Design And Dynamic Analysis of A Heavy Vehicle Front Axle Under Bending Loads

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Abstract- The wheel is circulate by central shaft is knows axle. For vehicles the axle is attached to the wheels and rotating with each other and rotating around the axle. Conventionally the front axle is a dead axle. In our project, a basic model of front axle is prepared. The optimization of front axle is done varying materials and its cross section. The present used material used steel. Steel is replaced with Composite materials Glass Carbon and S – 2 Glass epoxy to reduce the weight of the axle. By reducing the weight, steering becomes easier. And also the strength of the composite materials is more than that of steel. Dynamic analysis is done on the axle to determine displacement, stress and strain. Dynamic analysis is the analyzing under time varying loads

Keywords- Dynamic analysis, front axle, bending loads, ansys,

I. INTRODUCTION

Conventionally the front axle is a dead axle. In such a case, the front axle beam is usually a drop forging of steel. This type of axle is no more used in modern cars, although it is still being used in heavier vehicles. The steels used for this are 0.4% carbon steel or 1.3% nickel steel.. It is also non-independent, as deflection of a wheel on one side of the vehicle will be transferred to the other wheel.

The front axle (Fig).1 is designed to transfer the weight of the automobile from the springs to the front wheels, turning right or left as required. To stop interference due to front engine location, and for providing greater stability and safety at high speeds by lowering the centre of gravity of the road vehicles, the entire centre portion of the axle is dropped. As shown in Fig. 27.1, front axle includes the axle-beam, stub-axles with brake assemblies and back-rod and stub-axle arm.
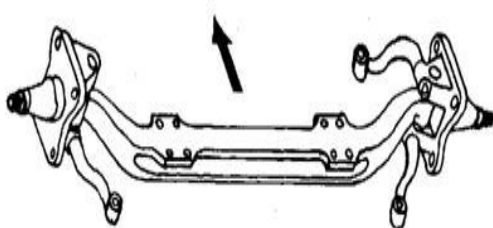

Fig .1 FRONT AXLES

The forked portion is integral with the steering knuckle. This type is mostly used in this facilitates the mounting of brake backing plate on the forged legs of the steering knuckle. In the Lemonier type front axle, instead of a yoke type hinge, an L-shaped spindle is used which is connected to the end of the axle by means of a pivot. It is normally utilized in tractors.

II. TYPES OF FRONT AXLE

Axles can be subdivided into either straight, drop, raised and independent categories.

They are

1. Straight axle dead
2. Drop axle-dead
3. Straight axle live
4. Live axle raised
5. Independent front axle

III. MATERIAL USED

1. Stell
2. Glass carbon composite
3. Glass

IV. INTRODUCTION OF CAD

As we know to design of an object in computer is difficult in computer in past days but now a day's it's so simple firstly we know Computer-aided design (CAD) it is software now a day's it's made so easy to draw 2D and 3D diagrams in computers. It's also called as computer-aided design and drafting (CADD).By the using of Computer Aided Drafting which explains the drafting process in computer. For many of design engineering CADD software is a flagship tool by using this software they shows the elegant designs of the objects as per the requirements. The output of CADD is in the form of print or machining operations.

The required output information is also important for CAD such as materials, processes, dimensions, and tolerances,

according to specific applications. The design curves and figures in two-dimensional (2D) space and solids surface in three-dimensional (3D) objects are shown in CAD software.. The design of geometric objects for object shapes, in particular, is often called computer-aided geometric design (CAGD).

ANSYS – AN OVERVIEW

For design and investigation of engineering difficulties or problems we can solve by using the software is called ANSYS software. The ANSYS is finite element analysis software for advanced by ANSYS INC. It is user friendly graphical user interface package. Many no of CAD Programmers have straight interfaces with the ANSYS program through software written by ANSYS.INC or by the CAD vendors. Interpreter for the programs like AutoCAD and Pro/Engineer are accessible from ANSYS.INC.

There are following tasks which enable the ANSYS finite element analysis software for engineers to execute the performance on the models.

1. Construct the computer models or send CAD models of structures, products, components or system.
2. Petition the operating loads or other design production state.
3. Examine the physical properties, such as stress levels, temperature disseminate, etc.
4. Optimize a design early in growth action to diminish manufacture prices.
5. Do prototype testing in ambient where it otherwise would be undesirable or impossible.
6. The essential goal of finite element analysis is to investigate how the responds from the elements or models under the certain loading condition

PROCESS FOR ANSYS ANALYSIS

By utilizing the Static analysis we can find out the displacements, stresses, strains and forces in structures or components during the loads conditions that do not leading remarkable inertia and damping effects. Firstly Steady loading conditions are to be assumed. These types of loading that can be applied in a static analysis include the forces and pressures, steady state inertial forces such as gravity velocity imposed (non zero) displacements, temperature (for thermal strain). A static analysis can be either linear or non linear. For your work we are choosing the linear statistic analysis. For Procedure of static analysis it consists 3 main steps they are:
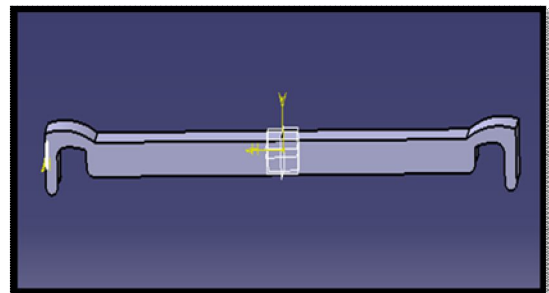
- Construction of the model
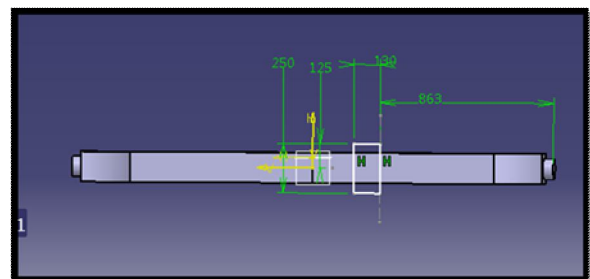
- Getting the solution.
- Reviewing the repercussion.

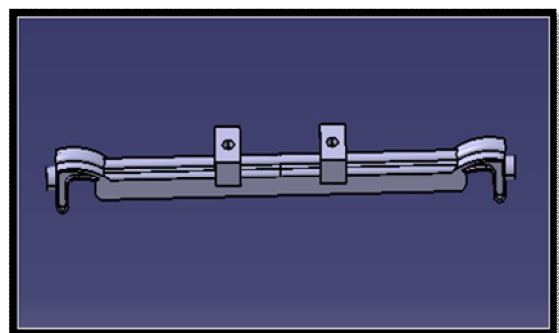## V. PROCEDURAL STEPS TO MODEL A FRONT AXLE SKETCH
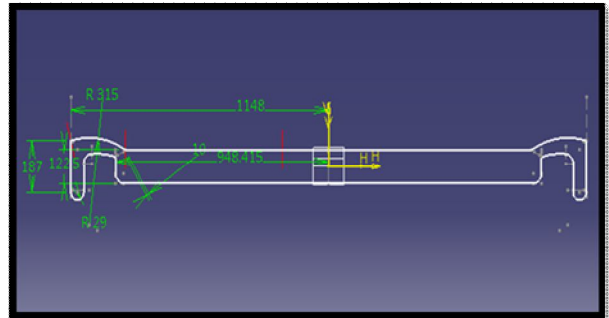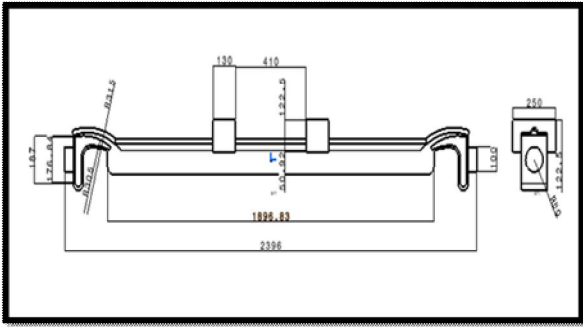

Fig.2 MODEL OF FRONT AXLE

Fig.3 SUPPORTS
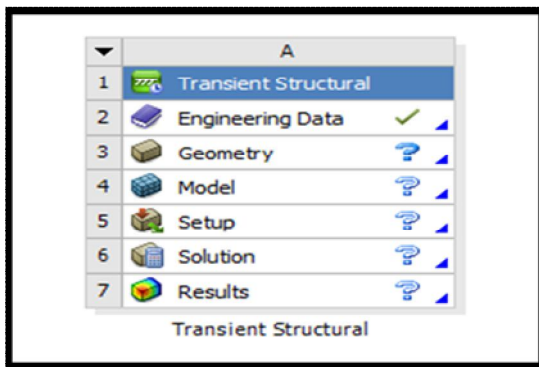

Fig.4 FINAL 3D MODEL

Fig.4 2D DRAWING

VI. DYNAMIC ANALYSIS OF FRONT AXLE
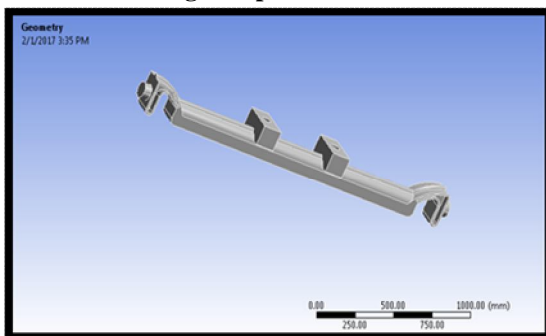
Initial Time

MATERIAL – STEEL

Ansys>Work bench 14.5>Double click on Transient Structural.
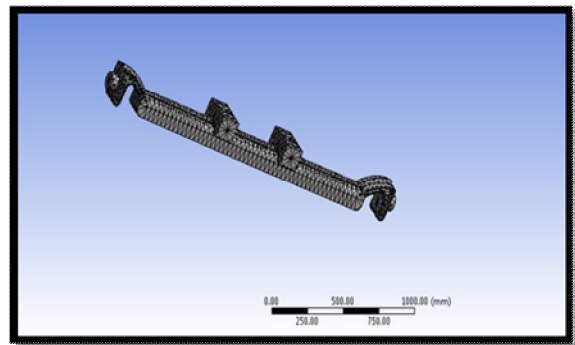

Select engineering data> window will be open in that enter required material properties> update project and return to the project.
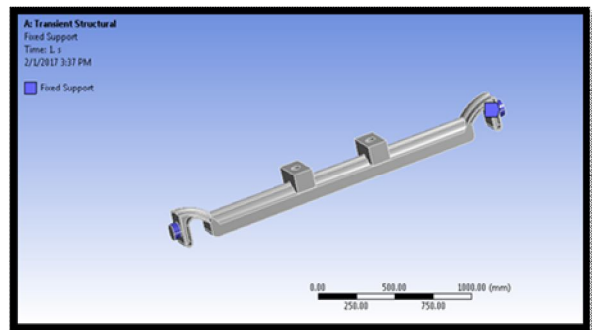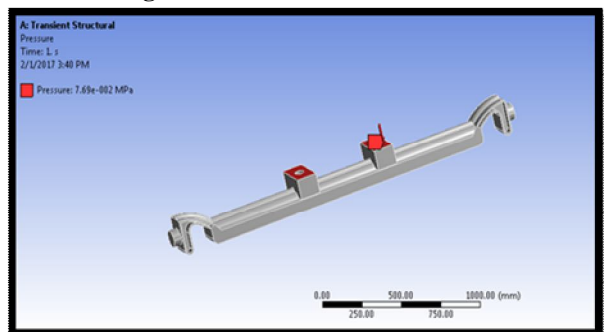
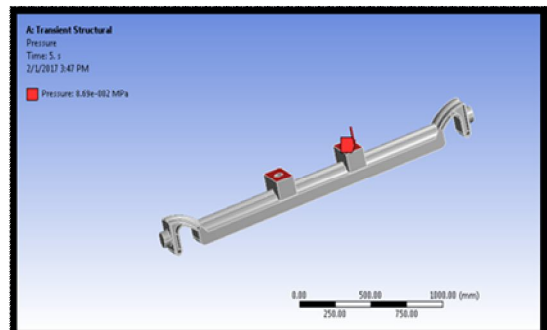**Fig.5 Imported model**
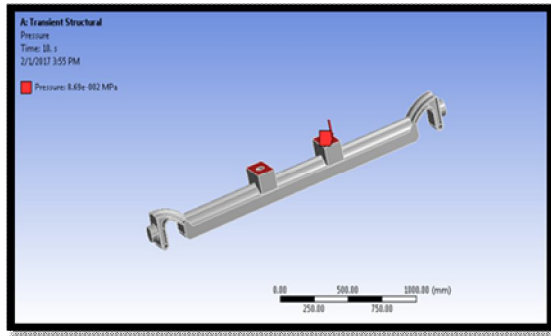

Fig.6 Meshed model

Fig.7 Fixed support

Fig.8 Pressure value at Initial time

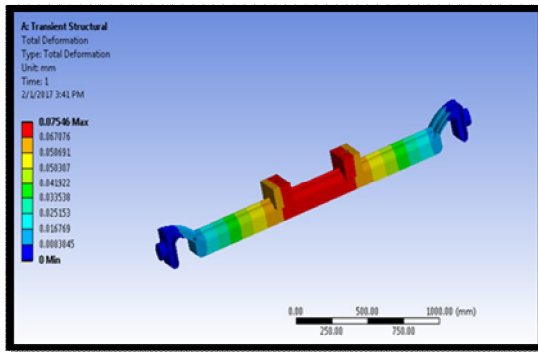**Fig.9 Pressure value at 5secs**

Fig.10 Pressure value at 10secs
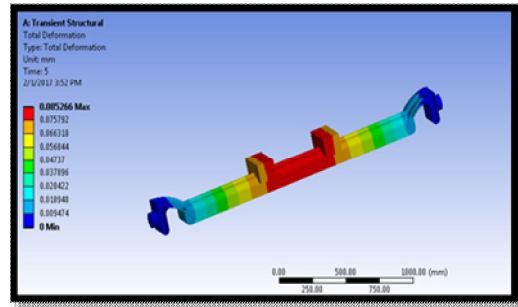
Repeat above procedure for each time step up to 10 sec.

Initial time

Fig.11 Deformation

Fig.12 Strain

Fig.13 Stress
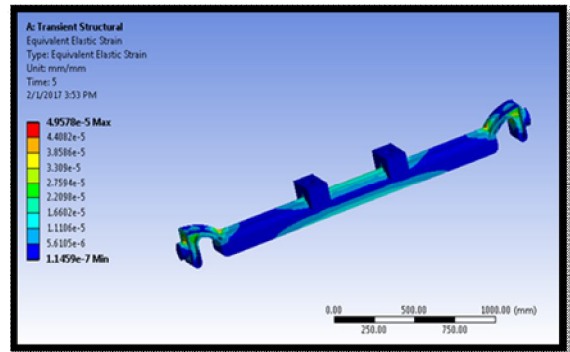
Time at 5 Sec

Fig.14 Deformation

Strain

Fig.15 stress
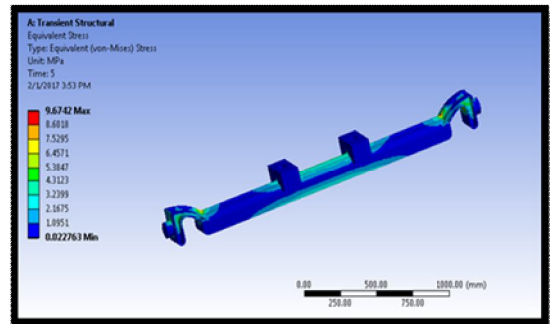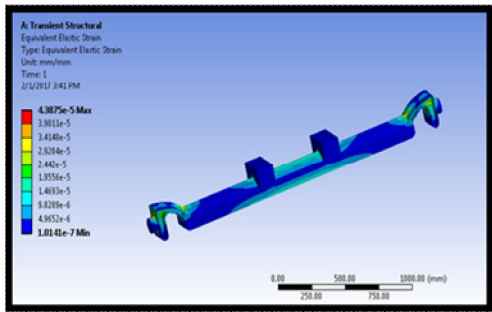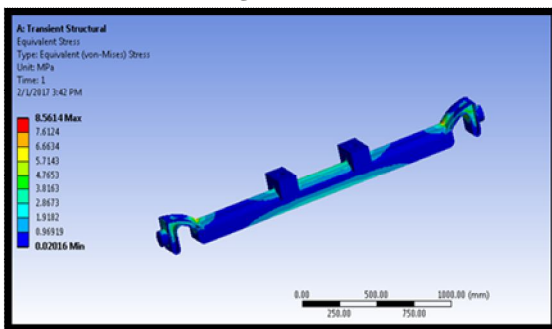
Time at 10 Sec

Fig.16 Deformation
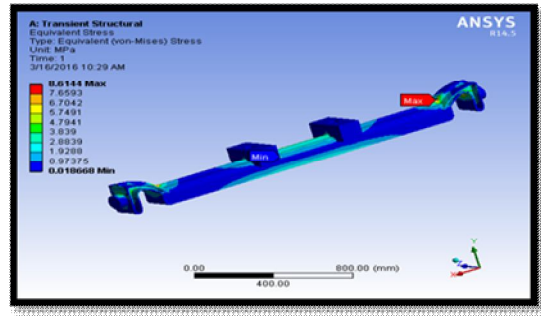
Fig.17 Strain

Fig .18 Stress

MATERIAL - S2 GLASS

Initial time

Fig.19 Deformation

Fig.20 Strain

Fig.21 Stress

Time - 5 Sec
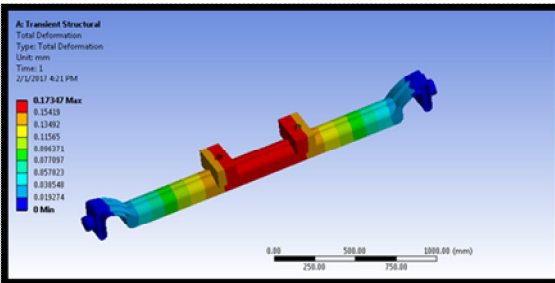
Fig.22 Deformation
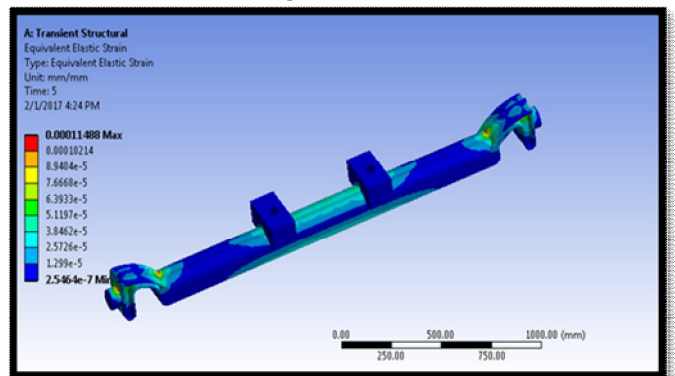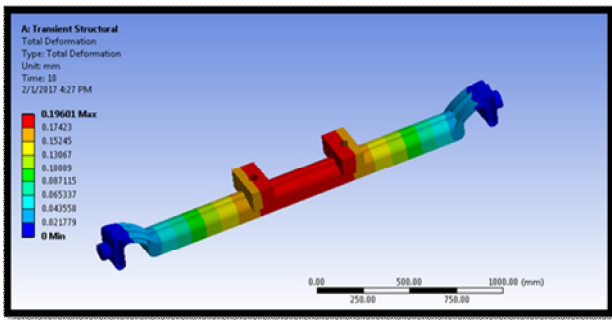

Fig.23 Strain
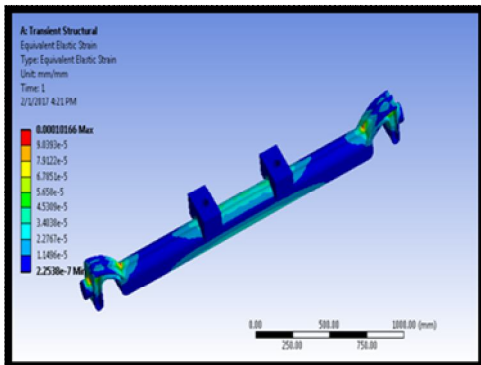
Fig.24 Stress
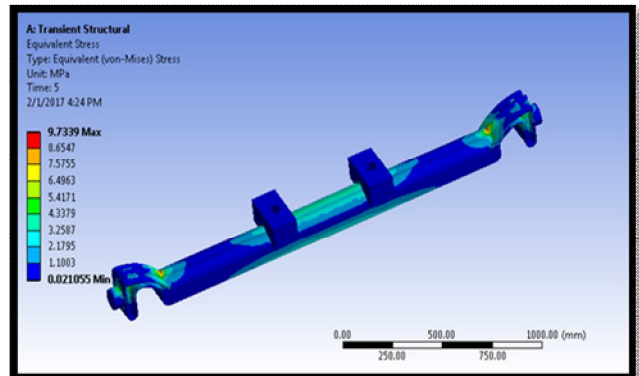
Time - 10 Sec

Fig.25 Deformation

Fig.26 Strain

Fig.27 Stress

Graph.1

Grarh.2

Graph.3
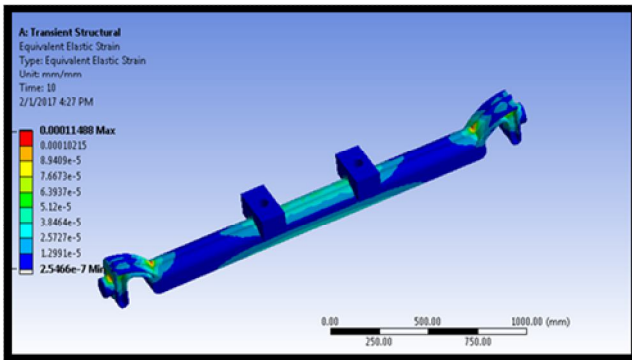
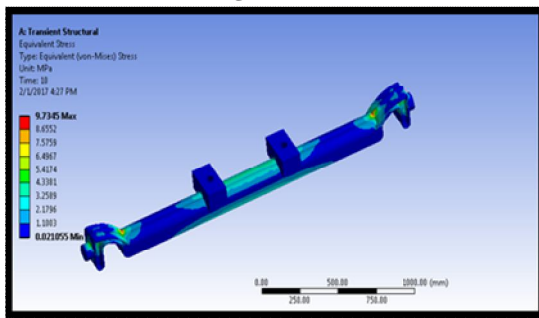**Table.1 DYNAMIC ANALYSIS RESULTS**

Material	Time(Sec)	Pressure (Mpa)	Deformation (mm)	Von-Mises Strain	Von-Mises Stress(Mpa)
Steel	Initial	0.0769	0.07546	4.3875e-5	8.5614
	5	0.0869	0.085266	4.9578e-5	9.6742
	10	0.0969	0.085273	4.9582e-5	9.675
S2 Glass	Initial	0.0769	0.17347	0.00010166	8.6144
	5	0.0869	0.196	0.00011488	9.7339
	10	0.0969	0.19601	0.00011488	9.7345
Glass Carbon	Initial	0.0769	0.11241	6.6158e-5	8.6415
	5	0.0869	0.12701	7.4758e-5	9.7648
	10	0.0969	0.14162	8.336e-5	10.888
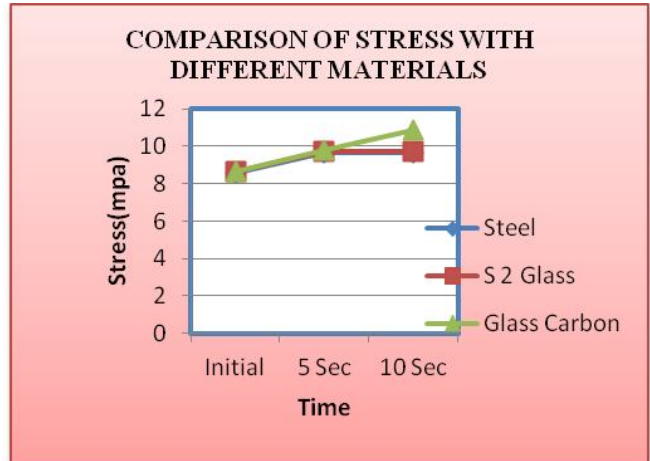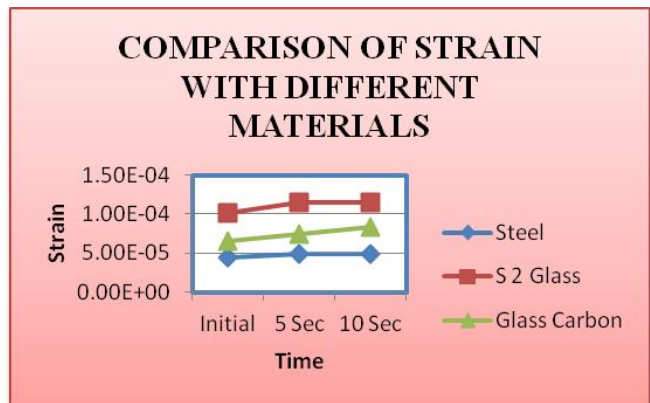
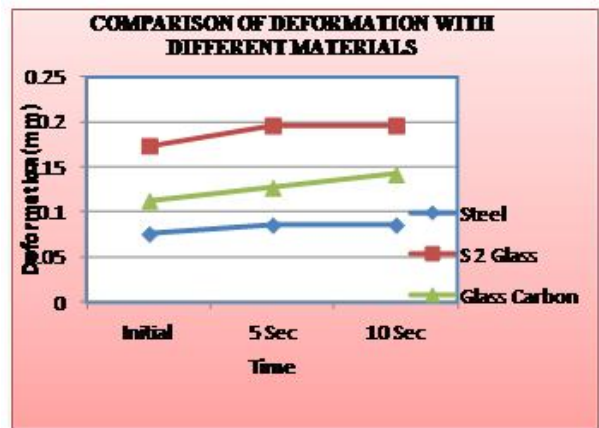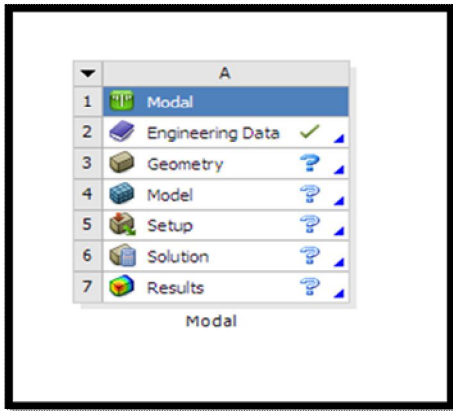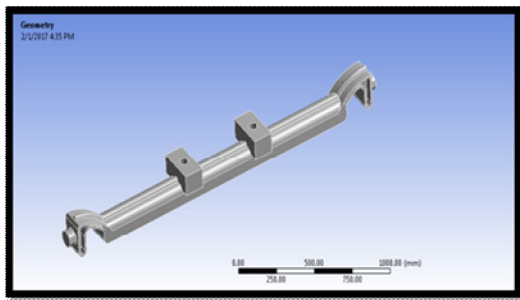**VII. MODAL ANALYSIS OF FRONT AXLE**

MATERIAL – STEEL

ANSYS> Work bench 14.5>Double click on Modal.

Right click on Engineering data>edit>apply material properties>return project>Update project.
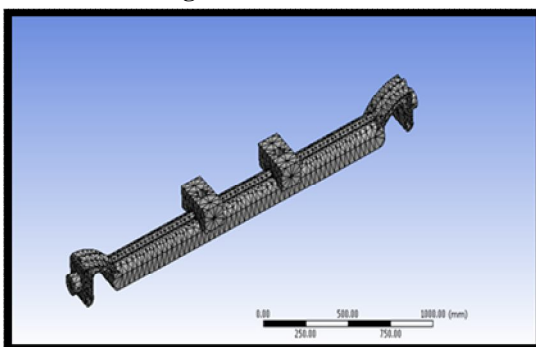
Right click on Geometry>Imported Geometry>browse>click on IGS file>Open.

Fig.28 Imported geometry

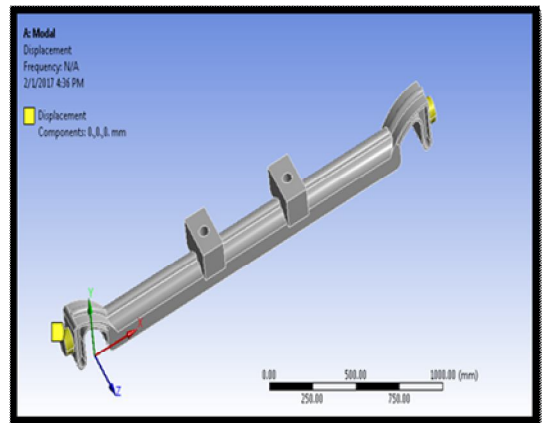Right click on Model>Edit>Right click on mesh>sizing>fine>Right click on mesh>generate mesh.

Fig.29 Meshed model

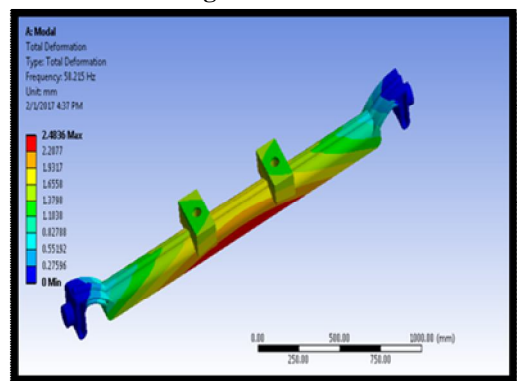Right click on Modal>Insert>Displacement>Select faces>apply.

Fig.30 Displacement

Right click on Solution>Insert>Deformation>Total>Mode1.
Right click on Solution>Insert>Deformation>Total>Mode2…..etc.
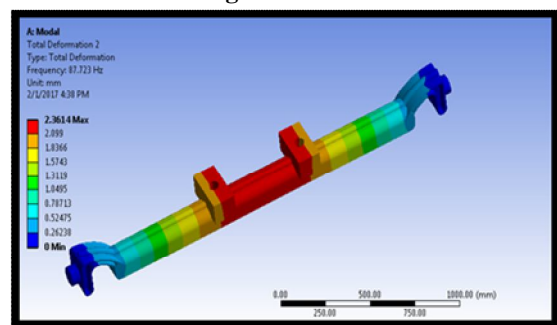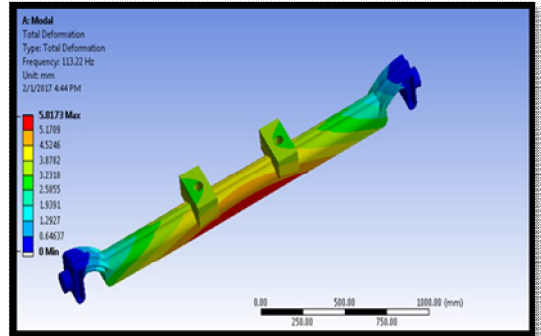Right click on Solution >Solve.

Fig.31 MODE 1

Fig.32 MODE 2

Fig.33 MODE 3
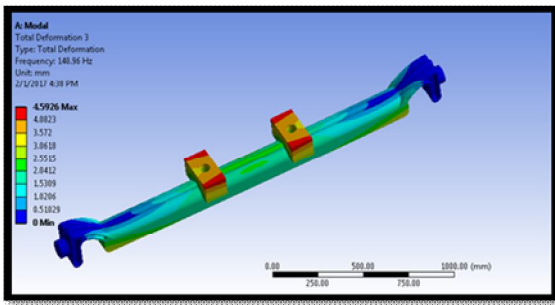
MATERIAL - S 2 GLASS

Fig.34 MODE 1

Fig.35 MODE 2

Fig.36 MODE 3

MATERIAL - GLASS CARBON

Fig.37 MODE 1
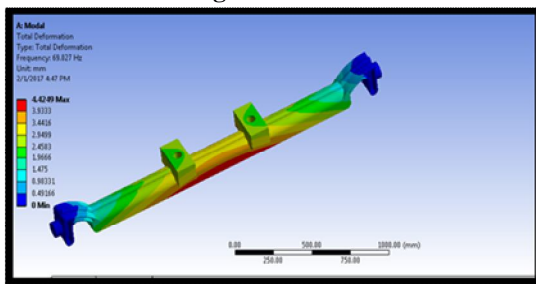
Fig.38 MODE 2
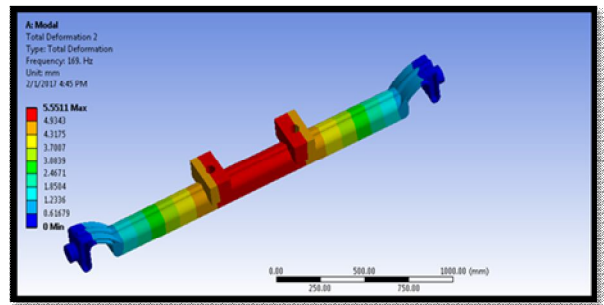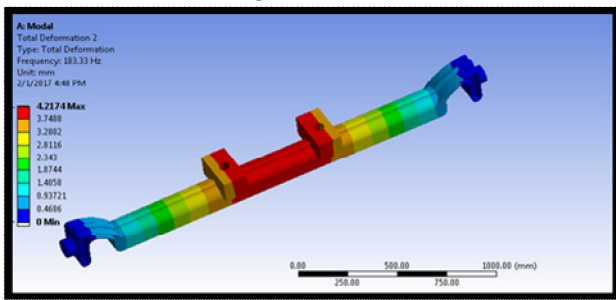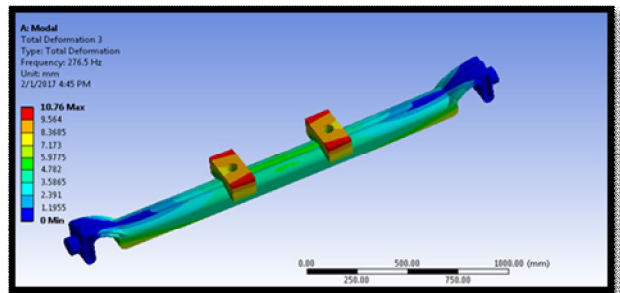
Fig.39 MODE 3
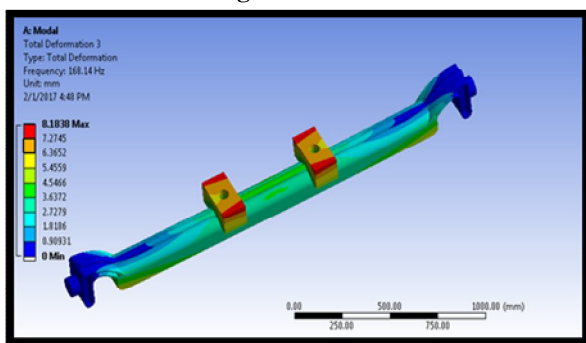
Table .2 MODAL ANALYSIS RESULTS

MATERIAL	MODE 1		MODE 2		MODE 3	
	Deformation (mm)	Frequency (Hz)	Deformation (mm)	Frequency (Hz)	Deformation (mm)	Frequency (Hz)
Steel	2.4836	58.215	2.3614	87.723	4.5926	140.96
S 2 Glass	4.4249	69.027	4.2174	103.33	8.1836	168.14
Glass Carbon	5.8173	113.22	5.5511	169	10.76	276.5
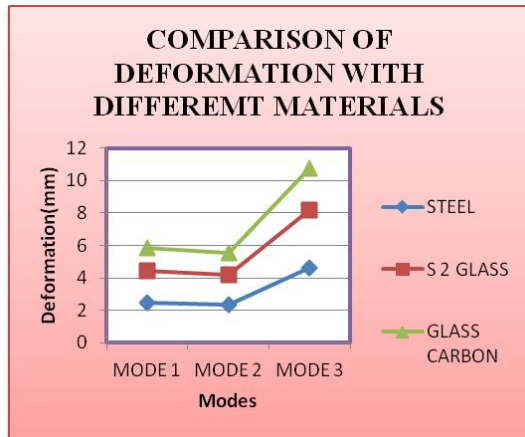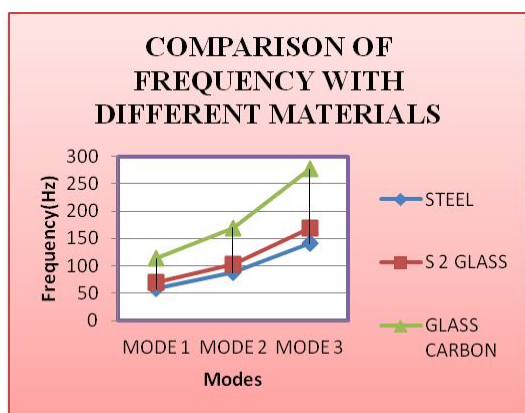
Graph.4

Graph.5

VIII. CONCLUSION

In this project a front axle is modeled in 3D modeling software CATIA. Transient analysis and Modal analysis is done on the front axle for three different materials Steel, S2 Glass and Glass Carbon. By observing the dynamic analysis, the stresses are less than the respective yield stress values for all the materials. The deformation and strain values are more for composite material S2 Glass than Steel and Glass Carbon. The stress value is less for S2 Glass.

By observing the modal analysis results, the deformation and frequency are more for Glass Carbon than S2 Glass and Steel. So the vibrations are more for front axle when Glass Carbon is used. So it can be concluded that considering the strength and weight, using S2 Glass is better for Glass Carbon.

IX. ACKNOWLEDGMENT

Perseverance, Inspiration & Motivation have always played a key role in the success of any venture. At this level of understanding it is difficult to understand the wide spectrum of knowledge without proper guidance and advice, hence we take this opportunity to express our sincere gratitude to our respected Project Guide Prof. Alok Kumar rohit who as a guide evolved an interest in us to work and select an entirely new idea for project work. He has been keenly co-operative and helpful to us in sorting out all the difficulties. We would also like to thank our Principal Dr. P. B. Mane, for their continuous advice and support

REFERENCES

[1] Siddarth Dey, P.R.V.V.V Sri Rama Chandra Murthy. D, P.Baskar, "Structure analysis of front axle beam of a light commercial vehicle," International Journal of Engineering Trends and Technology , Volume 11 Number 5 - may 2014.

[2] Ketan Vijay Dhande, Prashant Ulhe, "Design and analysis of front axle of heavy commercial vehicle," International Journal of Science, Technology & Management, Volume No.03,Issue No.12, December 2014.

[3] Aparajita P. Ray, Dr. R. R. Arakerimath, "Design Analysis and shape Optimization of front Axle of Automotive Truck," International Journal of Engineering and Management Research, Page Number:54-58

[4] Piyush C. Choudhari, Vimal D Sonara, Dr.Pravin Rathod, "Analysis and Design of Tractor Rear Axle Using Finite Element Method – A review," International Journal of Advance Engineering and Research Development Volume2, Issue 3, March - 2015

[5] Lalit Kumar, Chandrakant Singh, Bhumesh Kumar Dewangan, Prakash Kumar Sen, Shailendra Kumar Bohidar, "Study on the Front Axle and Rear Axle Attachment to Differential System," International Journal for Innovative Research in Science & Technology, Volume 1, Issue 7, December 2014.

[6] Javad Tarighi, Seyed Saeid Mohtasebi, Reza Alimardani, "Static and Dynamic analysis of front axle housing of tractor using finite element methods," Australian Journal of Agricultural Engineering, AJAE 2(2):45-49 (2011).