Material Optimisation Along with Realigning of Connecting Members of LCV/HCV Chassis

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Abstract:This paper aims to analyse the new material and specifications along with an I section ladder frame chassis with FEM analysis of automobile LCV/HCV chassis. Chassis analysis research is based upon strength. ,material, and on the basis of various loading conditions. However the material which has been selected is based upon previous researches. done on the automobile chassis and the final conclusion is thus made from it. On studying and analyzing the various aspects of the chassis design conclusion which would provide minimum strength area, less deformation is formulated which would be beneficial in development of chassis design.

Keywords - LCV, HCV, Ladder, Chassis,

I. INTRODUCTION

Chassis can be said as a supporting member of an automobile on which the complete structure gets mounted thus making it an important and integral part of the automobile construction. Chassis is a French word which means the whole except the body in case of heavy commercial vehicles. Components which are mounted on chassis are Engine, Differential Suspension, Transmission system, Drive shaft, Controls (braking and Steering), Electrical system etc. It consist of a pair of long member at the side which are interconnected with each other with two or three pairs of small members which are known as a connecting member.

As it has been discussed above the importance of chassis in the automobile industry so there is a tremendous requirement for its optimization to increase the safety factor and to bring down the weight of a chassis, Moreover basic requirements such as long fatigue life, have minimum resistance to air. The shape of a chassis should be such that it should get a uniformly distributed load (UDL) so that it could absorb vibration to maximum extent when in motion.

CLASSIFICATION OF CHASSIS:

On the basis of frames chassis can be defined in the following ways.

1. LADDER FRAME: It is the oldest and simplest form of chassis which is used still now in the number of SUV's. The major advantage of using these structure is that it offers good beam resistance because of its continuous rails from front to rear But it provides very poor torsion resistance hence a substitute for it which is still simple to construct is always in demand.

Fig 1:Ladder frame chassis

Ladder frame is further classified on the basis of section it has:

1. C-cross section type of ladder chassis frame.
2. I-cross section type of ladder chassis frame.
3. Rectangular box (Hollow) cross section type of ladder chassis frame.
4. Rectangular box (Intermediate) cross section type of ladder chassis frame.

2. TUBULAR SPACE FRAME: It is a type of frame in which dozens of circular rectangular and other cross sectional areas are employed. They are positioned in such a way that it provides mechanical strength to all the forces from all directions. It is basically a 3-D model. All the different cross sections of it are welded which forms a very complex structure.

3. MONOCOQUE: It is a single piece structure and the shape of the car is similar to what we employ as a monocoque chassis which makes it different from others as others provide only stress members. It is the most commonly used type of chassis used in nearly 99 percent of automobile manufactured today. Spot weldind is generally performed for joining various small particles.
The major advantage of using this type of chassis is that:

1. Space efficiency is quite high
2. It benefits crash production as it is mainly made of steel
3. When mass production is to be done it is cheap
   Its cost and complex design are the major disadvantages of it.

II. LITERATURE SURVEY

The literature has been gathered from the source and has been reviewed and recorded as follows. It includes the current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. An attempt has been made in the present article to given an overview of various techniques developed for the analysis of automobile frames and results of that analysis due to which further study on the chassis will become easy.

- The glass fiber reinforced material(E-glass) also has better qualities and can be relied on for safety in case of crashing. Moreover, fiber chassis are lighter and economical than conventional steel chassis.
- Fatigue failure is also made consideration in the analysis of chassis. Fatigue failure mainly occurs at the joints. The joints are the important part of the chassis assembly and can not be side kicked. Cruciform joints with some modifications to protect fatigue failure.
- By iterating on various design modifications existing chassis the chassis have become very much efficient than the earlier.
- Carbon epoxy could be a beneficial substitute for the formation of chassis having the general property of corrosion resistant, providing the same strength with weight nearly ¼ of the other materials.

The main thing which should be brought into attention is the use of Glass Fibre Reinforced Plastic as the use of material for chassis. Moreover if we change the specifications of chassis be it on main frame or changes in centre part it would lead to increase in strength which has been shown through this research paper.

The structure taken for analysis which has been concluded from the literature is an I shaped ladder chassis as it had been found adequate in previous analysis.

PROCESS FLOW CHART

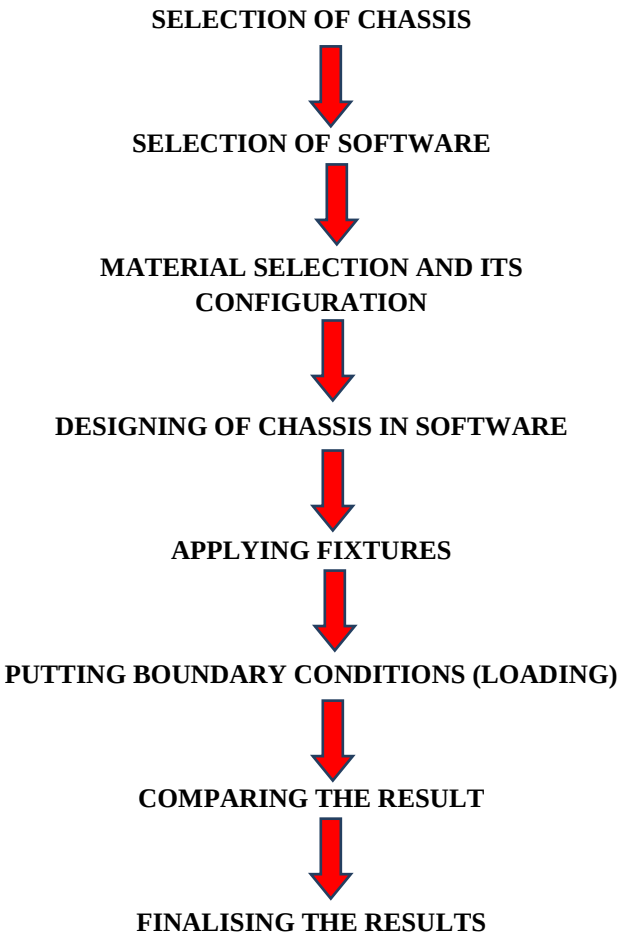

Fig 2 flow chart

III. PROCEDURE

The whole procedure included the formation of the **TOYOTA INNOVA 2.5G (2014)** chassis in solidworks software. Afterwards that several types of analysis are done on it. The results from this chassis are considered and after that making

VARIOUS TRANSFORMATIONS IN CHASSIS DESIGN best design was considered and it is listed below with the various differences in results.

The various stages of the original and the best transformed chassis design are listed below-

1. **Original chassis-** The original chassis design is made of **steel alloy 4130** material. The various analysis and the procedure on this chassis is shown below in the steps-

(a) The first step is the formation of the chassis in solidworks software. This chassis design was made in as the same design in the original car. It was measured accordingly.

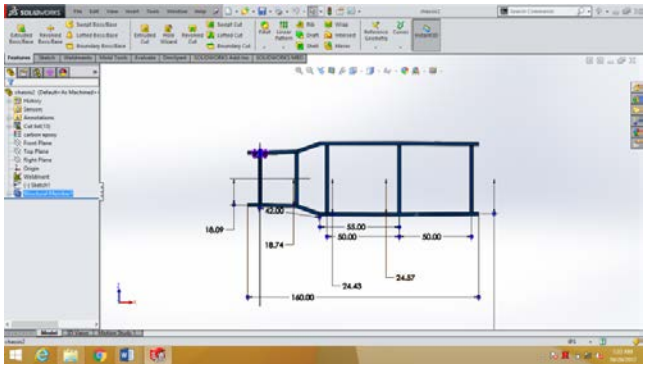

Fig.3 chassis design with dimensions

(b)The 3d view of the chassis is shown below

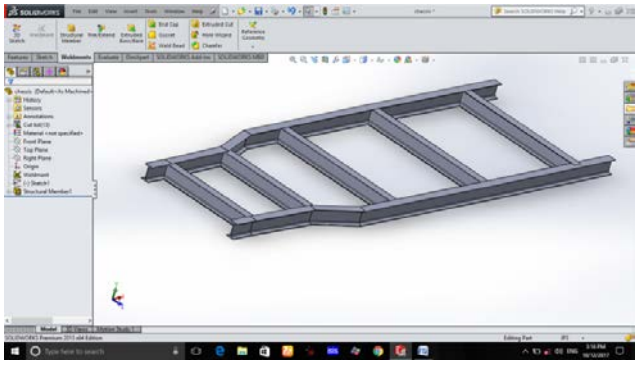

Fig4. Chassis view

(c)The chassis was made by using the **weldment module** of solidworks. It is shown below-

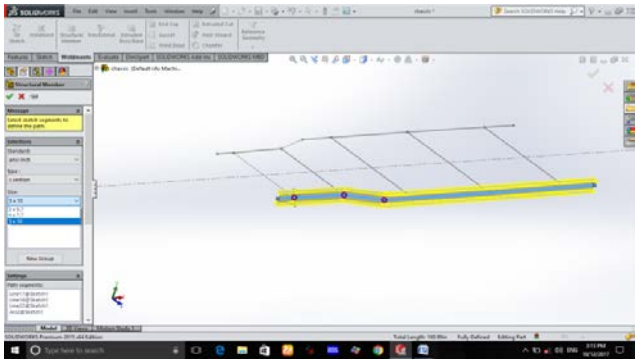

Fig.5weldment module

(D) Joint checking for the simulation.

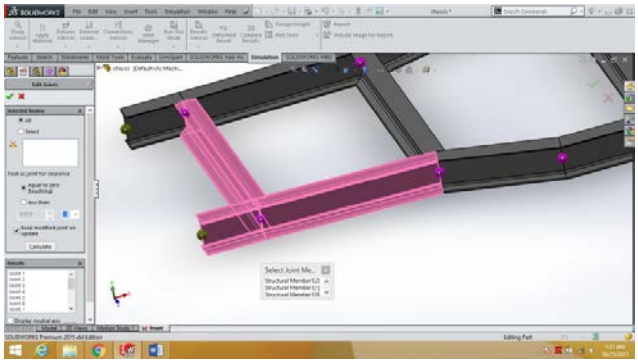

fig. 6 Checking of joints

(E) The first phase of the simulation is to define the fixed geometries.

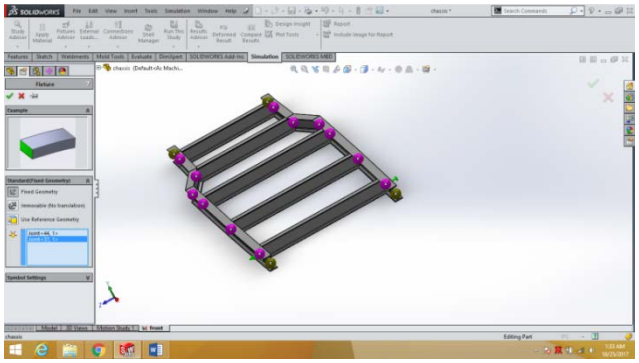

Fig.7 applying fixtures

(F) Front impact on the chassis was done by considering the mass of vehicle as 840Kg (**standard for simulation).**The acceleration for a uniform speed, is $28.5 m/s^2$.

Calculation is done by using the formula F=ma which comes out to be 132 KN.

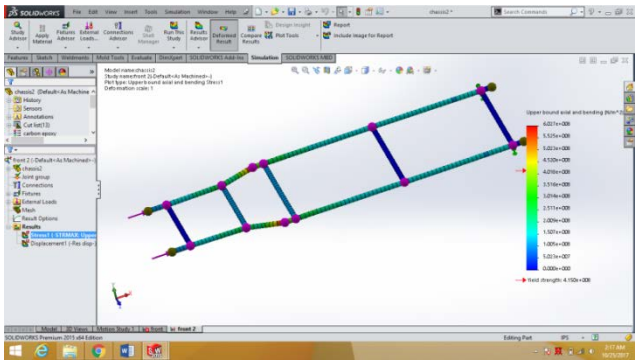

Fig.8 stress plot for chassis during front collision

By calculating the maximum stress area length which comes out to be 4 inch in the bend section as shown since this length is very small and the stress applied is maximum at that area so chances of failure are more

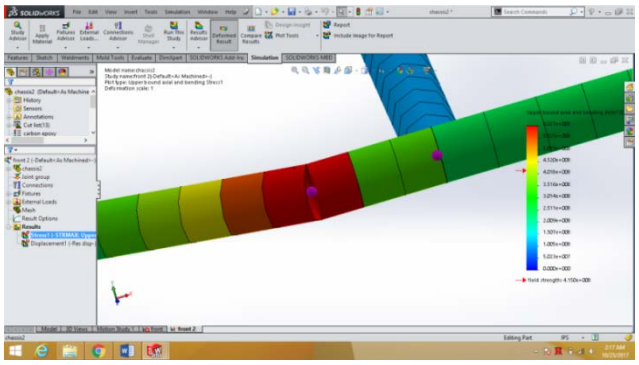

Fig.9 stress area concentration

(g) The displacement graph for the Frontal collision is shown below

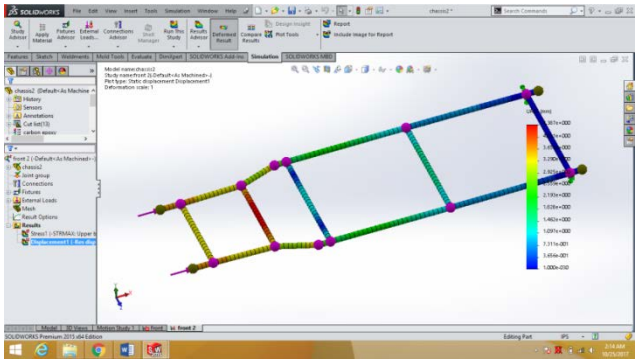

Fig.10 displacement during front collision

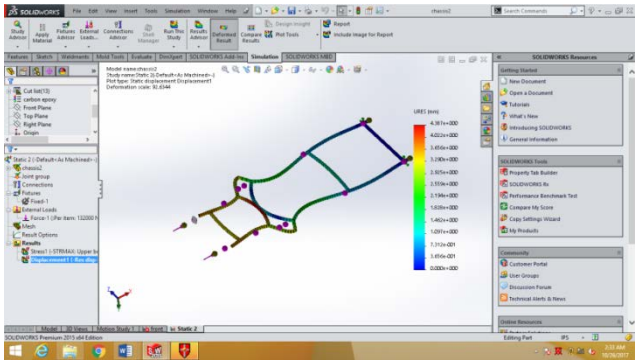

Fig. 11 Deformed Chassis with 99.152 scale

By observing from the above analysis we conclude that this chassis with the given material is more prominent to fail in the front collision when the maximum force is applied on it. The area where the maximum stress has been shown is less and its length is also very smaller so it could fail from that point as more stress is confined to that limited area. Moreover the maximum strength which is obtained from the analysis is less then the one which is obtained from the other experiments.

Various changes in the design of the chassis were made followed by the analysis performed on each variation. The results of these changes were observed and after several amount of changes in chassis design were made and the after these analysis the final chassis design was taken into consideration and then after that design was passed to various type of test design were performed on it.

And the result after the analysis are shown in a step wise manner below

2. **New and improved chassis**

(a) The improved chassis design is shown below

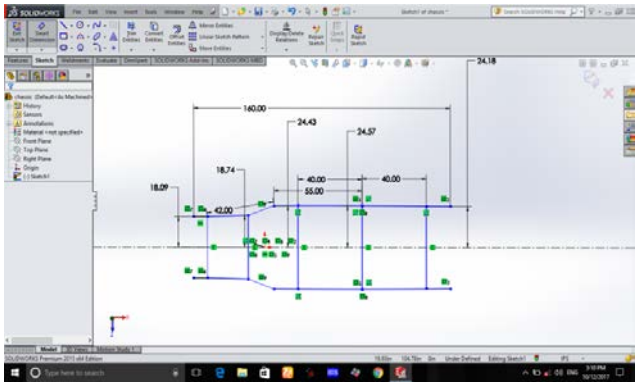

Fig 12 New chassis design

Analysis for the front collision of the chassis for a force of 132 kN was performed. The material applied on this chassis is E-glass epoxy with change in orientations of connecting members.

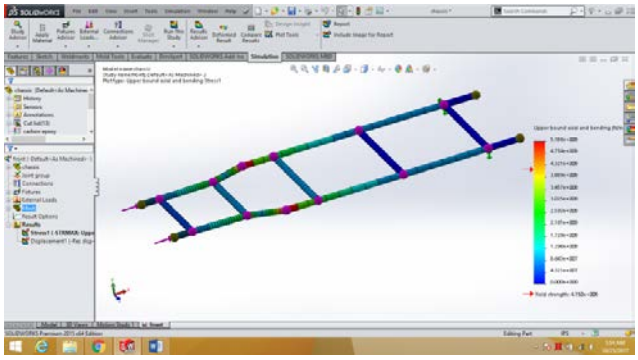

Fig 13 Front collision

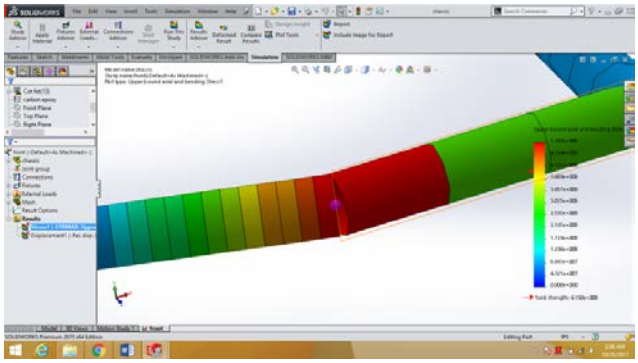

Fig 14 maximum stress length

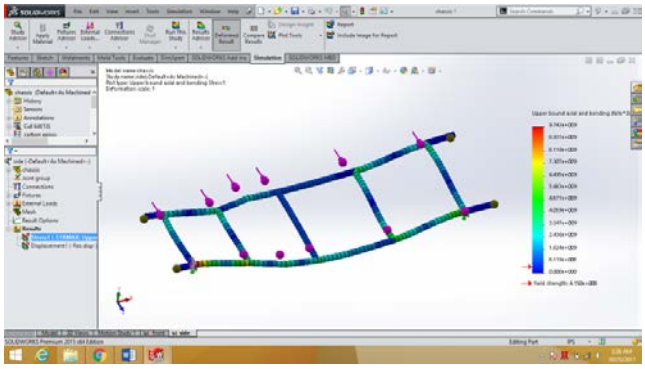

Fig.15 side impact

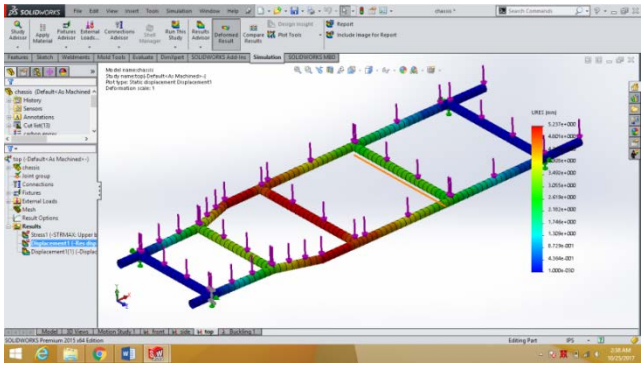

Fig 16 Top loading

IV. RESULTS AND DISCUSSIONS

From these calculations and various types of the analysis on the chassis design, it would be concluded that the glass fiber composite material(E-GLASS) is the best of all other available materials. And when it is optimized under the conditions on which other available chassis are put then it gives the accurate results which are required from it. Also when it is tested under the variation of weight then it again gives better results and also it is tested for various types of crash analysis. The results could be used to modify the present chassis.

All the results are illustrated below in the table-

Parameters	Older design	New design
Maximum Stress induced (front collision)	6 MPa	5.4 MPa
Maximum stress length (front collision)	4 inches	5.6 inches
Maximum displacement (front collision)	4.38mm	4.8mm
Side collision	---	9 MPa (max. stress)
Top collision	----	5.35 mm (maximum deflection)
Weight	187.33 kg	149.68 kg

So we can clearly see that the new chassis used has efficient properties in term of stress and strength. So the chassis with new dimension and properties have a future prospective.

V. CONCLUSION

Since from the above analysis it is clear that the chassis which was previously made of steel alloy chassis was heavier in weight and also it includes more stress concentration regions which could lead to its chances of failure. Although this chassis also gives more deflection when the standard test like top loading and front loading were applied on it.

After implementing various types of transformation in the chassis design and by selecting the proper material i.e. carbon epoxy(E glass), it can be thus concluded that the chassis with the improved size and material is better to be used in further researches. The length of stress concentration area is also lesser in the new chassis so it's chances of failure are also very lesser.

So from above we conclude that the new improved chassis is better to be used

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