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Design and Development of Chassis for Front-Wheel Drive Electric Tadpole Vehicle

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Abstract— The chassis is the most important structural member in On-Road vehicles. This project deals with the designing of a three-wheeler tadpole vehicle chassis, this includes deciding the dimensions, material, modelling and simulation of the chassis. Only the chassis receives the loads produced by the other parts of the vehicle. The vehicle chassis par deals with finalising the proper material and deciding the type of chassis, it also includes static and dynamic load calculation, and impact analysis. The Computer-Aided Designing (CAD) model of the chassis is also included in this project. This also consists of the analysis and simulation of the same. The final model was produced using SOLID WORKS and ANSYS. Five models were designed and simulated for the experience purpose, and the best model was selected depending on various characteristics. SolidWorks was used to build the chassis based on the suspension's pivot locations. All the factors from the literature analysis were considered when creating the design. For this project, a tubular space frame roll cage chassis is chosen.

Keywords: Wheelbase, Ergonomics, Tadpole Vehicle, Roll cage Tubular space frame, Static Axil load, FOS, Modal Frequency.

I. INTRODUCTION

When we think about cars, we automatically think about four wheels but that is not necessarily the best conFigureuration. Four wheels are initially less efficient than three wheels due to increased drag. When it comes to three-wheeled vehicles there are two basic designs Delta and Tadpole. Tadpole has two wheels up front and one in the rear, whereas Delta has one wheel up front and two in the back.

In comparison to the Delta design, the Tadpole design provides better dynamic stability, meaning it responds more safely and predictably to a variety of driving circumstances. Because the front wheels responsible for most of the breaking and because the Tadpole's two fronts are superior to the Delta's one. The teardrop shape of the Tadpole is actually a better aerodynamic design than the Delta, despite what might seem counterintuitive. Better directional stability, higher comfort, lessened wheel slippage, and better stopping power are just a few benefits of these kinds of cars. The Tadpole is a better overall design despite the Delta's steering and suspension being very simple.

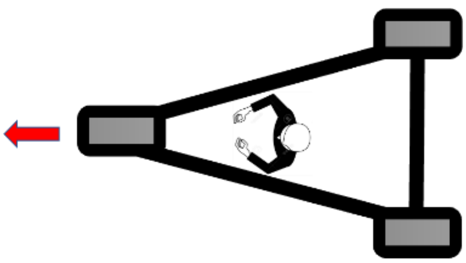

Figure 1: Delta ConFigureuration

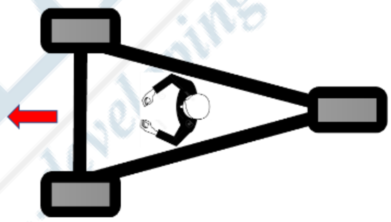

Figure 2: Tadpole ConFigureuration

II. METHODOLOGY

The first step in learning how to design a chassis or acquire information on a vehicle is to do a literature review, which entails reading and evaluating numerous journal articles. Materials for the construction of the chassis are chosen using the examined information. Dimensions, track width, wheelbase, and ground clearance are all taken into account throughout the design phase. After that, SOLIDWORKS is used to design the model. Only after a design is evaluated for viability in use does it receive validation. An ANSYS WORKBENCH is used for analysis. Side, front and rear impact results from the structural analysis are taken into account when deciding on the most appropriate model. The second phase of manufacture involves careful chassis construction.

A. Selection of Type of Chassis

Roll cage chassis was chosen for this project. In the case of a rollover accident, roll cages aid to support a vehicle's structure and keep it from collapsing in on itself. By giving them more protection from being crushed by the car, this can lessen the chance that passengers will get injuries. For

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instance, the roll cage shields the car from collapsing during a collision and protects the driver.

B. Selection of Type of Material

AISI 1018 (Mild Steel) was chosen for this project, due to its vast properties favourable for building a roll cage chassis. It has a good balance of toughness, strength and ductility.

C. Chassis Design

SolidWorks was used to build the chassis based on the suspension's pivot locations. All the factors from the literature analysis were considered when creating the design. The primary goal of the chassis design was to create a lightweight, ergonomically comfortable chassis that is structurally strong and capable of bearing all potential worst loading circumstances. time frame Roll cage chassis were chosen over other types of chassis because they are simple to manufacture and can be put together using inexpensive tools at home. For the building of the chassis, AISI 1018 (Mild Steel) with an outer diameter of 33 mm and a thickness of 3 mm was used because of its widespread availability and excellent mechanical qualities.

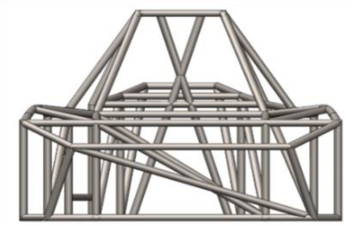

Figure 3: Front view of chassis

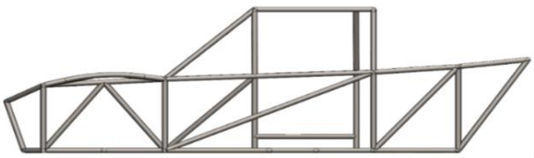

Figure 4: Side view of chassis

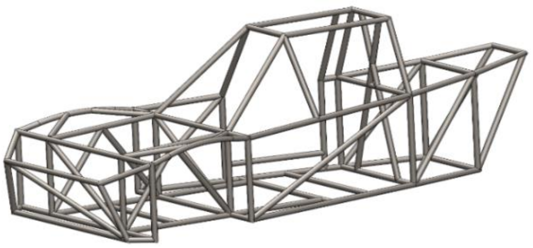

Figure 5: Isometric view of chassis

Table-1

Parameters	Dimensions
Wheel Base	2432 mm
Track Width	1422.4 mm
Height	1219.2 mm
Ground Clearance	210 mm
Wheel Size	12 in.

III. ERGONOMICS OF VEHICLE

In ergonomics, system productivity and human health are key considerations. It aims to achieve a good fit between people and their technological settings and tools. It considers the user's strengths and limits in order to make sure that the tasks, tools, information, and environment are appropriate for each user. Ergonomics, which has been designed ergonomically to suit anthropomorphic models of the tallest (95th percentile male) and the tiniest (5th percentile female) driver.

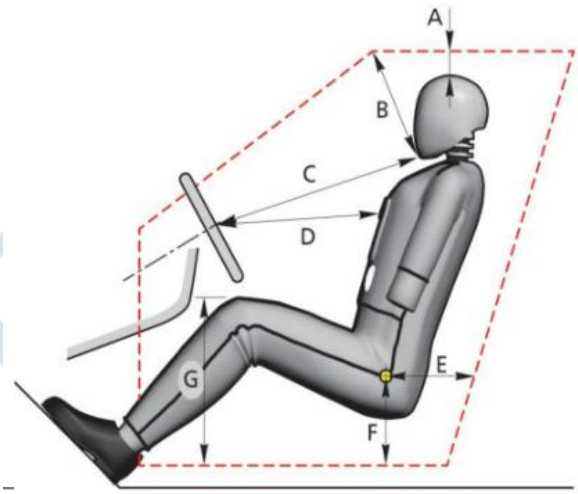

Figure 6: Landmark of Measurements

Where,

A -	Head/Roof Panel
B -	Chin/windscreen joint
C -	Chin/centre of the steering
D -	Centre of the steering wheel
E -	Hip-joint point(horizontal)
F -	Hip-joint point(vertical)
G -	Knee/floor covering

IV. ENGINEERING ANALYSIS

Initially, the frame chassis was designed using SOLIDWORKS to suit our purpose. This chassis is best suited for personal mobility services and to improve the protection and their technological tools and environments. It takes account of the user's capabilities and limitations in seeking to ensure that tasks, equipment, information. Lateral stability of the vehicle. In order to gain structural stability, engineering analysis is carried out using ANSYS software. Both modal and static impact analyses were performed on the intended chassis to ensure the rider's safety in worst-case scenarios. The complete simulation was performed using Ansys Workbench. As a Step file, the SolidWorks model was imported into Ansys Workbench.

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A. Front Impact Analysis

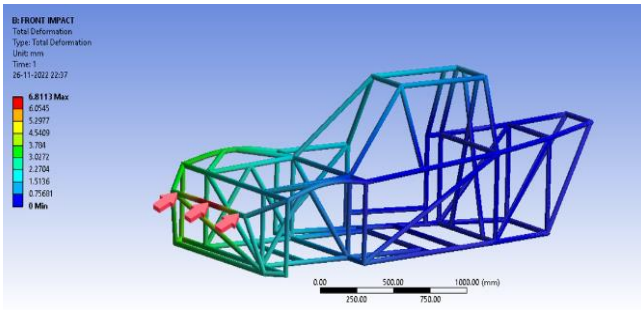

Figure 7. Front Impact

When **14387 N** of Force was applied for the front impact. These were the results obtained from the Ansys Simulation

Deformation in mm	FOS
Max deformation=6.37	Min=1.20

B. Side Impact

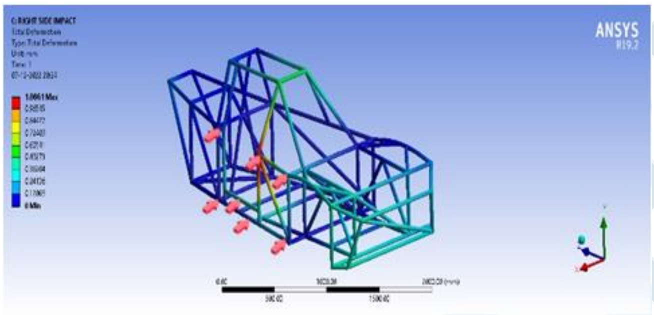

Figure 8. Side Analysis

When **9183 N** of Force was applied for the Side impact. These were the results obtained from the Ansys Simulation

Deformation in mm	FOS
Max deformation=1.08	Min=5.96

C. Bump Analysis

a. Front Bump Analysis

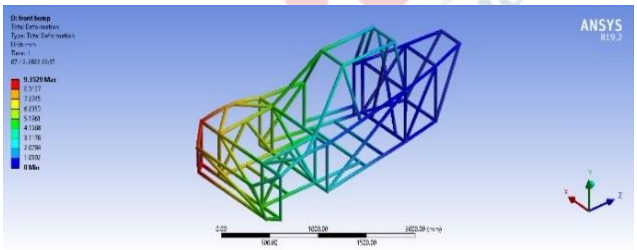

Figure 9. Front Bump Analysis

Deformation	FOS
Max deformation=9.35	Min=2.02

b. Rear Bump Analysis

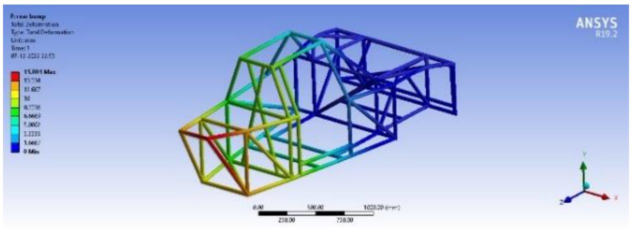

Figure 10. Rear Bump Analysis

Deformation	FOS
Max deformation=15.00	Min=1.19

D. Modal Frequency Analysis

1. Mode-1

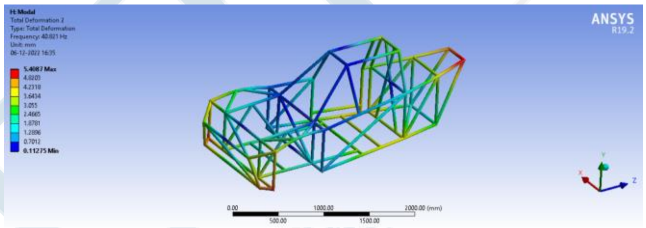

Figure 11. Frequency obtained = 40.821 Hz

2. Mode-2

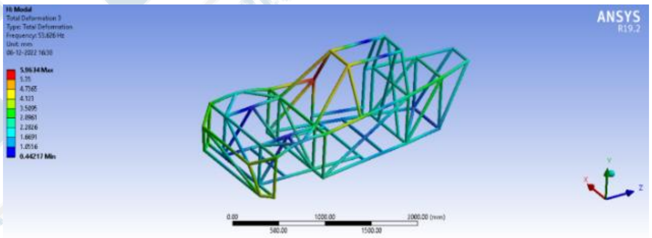

Figure 12. Frequency obtained = 53.626 Hz

3. Mode-3

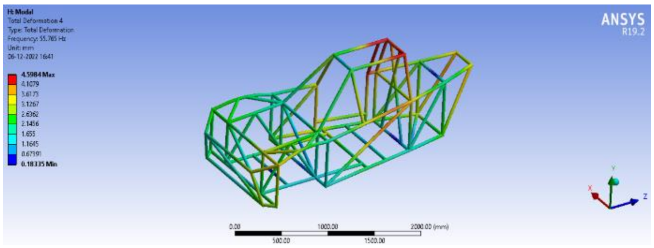

Figure 13. Frequency obtained = 55.765 Hz

4. Mode-4

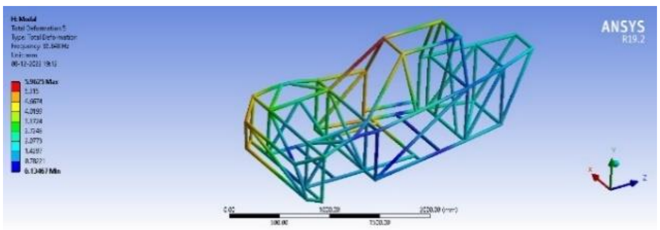

Figure 14. Frequency obtained = 65.648 Hz

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V. ASSEMBLY OF CHASSIS IN SOLIDWORKS

Figure 15: Rear Isometric view of Assembled chassis

Figure 16: Isometric view of Assembled chassis

VI. RESULTS

In accordance with recent innovations and trends of different types of chassis, after surveying the materials suitable for developing a chassis for electric tadpole vehicle AISI 1018 (mild steel) was chosen for the fabrication as the material has a good balance of toughness, strength and ductility. Tubular cross section tubes was selected, which has outer diameter of 33 mm and 3 mm in thickness, as it offers greater resistance to longitudinal compression pressures as well as greater resistance to bending forces than flat sheet additionally having best strength to weight ratio which is powerful in all directions.

When choosing the type of chassis, roll cage chassis was selected because it best meets our needs, provides excellent protection to the passenger, and helps to evenly distribute impact forces across the vehicle's body. The chassis was designed in SolidWorks and the same model was imported to the Ansys Workbench. The model was meshed with the given mesh size of 5 mm.

We have designed the chassis which has a track width of 1442.4 mm, wheel base of 2438 mm, ground clearance of 256 mm and we have obtained the frame weight of 140 kg which has capacity to withstand a wide range of loads, mechanical parts, and forces caused by the road during steering, and other stresses caused during braking and acceleration.

Figure 17: Front view of manufactured chassis

Figure 18 (a): Finished Product

Figure 18 (b): Finished Product

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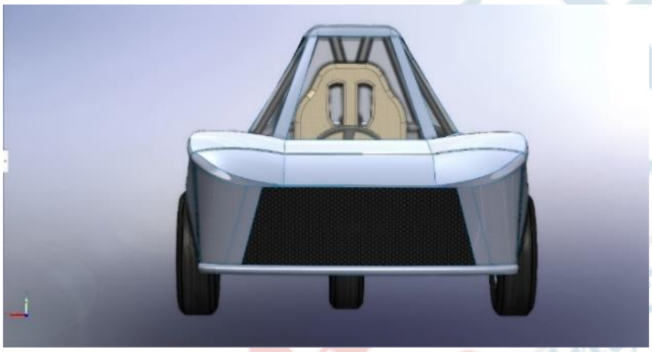
VII. CONCLUSION

The chassis concept model has been successfully created, examined, and constructed. SOLIDWORKS software is used for the design, and ANSYS is used for the analysis. Basic load calculations were carried out utilizing the strength of material ideas, and the outcomes were compared to those produced using ANSYS. The design stresses are within the material's strength limitations, and the ANSYS findings and theoretical results are in excellent agreement. AISI 1018 mild steel material was cut into cylindrical tubes using non-traditional manufacturing (Laser Cutting) techniques, and the tubes were subsequently built utilizing MIG welding in accordance with the Solid Works paradigm. Powder coated painting was done to give it a better appearance and to prevent corrosion. Based on these results the three-wheeler chassis was built which increases comfort and stability.

VIII. SCOPE FOR FUTURE WORK

By reduction of outer diameter, thickness and number of members, the weight of the chassis can be reduced in a greater amount where the acceleration of vehicle increases. For better protection, the vehicle can be enclosed using sheet metal, with an addition of seatbelt, horn, head lights and indicators. The chassis is designed in such a way that, it can be converted into Hybrid Vehicle.



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