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DESIGN AND DEVELOPMENT OF CHASSIS OFELECTRIC VEHICLE

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Abstract: We are from the chassis department and were required to build a strong and light chassis for 6 seated vehicles. Aspects of ergonomics, safety, ease of manufacture, and reliability are incorporated into the design specifications. The analysis is conducted on all major components to optimize strength and rigidity, improve vehicle components, and reduce complexity and manufacturing costs. 3D models have been made for analysis purposes by using Solidworks software and analysis has been made.3D assembly models of vehicles are designed for understanding purposes.

I. 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, SolidworksM is the software used for the modeling of the chassis. It is an advanced CAD/CAM/CAEsoftware. 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. Theladder frame has several members that cross-link to hold frame rails together. Asimple 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 autodesign.
The reason for the ladder frame type of chassis is that here it is easier to changethe design without having to change the chassis thereby saving overall design time. It also provides a good beam resistance because of its continuous rail fromfront to rear.

- Be structurally sound in every way over the expected life of the vehicle andbeyond.
- This means nothing will ever break under normal conditions.
- Maintain the suspension mounting locations so that handling is safe andconsistent under high cornering and bump loads.
- Support the body panels and other passenger components so that everythingfeels solid and has a long, reliable life.
- Protect the driver from external injuries.

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II. LITERATURE SURVEY

Rohan Y. Garud, Shahid C Tamboli [ISSN 0973-4562 Volume 13; 2018], "Structural analysis of automotive chassis, design modification, andoptimization"

From the optimization carried out of the chassis, it can be concluded that an advanced high strength steel chassis shows a better result as compared to the original thick steel chassis. Also, from the weight reduction point of view, a change in geometry topologywas carried out by changing the box section to the T section from cross members

K. Rajasekar Dr. R Saravanan [ISSN 2348- 7968 Volume 1; 7 Sept 2014], "The chassis design of on-road heavy vehicles"Conclusion:

The present study has analyzed the various literature. After a careful analysis of variousresearch studies conducted so for it has been found that sufficient studies have not beenconducted on the variable section chassis concept. Hence in order to fill the gap future research studies may be conducted on the variable section chassis concept in automobiles.

Vijayan S.N. Sendhilkumar [Vol 7, 15697-15701, May 2015], "Design and analysis of automotive chassis considering cross-section andmaterial"

The existing heavy vehicle chassis of EICHER is considered for design and analysis with different cross-sections for different materials like S-Glass Epoxy composites is performed. The model of the chassis was created in Pro-E and analyzed with ANSYSfor the same load conditions. After analysis comparison is made between existing conventional steel chassis and S-Glass Epoxy composite materials in terms of deformation and stresses, to select the best one.

M. Z. A Rashid, Marian Sulaiman [ISSN 1913- 1844, Volume no.9, 2015], "Design and simulation study of small four-wheel vehicle chassis for a singledriver"

This paper has presented a design for a four-wheel chassis design which can be occupiedor driven by a single driver. The chassis structure selected is the space frame type chassis. Static test is also performed on the chassis design using the simulation functionin the Solidworks software. Then, the basic chassis frame structure is fabricated using the materials selected which is the 25mm x 25mm square mild steel tube with the thickness of 1.6mm. The static test conducted using simulation function in Solidwork software determines the Von Mises stress, resultant displacement and equivalent strain experienced by the chassis frame structure. In the static test, the finest available mesh ischosen in order to increase the accuracy of the result obtained. Then, the result obtainedare analysed and discussed. Modification on the chassis frame structure will be done during later to minimize the Von Mises stress, resultant displacement and equivalent strain experienced by the chassis frame. Based on the result obtained from the static test,the factor of safety (FOS) of the chassis frame structure has the minimum value of 3 at most of the parts, calculated based on the Von Mises Stress contour. However, there arealso location where the factor of safety (FOS) is less than 2 which located at the joint ofthe chassis frame structure. Therefore, improvement has to be made on the structure to increase the factor of safety value.

III. METHODOLOGY

- 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.

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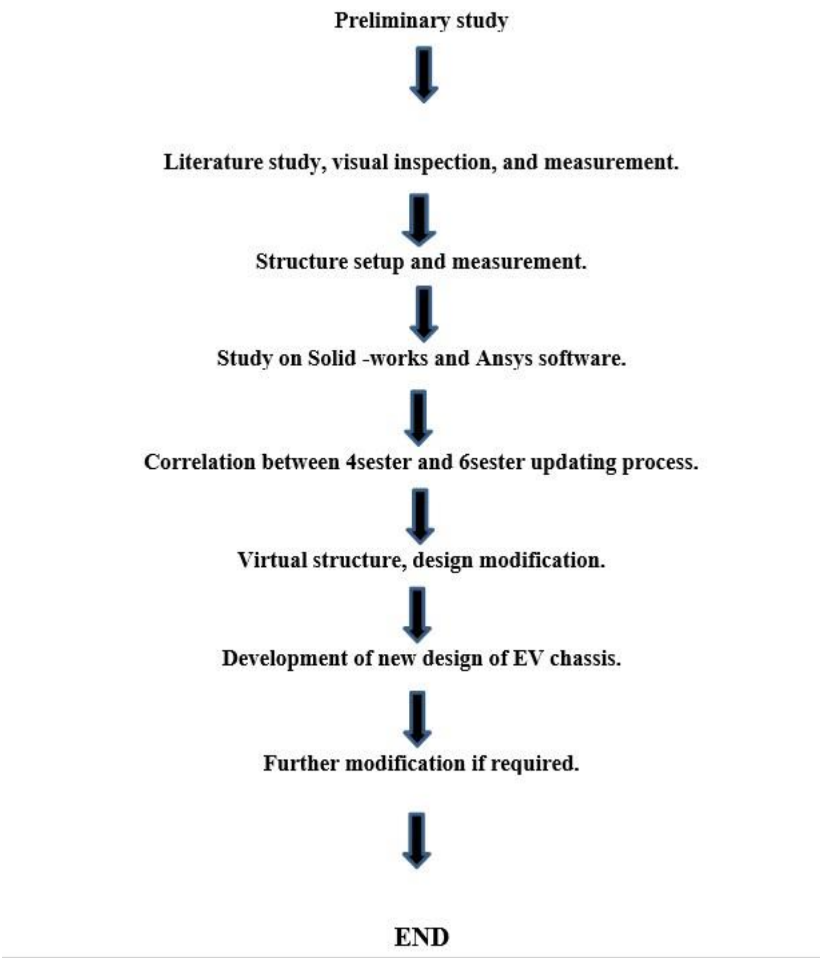

LADDER FRAME:
The history of the ladder frame chassis dates back to the times of the horse drawn carriage. It was used for the construction of ‘body on chassis’ vehicles, which meant a separately constructed body was mounted on a rolling chassis. The chassis 22 consistedof two parallel beams mounted down each side of the car where the front and rear axleswere leaf sprung beam axles. The beams were mainly channelled sections with lateral cross members, hence the name. The main factor influencing the design was resistanceto 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 themid-1930’s. A typical ladder frame shown as below.

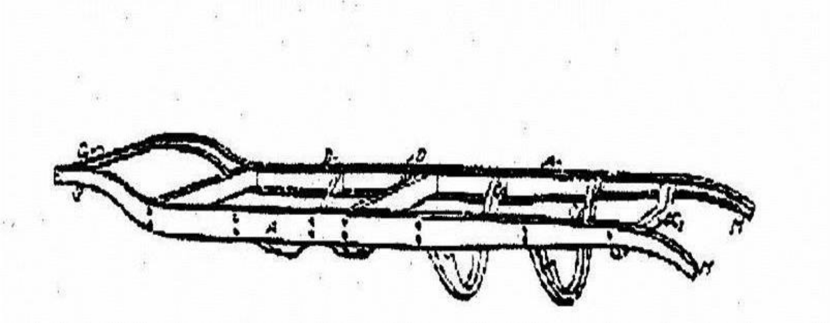

Fig. Ladder frame chassis

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Fig. Ladder frame

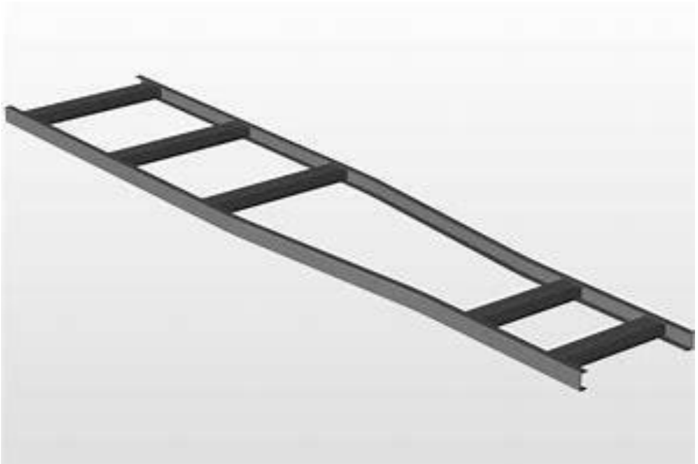
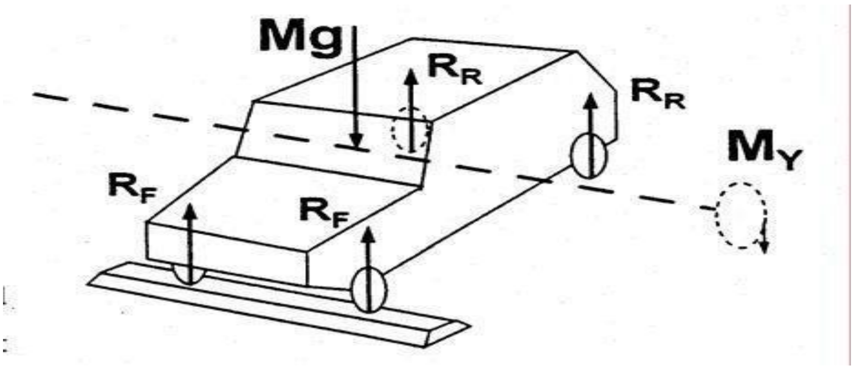


Fig. Ladder frame CAE model

THEORY OF LOAD CASES:
A chassis is subjected to three load cases: bending, torsion, and dynamic loads.The bending (vertical symmetrical) load case occurs when both wheels on one axle of the vehicle encounter a symmetrical bump simultaneously. The suspension on this axle is displaced, and the compression of the springs causesan upward force on the Suspension mounting points.This applies a bending moment to the chassis about a lateral axis.



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The torsion (vertical asy3mmetric) load case occurs when one wheel on an axletrike a bump. This load is causing the chassis to torsion as well as bending. It has been found both in theory and in practice that torsion is a more severe load case than bending.

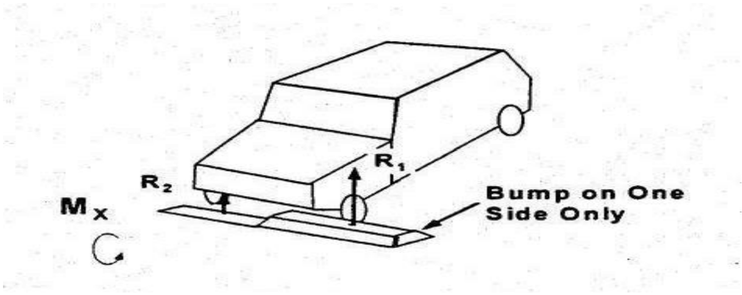

Fig. Torsion Load case

The dynamic load case comprises longitudinal and lateral loads during acceleration,braking, and cornering. These loads are usually ignored when analyzing structural performance and this analysis will follow the free boundary condition procedures. Atorsion stiffness chassis offers several advantages:
According to vehicle dynamics principles, for predictable and safe handling, the geometry of the suspension and steering must remain as designed. For instance, the camber, caster, and toe angles could change with torsion twist causing “bump steer.”

Once again according to vehicle dynamics principles, a suspension should be stiff and well-damped to obtain good handling. To this end the front suspension, chassis,and the rear suspension can be seen as three springs in series as shown in If the chassisis not sufficiently stiff in torsion, then any advantages gained by stiff suspension willbe lost. Furthermore, a chassis without adequate stiffness can make the suspension and handling unpredictable, as it acts as an un-damped spring.

IV. DESIGN CALCULATION

Side Members C section: Dimensions: MC75 D- 75 mm B – 40 mmt – 4.8 mm
Section Length one Side – 2.6 m
Weight of C channel one side = length in m * 7.14 kg/m (As per Chart)Weight of C channel both sides = 2* 2.6 * 7.14 = 37.128 Kg Dimensionsof outer Cross Members
Type: C section MC 75
D- 75 mm B – 40 mm t – 4.8 mm
Weight of C channel one side = length in m * 7.14 kg/m (As per Chart)No of outer members = 2
Weight = 2 * 1.5 * 7.14 = 21.42 KgDimensions of Cross members Type: C section MC 75
No of cross members = 4
D- 75 mm B – 40 mm t – 4.8 mmWeight = 4 *1.5 * 7.14 = 42.84 Kg
Total weight of chassis = 37.128+21.42+42.84 = 101.388 kgPay load = 600 Kg
Weight of Steering Assembly = 20 KgWeight of Seating Arrangement = 10 kg
Weight of Battery = 300 Kg (18 Kg*12) 8 WATTWeight of Motor = 30 kg
Weight of Breaking Assembly = 20 kgWeight of Electronic Accessories = 20 KgTotal weight on Chassis = 1000 kg.

NEW CHASSIS DESIGN:
6-SEATER:

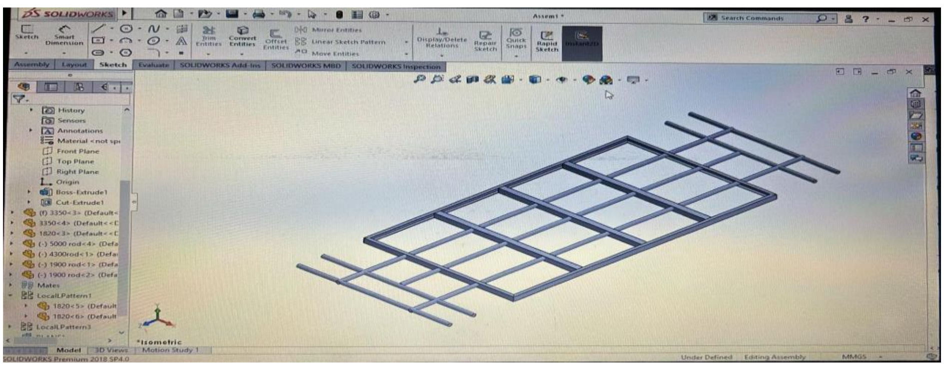

Fig. CAE model

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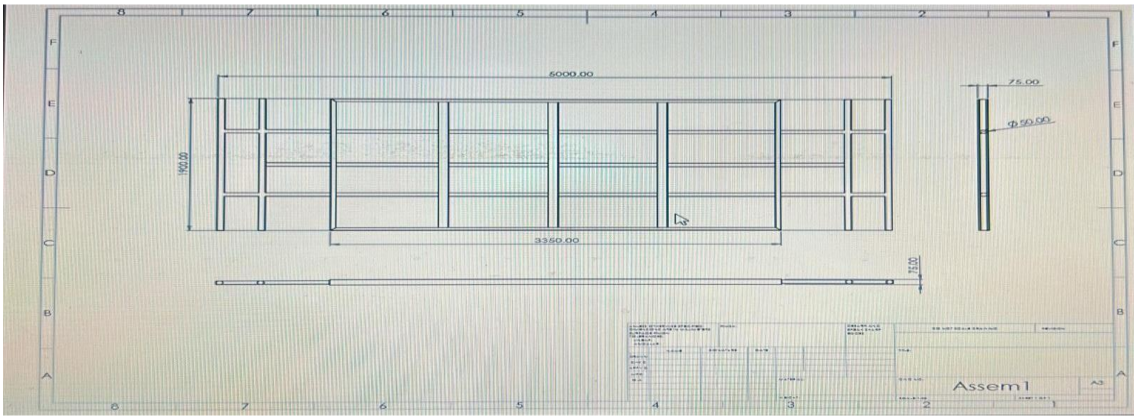

Fig. AutoCad model 6-seater

V. CONCLUSION & FUTURE SCOPE

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. 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.

- Part is safe under the given loading condition. (4-seater 500 kg) (6-seater= 700kg).
- The new chassis frame was analyzed and the part is safe under the loadconditions which is 1000kg.
- To improve performance, geometry has been modified which enables thereduction of stress levels marginally well below the yield limit.
- For Load conditions C cross-section chassis will be used.
- All design and analysis for the chassis component had been conducted properly.
- In This project also all students have increased soft skills such as leadership, teamwork, and spirit during accomplishment.

Future Scope:
The new design of the chassis frame was modeled and analyzed. For manufacturing, C-channel Structural steel will be used. The quotation for the following C-channel has been taken from a few traders. The future work is getting the material and starting the manufacturing of the chassis frame.

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