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Design And Analysis Of Chassis For Electric Vehicle

Suraj Kumar[1], Ravi Girgoswami[2], Abhishek Shukla[3], Pranit Shinde[4], Mr. N.T. Rathod[5]

[1-4]B.E. student Department of Mechanical Engineering, ISB&M College of Engineering, Pune, India
[5]Faculty, Department of Mechanical, ISB&M College of Engineering, Pune, India

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ABSTRACT: This document focuses on the design and analysis of the electric Eco-Drive chassis. The chassis is a frame like a skeleton in which all parts of the machine are installed. The main criteria for the development of electric vehicle chassis are rigidity, strength and cost elimination. The chassis is the most important part of an electric vehicle, representing safety and life. In order to meet the performance requirements of the automotive market dominated by motor vehicles, the design of electric vehicles must be lightweight, durable and long-lasting. In addition to the battery, the chassis of the vehicle carries a considerable amount of weight. The lightweight chassis has been optimized and will not affect the proper rigidity and strength. Various materials have been considered and evaluated. The main goal is to use static and modal analysis to evaluate chassis deformation to reduce weight and improve vehicle performance in challenging low-energy races. The 3D modelling and FE analysis of the chassis was done using Catia V5 software. The main framework is the focus of this analysis.

INTRODUCTION

Today's automotive industry may face some of the biggest technical challenges in its history. In most parts of the world, regulations and laws are being formulated to improve fuel economy and reduce exhaust emissions. These challenges, coupled with rapidly changing customer preferences and growing market demand to improve vehicle performance and reliability, require automotive companies to reconsider their previous methods and find better ways to reduce costs over time. Since then, automakers are expected to start developing more electric vehicles and slightly reduce the demand for oil. Over time, it became clear that when starting a design project for a new commuter vehicle, an electrical solution must be selected. In fact, this solution has several advantages. Although electric vehicles are the real solution to the global warming problem facing the world today, they are a relatively cheap way to travel.The chassis is an important part of any vehicle because it serves asa foundation for the body and other components.Extreme stress, extreme deflection, and equilateral stress are allimportant parameters to consider when designing a chassis.The achievement of lightweight and stiff car structures generallyplays a critical role in maximizing the efficiency of the electric car.Themain focus will be lightweight materials, advanced productionprocesses and special electrical chassis design for improvingenergy efficiency of electric car structures.The current work aims to develop a modelling and simulationmethodology for the future electric chassis of the automobile

PROBLEM STATEMENT

The need for energy storage and consumption is increasing every day. As a result, electric car usage is on the rise. Any vehicle's chassis is its base. As a result, electric car chassis should be well-designed and constructed. The chassis is the most important structural component that ensures the vehicle's safety. As a result, if the chassis' weight can be decreased while still fulfilling structural standards, the car's performance is likely to increase.

OBJECTIVE

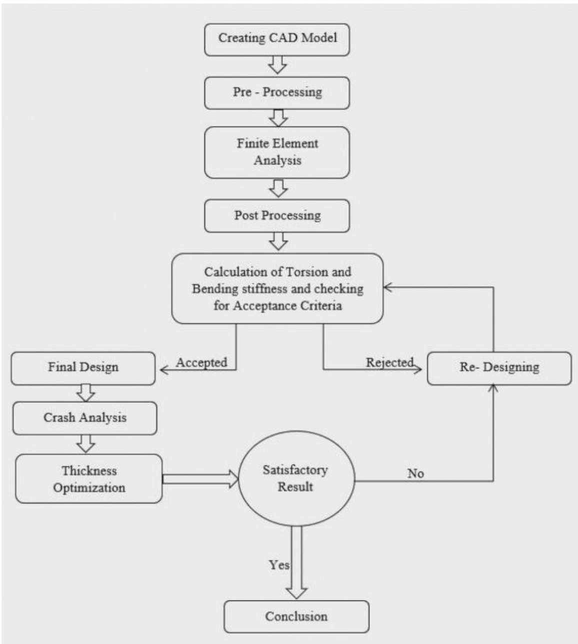
The objectives of paper are as follows:

- The selection of material for chassis.
- To construct the appropriate chassis for electrical vehicle.
- To determine the maximum stress

FUTURE SCOPE

Electric vehicles have become a national obsession in the United States and Europe. It became a popular activity throughout time, and other countries quickly followed suit. Electric vehicles are becoming a popular alternative for the foreseeable future. As a consequence, this study covers the design, modeling, and simulation procedures for an electric car's chassis in detail. Indian businesses are also developing electric automobiles on a limited basis. Electric cars, on the other hand, must have lower pricing in order to gain popularity.

METHODOLOGY



The method overview begins with creating a CAD model for the initial design of the chassis using design methodology rules.

- This initial design is subjected to FEA to determine whether it meetsthe acceptance criteria.
- The design is then modified further by creating lightweight crossmembers. Modifications are made to chassis made of variousmaterials to make it light weight until the design meets the acceptance criteria.
- The final chassis selected is optimized to reduce weight byoptimizing thickness.
- If the optimization of thickness is successful for the chassis chosen, the design is possible.
- The acceptance criteria for the optimized chassis are therefore rechecked. If the optimization of thickness fails, the design isconsidered as a chassis which cannot be implemented.
- The chassis is therefore reconstructed. The whole process goes frompost-processing through the optimization of thickness to checkingcriteria for acceptance until the chassis design is feasible.
- Depending on the following factors additions and modifications can be done to the chassis in terms of cross members, Strength: Chassis should have a high strength to maintain stability. It should also have the capacity to withstand the weight of 30 components and other loading conditions. So, to improve the strength of chassis, few cross-members can be added.
- Stiffness: In other words, stiffness can be supposed as resistance to deflection. An automobile chassis should have high torsional stiffness and bending stiffness as discussed in 3.3. So, to improve the stiffness of chassis, crossmembers can be added.
- Weight: If cross-members are added by considering the above factors to improve chassis performance, then eventually the weight of chassis is increased. Due to this performance of the vehicle can be reduced. To avoid this, the cross members should be designed using less material and must be light weight. Instead of using multiple cross-members, a single stiffened crossmember should be placed in that region.
- Cost: If the cost of the material chosen is high, then it should be made sure that the chosen material is strong enough with less weight. Removing unwanted material from chassis can also reduce the cost.

LITERATURE REVIEW

Kenji KARITA, Yoichiro KOHIYAMA, Toshihiko KOBIKI, KiyoshiOOSHIMA, Mamoru HASHIMOTO (2003) had developed a chassis made by Aluminium.

The material selected for the frame is 6061-T6. They used the Variablesection extrusion method for making the chassis. It's developed withthe help of computer Aided Engineering. Aluminium material gives an advantage of weight reduction. From this study authors found that the Aluminium chassis meets the target of weight reduction, strength andrigidity. Also, they concluded that the remaining technical issues willbe addressed to enable commercial adoption of the aluminium frame.

Alireza Arab Solghar, Zeinab Arsalanloo (2013) studied and analyzed the chassis of Hyundai Cruz Minibus.

ABAQUS Software was used for modelling and simulation. Self-weight of the chassis is considered for static analysis and Acceleration, Braking and Road Roughness were considered for dynamic analysis. It's observed that the stresses on chassis caused by braking weremore compared with acceleration.

M. Ravichandra, S. Srinivasalu, Syed altaf Hussain (2012) studied the alternate material for chassis. They studied and analysed Carbon/Epoxy, Glass/Epoxy and S-glass/Epoxy as chassis material in various cross sectionslike C, I and Box Section. TATA 2515EX chassis was taken for study. Pro-E andAnsys software were used for this work. Study reveals that the Carbon/EpoxyI section chassis has superior strength, stiffness and lesser weight comparedto other materials and cross section.

Roslan Abd Rahman, Mohd Nasir Tamin, Ojo Kurdi (2008) used FEM stress analysis as a preliminary data for fatigue life prediction. They used

ABAQUS software for simulation and analysis and taken ASTM Low Alloysteel A710 (C)for study. Primary objective was to find the high stressed areawhere the Fatigue Failure will start. It's found that the chassis opening areahaving contact with bolt experiences high stress.

N.V.Dhandapani, G Mohan kumar, K.K.Debnath (2012) have used Finite element methods to study the effect of various stress distribution using

Ansys software. To investigate the field failure of 100Ton dumper theyintroduced gussets in failure area. After modification the chassis structurewas validated by linear static analysis andfound that the modified chassiswas safe.

DESIGN AND ANALYSIS OF CHASSIS STRUCTURE

CATIA part design and generated structural analysis is used in the design analysis optimization process. Due to time constraints and the team's CATIA drawing skills, the 3D model is just a solid model with a simple cross-section, but it can still illustrate the entire chassis structure.

BASIC CALCULATION FOR CHASSIS FRAME

- Front Overhang = 12 in
- Rear Overhang = 14 in
- Wheelbase = 53 in
- Material of the chassis is mild steel
- E = 2e+11 N/mm*mm
- PR = 0.266
- Density = 7860 kg/m*m*m
- Capacity of the vehicle is of 6 person i.e. About 480 kg = 4708 N
- Capacity of the vehicle with 1.1% = 5178 N
- Weight of the body, Motor and Batteries = 124 kg = 1216 N
- Total load acting on the chassis is = 6394 N

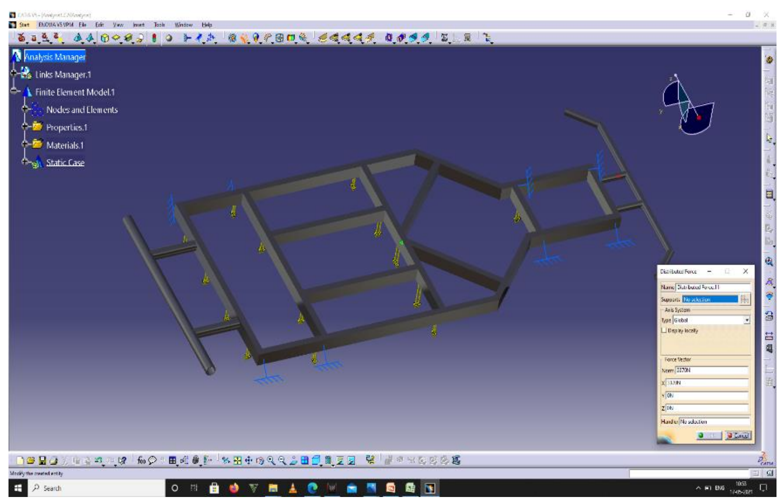
SOLID MODELING

After load approximation and material selection, CAD model was prepared using CATIA V5 and this software was also used for Finite Element Analysis (FEA).

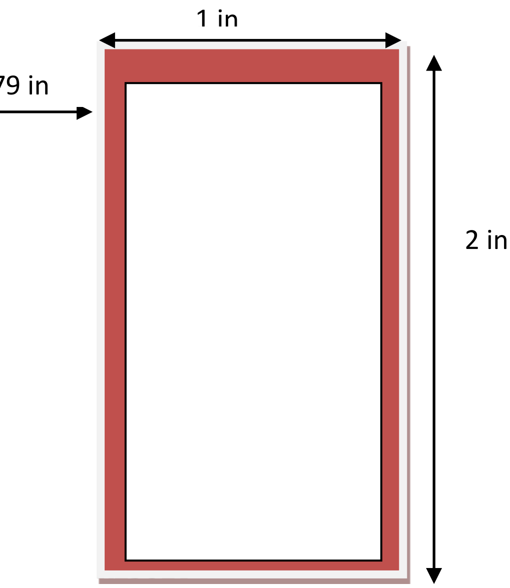
FE Analysis of chassis

The EV chassis model is loaded by static forces from the vehicle body and load. For this model, for Vehicle plus body, the maximum loaded weight is 604kg. The load is assumed to be distributed uniformly. Detail loading of model is shown in Figure. The magnitude of force on the upper side of chassis is 6394 N. We have also considered earth gravity for the chassis.

There are 4 boundary condition (distributed into 8) applied to the chassis on the front and rear of it. They are shown in figure.

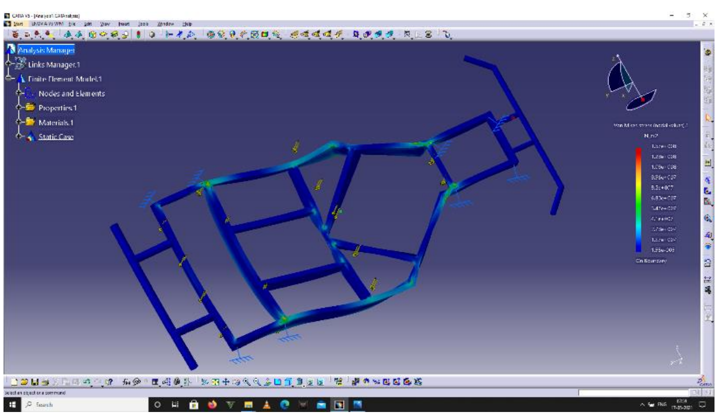


Cross section of the material



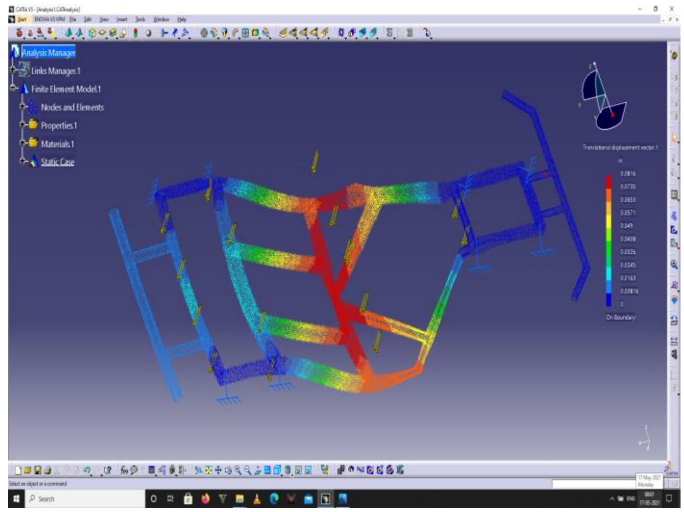
The location of maximum Von Misses stress and maximum shear stress are at joint of side bar and supporting member. The Von Misses stress magnitude of critical point is 1.37e+8 Pa and the maximum shear stress magnitude is 6.34e+7 Pa.

Max equivalent stress at critical point is 1.4e+8 Pa.



Displacement

The magnitude of maximum displacement is 0.0816 in = 2.07 mm, which is within safe limit according deflection span ratio.



Conclusion

Overall weight of the chassis is 21.42 kg.

From the above result stress is localised at certain points. Stress concentration can be minimised by adding thick plate at the joint of side bar and supporting member providing extra strength.

Failure generally occurs at welding point so side members and maximum portion of the chassis should be made using bending process and using rivets to add supporting members.

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