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ANALYSIS OF MONO LEAF SPRING

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ABSTRACT

In general springs are used to absorb shocks and to prevent the vibrations. Even though various types of springs are available in the market. Leaf springs are plays a major role in the automobile industry. The objective of this present work is to estimate deflection stress and mode frequency induced in the mono leaf spring of a lorry .The Leaf was modeled and analysis were carried out on Steel and Composite materials (E glass epoxy and carbon epoxy) for both. The results show that by using the composite Leaf, We can reduce the stresses induced in the member. After comparing Results Composite Leaf has less stresses and will been added advantage to use leaf springs in Automobile industries. Replacing of conventional springs with composites reduces the total weight of the body and hence power consumption could be reduced and Life is Increases.

KEY POINTS: *LeafSpring,Pro-e,Ansys-13.*

1. INTRODUCTION

A spring is defined as an elastic body, whose function is to distort when loaded and to recovers its original shape when the load is removed. Semi- elliptic leaf springs are almost universally used for suspension in light and heavy commercial vehicles. For cars also, these are widely used in rear suspension. The spring consists of a number of leaves called blades. The blades are varying in length. The blades are us usually given an initial curvature or cambered so that they will tend to straighten under the load. The leaf spring is based upon the theory of a beam of uniform strength. The lengthiest blade has eyes on its ends. This blade is called main or master leaf, the remaining blades are called graduated leaves. All the blades are bound together by means of steel straps. The spring is mounted on the axle of the vehicle. The entire vehicle rests on the leaf spring. The front end of the spring is connected to the frame with a simple pin joint, while the rear end of the spring is connected with a shackle as show in fig1.1

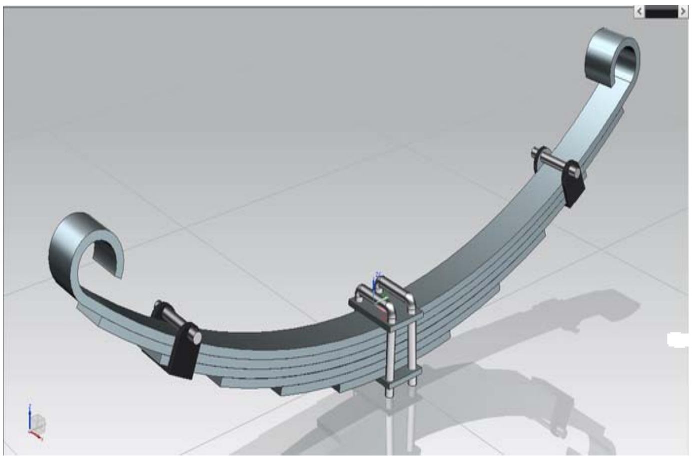

Figure 1: Leaf Spring

Shackle is the flexible link which connects between leaf spring rear eye and frame. When the vehicle comes across a projection on the road surface, the wheel moves up, leading to deflection of the spring. This changes the length between the spring eyes. If both the ends are fixed, the spring will not be able to accommodate this change of length. So, to accommodate this change in length shackle is provided as one end, which gives a flexible connection.

Spring eyes for heavy vehicles are usually bushed with phosphor bronze bushes. However, for cars and light transport vehicles like vans, the use of rubber has also become a common practice. This obviates the necessity of lubrication as in the case of bronze bushes. The rubber bushes are quiet in operation and also the wear on pin or the bush is negligible. Moreover, they allow for slight assembly misalignment, "Silentbloc' is an example of this type of bushes. Fatigue strength and hence the life of spring can be increased by shot – peening the top surface of each leaf, which introduces a compressive residual stress, rounding the edges of the leaves also avoids stress concentration, thereby improving the fatigue strength. When the leaf spring deflects, the upper side of each leaf tips slides or rubs against the lower side of the leaf above it. This produces some damping which reduces spring vibrations, but since this available damping may change with time, it is preferred not to avail of the same. Moreover, it produces squeaking sound, Further if moisture is also present, such inter-leaf friction will cause fretting corrosion which decreases the fatigue strength of the spring, and phosphate paint may reduce this problem fairly. Occasionally, thin liners of zinc or any other soft metal are also help to keep the value of the friction coefficient constant. In some springs special inserts are provided at the end of each leaf, excepting however the master leaf. The material for the inserts may be rubber or waxed cloth, or even some soft bearing metal impregnated with oil. This gives efficient spring operation. Sometimes the leaf springs are provided with metallic or fabric covers to exclude dirt. The covers also serve to contain the lubricant used in between the spring leaves. The leaves of the leaf spring require lubricant at periodic intervals. If not, the vehicle is jacked up so that the weight of the axle opens up the leaves. The spring is then cleaned thoroughly and sprayed with graphite penetrating oil.

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However, it is important to remember that in some vehicles, (e.g. Ambassador) it is specified that the lubricant of spring leaves should not be done. In such cases the instruction must be followed. The lubrication of shackle pins at regular intervals, say 1000km, should also be done with S.A.E 140 oil. However, no lubrication is required when rubber bushes are used, as in case of the Hindustan Ambassador car.

2. MODELLING OF LEAF SPRING

The following are the model dimensions.

Camber = 80mm

Span = 1100mm

Thickness of Leaves = 11mm

Number of Leaves = 01

Number of Full Length Leaves Nf = 1

Number of Graduated Length Leaves Ng = 1

Width = 70mm

Model is created witth Pro-e

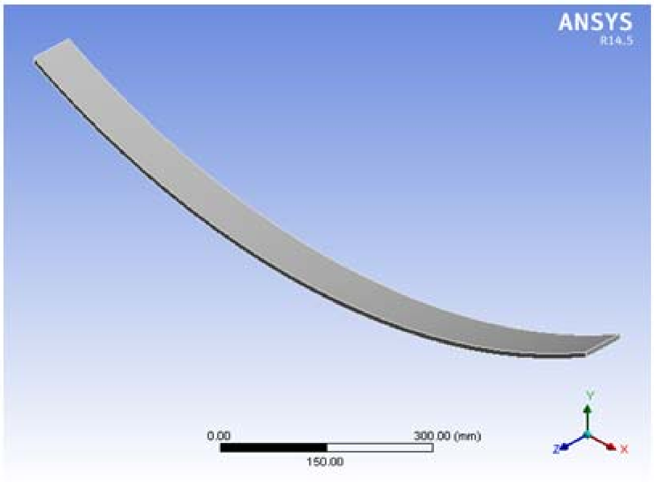
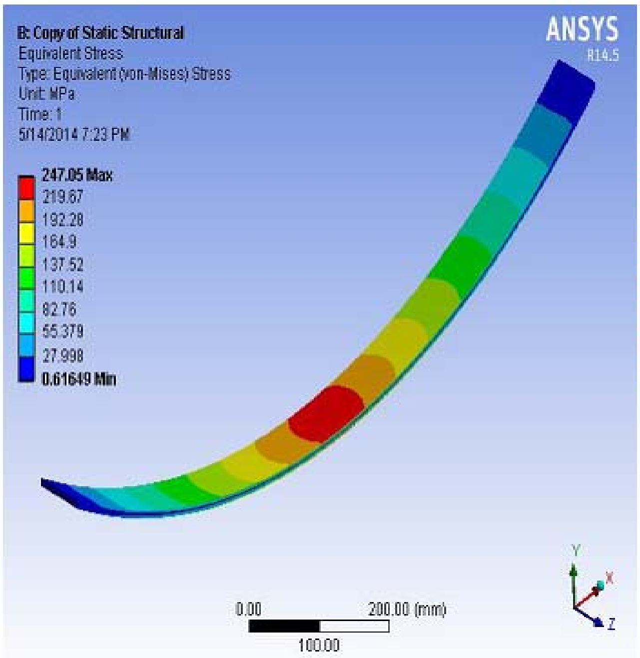
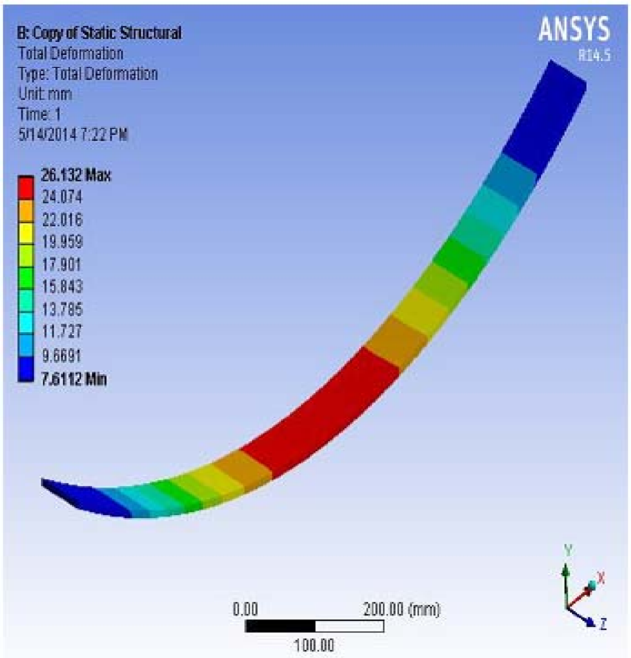


Fig 2 leaf with dimensions

3. ANALYSIS OF MONO LEAF (STEEL) WORK BENCH

A point Load of 1000N is applied at centre





Analytical Calculations

Bending stress = $(6\ F.L) / b.t^2$ = 309.91 N/mm^2

Deflection $\delta = 4F.L^3 / Ebt^3$ = 22.34 mm

Parameter	Analytical	FEA	Difference
Deflection (mm)	22.42	26.13	13.04%
Bending Stress (N/mm^2)	309.12	247.05	20.03 %

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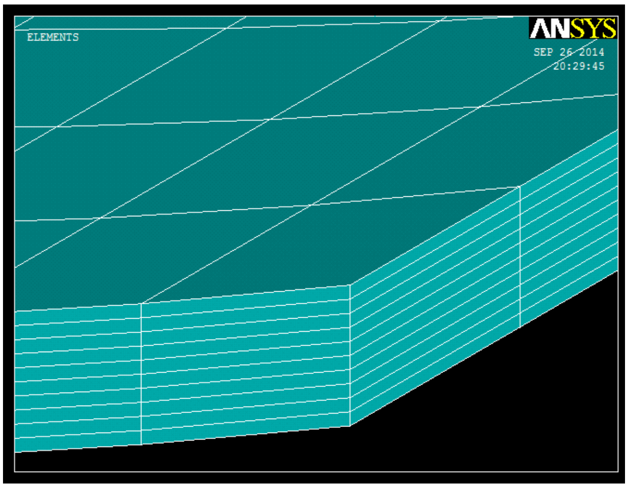
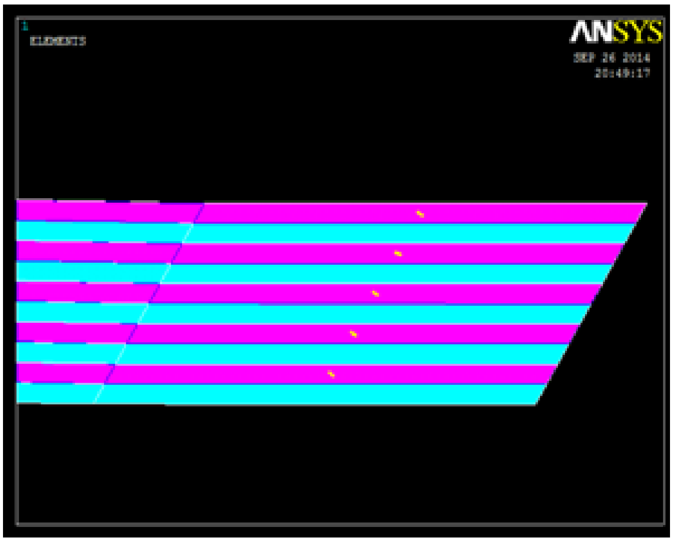
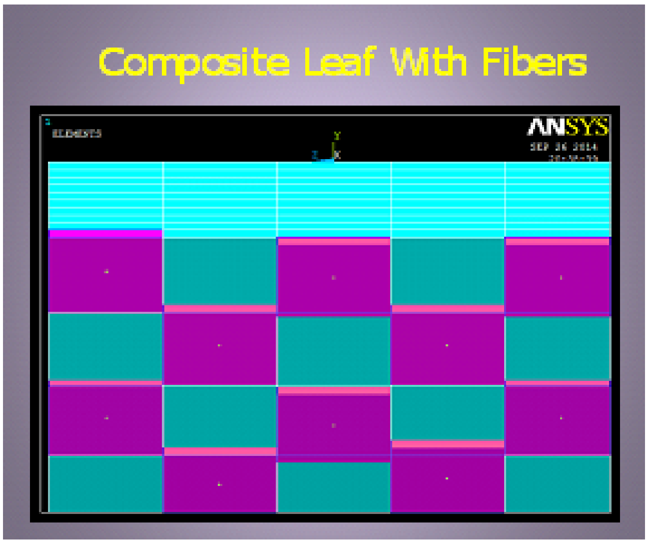
4. COMPOSITE MATERIALS

Composite materials (also called **composition materials** or shortened to **composites**) are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct Material Properties are shown below for both within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter or less expensive when compared to traditional material for The Analysis E-Glass Epoxy and Carbon Epoxy's are considered. And Divided the Leaf into Ten Layers By using Ansys Classic-13

Property	E-Glass Epoxy	Carbon Epoxy
Exy	34000 MPa	147 GPa
Eyz=Ezx	6530 Mpa	10.3 GPa
µxy & µxz	0.217	0.27
µyz	0.366	0.54
G1,2 & G1,3	2433 Mpa	7 Gpa
G2,3	1698 MPa	3.7 GPa



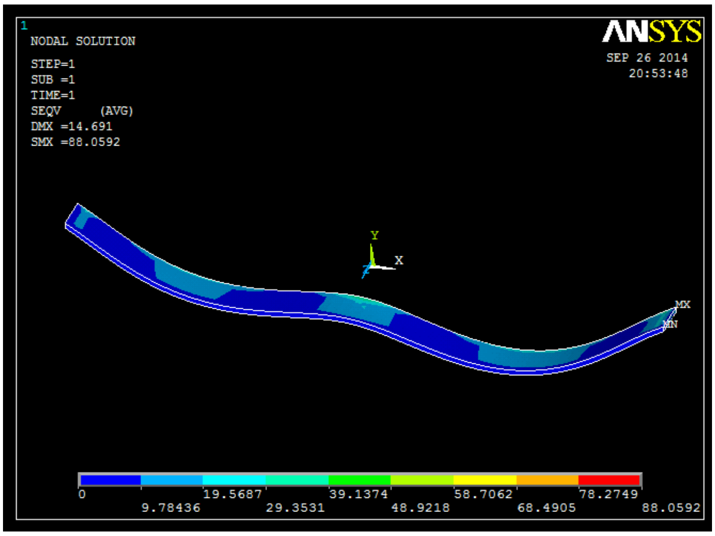




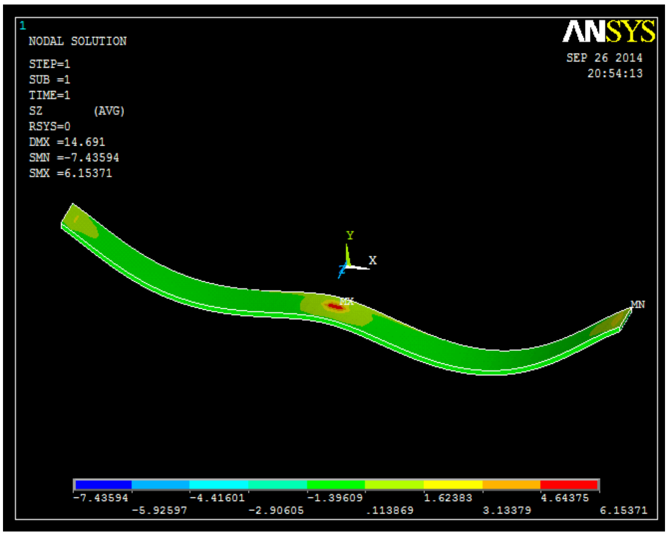
Leaf with Fibers

5. ANALYSIS OF MONO LEAF (E-GLASS EPOXY)

VON MISES STRESS



STRESS Z-COMPONENT



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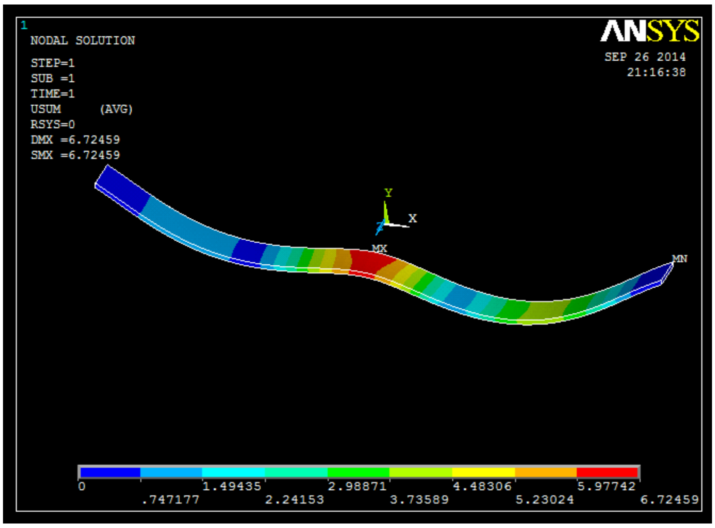
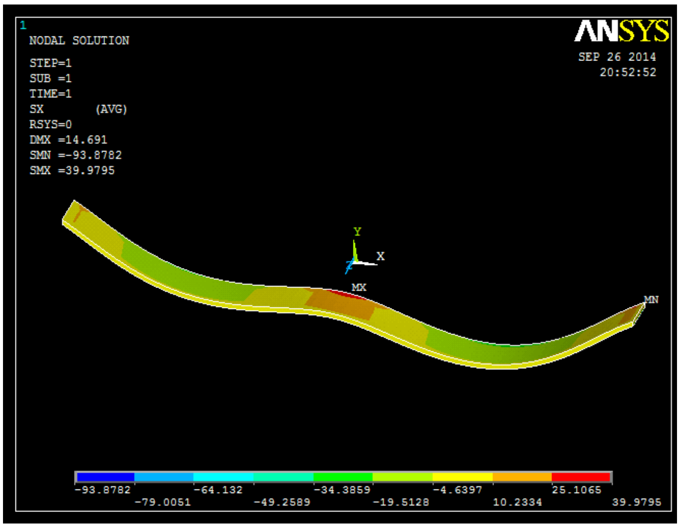
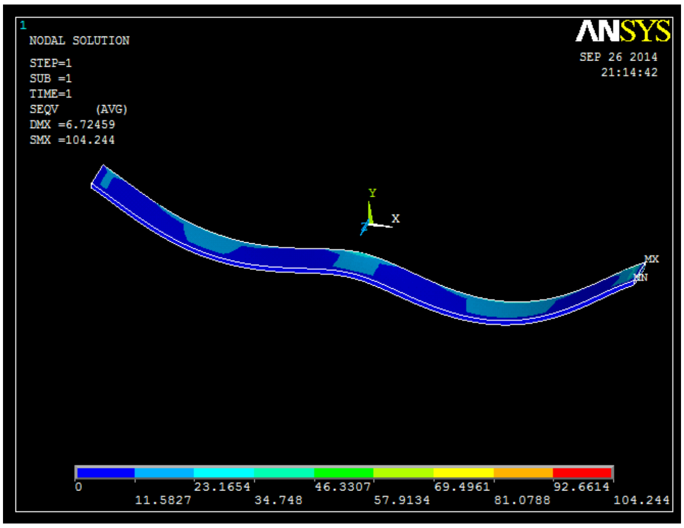
MAX DEFLECTION

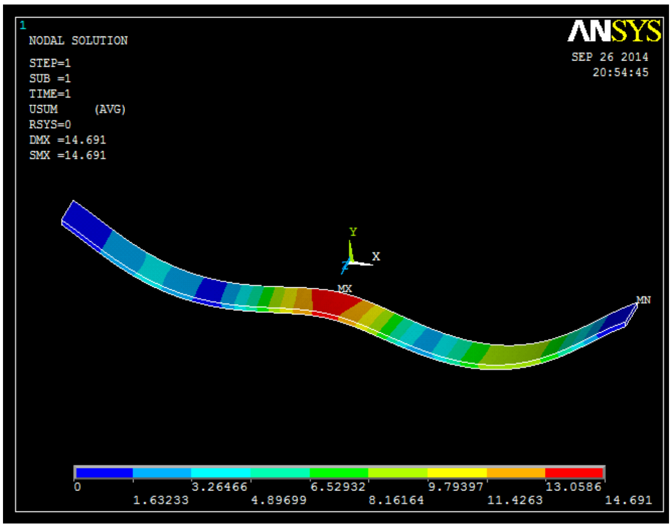


STRESS X-DIRECTION



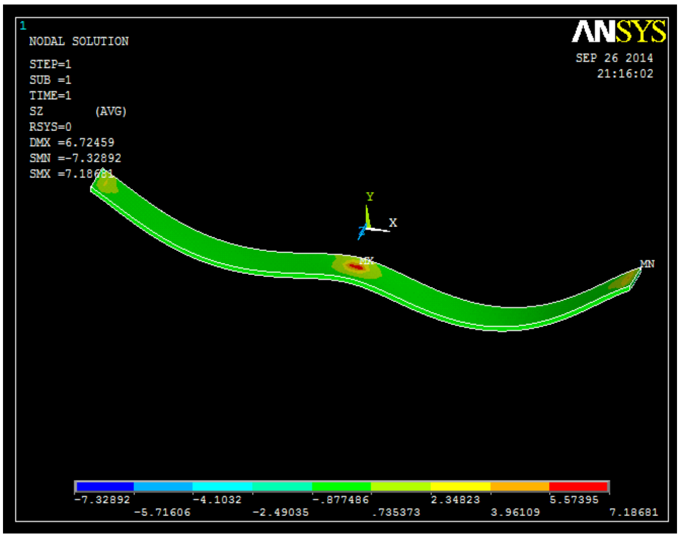
6. ANALYSIS OF MONO LEAF (CARBON EPOXY)

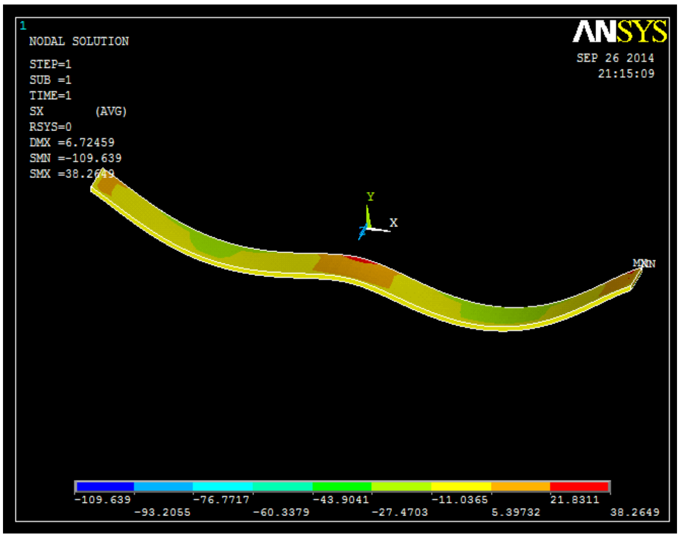




VON MISES STRESS

MAX DEFLECTION





STRESS –Z COMPONENT

STRESS –X COMPONENT

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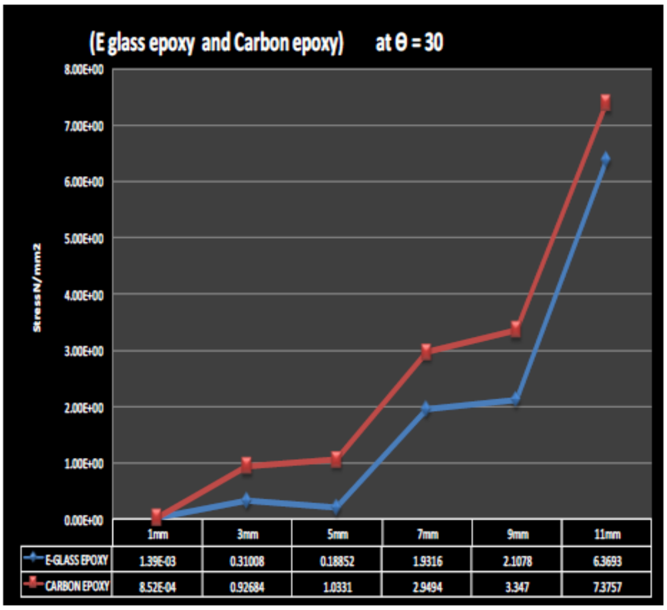
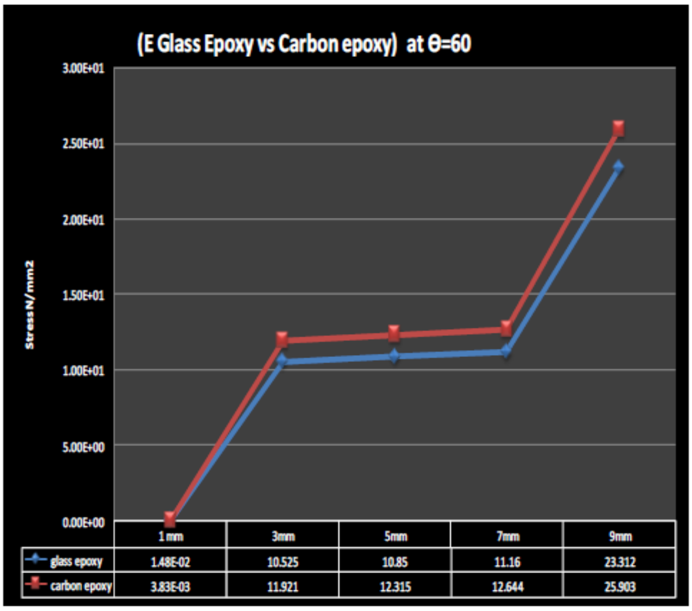
TABULAR FORM OF RESULTS

COMPOSITE MATERIAL	X-Component Stress (N/mm^2)	Z-Component Stress (N/mm^2)	Deflection (mm)	Von Mises Stress (N/mm^2)
E_GLASS EPOXY	39.97	6.15	6.97	88.05
CARBON EPOXY	38.26	7.18	14.69	104.24

VARIATION OF STRESSES OF LEAF THICKNESS FROM 1MM TO 11MM FOR COMPOSITES





RESULTS OF MODAL ANALYSIS

SET	E-GLASS EPOXY Frequency (HZ)	CARBON EPOXY Frequency (HZ)
1	16.983	5.387
2	19.017	9.537
3	37.451	23.226
4	42.516	35.314
5	65.797	39.833

7. CONCLUSIONS AND FUTURE SCOPE OF WORK

- The Leaf considered in the project is of a Heavy Weight Vehicle Lorry.
- The Leaf's are modeled considering them as Steel ,E Glass and Carbon epoxy
- The Variation of stresses from top to bottom of the leaf was shown in graph.
- After analysis it was found the stresses & Deflections are less in the Leaf with E Glass epoxy when compared to Steel and carbon epoxy.
- Modal Analysis was also done for both Composites. E-Glass Epoxy Gives Better Results when compared to Carbon Epoxy
- An efficient design and manufacturing process of composite material leaf spring can reduce the cost and weight of the vehicle, the results show that by using the composite Leaf ,
- We can reduce the stresses induced in the member.
- After comparing Results Composite Leaf has less stresses and will been added advantage to use leaf springs in Automobile industries.
- Replacing of conventional springs with composites reduces the total weight of the body and hence power consumption could be reduced and Life is Increases.

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