Desing and development of electric vehicle chassis (Golf Car)

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Abstract. In this paper, six-seater Golf Cart chassis has been designed and developed in The Anantrao Pawar College of engineering Pune. All Chassis material Design Analysis is done. The Golf Cart can sustain a maximum load of 15 KN on the bumpy and terrain road at a maximum speed of 48 Km/hr. The batteries of the Golf Cart are placed below the seats to minimize the car space and over-turning moments on terrain roads. The modeling of Chassis Design of the Golf cart has been done in CATIA software. The maximum torque obtained at the 800, 1360 and 1500 RPM are the 2.1 Nm in 0.35 s. The six-seater Golf Cart works very efficiently and smoothly on the smooth, bumpy, and terrain road. It is very efficient to take the load of six passengers in a rural area. It did not produce noise and air pollution due to use of DC motor

Keywords: Golf Cart, Design, and Chassis.

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 suspension and two the wheels. Chassis is a major component of a vehicle system. It consists of an internal framework that supports man-made objects. It is the underpart of the vehicle which consists of frame and running gear like engine, transmission system, suspension system, etc. The automotive chassis is tasked with keeping all components together while driving and transferring vertical and lateral loads, caused by acceleration, on the chassis through suspension and the wheels. The key to good chassis design is that the further, the mass is away from the neutral axis the more rigid it is. In this project, SolidWorks is the software used for the modeling of the chassis. It is an advanced CAD/CAM/CAE software. The design and analysis of the chassis are done by identifying the location of high-stress areas. The chassis design used in this project is the ladder frame chassis Ladder frame chassis is the simplest and oldest of the chassis design used in modern vehicular construction. It is originally adapted from horse and buggy style carriages. As it provides sufficient strength for holding the weight of the components. The ladder frame has several members that cross-link to hold frame rails together A simple design of rails connected by a simple span and simulated provides a very good indication of how a ladder frame is useful in regards to performance auto design. The reason for the ladder frame type of chassis is that here it is easier to change the design without having to change the chassis thereby saving overall design time. It also provides a good beam resistance because of its continuous rail from front to rear. A good chassis must have following characteristics: • Be structurally sound in every way over the expected life of the vehicle and beyond. This means nothing will ever break under normal conditions. • Maintain the suspension mounting locations so that handling is safe and consistent under high cornering and bump loads. • Support the body panels and other passenger components so that everything feels solid and has a long, reliable life. • Protect the driver from external injuries which is essential in every chassis design

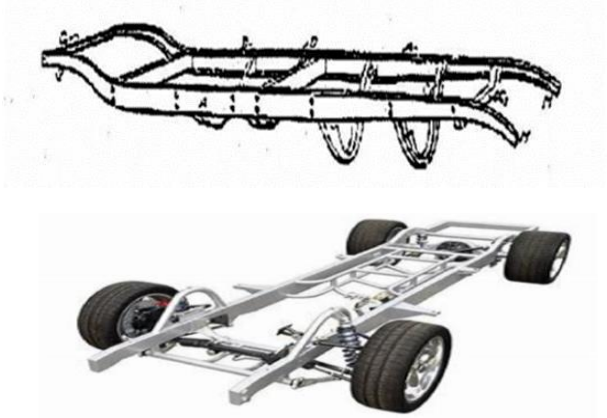


Fig 1: Ladder frame

Fig 1 Shows The history of the ladder frame chassis dates back to the times of the horse drawn carriage. It was used for the construction of 'body on chassis' vehicles, which meant a separately constructed body was mounted on a rolling chassis. The chassis 22 consisted of two parallel beams mounted down each side of the car where the front and rear axles were leaf sprung beam axles. The beams were mainly channeled sections with lateral cross members, hence the name. The main factor influencing the design was resistance to bending but there was no consideration of torsion stiffness. A ladder frame acts as a grillage structure with the beams resisting the shear forces and bending loads. To increase the torsion stiffness of the ladder chassis cruciform bracing was added in the 1930's. The torque in the chassis was retrained by placing the cruciform members in bending, although the connections between the beams and the cruciform must be rigid. Ladder frames were used in car construction until the 1950's but in racing only until the mid-1930's. A typical ladder frame the chassis is the framework that is everything attached to it in a vehicle. In a modern vehicle, it is expected to fulfill the following functions •Provide mounting points for the suspensions, the steering mechanism, the engine and gearbox, the final drive, the fuel tank, and the seating for the occupants; •Provide rigidity for accurate handling; •Protect the occupants against external impact. While fulfilling these functions, the chassis should be light enough to reduce inertia and offer satisfactory performance. It should also be tough enough to resist fatigue loads that are produced due to interaction between the driver, engine, power transmission and road conditions. Bases on this we can design chassis

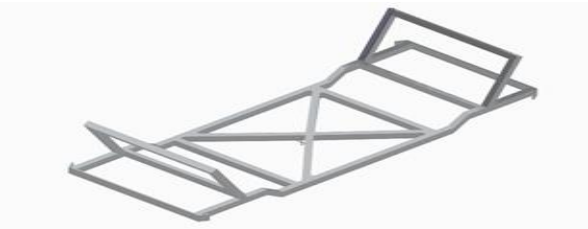


Figure 2: Design of chassis with x type crosse section.

Fig 2 shows the design of chassis with the x type cross section where the section of the base are connected with each other in x form where the one end of the chassis is connected to another with x form and this design is also safe and we can use it for construction.

The Fig 2 design is made in software called solid works and the figure 3 design is made in a software called Catia, All the design which are made for chassis is first developed in the software so we can get an idea of the actual product without actually creating it and after creating the design the design further goes for analysis such as crash test, noise test, vibration test, hardness test. We have done many test and we will show the result in the research paper as well. Also the design which are made are made based on the calculations and the dimensions, each and every dimension is important for the design to be filled correctly because the analysis is done on the cad model and if the design is not okay than the analysis result will come incorrect which will result in loss of time and efforts as well, after the dimension the cad design is also designed using the material because all the software's have the option to select material for the design they have built and every design has different extensions like STEP. , IGS, STL. , DXF. , ACIS-SAT. And many more extension are there However STEP file is mainly used for the analysis as it is widely used.

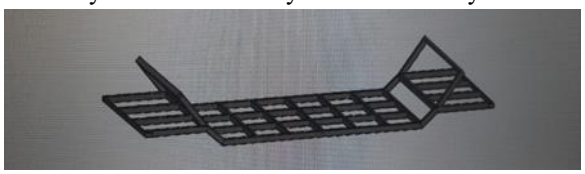


Figure 3: Design of chassis with square type crosse section

Fig 3 shows the design of chassis with the square type cross section where the section of the base are connected with each other in square form where the one end of the chassis is connected to another with a rectangular shape form and this design is also safe and we can use it for construction. This design is much better than the x type cross section because it has more area covered at the base which provides more support and can take more load on the chassis giving better result

2. Material used in the chassis of electric Golf cart The materials used in the construction of electric vehicle (EV) chassis are critical to achieving a balance of strength, durability, weight, and cost. Here are the primary materials commonly used:

- Aluminum: Properties: Lightweight, strong, corrosion-resistant, and easily recyclable
- Applications: Frequently used in the chassis, body panels, and structural components.
- Advantages: Reduces vehicle weight, which is crucial for extending the range of electric vehicles. It also offers good energy absorption in case of a crash.
- High-Strength Steel: Properties: Stronger and more durable than regular steel, relatively low cost.

Applications: Often used in the chassis and safety-critical components such as the passenger cell.
Advantages: Provides excellent structural integrity and crash protection while maintaining affordability It has very good load capacity The material used in the design of chassis is chosen as structural steel. Choosing the material is important for the chassis as it carries the load of human being and other structure of the Golf cart so the material should be selected according to the property of hardness such as structural steel. There are many more material which can be used for construction however Thet are used based on the load of the vehicle for example Aluminum and magnesium cans also be used but they have low strength and load carrying capacity so we use structural steel for it's affordability and High strength. Steel price ranges between 50 Rs to 70 Rs based on the diameter of steel.
The figure shows the Maximum principal elastic stress test has been done and the results are good and the highest Maximum Principal elastic stress valued is 5.0697e-7 Max. which is good for construction and passed.

3. Analysis
Analysis of electric vehicle is carried out in many software's and those are hyper mesh, Ls dyna, Ansys, and many more. The analysis of the design has also been done and the results are passed where we can use the design for constructions the design can be used for manufacturing based on the analysis results. These are the result.

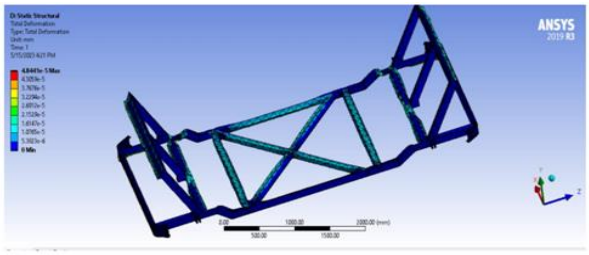
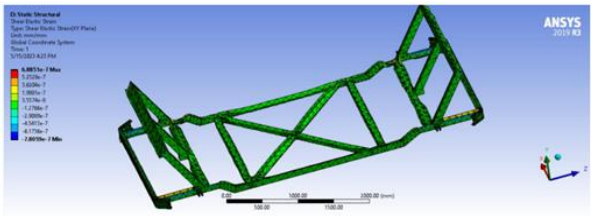


Figure 4 : The total deformation test analysis
The figure shows that the total deformation test has been done and the result are great the highest deformation valued is 408441e-5 Max. which is good for construction and passed.



9.5 SHEAR ELASTIC STRAIN

Figure 5: The Shear Elastic Strain analysis test analysis result.|
The figure shows the shear elastic strain test has been done and the results are good and the highest elastic strain valued is 6.8851e-7 Max. which is good for construction and passed

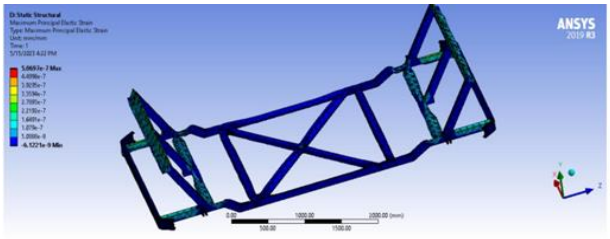


Figure 6: The Maximum principal elastic stress test analysis.

4. Cost Estimation of the electric vehicle Chassis
Table no. 1: The cost estimation of the certain part of the chassis.

Sr .No.	Name of Member	Dimensions of Member					Name of Suppliers		
		Length	Height/Depth	width	Thickness	Weight	S. MAHIPAL	RAMDEV STEEL	NEO MEGA STEEL
1.	C-Section : Side member 1	7.5 m	75 mm	40 mm	4.8 mm	53.55 Kg	Rs. 43 / Kg = 43x 350 = Rs. 15050/-	Rs. 42 / Kg = 43x 350 = Rs. 14700/-	Rs. 35/ Kg = 43x 350 = Rs. 12250/-
2.	C-Section : Side member 2	7.5 m	75 mm	40 mm	4.8 mm	53.55 Kg			
3.	Outer Cross Members 1	5 m	75 mm	40 mm	4.8 mm	35.7 Kg			
4.	Outer Cross Members 2	5 m	75 mm	40 mm	4.8 mm	35.7 Kg			
5.	Cross members 1	5 m	75 mm	40 mm	4.8 mm	35.7 Kg			
6.	Cross members 2	5 m	75 mm	40 mm	4.8 mm	35.7 Kg			
7.	Cross members 3	5 m	75 mm	40 mm	4.8 mm	35.7 Kg			
8.	Cross members 4	5 m	75 mm	40 mm	4.8 mm	35.7 Kg			
Total Weight						321.3 Kg			

5.CONCLUSION

In the present work, a ladder-type chassis frame for campus drive vehicles was designed and analyzed. Based

on the analysis results of the present work, the following conclusions can be drawn.

1) Part is safe under the given loading condition. (4-seater 500 kg) (6-seater= 700 kg).

2) The new chassis frame was analyzed and the part is safe under the load conditions which is 1000kg.

3) To improve performance, geometry has been modified which enables the reduction of stress levels marginally well below the yield limit.

4) For Load conditions C cross-section chassis will be used.

5) All design and analysis for the chassis component had been conducted properly.

6) In This project also all students have increased soft skills such as leadership, teamwork, and spirit during accomplishment

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