44mm	283.56Mpa	1.41	
4. Torsion	5KN 1.83mm	285.53Mpa	1.37	
5. Seating	5KN 2.3193mm	281Mpa	1.7156	

IX. CONCLUSION

Server factors to be considered that are common to all engineering vehicles and the present work tells us in detail about the construction and the materials used in our go-kart. The CAD model is designed using CATIA Vs software which helps us to visualize our design and gives us the ability to innovate our design using 2021R1 software by performing various tests and advanced engineering simulations on our chassis. Our designs are analysed which helps in revising and finalizing our chassis designs. errors in its construction. The Ansys 2021R1 has undergone CAD model optimization, using finite element techniques to validate its endurance under various loads and front and rear impacts through various methods such as real-world clatter enumeration and crash testing on the go-kart's frame has been validated Adopted and the use of finite element analysis has proved very useful for Design of the chassis of the go-kart for competitive learning. we successfully analysed the frame for its strength against front, rear impacts, Lateral, torsion and weighting in the sitting position. This report describes in detail with various impact analysis on chassis and optimization is brought about by reducing its weight. the design is Perfect for use at events with all systems.

Fig. 9.1: Fabricated Chassis of Go-Kart

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