

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

Design and Analysis of a Automobile Chassis by using Composite Material E-Glass Epoxy

Prashanth. A¹, Dumpa Suresh², V. Sivaramakrishna³

Assistant Professor, Department of Mechanical Engineering, Malla Reddy Engineering College, Hyderabad, India¹

Assistant Professor, Department of Mechanical Engineering, Malla Reddy Engineering College, Hyderabad, India²

Assistant Professor, Department of Mechanical Engineering, VNR Vignan Jyothi Engineering College,
Hyderabad, India²

ABSTRACT: The automotive chassis is considered to be one of the significant structures of an automobile. It is usually made up of steel frame, which holds the body and motor of an automotive vehicle. More precisely, automobile chassis is a skeletal frame on which various mechanical parts like engine, tires, axle assemblies, brakes, steering etc., are mounted. It provides strength and flexibility to vehicle. In the present work an attempt is made to replace the chassis frame made up of steel with a composite material like E-Glass Epoxy. At first the chassis frame is modelled by considering c-cross section in CATIA V5 software and then it is imported to ANSYS13.0. The analysis is done on E-Glass Epoxy subjected to similar conditions as that of chassis made up of steel. The results are then estimated to finalise the best among two materials.

KEYWORDS: Chassis frame, E-Glass Epoxy, CATIA, ANSYS

I. INTRODUCTION

Introduction of Chassis Frame: Chassis is a French term and was initially used to denote the frame parts or Basic Structure of the vehicle. It is the back bone of the vehicle. A vehicle with out body is called Chassis. The components of the vehicle like Power plant, Transmission System, Axles, Wheels and Tyres, Suspension, Controlling Systems like Braking, Steering etc., and also electrical system parts are mounted on the Chassis frame. It is the main mounting for all the components including the body. So it is also called as Carrying Unit. The following main components of the Chassis are 1.Frame: it is made up of long two members called side members riveted together with the help of number of cross members. 2.Engine or Power plant: It provides the source of power 3.Clutch: It connects and disconnects the power from the engine fly wheel to the transmission system, 4. Gear box.

The frame is the main part of the chassis on which remaining parts of chassis are mounted. The frame should be extremely rigid and strong so that it can withstand shocks, twists, stresses and vibrations to which it is subjected while vehicle is moving on road. It is also called underbody. The frame is supported on the wheels and tyre assemblies. The frame is narrow in the front for providing short turning radius to front wheels. It widens out at the rear side to provide larger space in the body.

1.1 TYPES OF FRAME: There are three types of frames :

- a) Conventional frame
- b) Semi integral frame, and
- c) Integral frame.

Conventional Frame:

It is non load carrying frame. The loads of the vehicle are transferred to the suspensions by the frame. This suspension in the main skeleton of the vehicle which is supported on the axles through springs. The body is made of flexible

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

material like wood and isolated frame by inserting rubber mountings in between. The frame is made of channel section or tubular section of box section. Example :This type of frame is used for trucks.

1.1.1 Semi-integral Frame:

In this case the rubber mountings used in conventional frame between frame and suspension are replaced by more stiff mountings. Because of this some of the vehicle load is shared by the frame also. This type of frame is heavier in construction. Example Popular in European and American car.

1.1.2 Integral Frame:

In this type of construction, there is no frame. It is also called unitized frame body construction. In this case, the body shell and underbody are welded into single unit. The underbody is made of floor plates and channel and box sections welded into single unit. This assembly replaces the frame. This decreases the overall weight compared to conventional separate frame and body construction.

1.2 Types of Sections Used In Frames:

1.2.1 Ladder Frame: A ladder frame car chassis is a common type of frame used as a base for vehicles, creating a solid base from the shape that the name suggests.

1.2.2 Backbone: A substantial central component is necessary for a backbone car chassis, connecting the front and rear of the entire frame.

1.2.3 Monocoque : A monocoque car chassis is one that uses metal that is molded from sheets of the material, which is the same method used to build other parts of the frame. This type of chassis is similar to a unibody type.

1.2.4 Space: A space chassis can also be known as tubular even though it is not tubular in the true sense. The components are welded together to create a strong frame that comprises some flexibility.

1.2.5 Combination: You will often find that a car chassis is not any single types, taking elements from a range of different types to create a version that is best suited to the car frame.

1.3 DIFFERENT MATERIALS USED FOR CHASSIS MAKING

1.3.1 Steel: The main factors of selecting material specially for body is wide variety of characteristics such as thermal, chemical or mechanical resistance, ease of manufacture and durability. So if we want to choose a material with these characteristics, Steel is the first choice. There was many developments in irons and steels over the past couple decades that made the steel more light-weight, stronger, stiffer and improving other performance characteristics. Applications include not only vehicle bodies, but also engine, chassis, wheels and many other parts. Iron and steel form the critical elements of structure for the vast majority of vehicles, and are low-cost materials. The prime reason for using steel in the body structure is its inherent capability to absorb impact energy in a crash situation. The prime reason for using steel in the body structure is its inherent capability to absorb impact energy in a crash situation.

1.3.2 Aluminium: There are a wide variety of aluminium usage in automotive powertrain, chassis and body structure. Use of aluminium can potentially reduce the weight of the vehicle body. Its low density and high specific energy absorption performance and good specific strength are its most important properties. Aluminium is also resistance to corrosion. But according to its low modulus of elasticity, it cannot substitute steel parts and therefore those parts need to be re-engineered to achieve the same mechanical strength, but still aluminium offers weight reduction. Recent developments have shown that up to 50% weight saving for the body in white (BIW) can be achieved by the substitution of steel by aluminium. This can result in a 20-30% total vehicle weight reduction. The cost of aluminium and price stability is its biggest obstacle for its application.

1.3.3 Magnesium: There are a wide variety of aluminium usage in automotive powertrain, chassis and body structure. Use of aluminium can potentially reduce the weight of the vehicle body. Its low density and high specific energy absorption performance and good specific strength are its most important properties. Aluminium is also resistance to

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

corrosion. But according to its low modulus of elasticity, it cannot substitute steel parts and therefore those parts need to be re-engineered to achieve the same mechanical strength, but still aluminium offers weight reduction. Recent developments have shown that up to 50% weight saving for the body in white (BIW) can be achieved by the substitution of steel by aluminium. This can result in a 20-30% total vehicle weight reduction.

1.3.4 E Glass Epoxy fibre: Glass has been the predominant fiber for many civil engineering applications because of an economical balance of cost and specific strength properties. Glass fibers are commercially available in E-Glass formulation (for electrical grade), the most widely used general-purpose form of composite reinforcement, high strength S-2® glass and ECR glass (a modified E Glass which provides improved acid resistance).

1.4 Composition of E-Glass:

| Properties | E-Glass |
|-----------------------------|---------|
| Density(g/cm ³) | 2.6 |
| Young's Modulus(GPa) | 72 |
| Tensile Strength(GPa) | 1.72 |
| Tensile Elongation(%) | 2.4 |

Table: 1.1

1.5 Mechanical Properties of E-Glass:

| Constituent | Weight Percentage |
|--------------------------------------|-------------------|
| SiO ₂ | 54 |
| Al ₂ O ₃ | 14 |
| CaO + MgO | 12 |
| B ₂ O ₃ | 10 |
| Na ₂ O + K ₂ O | Less than 2 |
| Impurities | Traces |

Table 1.2

II. LITERATURE REVIEW

“Swami K.I. et al. (Jan. 2014) The Automotive chassis is considered as the backbone of the vehicle. An important consideration in chassis design is to have adequate bending stiffness for better handling characteristics. So, strength and stiffness are two important criteria for the design of the chassis. This paper related with work performed towards the static structural analysis of the truck chassis. Structural systems like the chassis can be easily analyzed using the finite element techniques. So a proper finite element model of the chassis is to be developed. The chassis is modeled in ANSYS. Analysis is done using the same software”.

“Pankaj Saini and Ashish Goel stated that the comparative analysis between the conventional steel leaf spring and composite material like polymer reinforced with glass fiber i.e Carbon epoxy, E-glass based epoxy and Graphite

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

epoxy used for designing leaf spring. They done the modeling in the Auto-CAD 2012 software and ANSYS 9.0 used for analysis. the static analysis results shows that maximum displacement of conventional steel leaf is 10.16 mm and that for E-glass based epoxy is 15 mm for Graphite epoxy is 15.75 mm and for carbon/epoxy 16.21 mm the values of stress for conventional steel leaf is 67 N/mm and 163.22 Mpa, 663.68 Mpa, and 300 Mpa, for composite material resp. Out of that graphite epoxy has more stress the conventional material steel leaf so E-glass based epoxy leaf spring can be replaced from stress and strain point of view”.

“Design and Analysis of Composite Drive Shaft using ANSYS and Genetic Algorithm”. This study deals with the review of optimization of drive shaft using the Genetic Algorithm and ANSYS. Here the replacement of the conventional steel is done by the composite materials of glass fiber of carbon fiber and optimization is done for further selection of most effective material Genetic algorithm technique is used. Substitution of composite material over the conventional steel material for drive shaft has increasing the advantages of design due to its high specific stiffness and strength”.

“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 they introduced gussets in failure area. After modification the chassis structure was validated by linear static analysis and found that the modified chassis was safe”.

“Kutay Yilmazcoban, Yasar Kahraman (2011) have studied and optimized the thickness of a middle tonnage truck chassis by using Finite Element technique. The main objective of this work was to reduce the material usage through that gaining reduction in material cost. They had analyzed three types of thickness material to chassis and compared the results by stress and displacement. Study reveals that the 4mm thickness is safe enough to carry 15ton Load”.

III. DESIGN OF CHASSIS

It is a document that includes the specifications for a part's production. Generally the part drawings are drawn to have a clear idea of the model to be produced. The part drawing of the entire frame is drawn with all the views in CATIA V5 R20. The components that are generated in part module are imported to assembly module and by using ‘insert components’ command and all these components are mated together to form the required assembly. The different views of assembly and the drawing generated in CATIA V5 R20 are as shown below.

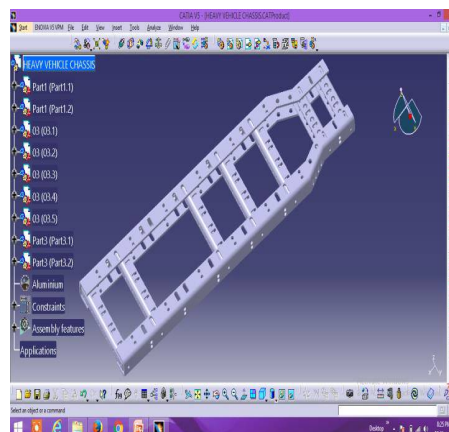


Figure: 3.1

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

3.1 Steel:

3.1.1 Stress pattern for steel chassis

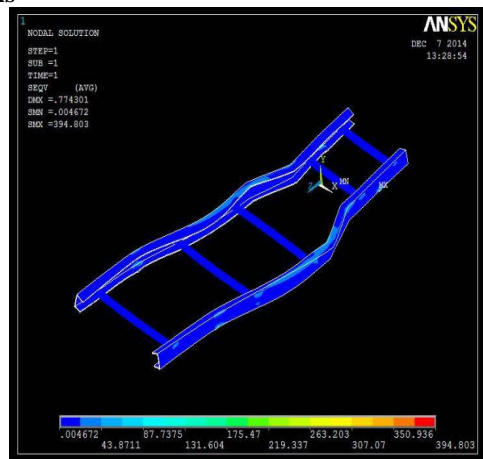


Figure: 3.2

Direction of loading is Z direction. The uniform load is applied at the edges of the chassis and the value is 3446MPa.

3.1.2 Displacement Pattern for Steel chassis

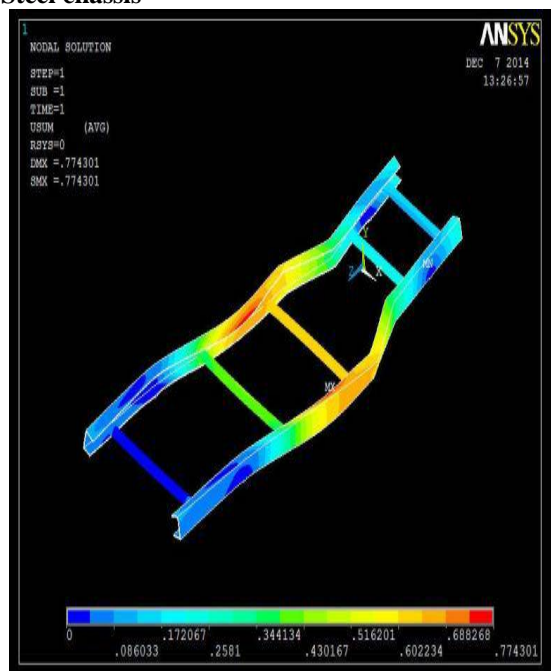


Figure: 3.3

Direction of loading is Z direction. The uniform load is applied at the edges of the chassis and the maximum displacement value is 5.72 mm.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

3.2 E-Glass Epoxy:

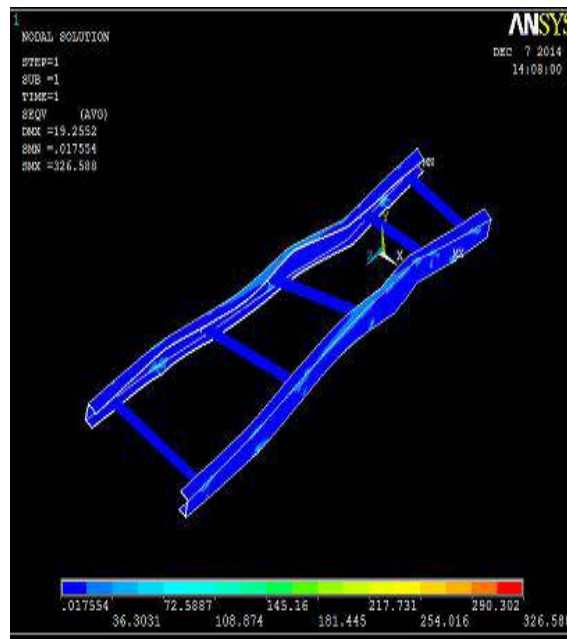
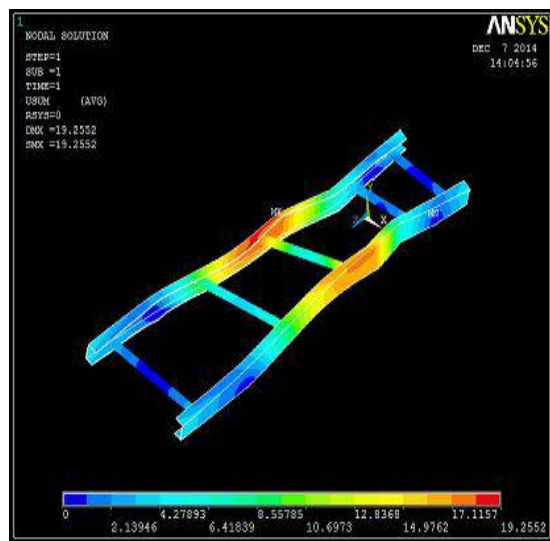


Figure: 3.3

3.2.1 Stress pattern for E-glass-epoxy chassis

Direction of loading is Z direction. The uniform load is applied at the edges of the chassis and the value is 2964MPa.

3.2.2 Displacement pattern for E-glass-epoxy chassis:



Direction of loading is Z direction. The uniform load is applied at the edges of the chassis and the displacement value is 4.14 mm.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

IV. RESULTS & DISCUSSIONS

From the above analysis, the results obtained for stresses and deformations for Steel & E-Glass Epoxy are compared.

| Material | Structural Steel | E-Glass Epoxy |
|----------------------------|------------------|---------------|
| Mass(kg) | 415 | 135 |
| Max.Normal Stress(MPa) | 3446 | 2964 |
| Max.Equivalent Stress(MPa) | 17768 | 17126 |
| Max. Deformation(mm) | 5.72 | 4.14 |

Table: 4.1

4.1 The results obtained are graphically represented as follows:

4.1.1 Graphical Representation of Mass:

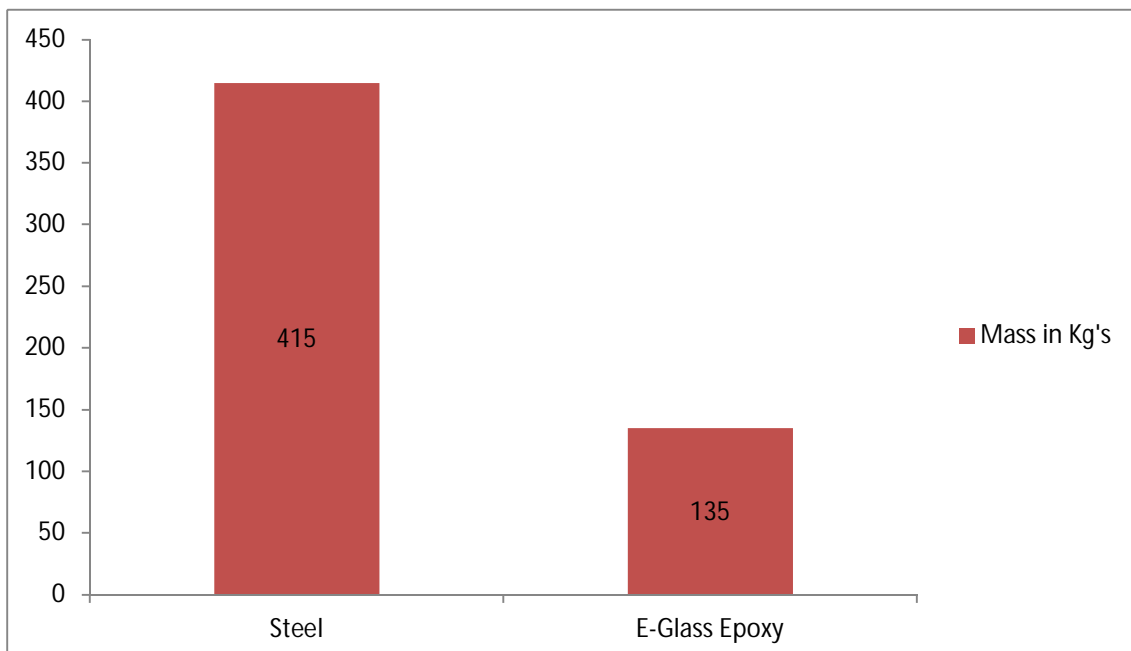


Figure: 4.1

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

4.1.2 Graphical Representation of Normal Stress:

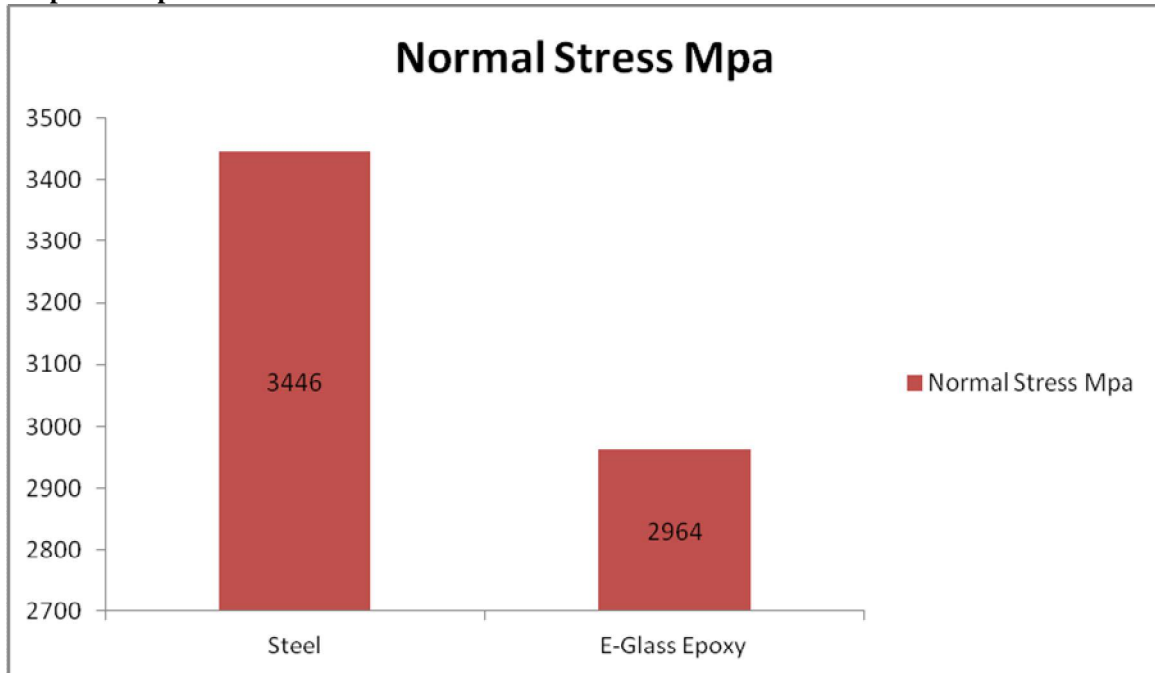


Figure: 4.2

4.1.3 Graphical Representation of Normal Stress:

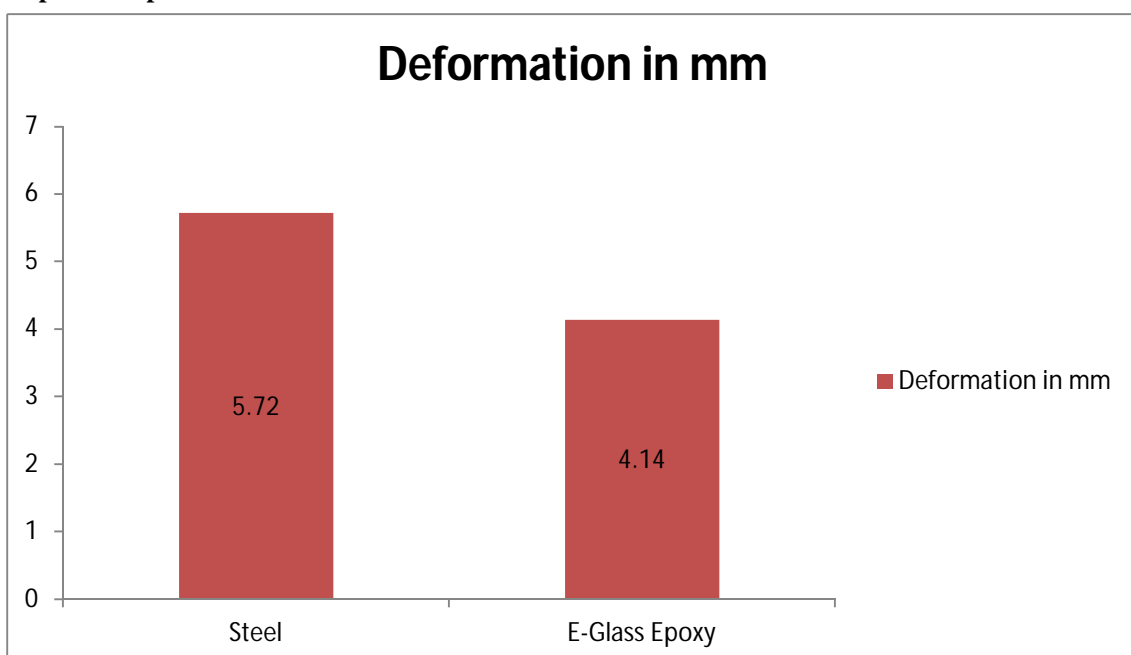


Figure:4.3

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

V. CONCLUSION

Generally steel is used for making chassis. In this we have considered a composite material like E-Glass Epoxy for chassis. When we compare steel and E-Glass Epoxy the weight reduction is 75% to 85%. On the basis of results it was observed that E-Glass Chassis has superior strength, decrease in deformation, normal stress, weight & fuel consumption compared to structural steel. Therefore, E-Glass Epoxy is most preferable for making chassis.

VI. FUTURE SCOPE

There is a more scope for further research in chassis simulation to solve vibration, frequency response and mode shape analysis related problems. This chassis structure should be further analyzed and improved on the overall performance especially on structural dynamic behavior and quality auditing for better refinement. Based on these factors, the overall recommendation is to study the structural analysis and should be covered on the overall truck system and after that focus on the specific area such as chassis. This analysis will help to make full body refinement and improvement because it can be related to actual running condition.

REFERENCES

1. Vijaykumar V. Patel, and R. I. Patel, "Structural analysis of a ladder chassis frame", World Journal of Science and Technology 2012, 2(4):05-08 ,ISSN: 2231 – 2587, April 21, 2012. 2. Parkhe Ravindra,*and Sanjay Belkar, "Performance Analysis of Carbon Fiber with Epoxy Resin Based Composite Leaf Spring", International Journal of Current Engineering and Technology, Vol.4, No.2 (April 2014).
2. Smita, C. Saddu, Modeling and analysis of composite as an alternative material for leaf spring, volume 11, Issue IV May- june 2014) , PP 39-44.
3. J. William Fitch, "Motor Truck Engineering Handbook-Fourth edition" SAE Inc, Warrendale, U.S.A, 1993.
4. Nitin S. Gokhale- Practical Finite Element Analysis.
5. AutarK.Kaw. Mechanics of Composite Materials. 2e. Taylor and Francis Group, LLC, 2006.
6. Cicek Karao a journal on analysis Science and Technology 2012, of a chassis frame with joints was performed by using software
7. M. Ravi Chandra, S. Sreenivasulu & Syed Altaf Hussain, "Modeling And Structural Analysis Of Heavy Vehicle Chassis Made Of Polymeric Composite Material By Three Different Cross Sections", Journal of Mechanical and Production Engineering Research and Development (IJMPERD), ISSN 2249-6890, Vol.2, Issue 2,Sep 2012 45-60.
8. K.W. Poh, P.H. Dayawansa, A.W. Dickerson, I.R. Thomas, Steel membrane floors for bodies of large rear- dump mining trucks, Finite Elements in Analysis and Design 32, (1999), 141-161.
9. H J Beermann, English translation by Guy Tidbury, The Analysis of Commercial Vehicle Structures, Verlag TUV Rheinland GmbH Koln-1989. [9] Mohd Husaini Bin Abd Wahab, "Stress Analysis of Truck Chassis", Project Report University Malaysia Pahang, 2009
10. Machine Tool Design hand book by Central Machine Tool Institute Edition 1 – 2004 Mc Graw Hill Publications.
11. Ahid D. Nashif, David I. G. Jones and John P. Henderson, "Vibration Damping", John Wiley & Sons Publication, 1985, Newyork.
12. K. J. Buhariwala and J. S. Hansen, "Dynamics of Visco elastic Structures", AIAA Journal, Vol. 26, February 1988, pp 220-227.