Design and analysis of composite leaf spring

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Abstract – *Automobile manufacture industries has shown interested in the replacement of conventional leaf spring with composite leaf spring. It has high strength, impact strength and bear high load. This paper describes the design and analysis of composite leaf spring .The objective is to compare the deflection, equivalent elastic strain and equivalent stress of carbon epoxy carbon fiber, E glass epoxy over conventional leaf spring. Deflection is one of the important properties of the leaf spring. It should absorb shock loads and vertical vibrations due to road abnormalities. the potential energy is stored as strain energy and then slowly released in leaf spring. The leaf springs was modeled in Auto-CAD 2012 and analysis was done using ANSYS 9.0.By comparisons we found that E glass epoxy leaf spring has high deformation.*

***Key Words*: conventional leaf spring, composite leaf spring, deflection, vertical vibrations, shock loads road abnormalities**

1. INTRODUCTION

Natural resources and economize energy, In order to save weight reduction and more deflection has been the main focal point of automobile manufacturers in the present situation. Deflection is one of the major defects in the conventional leaf spring. The composite leaf spring has more deflection than that of the conventional leaf spring. By replacing the composite leaf spring the weight of the vehicle can be reduced. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. The suspension leaf spring is one of the potential items for weight reduction in automobiles as it accounts for 10% - 20% of the un-sprung weight. This achieves the vehicle with more fuel efficiency and improved riding qualities. The introduction of composite materials was made it possible to reduce the weight of leaf spring without any reduction on load carrying capacity and stiffness. Since, the composite materials have more elastic strain energy storage capacity and high strength to weight ratio as compared with those of steel, multi-leaf steel springs are being replaced by mono-leaf composite springs. The composite material offer opportunities for substantial weight saving but not always be cost-effective over their steel counterparts.

2 LITERATURE REVIEW

A composite material is the combination of two or more materials that produce a synergistic effect so that the combination produces aggregate properties that are different from any of those of its constituents attain independently. This is intentionally being done today to get different design, manufacturing as well as service advantages of products. Up on those products leaf spring is the focus of this project for which researches are running to get the best composite material, which meets the current requirement of strength and weight reduction in one, to replace the existing steel leaf spring. Here researches on this area are well reviewed showing the back ground of this project, as follows:

Mr.Abdul Rahim Abu Talib, Aidy Ali, G. Goudah, Nur Azida Che Lah and A.F. Golestaneh [1] worked on developing a composite based elliptic spring for automotive applications. After that using this conclusion they have change steel leaf spring by composite material and analyze it with same loading condition. They concluded that composite elliptical springs have superior fatigue performance than steel. They consider light and heavy trucks with steel elliptic spring for analysis of fatigue performance and weight reduction by using ANSYS software. The objective is to compare the load carrying capacity, fatigue performance and weight savings of composite leaf spring with that of steel leaf spring. Also they have compared the finite element result of fatigue life and weight reduction with existing analytical and experimental result. The conventional steel leaf spring and weight reduction ratio is achieved.

Mr. Anandkumar A. Satpute and Prof. S. S. Chavan [2] worked on mono composite leaf spring –design and testing. In his work, they consider light vehicle of Maruti Omni's rear suspension system with steel leaf spring for analysis of strength and weight reduction ratio by using ANSYS software. The goal is to compare strength and weight savings of composite leaf spring with that of steel leaf spring. Also they have compared the finite element result of strength and weight reduction ratio with existing analytical and experimental result. After that using this result they have return steel leaf spring by composite material of Glass fiber-7781 and epoxy resin and analyze it with same loading condition. After they concluded that the results of the analytical and experimental analysis are almost same and they use the composite material instead of steel, they have to change dimensions. Here they have changed the thickness from 5 mm to 12 mm. The weight reduction is achieved 88%. The composite material is having chipping resistance problem, but it may avoid by using carbon fibers.

AshishV.Amrute, Edward Nikhil karlus [3] presented work on design & assessment of leaf spring. Main objective of this work is to compare the load carrying capacity, stresses and weight saving of composite leaf spring with that of steel leaf spring. Here the multi leaf spring consist of three full length leaves in which one is with eyed ends used by a light commercial vehicle. For analysis of leaf spring Tata ace ex vehicle taken as prototype. This work deals with replacement of conventional steel leaf spring of a light commercial vehicle with composite leaves spring using E-glass/Epoxy. Dimensions of the composite leaf spring are to be taken as same dimension of the conventional leaf spring. The Theoretical and CAE results are compared for validation. From results it is proved that the bending stresses are decreased by 25.07% in composite leaf spring means less stress induced with same load carrying condition. The conventional multi leaf spring weights about 10.27kg where the E-glass/Epoxy multi leaf spring weighs only 3.26 kg. Thus the weight reduction of 67.88% is achieved by using composite material rather than using steel material.

Dev dutt Dwivedi and V.K.Jain [4] had done Design and analysis of composite leaf spring. ANSYS14.5 has been used to conduct the analysis. Static structural tool has been used of ANSYS. A three layer composite leaf spring with full length leave. E-Glass/epoxy composite material has been used. Conventional steel leaf spring results have been compared with the results obtained for composite leaf spring. E glass/epoxy material is better in strength and lighter in weight as contrast with conventional steel leaf spring. A wide amount of study has been conducted in his paper to investigate the design and analysis of leaf spring and leaf spring fatigue life. Results demonstrate that composite leaf spring deflection for a particular load is less compared to conventional leaf spring. Stress generated in the E-Glass/Epoxy leaf spring is lower than steel leaf spring. Composite (E-Glass/Epoxy) leaf spring directional deformation is low compared to steel leaf spring. Composite leaf spring is lighter in weight compared to conventional steel leaf.

N. P. Dhoshi, Prof. N. K. Ingole and Prof. U. D. Gulhane [5] have worked on analysis and method. In this paper, they consider tractor trailer with seventeen-leaf steel spring for analysis of stress and deflection by using ANSYS 11.0 software. The objective is to compare the load carrying capacity, stiffness and weight savings of composite leaf spring with that of steel leaf spring. Also they have compared the finite element result of stresses and deflection with existing analytical and experimental result and using this result they replace steel leaf spring by composite material of E-glass/epoxy and analyze it with same loading condition for stresses and deflection. The dimensions and the number of leaves for both steel leaf spring and composite leaf springs are considered to be the same. They consider design constraints were stresses and deflections. They concluded that, the composite leaf spring have much lower stress and deflection than that of existing steel leaf spring. Also they concluded that weight of composite leaf spring was nearly reduced up to 80% compare to steel leaf spring.

Edward Nikhil Karlus [6] in his paper he adds some effort to reduce the mass of the leaf spring to perform optimization of the mono parabolic leaf spring (PLS) with the help of their shape parameters. The response parameters taken were Mass, deflection and the maximum vonmises stress, where as for the input various shape parameters e.g. sectional thicknesses, camber, leaf span etc. The optimization of the PLS has been done with the help of Adaptive single objective optimization algorithm. The outcome of his work gives better and lighter design for the automotive designer to modify the design. By the reduction of weight and controllable stress and deflection, the mass of optimized Carbon- Epoxy composite leaf spring is to be lesser than that of steel leaf spring. In totally it is found that the optimized Carbon- By the reduction of weight and controllable stress and deflection, the mass of optimized Carbon- Epoxy composite leaf spring is to be lesser than that of steel leaf spring. Which means the proposed new (optimized Carbon-Epoxy composite) material and shape can be used to satisfy the second objective.

K. K. Jadhao and DR. R S. Dalu [7]have worked on experimental investigation & numerical of composite leaf spring. They describe static analysis of steel leaf spring and composite multi leaf spring by using ANSYS software. Primary objective is to compare the carrying capacity, stiffness and weight savings of composite leaf spring with that of steel leaf spring. The material selected was glass fiber reinforced plastic (GFRP) and the polyester resin can be used which was more economical this will reduce total cost of composite leaf spring. They have compared the analysis results with experimental results. They concluded that, Composite leaf spring have much lower stress and higher stiffness than that of existing steel leaf spring. Also they concluded that weight of composite leaf spring was nearly reduced up to 85% compare to steel leaf spring.

Joo-teck Jeffrey and Tarlochan Faris [8] have worked on Finite element analysis on the static and fatigue characteristics of composite multi-leaf spring. In this paper, they investigated the static and fatigue behaviors of steel and composite leaf spring using the ANSYS V12 software. The dimensions of an existing conventional leaf spring of a light commercial vehicle were used. The same dimensions were used to design composite leaf spring for the two materials, E-glass fiber/epoxy and E-glass fiber/vinyl ester, which are of great interest to the transportation industry. The design constraints were bending stresses, deflection and fatigue life. They concluded that, the maximum bending stresses and deflection in composite leaf spring are much lower than that of steel spring. The fatigue life of E-glass/epoxy or E-glass/vinyl ester composite leaf spring was proven to be 2 and 4 times higher than that of steel leaf spring.

Kumar Krisha and Aggarwal M.L [9] have worked on Computer aided FEA comparison of mono steel and mono GRP leaf spring. In this paper, they consider material of the mono steel leaf spring is SUP9 for analysis of stress and deflection by using ANSYS software. The objective is to compare the load carrying capacity, stiffness and weight savings of composite leaf spring with that of steel leaf spring. Also they have compared the finite element result of stresses and deflection with existing analytical and experimental result. After that using this result they have replace steel leaf spring by composite material of GRP (Glass Reinforced Plastic) and analyze it with same loading condition for stresses and deflection. The dimensions and the number of leaves for both steel leaf spring and composite leaf springs are to be the same. They consider design constraints were stresses and deflections. From the results they concluded that, when steel leaf spring is replaced by composite material (GRP),The deflection is reduced by 6.51%.The bending stress in GRP leaf spring is decreased by 83.64% that of steel leaf spring. The material saving 71.85% is obtained by weight.

Makarand B. Shirke and Prof. V. D. Wakchaure [10] studied on performance association of static and fatigue behavior of steel and glass epoxy composite leaf spring of light motor vehicle. They consider light motor vehicle steel leaf spring for analysis of stress and deflection by using ANSYS workbench 14.0 software. The objective is to reduce cost, weight that is capable of carrying given static external forces without failure. They have replaced steel leaf spring by composite material of Glass Epoxy and analyze it with same loading condition for stresses and deflection. From the analysis they concluded that, the composite leaf spring have 62.27 % lesser stress and lesser deflection compared to steel leaf spring. The predicted life of the steel leaf spring is 106 cycles and composite leaf spring is 109 cycles which are higher than that of exiting steel leaf spring. Composite leaf spring weight is reduced by 65.28 % as compare to steel leaf spring.

Malaga. Anilkumar, T. N. Charyulu and Ch. Ramesh [11] studied on design optimization of leaf spring. The objective of this paper is to replace the multi-leaf steel spring by three types composite leaf spring for the same load carrying capacity and stiffness. Since the composite materials have more elastic strain energy storage capacity and high strength-to-weight ratio as compared to those of steel. It is possible to reduce the weight of the leaf spring without any reduction on load carrying capacity and stiffness. The design constraints were limiting stresses and displacement. Modeling and analysis of both the steel and composite leaf springs have been done using ANSYS 9.0 software. From the static analysis results, they saw that the von-mises stress in the steel is 596.047 MPa and the von-mises stress in E-glass/epoxy,Graphite/epoxy and Carbon/epoxy is 475.606 MPa, 155MPa and 1061 MPa respectively.And they was found that the maximum displacement of 92.591 mm in the steel leaf spring and the corresponding displacements in E-glass/epoxy, graphite/epoxy and carbon/epoxy are 89.858 mm, 80.369 mm and 82.662 mm in composite leaf spring. Composite leaf spring reduces the weight by 85% for E-Glass/Epoxy, 94.18% for Graphite/Epoxy and 92.94 % for Carbon/Epoxy over conventional leaf spring.

Pankaj Saini, Ashish Goel and Dushyant Kumar [13] have worked on design and analysis of composite leaf spring for light vehicles. In this paper, they consider passenger vehicle with ten-leaf steel spring for analysis of stress and deflection by using ANSYS 9 software. The objective is to compare the stresses and weight savings of composite leaf spring with that of leaf spring. The material selected was E-glass/epoxy, carbon epoxy and graphite epoxy which is use against conventional steel. The dimensions and the number of leaves for both steel leaf spring and composite leaf springs are considered to be the same. They consider design constraints were stresses and deflections. From the static analysis results it was found that there is a maximum displacement of 10.16mm in the steel leaf spring and the corresponding displacements in E-glass/epoxy, Graphite epoxy, and Carbon epoxy are 15 mm, 15.75 mm and 16.21 mm. From the static analysis results, the von-mises stress in the steel is 453.92 MPa and the von-mises stress in E-glass epoxy, Graphite epoxy and Carbon epoxy is 163.22 MPa, 653.68 MPa and 300.30 MPa exiting respectively. A comparative study has been made between steel and composite leaf spring with respect to strength and weight. Composite mono leaf spring reduces the weight by 81.22% for E-Glass/epoxy, 91.95% for Graphite epoxy, and 90.51 % for Carbon epoxy over conventional leaf spring.

M. M. Patunkar and D. R. Dolas [14] have worked on modeling and analysis of composite leaf spring under the static load condition by using FEA. In this paper, they consider commercial vehicle suspension system with leaf spring for modeling and analysis of stress, deflection and weight reduction ratio by using ANSYS 10.0 software for better understanding. They have compared the analysis results of stresses, deflection and weight reduction ratio with existing analytical and experimental solution. After that using this result they have replace steel leaf spring by composite material of glass fiber rain forced plastic and analyze it with same loading condition. Under the same static load conditions for deflection and stresses of steel leaf spring and composite leaf spring are found with the great difference. Deflection of composite leaf spring is less as compared to steel leaf spring with the same loading condition. They concluded that optimize conventional steel leaf spring have weight 23 Kg. whereas composite leaf spring weight is only 3.59 Kg. So it is indicating the reduction in weight by 84.40% at same level of performance. Composite leaf spring can be used on smooth road with very high performance expectations. However on rough road conditions due to lower chipping resistance failure from chipping of composite leaf spring.

Y. N. V. Santhosh Kumar, M. Vimal Teja [16] presented work on design and analysis of composite leaf spring. They also discussed that the advantages of composite materials like higher specific stiffness and strength, higher strength to weight ratio. This work deals with replacement of conventional steel leaf spring with a Mono Composites leaf spring using E-Glass/Epoxy. For this they selected design parameters and analysis of it. Main objective of this work is minimizing weight of the composite leaf springs as compared to the steel leaf spring. For this they selected the composite material was E-Glass/Epoxy. The leaf spring was designed in ProE and the analysis was done using ANSYS Metaphysics. From results they observed that the composite leaf spring weighed only 39.4% of the steel leaf springs for the analyzed stresses. So from result they proved that weight reduction obtained by using composite leaf springs as compared to steel was 60.48 %, and it was also proved that all the stresses in the leaf springs were well within the allowable limits and with good factor of safety. It was found that the perpendicular orientation of fibers in the laminate offered good strength to the leaf spring.

B.Srikanth goud and G.Bheemanna [17] In his thesis a leaf spring is designed and modeled in3D modeling software Pro/Engineer. Present used material for leaf spring is Steel. In this project, the material is replaced with composites since they are less dense than steel and have good strength The composites used are E Glass Epoxy and Aluminum Reinforced with Boron Carbide. Modeling is done in Pro/Engineer. By replacing the material with composites, the weight of the leaf spring is reduced; the weight is reduced almost by 267kgs when Aluminum Reinforced with Boron Carbide is used and almost by 246kgs when E Glass is used.

Trivedi Achyut V [18] describes that Static Analysis of 3-D model of conventional leaf spring is performed using analysis commercial software. And that dimensions are used for composite multi leaf spring as well by taking composites as carbon/Epoxy and Graphite/Epoxy. The constraints are stress and deformation and weight of the Automobile firm has shown greater interest for material replacement of conventional steel leaf spring with that of composite leaf spring, as the composite has high strength to weight ratio, good corrosion resistance. The objective of this work is to compare the load enhancing capacity, and weight savings of composite leaf spring with respect to conventional steel leaf spring. The dimensions of an existing conventional steel leaf spring of a Light design calculations. For static condition static analysis done and for real time problem dynamic analysis work present here. In his research he concludes that with respect to conventional steel leaf spring composites having high strength to weight ration. Also composites having nearly 400% less weight than conventional steel leaf spring.

M.Venkatesan and D.Helmen [19] have worked on design and analysis of composite leaf spring in light vehicle. In this paper, they consider passenger cars with seven-leaf steel spring for analysis of stress and deflection by using ANSYS 10 software. The objective is to compare the load carrying capacity, stiffness and weight savings of composite leaf spring with that of steel leaf spring. Also they have compared the finite element result of stresses and deflection with existing analytical and experimental result. After using that result they have replace steel leaf Spring by composite material of E-glass/Epoxy and analyze it with same loading condition for stresses and deflection. The dimensions and the number of leaves for both steel leaf spring and composite leaf springs are considered to be the same. They consider design constraints were stresses and deflections. They concluded that, the composite leaf spring having 67.35% less stress, 64.95% higher stiffness and 126.98% higher natural frequency than that of existing steel leaf spring. A weight reduction of 76.4% is achieved by using optimized composite leaf spring.

Yogesh Nikam, Dr.AvinashBadadhe [20] his research paper shows some of the general study on the design, analysis and fabrication of composite leaf spring. Leaf springs are one of the popular suspension components they are frequently used, especially in commercial vehicles. This paper literature has indicated a more interest in the replacement of steel spring with composite leaf spring. The suspension system included in a vehicle significantly affects the behavior of vehicle, i.e. vibration characteristics including ride comfort and stability etc. These springs are commonly used in the vehicle suspension system and are subjected to billions of varying stress cycles leading to fatigue failure and a lot of research have been done for improving the performance of leaf spring. Many materials are used for leaf spring .but it is found that fiberglass material has good strength characteristic and lighter in weight as compare to steel for leaf spring. In this paper the author is reviewed few papers on use of different optional materials and effect of material on leaf spring performance.

3 PROBLEM DEFINITIONS

Deflection of the leaf spring is one of the potential items to develop the durability and increase load capacity of the automobile. The relationship of the specific strain energy can be expressed as it is well known that springs, are designed to absorb and store energy and then liberate it slowly. Ability to store and absorb more amount of strain energy ensures the comfortable suspension system. It can be easily observed that material having lower modulus and density will have a greater specific strain energy capacity. The introduction of composite leaf spring made it possible to reduction of weight of the leaf spring without reduction of load carrying capacity and increase in deflection due to more elastic strain energy storage capacity and high strength to weight ratio.

4. METHODOLOGY

- The leaf spring was modeled in Auto-CAD 2012 and analysis was done using ANSYS 9.0 software.
- Finite element model is prepared on CAD geometry.
- Hyper mesh software used to create mesh.
- Hexahedral mesh done on leaf spring geometry.
- Then deck is prepared
- Deck preparation steps –
- Apply material properties.
- Apply boundary conditions.
- Apply load.
- Solution of the maximum displacement absorbed
- Solution of the maximum stress absorbed

5. DESIGN ANALYSIS

The ends of the leaf spring are produced in the form of an eye. The front eye of the leaf spring is attached straightly with a pin to the frame so that the eye can revolve without restraint about the pin but no translation is takes place. The back eye of the spring is linked to the shackle which is a flexible link the next end of the shackle is linked to the frame of the vehicle. One eye of the leaf spring is reserved fixed (cylindrical support) and the other eye is given certain degree of rotation to allow the leaf spring to deflect by some amount along its length (X direction).

5.1 Modeling

To create a new static structural analysis .Geometry is imported in to the mechanical window. The leaf spring is considered to be a single body. Leaf spring has two eye ends. Let us define the Cartesian co ordinates system. Rename the co ordinates system as cso 01.To define this co ordinates systems it requires the geometry reference. Geometry surface is selected in the selection filter, pick the first cylindrical surface. Since it is Cartesian co- ordinates system (rename as cso02) .The geometry of the new co ordinate system is replaced by the other end of the cylindrical surface. Geometry surface is selected in the selection filter, pick the second cylindrical surface. Currently three co ordinate system occurs.

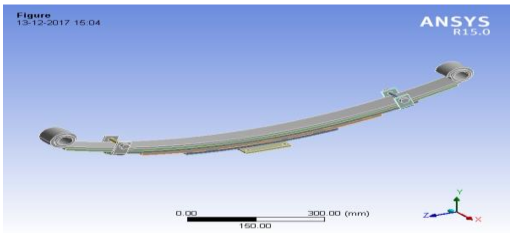


Fig -1: Model of leaf spring

As it is all three direction as restricted the translation degree of
x component is 0,y component is 0,z component is 0.
Rotational degree of
x component is 0,y component is 0,z component is free
Define boundary condition for second end.
Static structure > insert > remote displacement
Pick the second cylindrical surface and apply
Co ordinate system 2
x component is 0,y component is 0,z component is 0.
As it move along length translation degree of
x component is free,y component is 0,z component is free
Location of remote displacement.
x coordinate is 0,y coordinate is 0,z coordinate is 0 .
Translate degree of
x component is free,y component is 0,z component is 0
Rotational degree of
x component is 0,y component is 0,z component is free
Apply the displacement constraint
Static structure > insert > displacement
Select the surface and then apply
x component is 0,y component is 5, z component is 0

5.2 Meshing

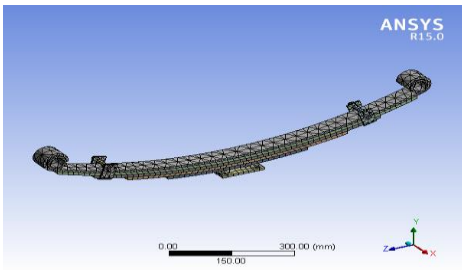


Fig -2: Meshing of leaf spring

- After providing the material to the model, meshing to be done
- Mesh > insert > seizing. All the faces should be seized with the element sizes of 5mm and make sure that the surface is selected in the selection filter. Select all, this will select the surfaces on the leaf springs then apply

- Mesh > generate mesh. It will take few minutes to update.
- In Face seizing the element seizing should be mention.re mesh the model then generate mesh. The statistics of ode and elements are found

5. 3 Apply load

The load 8000N is applied on the leaf spring.

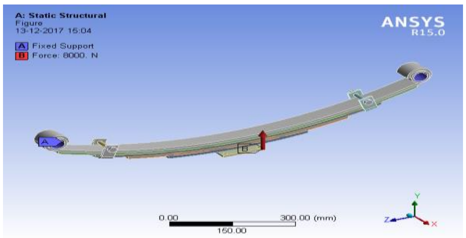


Fig -3: Applying load on leaf spring

5.4 conventional leaf spring

Table -1: Material properties of spring steel

Density	7.83e-006 kg/mm³
Young modulus MPa	2.04e+005
Poisson's ratio	0.3

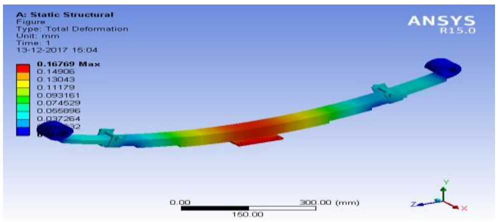
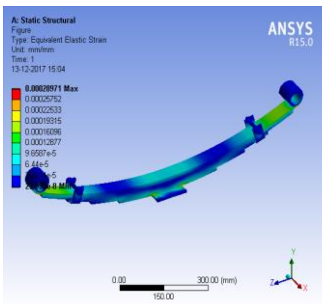


Fig -4: Total deformation of conventional leaf spring



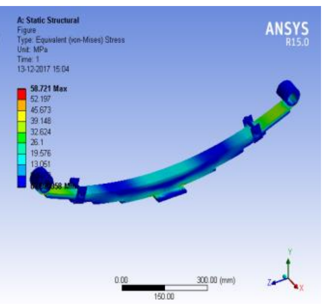


Fig -5: Equivalent Elastic Strain **Fig -6**: Equivalent Stress

Table -2: Conventional leaf spring – result

CONVENTIONAL SPRING	MINIMUM	MAXIMUM
Total deformation	0	0.167
Equivalent elastic strain	2.699 e-8	0.0002897
Equivalent stress	0.002935	58.72

5. 5 carbon epoxy leaf spring

Table -3: Material properties of carbon epoxy

Density	1.6e-009 tonne mm^-3
Young modulus MPa	1.75e+005
Poisson's ratio	0.3
Bulk modulus MPa	1.416e+005
Shear modulus MPa	65385

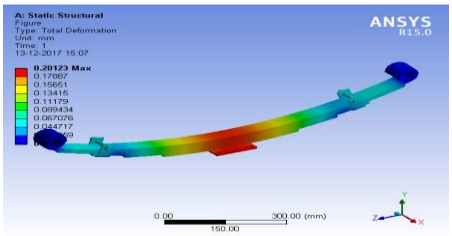
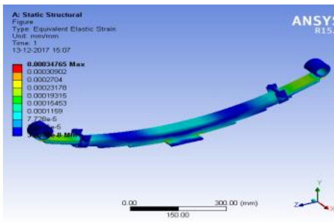


Fig -7: Total deformation of carbon epoxy leaf spring



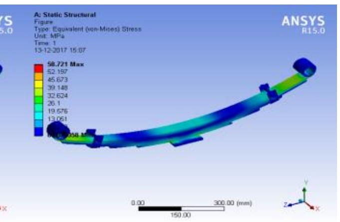


Fig -8: Equivalent elastic strain **Fig -9**: Equivalent stress

Table -4: Carbon epoxy leaf springs –result

CARBON EPOXY	MINIMUM	MAXIMUM
Total deformation	0	0.20123
Equivalent elastic strain	3.2392e-008	3.4765e-004
Equivalent stress	2.9358e-003	58.721

5.6 carbon fiber leaf spring

Table -5: Material properties of carbon fiber

Density	6.3e-018 tonne mm^-3
Young modulus MPa	2.75e+005
Poisson's ratio	0.34
Bulk modulus MPa	2.8646e+005
Shear modulus MPa	1.0261e+005

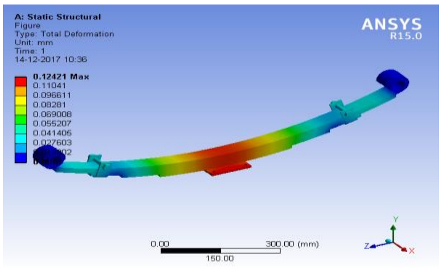


Fig -10: Total deformation of carbon fiber leaf spring

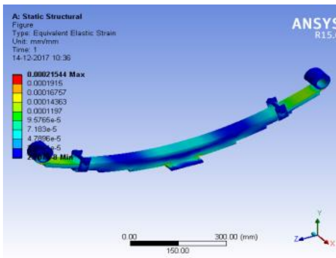
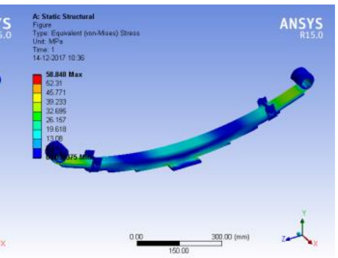



Fig -11: Equivalent elastic strain **Fig -12**: Equivalent stress

Table -6: Carbon fiber leaf spring –result

CARBON FIBRE	MINIMUM	MAXIMUM
Total deformation	0	0.12421
Equivalent elastic strain	2.707e-008	2.1544e-004
Equivalent stress	3.7375e-003	58.848

5.7 E glass epoxy leaf spring

Table -7: Material properties of E glass epoxy

Density	2.6e-018 tonne mm^-3
Young modulus MPa	6530
Poisson's ratio	0.217
Bulk modulus MPa	3845.7
Shear modulus MPa	2682.8

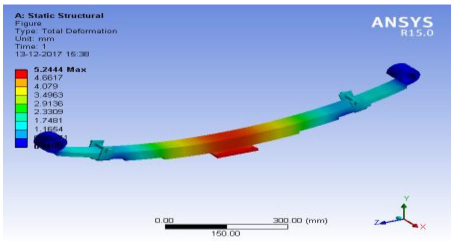


Fig -13: Total deformation of E glass epoxy leaf spring

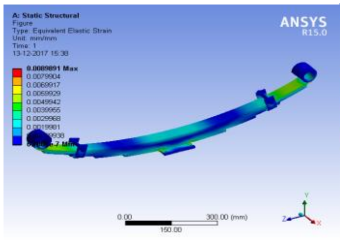
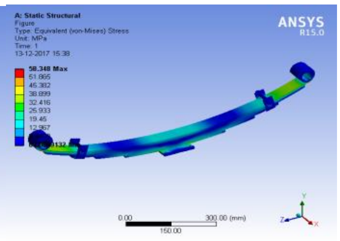



Fig -14: Equivalent elastic strain **Fig -15**: Equivalent stress

Table -8: E glass epoxy leaf spring –result

E GLASS EPOXY	MINIMUM	MAXIMUM
Total deformation	0	5.2444
Equivalent elastic strain	6.7001e-007	8.9891e-003
Equivalent stress	8.9132e-004	58.348

Table -9: Result comparison of all leaf springs

leaf spring type	Total deformation	Equivalent elastic strain	Equivalent stress
conventional	0.167	0.0002897	58.72
Carbonepoxy	0.20123	3.4765e-004	58.721
carbon fiber l	0.12421	2.1544e-004	58.848
E glass epoxy	5.2444	8.9891e-003	58.348

6. CONCLUSIONS

A comparative study has been made between conventional leaf spring and composite leaf spring of carbon epoxy, carbon fiber, E glass epoxy with respect to deflection. Among these E-glass epoxy has the better deformation. Composite leaf spring reduces the friction co efficient and wear rate and increase the strength, fatigue life by over conventional leaf spring.

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