Journals Pub
International Journal of
Structural Mechanics and
Finite Elements
https://journalspub.com/journal/ijsmfe/
ISSN: 2582-5054
Volume 12, Issue 1, 2026
January–June
DOI (Journal): 10.37628/IJSMFE
Research IJSMFE

Design and Finite Element Analysis of Go-Kart Tubular Chassis Using Ansys

Ajith K.[1], Manujesh B.J.[2,*], Varun Kumar[3], Hithesh O.[3]

Abstract

The design of a go-kart chassis involves the vehicle's performance, safety, and handling characteristics. The present work focuses on the conceptual design, modeling, and structural analysis of a go-kart chassis aimed at achieving an optimal balance between strength, weight, and driver comfort using FEA software ANSYS. A detailed chassis model was developed based on ergonomic considerations and racing standards. The design was evaluated through an FEM approach to assess stress distribution, deformation, and factor of safety under dynamic loading conditions. Special attention was given to material selection, weight optimization, and ease of manufacturing to ensure both performance efficiency and cost-effectiveness. The results demonstrate that the proposed chassis design meets the required safety standards while maintaining structural integrity and enhancing maneuverability. This present work not only provides a technical framework for go-kart chassis design but also emphasizes a human-centered approach prioritizing driver comfort, safety, and real-world usability. In addition to structural assessment, this study emphasizes the significance of combining engineering analysis with practical design limitations commonly faced in student motorsport projects and small-scale racing vehicle development. The modeling stage incorporated realistic loading scenarios, including cornering forces, braking effects, and the distribution of driver weight, to represent real operating conditions as closely as possible. Considering these factors in the analysis helps in understanding how the chassis performs under repeated dynamic loads and improves confidence in its structural reliability. Moreover, the design approach presented in this research can act as a useful guideline for future researchers and student teams working on go-kart chassis development. The study also demonstrates the advantages of simulation-based design methods, which help minimize dependence on multiple physical prototypes, and therefore, reduce development time and overall cost. By applying systematic modeling and analysis techniques, the research supports the development of lightweight yet strong chassis structures. Ultimately, the work contributes toward enhancing the performance, durability, and practical applicability of go-kart chassis designs used in competitive and educational motorsport environments.

***Author for Correspondence**
Manujesh B.J.
E-mail: manujesh@gmail.com

[1]Assistant Professor, Department of Mechanical Engineering, Vivekananda College of Engineering and Technology, Puttur, Karnataka, India
[2]Professor & Head, Department of Mechanical Engineering, Vivekananda College of Engineering and Technology, Puttur, Karnataka, India
[3]Students, Department of Mechanical Engineering, Vivekananda College of Engineering and Technology, Puttur, Karnataka, India

Received Date: March 11, 2026
Accepted Date: March 12, 2026
Published Date: March 26, 2026

Citation: Ajith K., Manujesh B.J., Varun Kumar, Hithesh O. Design and Finite Element Analysis of Go-Kart Tubular Chassis Using Ansys. International Journal of Structural Mechanics and Finite Elements. 2026; 12(1): 56–64p.

Keywords: Go-kart chassis, structural analysis, FEA, lightweight design, ergonomics, safety

INTRODUCTION

The chassis is the primary structural framework of a vehicle, composed of multiple cross-sectional tubes with specific wall thicknesses designed to support various vehicle components while ensuring the safety of the driver. The chassis design presented in this study is intended for a kart powered by an *Aprilia SR 150 engine with a displacement of 154.8 cc.* Since the kart operates on a smooth racing track, achieving higher speed becomes a critical objective. To support this requirement, minimizing the overall vehicle weight – particularly the chassis weight – is essential while maintaining an optimal strength-to-weight ratio.

To achieve an efficient and optimized chassis design, advanced 3D modeling and simulation tools are extensively utilized. Software, such as CAD modeling platforms and *ANSYS*, are employed for structural analysis and validation of the design. This paper outlines the design methodology, calculations, and optimization procedures used to develop effective kart chassis. Furthermore, the design strictly follows the constraints and safety regulations specified in the *FKDC Season 9 rulebook.*

Karting is a rapidly growing motorsport that offers simplicity, affordability, and safety for both professional and amateur drivers. Originating in the 1950s as a recreational activity by airmen, it has evolved into an organized sport worldwide [1]. Go-karts are compact, lightweight, four-wheeled vehicles designed mainly for flat tracks, typically without suspension to minimize weight and enhance handling [2].

The chassis, also known as the vehicle's skeleton, serves as the main load-bearing framework that supports essential components such as the engine, steering, braking system, and driver seat [3]. It must be rigid enough to resist bending, torsion, and vibrations while maintaining a high strength-to-weight ratio to ensure better acceleration and safety [4]. Finite element analysis (FEA) tools, like ANSYS and Hyper Works, are widely used to study stress distribution, deformation, and modal characteristics under various impact conditions [5].

According to the International Karting Commission (CIK-FIA), go-kart chassis can be open, caged, straight, or offset types depending on track and performance needs [6]. Material selection plays a vital role in chassis strength and durability, with AISI 1018, 1020, and 4130 steels commonly used due to their ductility, cost-effectiveness, and superior strength-to-weight properties [7]. Circular tubular frames are preferred for their higher torsional rigidity and energy absorption during impact compared to square sections [8].

Chassis and roll cage structures are fabricated by cutting, bending, and welding steel tubes as per safety and competition regulations [9]. Modern design optimization integrates CAD modeling and simulation to minimize weight while maintaining stiffness and crashworthiness [10]. Overall, the go-kart chassis design focuses on achieving a balance between lightweight structure, strength, safety, and cost efficiency through advanced analysis and material selection (Figures 1–4).

MATERIAL SELECTION

For the selection of material for the chassis, a detailed study was conducted considering various material properties such as strength, weight, weldability, manufacturability, and cost. After comparing several materials, including AISI 1018, AISI 1020 and AISI 4130, we selected AISI 4130 as the most suitable material for the chassis. AISI 4130 steel, commonly referred to as chromoly steel, possesses excellent mechanical characteristics including high yield strength, good toughness, and an outstanding strength-to-weight ratio. Additionally, the material exhibits favorable weldability and machinability, which simplifies manufacturing and fabrication processes. Due to these properties, AISI 4130 is widely considered a suitable material for constructing vehicle chassis structures. The use of AISI 4130 ensures that the roll cage can absorb maximum impact energy, thereby preventing material failure or fracture during high-impact conditions. Hence, AISI 4130 has been chosen as the final material for the chassis design (Tables 1 and 2).

Table 1. Material properties.

Material AISI 4130	
Density	7850 kg/m^3.
Young`s Modulus	205 GPa.
Yield strength	435 MPa.
Ultimate strength	560 MPa.
Strength-to-weight ratio	71.3 kN-m/kg.
Hardness	217 BHN.
Elongation at break	25%.

The chemical composition of the material is:

- Chromium Cr = 0.95%.
- Molybdenum Mo = 0.20%.
- Carbon C = 0.30%.
- Manganese Mn = 0.50%.
- Phosphorus P = 0.020%.
- Sulfur S = 0.020%.
- Silicon Si = 0.25%.
- Iron Fe = 97.76%.

CAD MODEL

The entire Space frame was modeled in AutodeskFushion360 software.

The following are the considerations for the design:

- *Driver Ergonomics:* The emphasis of the design is on driver comfort.
- *Nodal Geometry:* To increase the load transfer path.
- Mounting points for the integration of transmission, steering, seat, tires, and brakes.

Figure 1. CAD model of chassis.

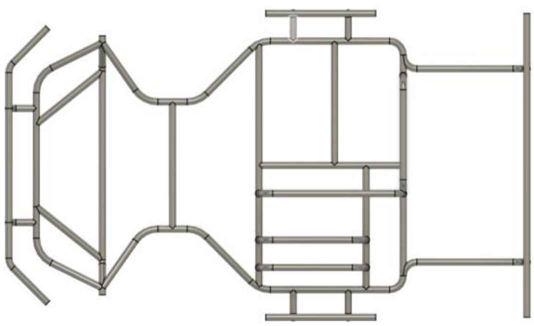

Figure 2. Top view of chassis.

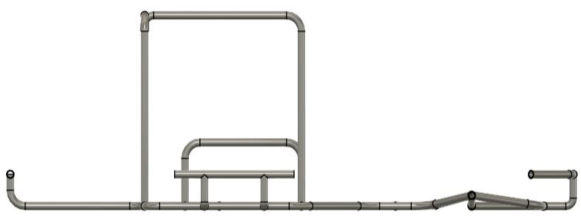

Figure 3. Side view of chassis.

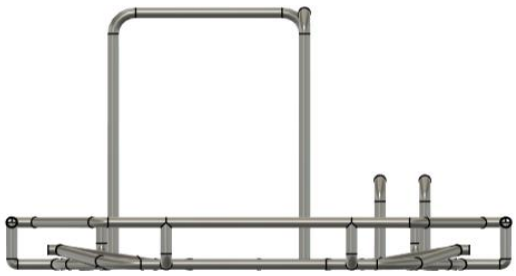

Figure 4. Front view of chassis.

Table 2. Chassis specification.

Diameter of Pipe	25.4 mm.
Section Thickness	2 mm.
Type of Pipe	Seamless.
Length of Chassis	1900 mm.
Width of Chassis	1300 mm.
Wheel base	1320 mm.
Height of Chassis	820 mm.

FINITE ELEMENT ANALYSIS

In addition to meeting the minimum material requirements established during team discussions, the structural integrity of the chassis frame was evaluated by comparing the simulation results with the standard mechanical properties of the selected material. Finite Element Analysis (FEA) was carried out using ANSYS software to assess the performance of the design. For this analysis, the existing chassis model was imported into the software and subjected to different loading conditions to determine the stress distribution.

Three primary impact scenarios were simulated: frontal impact, side impact, and rear impact. These load cases were applied to replicate potential real-world conditions that the chassis might experience during operation. The results of the simulations indicated that the stresses and deformation levels remained within the acceptable limits, confirming that the chassis design satisfies the required safety and structural performance criteria.

The chassis was evaluated under different impact scenarios, including frontal, rear, and side impacts, with primary emphasis on ensuring driver safety. Several design iterations were performed during the development process, and the most efficient configuration was selected based on structural performance and optimization results.

Meshing

Auto meshing has been done in ANSYS 19.2 software (Figure 5). The following data has been found after meshing the chassis (Table 3).

Figure 5. Auto meshing in ANSYS 19.2.

Table 3. Meshing data.

No of Nodes	97999.
No of elements	48653.

Impact Analysis

The impact forces were calculated using Newton's second law, which states that the net force acting on a body is equal to the product of mass and acceleration of the body.

- Force = mass × acceleration.
- Force = rate of change of momentum.
- Impulse = force × time = change in momentum = mass × change in velocity.

We used an impact force of 5000 N in each case of analysis, and the time of impact considered is 0.2 seconds as per industrial standards.

Front Impact

For the front impact, engine and driver load were given at respective points. The kingpin mounting points and rear wheel positions were kept fixed (Figures 6–8).

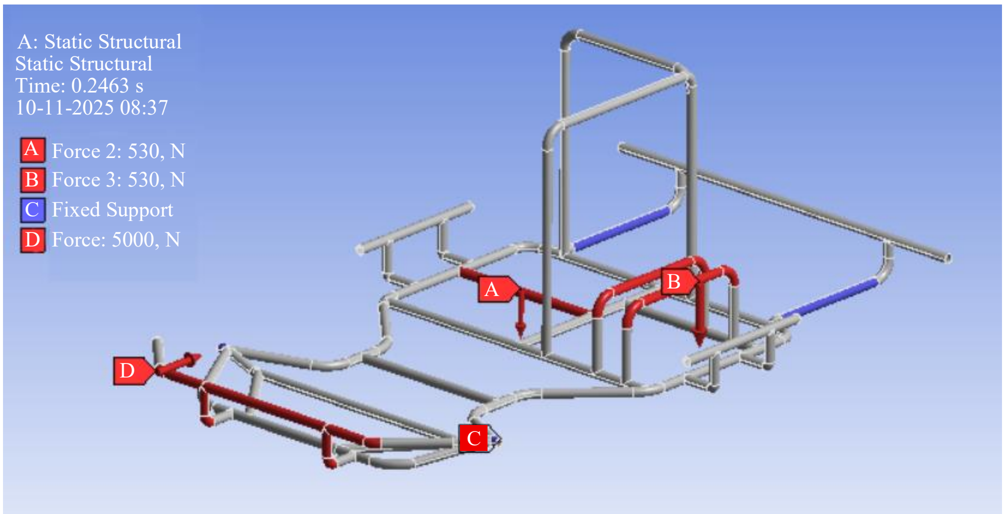

Figure 6. Front load and constrain.

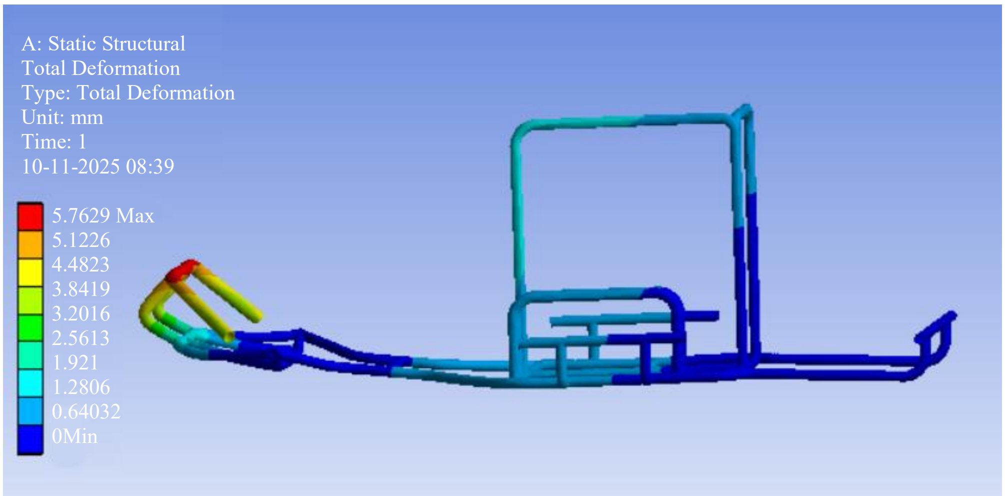

Figure 7. Front deformation.

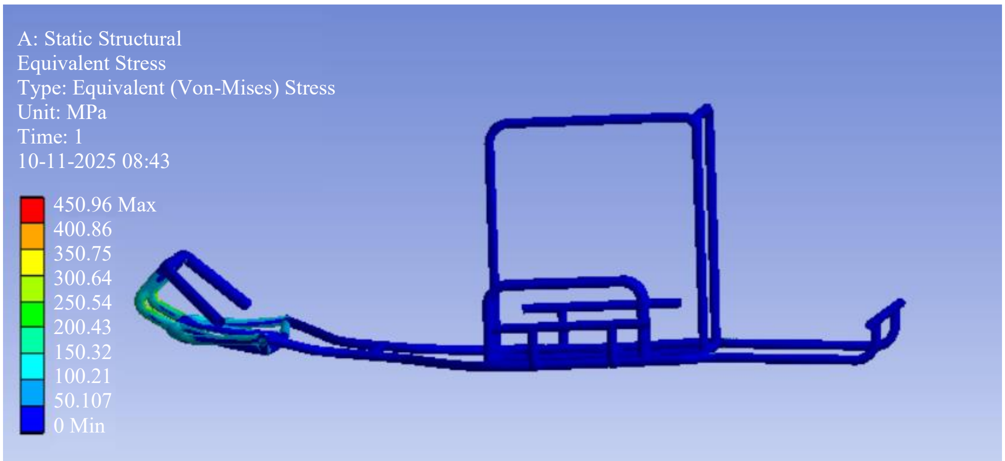

Figure 8. Front equivalent stress.

Modifications

Triangulation was done at the front side so that the force travels in the body and is minimized.

Rear Impact

Considering the worst-case collision for rear impact, force was calculated as similar to front impact (Figures 9–11).

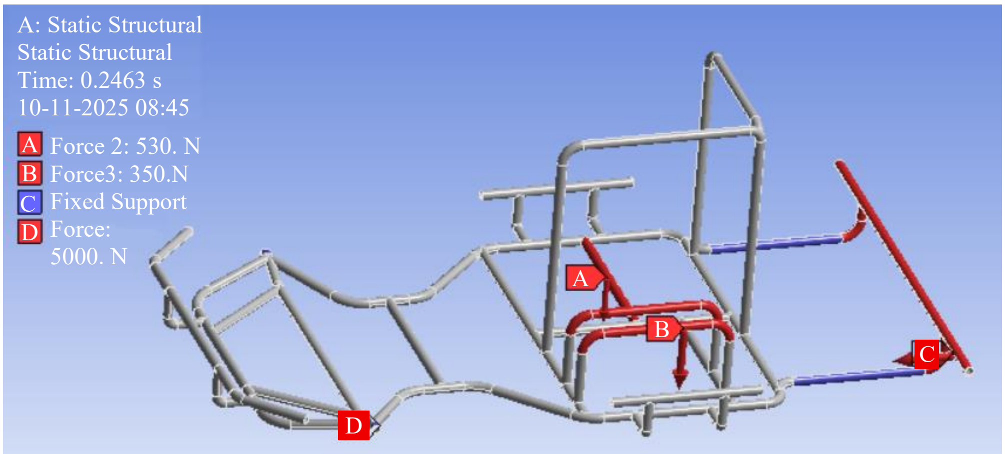

Figure 9. Rear load and constrain.

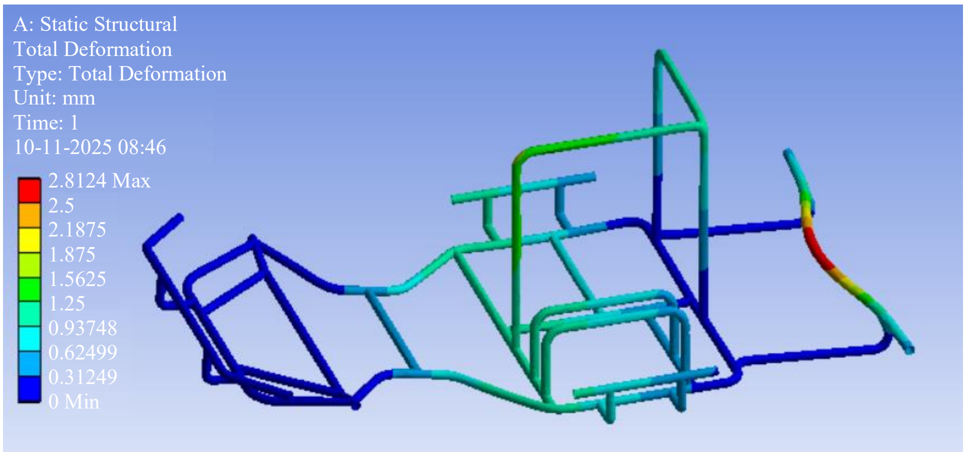

Figure 10. Rear deformation.

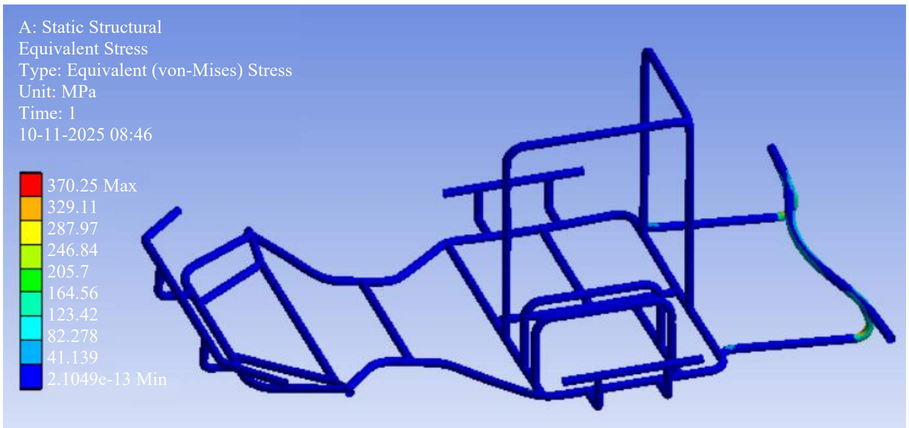

Figure 11. Rear equivalent stress.

Modification

The distance between the two straight members at the rear was modified several times to check where the suitable position should be.

Side Impact

The most probable condition of an impact from the side would be with the vehicle already in motion (Figures 12–14).

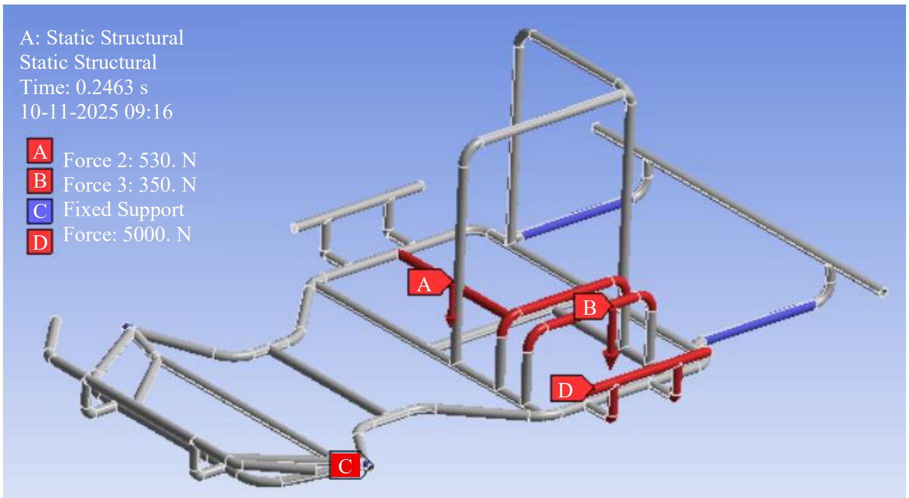

Figure 12. Side load and constrain.

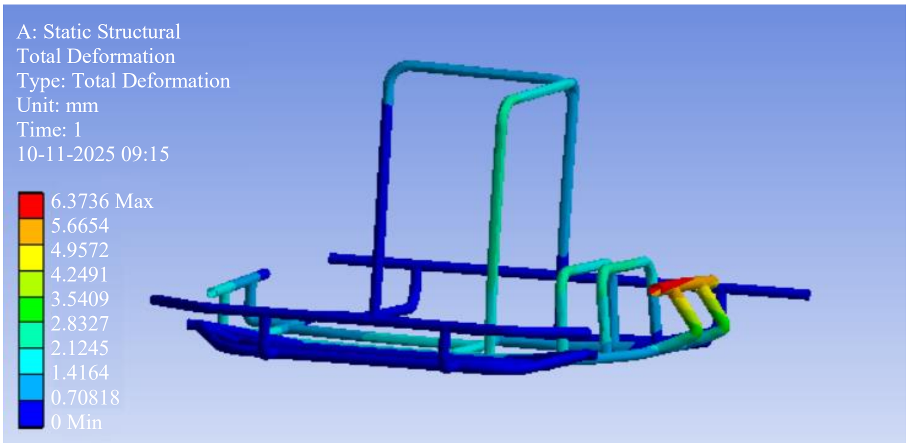

Figure 13. Side deformation.

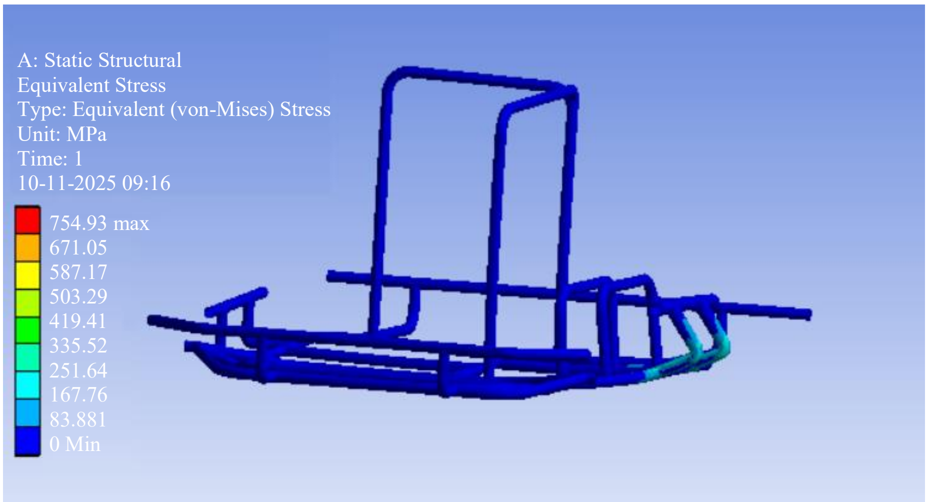

Figure 14. Side equivalent stress.

Modification

The distance of the side bumper end from the firewall was taken near so the stress developed should travel to the node of the firewall.

RESULTS

Tables 4–6 show the results.

Table 4. Front impact.

Deformation	5.77 mm.
Max. Stress	450.96 Mpa.

Table 5. Real impact.

Deformation	2.81 mm.
Max. Stress	370.25 Mpa.

Table 6. Side impact.

Deformation	6.37 mm.
Max. Stress	754.93 Mpa.

CONCLUSION

After conducting analyses for frontal, side, and rear impact conditions and implementing the required design modifications, the final chassis configuration was selected.

The redesigned chassis demonstrates improved stiffness and strength compared to the earlier configuration. Optimization was achieved by adjusting the dimensions of the tubular members at critical locations. After multiple design iterations and evaluations, the final chassis structure was established.

The calculations and simulations were performed by assuming extreme loading conditions. Even under these severe scenarios, the chassis demonstrated acceptable performance. In real operating conditions, such extreme loads are unlikely to occur; therefore, the actual stresses and deformations experienced by the chassis are expected to be lower than those observed in the analysis.

The analysis was carried out without including shock-absorbing components in the model. If these components had been taken into account, the resulting stresses in the chassis would likely have been significantly lower.

We finalized the chassis; it has been fabricated by Team REVAAN RACING and participated in the Formula Kart Design Challenge (FKDC) Season 9, October 2025, held at Coimbatore, Tamil Nadu (Figure 15).

Figure 15. Fabricated go kart.

Acknowledgment
We are very grateful to Team REVAAN RACING, who supported and shared the required resources.

REFERENCES

1. Thakare P, Mishra R, Kannav K, Vitalkar N, Patil S, Malviya S. Design and analysis of tubular chassis of go-kart. Int J Res Eng Technol. eISSN: 2319-1163; pISSN: 2321-7308.
2. Virendra M, Pattanshetti SP. Design and analysis of go-kart chassis. Int J Mech Ind Technol. 2016 Apr–Sep;4(1):150–164. ISSN: 2348-7593.
3. Saini NK, Rana R, Hassan MN, Goswami K. Design and impact analysis of go-kart chassis. Int J Appl Eng Res. 2019;14(9):Special Issue. ISSN: 0973-4562.
4. Kalita U, Teja YST, Manikanta DSVV. Design and analysis of go-kart chassis. Int J Eng Dev Res. 2018;6(2). ISSN: 2321-9939.
5. Krishnamoorthi S, Prabhu L, Shadan MD, Raj H, Akram N. Design and analysis of electric go-kart.
6. Hajare K, Shet Y, Khot A. A review paper on design and analysis of a go-kart chassis. Int J Eng Technol Manag Appl Sci. 2016 Feb;4(2). ISSN: 2349-4476.
7. Kiran RSK, Chandu SS. Design and analysis of go-kart chassis using distinctive materials. Int J Res Appl Sci Eng Technol. 2020 Jul;8(7). ISSN: 2321-9653.
8. Burri J, Kyatham A, Katta S, Alapati K. Design and analysis of chassis for a FSAE car. Int J Eng Res Technol. 2021 Nov;10(11). ISSN: 2278-0181.
9. Garud RY, Tamboli SC, Pandey AA. Structural analysis of automotive chassis, design modification and optimization. Int J Appl Eng Res. 2018;13(11):9887–9892. ISSN: 0973-4562.
10. Mishra Y. Design and analysis of ladder frame chassis. Int J Eng Technol. 2020 Aug;7(8). ISSN: 2395-0056; pISSN: 2395-0072.

