ISSN : 2455-9679
Impact Factor : 2.865

IJRTSM
INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"ANALYSIS OF LEAF SPRING USING COMPOSITE MATERIAL IN SANDWICH PATTERN "

Sarfaraz Husain Qureshi [1], Mr.Vaibhav Jain[2]

[1]*M.Tech Research Scholar, Department of Mechanical Engineering, Malwa Institute of Technology, Indore (M.P.)*
[2,]*Sr.Asst. Professor, Department of Mechanical Engineering, Malwa Institute of Technology, Indore (M.P.)*

ABSTRACT

A leaf spring is a simple form of spring, normally used for the suspension in wheeled cars. Leaf springs are long and narrow plates attached to the body of a trailer that rest above or under the trailer's axle. For safe and cozy using, to prevent the street shocks from being transmitted to the car components and to guard the occupants from road shocks it's miles important to determine the maximum safe strain and deflection. The objective is to find the stresses and deformation in the leaf spring via making use of static load on it. One-of-a kind materials with special mechanical properties are taken into consideration for the structural static evaluation. Consequently within the gift paintings, leaf spring is designed by means of considering static load on automobile. The leaf spring is modelled using CATIA V5 for the three materials, steel (SUP9), Glass epoxy and Carbon epoxy which are of great interest to the transportation industry.

Keyword: *Leaf spring, Materials, Finite Element Analysis (FEA), Epoxy, ANSYS, CATIA*

I. INTRODUCTION

The chassis of an automobile includes the tires and the wheels that let the automobile move on the surface by maintaining the right amount of friction to keep it on that surface. The frame also holds together the vehicle structure white supporting the engine and body loads. This chassis is mounted over a suspension system, which also works as a load support for the automobile. The most common type of suspension system available for commercial vehicles is the leaf spring suspension. Leaf springs are beams of high deflection that can be used individually as a single leaf, or in stacked assemblies of up to twenty leaves, as multi-leaf depending on the type of the vehicle to be used on.

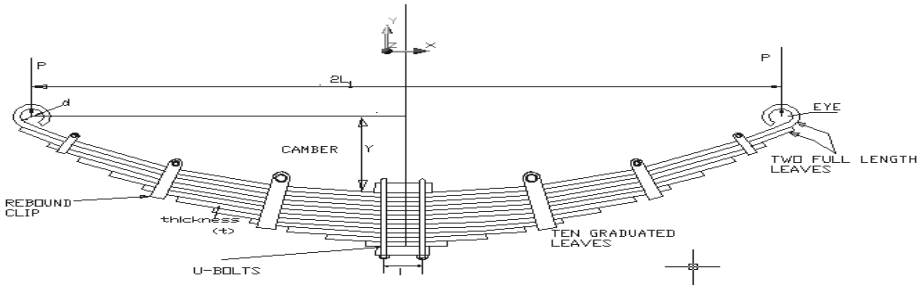


Fig.1.1: Semi elliptic leaf springs

Leaf springs function by absorbing the normal forces and vibration impacts due to road irregularities by means of the leaf deflection, stored in the form of strain energy for a short period, and then dissipated.

Terms Involved:

ISSN : 2455-9679
Impact Factor : 2.865

1. **Span**: Horizontal Distance between the Eyes of spring.
2. **Main Leaf**: The Long leaf fastened to the supports is called main leaf or master leaf.
3. **Eye**: Main leaf ends are bent to form the Eyes.
4. **Camber**: Distance b/w horizontal axis joining 2 eyes and main leaf.
5. **Auxiliary Leaves**: Other leaves below main spring are called Graduated leaves.

II. LITERATURE RIVEW

The chapter here shows the review of previous journals based on study and analysis of leaf spring. The study in this chapter is subdivided into number of categories on the basic of work done in past.

V.K. Aher et. al.[1] The purpose of this paper is to predict the fatigue life of steel leaf spring along with analytical stress and deflection calculations. This present work describes static and fatigue analysis of a steel leaf spring of a light commercial vehicle (LCV).The non-linear static analysis of 2D model of the leaf spring is performed using NASTRAN solver and compared with analytical results. The pre-processing of the model is done by using HYPERMESH software. The stiffness of the leaf spring is studied by plotting load versus deflection curve for various load applications. The simulation results are compared with analytical results. The fatigue life of the leaf spring is predicted using MSC Fatigue software.

Shishay Amare Gebremeskel et.a l[2] material plays very important role in every manufacturing process. The paper also describes and solves the major issues of vehicles weight through use of composite material E-Glass/Epoxy composite shown in Fig. 1. Their work focuses on constant cross section design, weight reduction, and design. The result shows that shear stress in much less than the shear strength (τ= 3mpa) and the design is safe even for flexural failure. They focus on their work for design of leaf spring used in three wheelers.

Anand Kumar et.al [3] the very first issue in every automobiles is weight reduction with maintenance of strength. The paper here comprises of use of 55SI2MN90 for steel leaf and Glass-fiber 7781 for composite leaf spring as a material. The work comprises of hand layup method and mathematical calculation the paper also discusses about the fabrication of leaf spring and for this a wooden made pattern is used. The pattern is created according to design dimensions. The mono composite made up of hand layup method.

Anil kumar et.al [4] the paper comprises of work done on the conventional steel leaf spring with variable composite materials like Graphite, Carbon, and E-Glass/Epoxy etc .The different effects occurs on the working condition of leaf spring is analyze here with the help of mathematics and Ansys software. The experiment is performed with the help of 10 leaf springs, 2 full length and 8 in graduated. Stress based analysis and modal analysis is performed with the help of ANSYS software shown in the figure given below. The results concluded that the static analysis of steel leaf spring displacement is 92.59mm which is below the chamber length of leaf spring and stiffness noted as 35.60mm.

III. OBJECTIVES

The objectives of the work are:

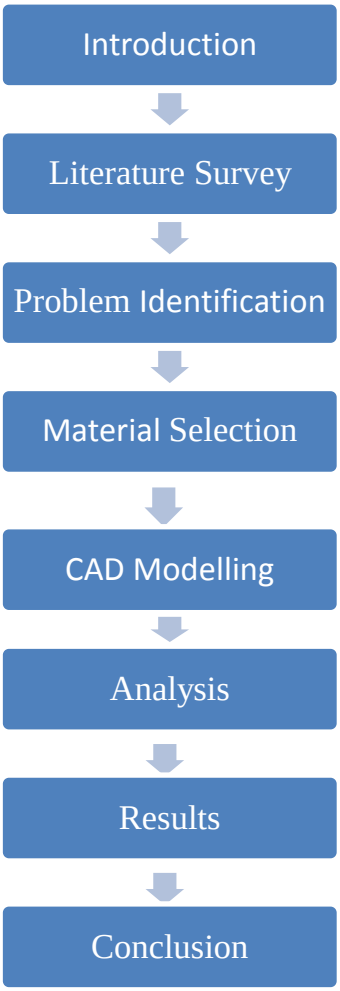
a) To design and analyse leaf spring with composite material.
b) To model a composite leaf spring with specific dimensions using Catia.
c) To provide optional material for leaf spring as the usage of composite materials has resulted in considerable amount of weight saving in the range.
d) To design and analyse a composite leaf spring with different material for an automobile like conventional steel and new carbon Epoxy,Glass epoxy.
e) To compare the results of conventional steel spring and new carbon epoxy,Glass epoxy.

IV. PROBLEM STATEMENT

Due to its large volume production, it is only logical that optimization of the leaf spring for its weight or volume will result in large-scale savings. It can also achieve the objective of reducing the weight of the vehicle component, thus reducing inertia loads, reducing vehicle weight and improving vehicle performance and fuel economy. So considering automobile development and importance of relative aspect such as fuel consumption, weight, riding quality, and handling, hence development of new material is necessary in the automobile industry.

ISSN : 2455-9679
Impact Factor : 2.865

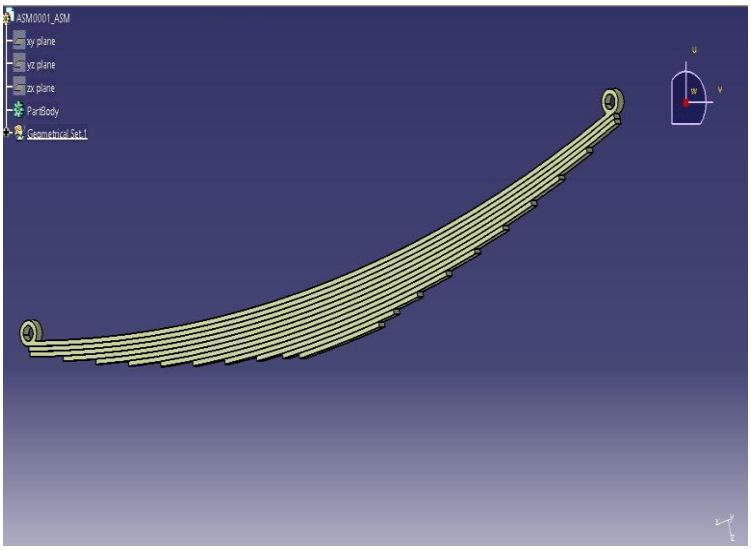
V. RESEARCH METHODOLOGY



VI. DESIGN & ANALYSIS

CAD Modelling:

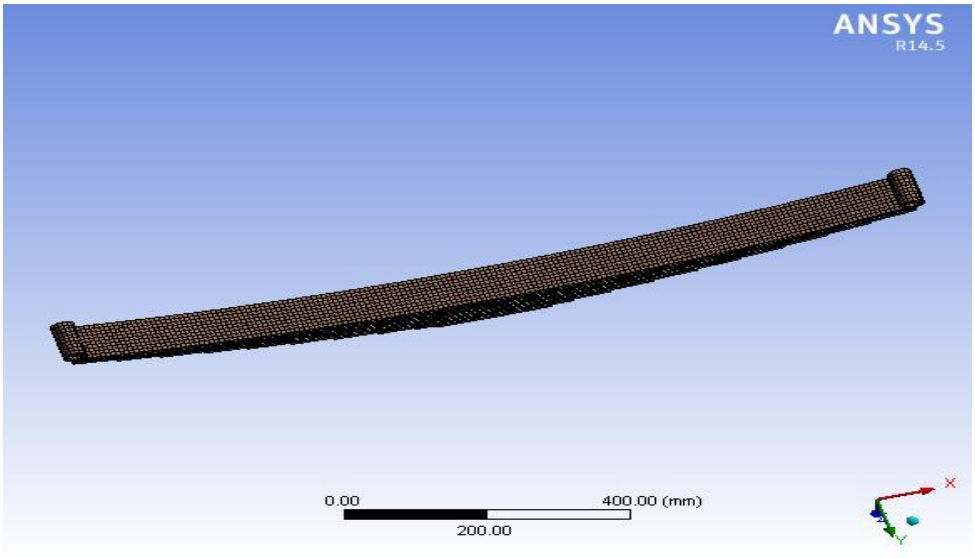
CAD model designs with conventional and composite materials of leaf spring are created in CATIA V5 R20 which contains special tools in generating typical surfaces, which are later converted into solid models.



ISSN : 2455-9679
Impact Factor : 2.865

Meshed model of leaf spring

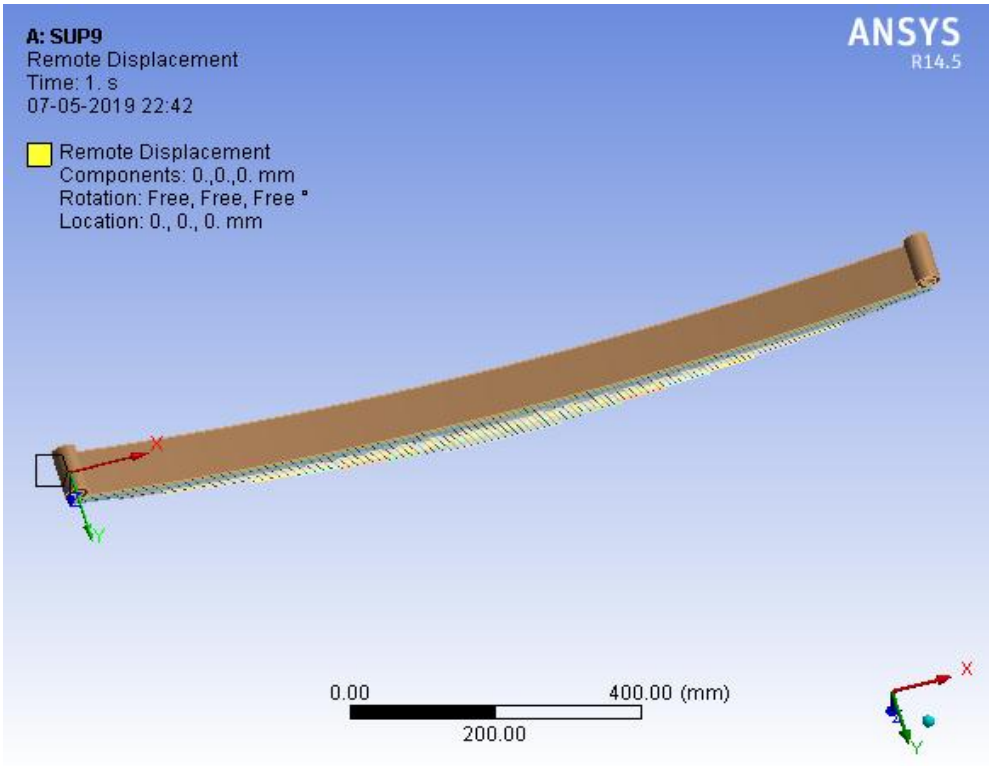
Meshing involves division of the entire of model into small pieces called elements. This is done by meshing. It is convenient to select the free mesh because the leaf spring has sharp curves, so that shape of the object will not alter. To mesh the leaf spring the element type must be decided first.



Loading and boundary conditions

a) **Remote displacement 1**

Front end of the leaf spring is restricted to move in X ,Y and Z direction and allow to rotate in all direction. Below Fig. shows the front end boundary condition.

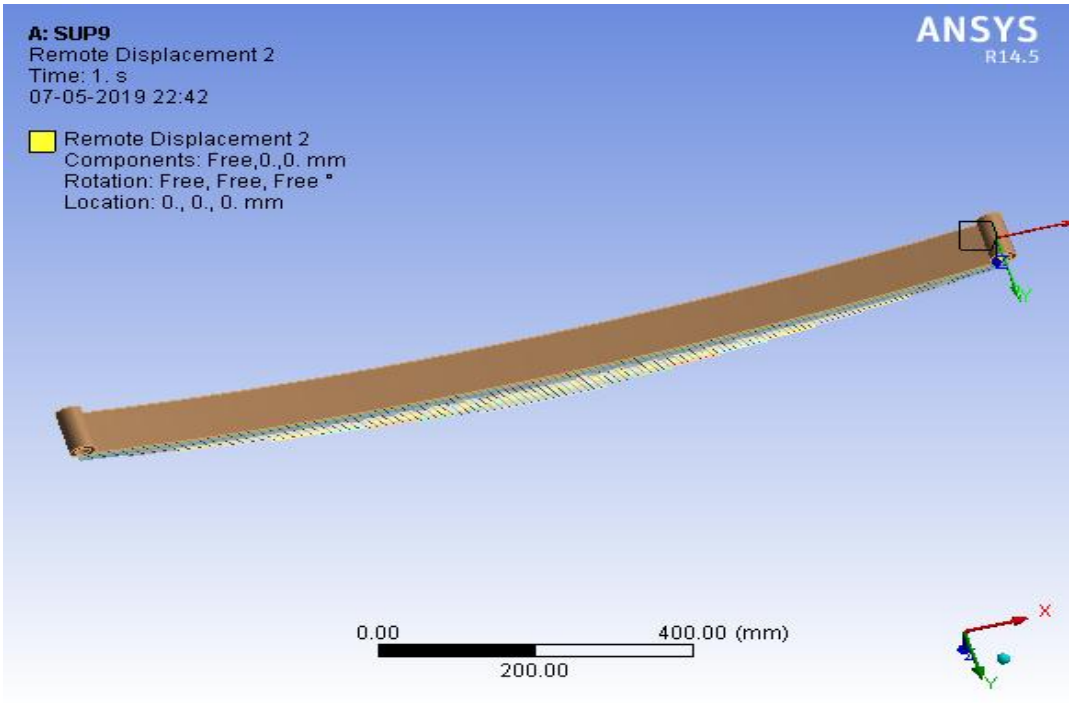


b) Remote displacement 2

As there is shackle provided at other end of the leaf spring because of which the leaf spring only translate in one plane and other movements that is degree of freedom are blocked. So with the reference of this a cylindrical support is applied to the other eye end of the leaf spring model. This support allows the movement of the leaf spring in X axis and

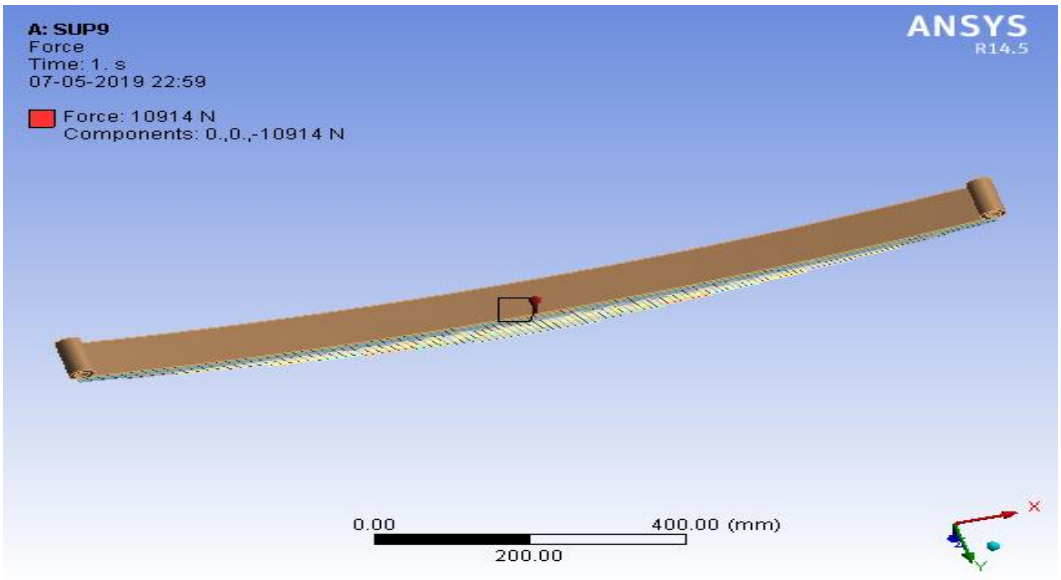
ISSN : 2455-9679
Impact Factor : 2.865

fixed in Y& Z direction, rotation about all axis. Figure 4.4 shows the boundary condition of the rear end of the leaf spring.

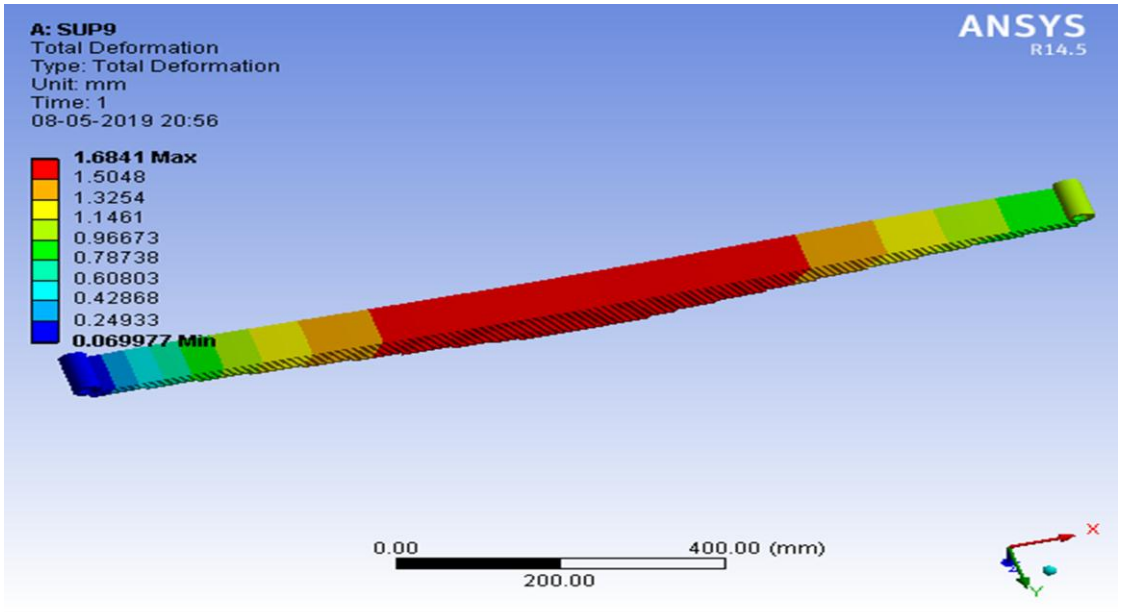


c) Loading Condition

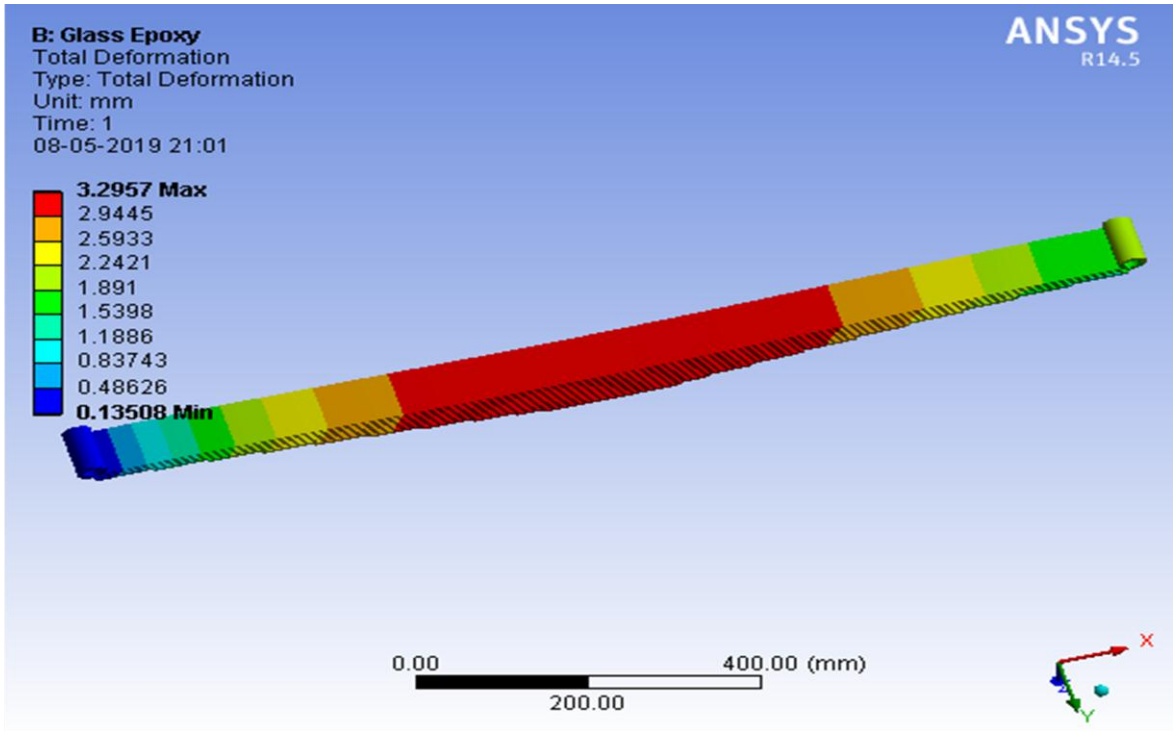
The load is uniformly distributed on the leaf spring, here in this study there are three types of loads applied for getting actual results. According to vehicle conditions the load direction is upward.



ISSN : 2455-9679
Impact Factor : 2.865

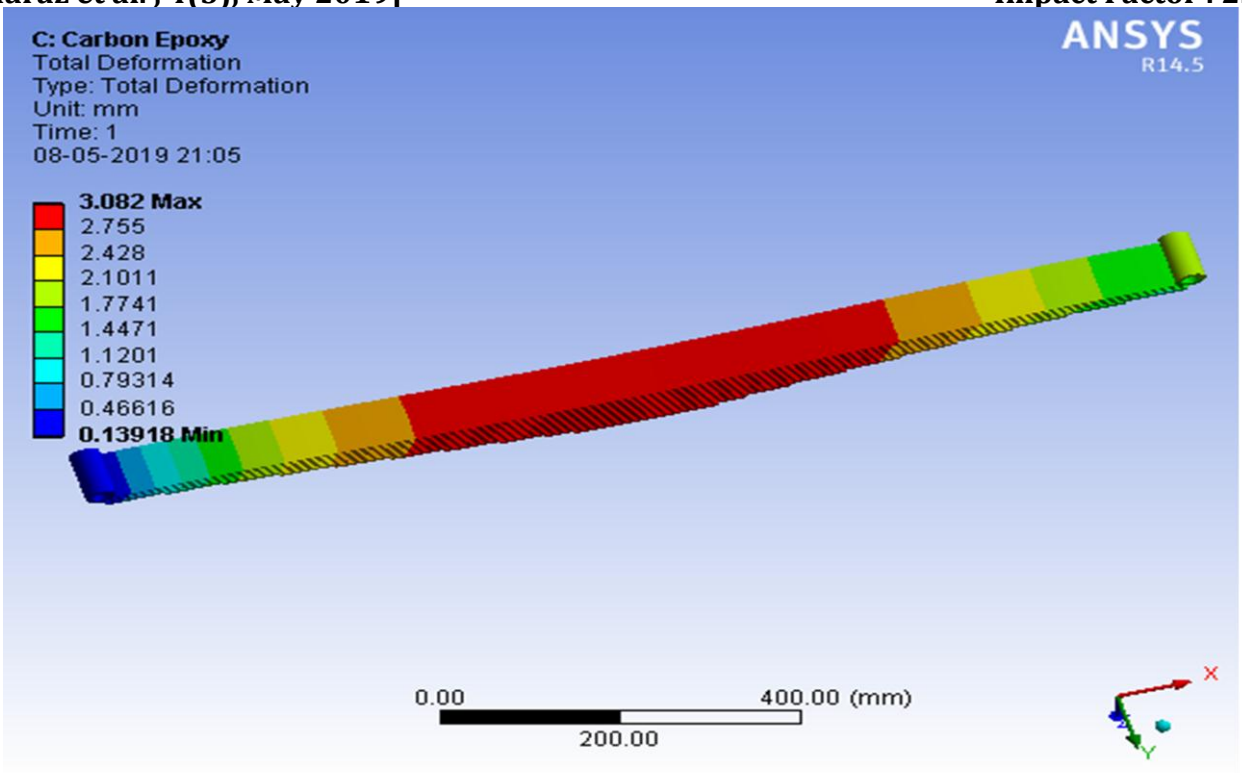


Total Deformations in SUP9 at 10914 N

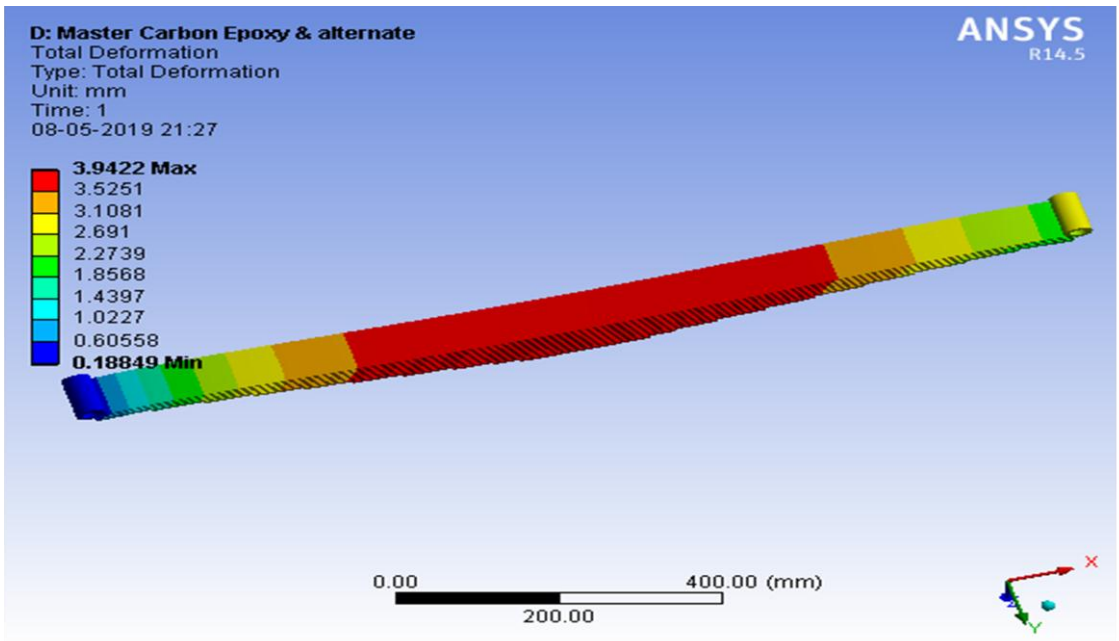


Total Deformations in Glass Epoxy with alternate plate of SUP9 at 10914 N

ISSN : 2455-9679
Impact Factor : 2.865

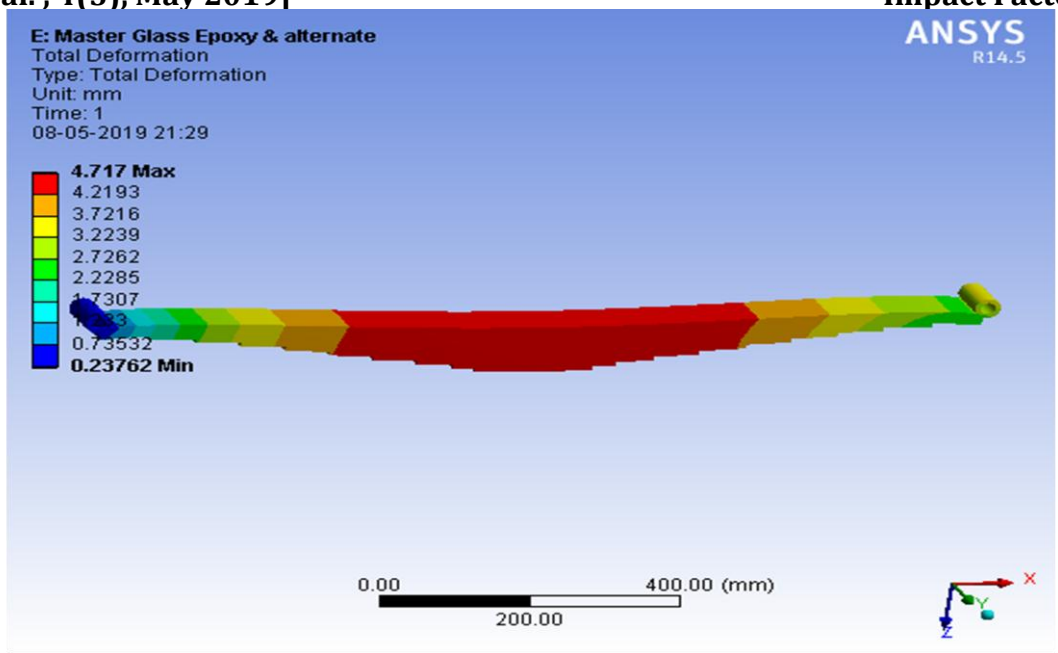


Total Deformations in Carbon Epoxy with alternate plate of SUP9 at 10914 N

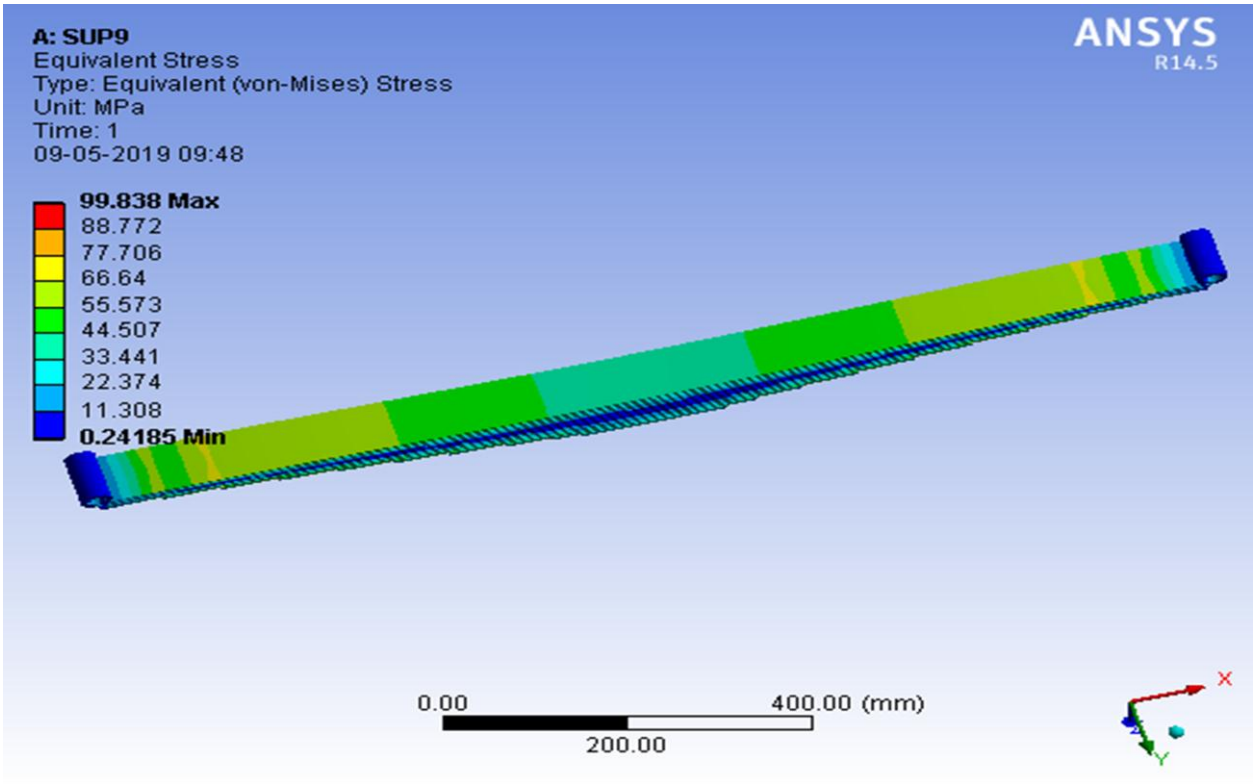


Total Deformations in Master leaf of Carbon Epoxy with alternate plate of SUP9 at 10914 N

ISSN : 2455-9679
Impact Factor : 2.865

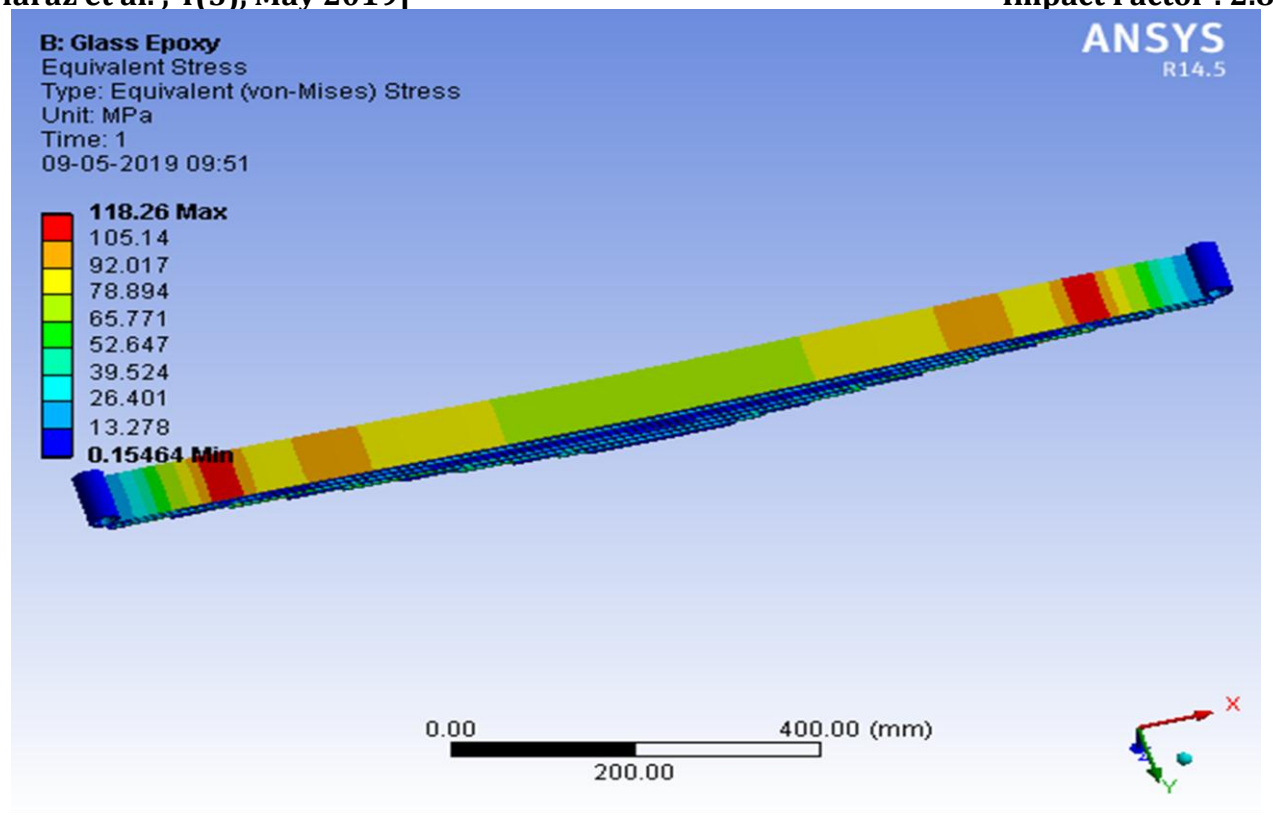


Total Deformations in Master leaf of Glass Epoxy with alternate plate of SUP9 at 10914 N

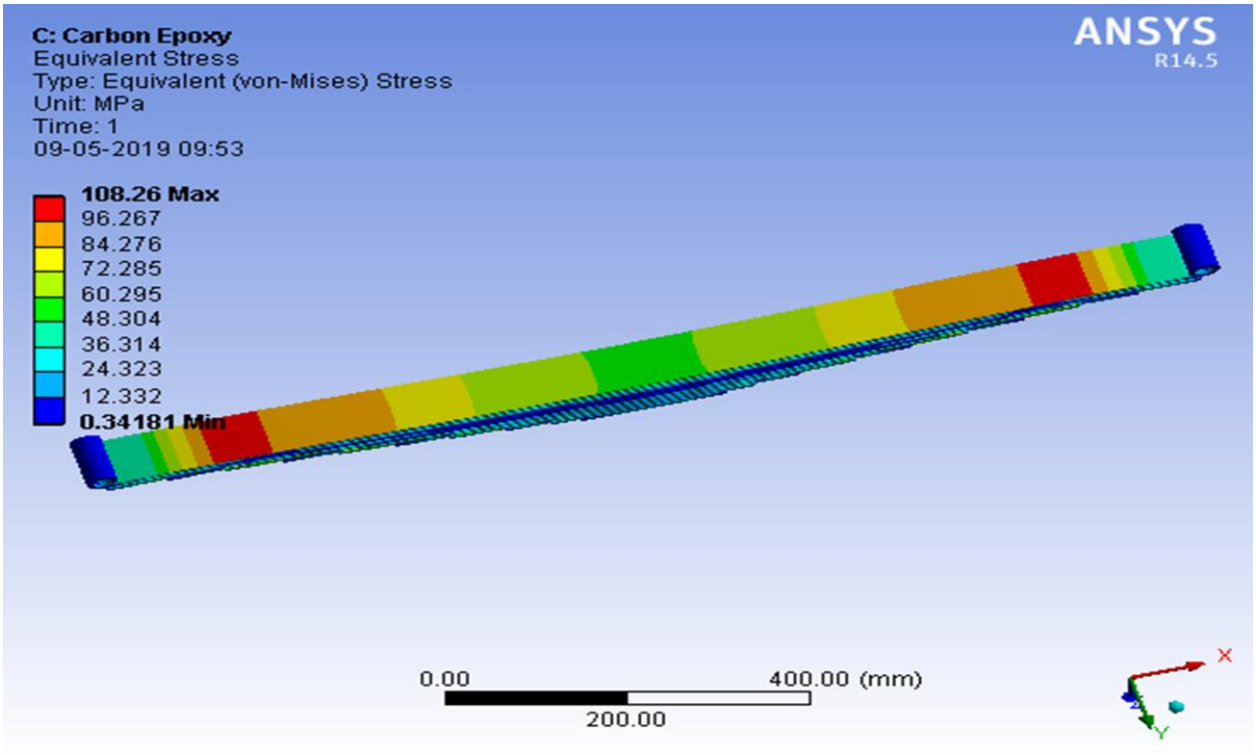


Equivalent stress in SUP9 at 10914 N

ISSN : 2455-9679
Impact Factor : 2.865

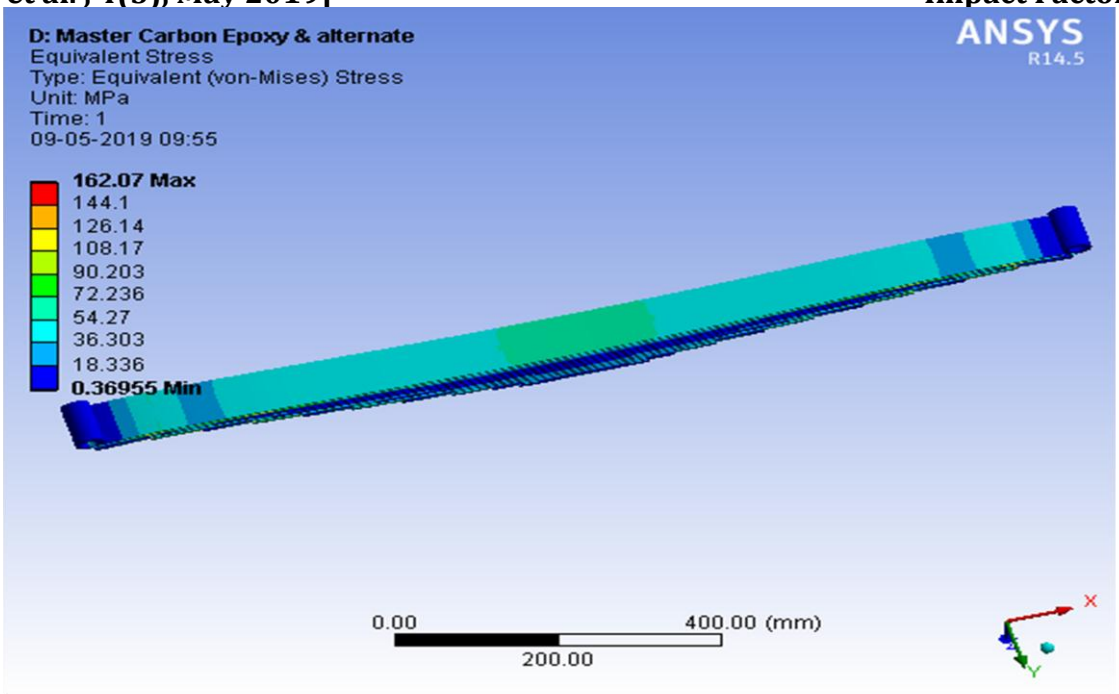


Equivalent stress in Glass Epoxy at 10914 N

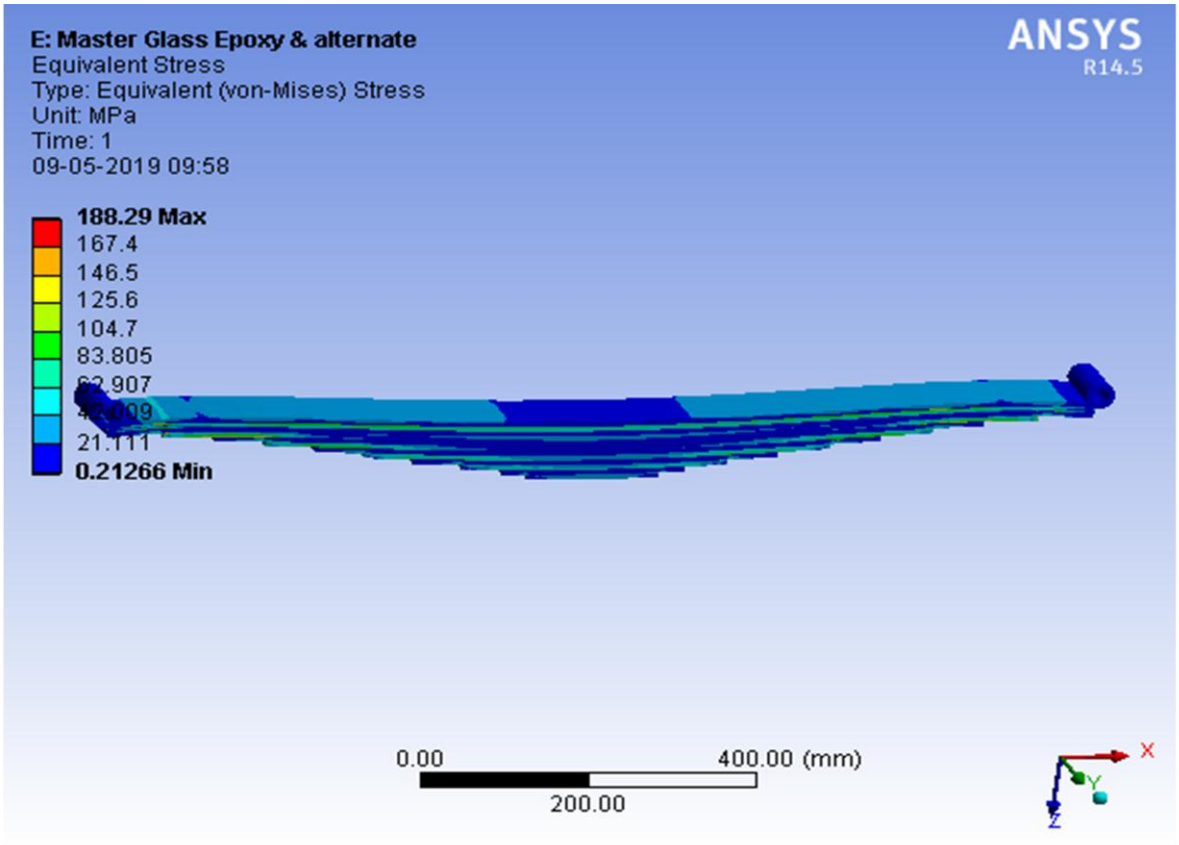


Equivalent stress in Carbon Epoxy at 10914 N

ISSN : 2455-9679
Impact Factor : 2.865

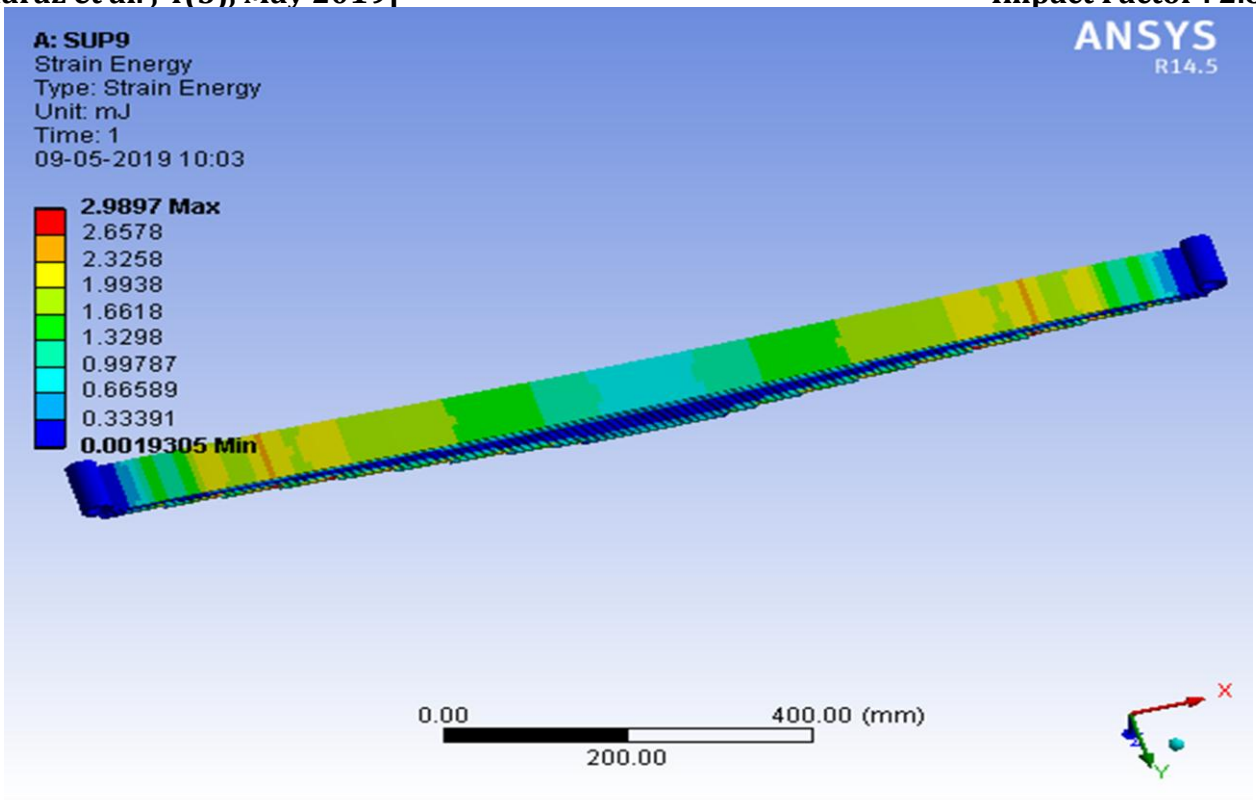


Equivalent Stress in Master leaf of Carbon Epoxy with alternate plate of SUP9 at 10914 N

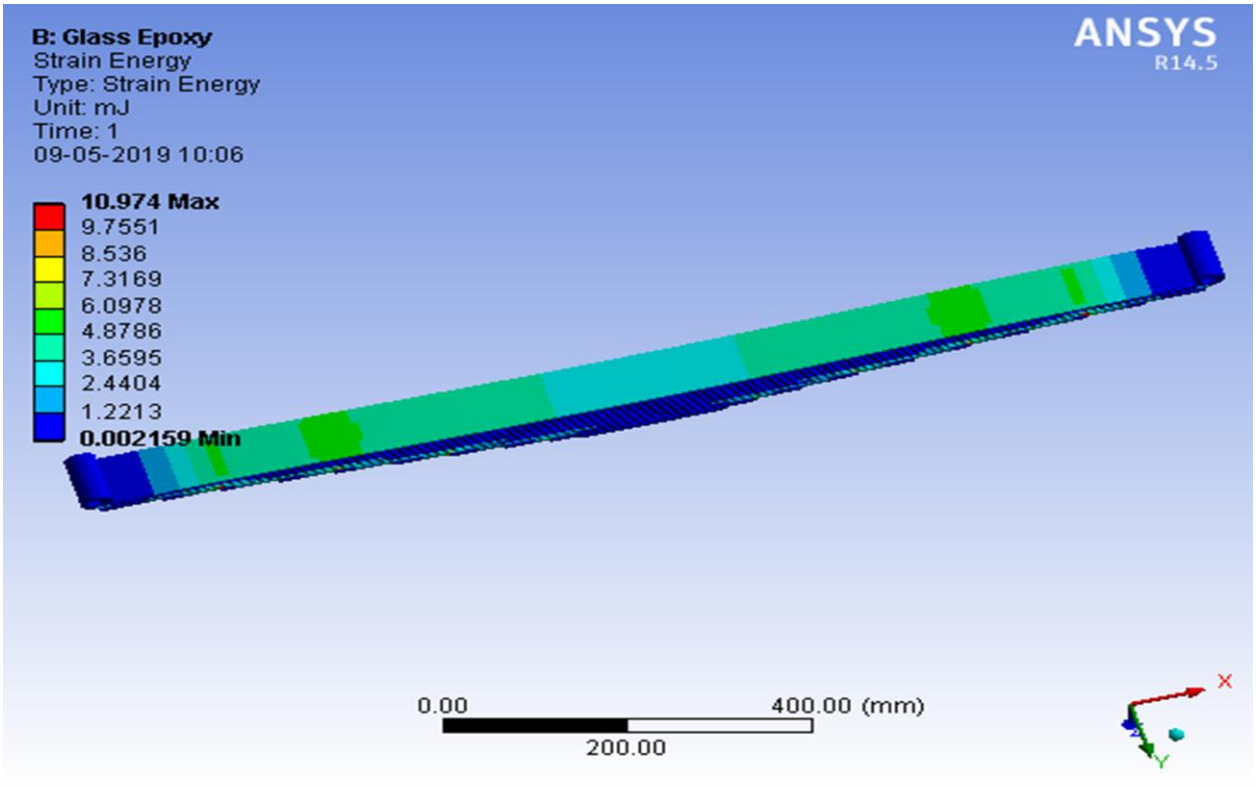


Equivalent Stress in Master leaf of Glass Epoxy with alternate plate of SUP9 at 10914 N

ISSN : 2455-9679
Impact Factor : 2.865

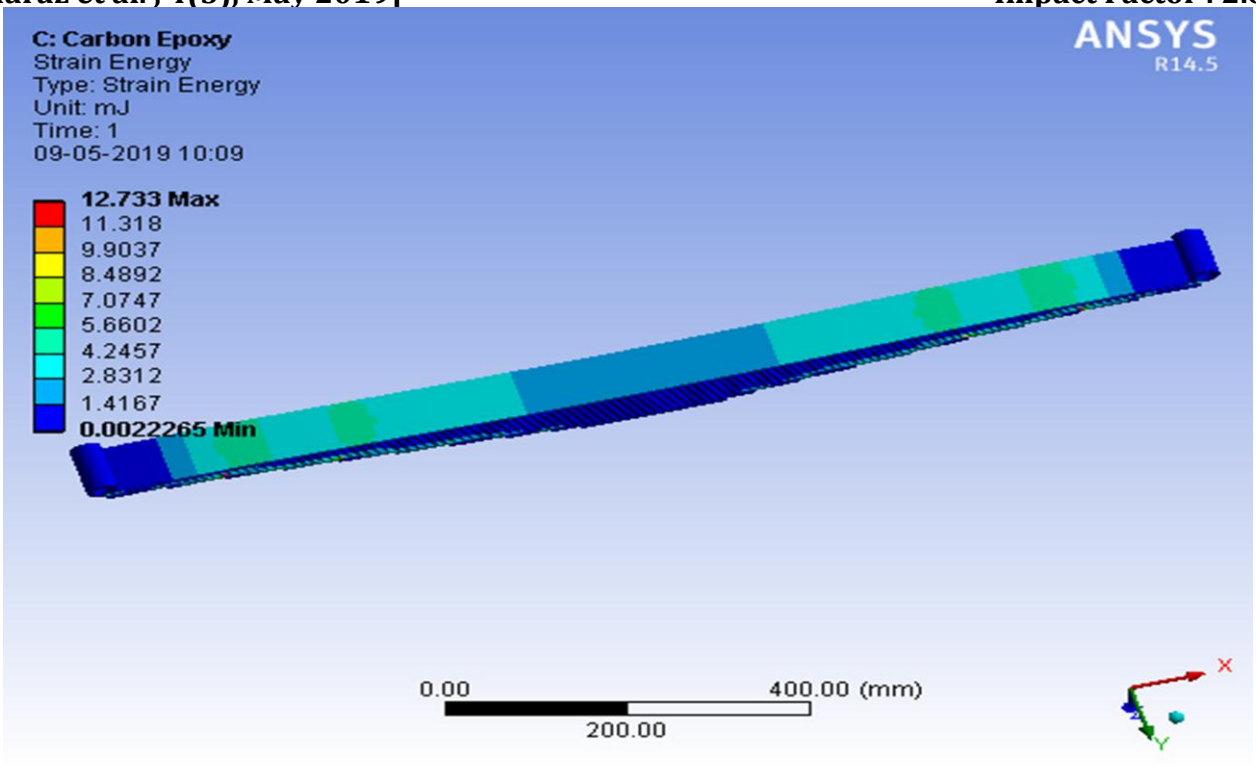


Strain Energy stored in SUP9 at 10914 N

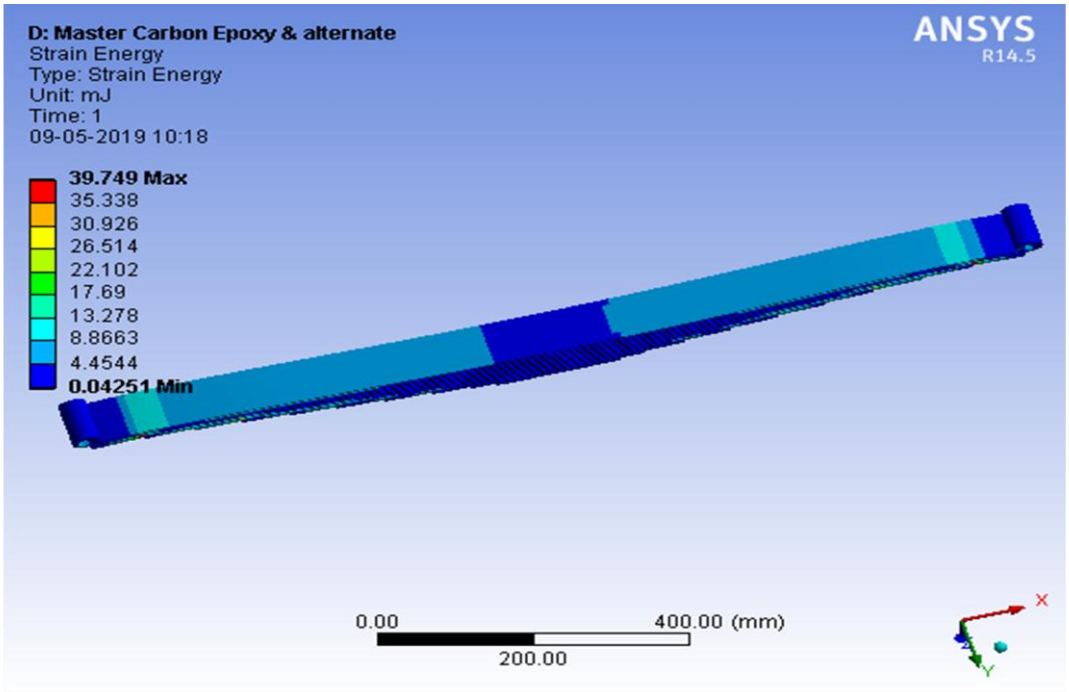


Strain Energy stored in Glass Epoxy at 10914 N

ISSN : 2455-9679
Impact Factor : 2.865

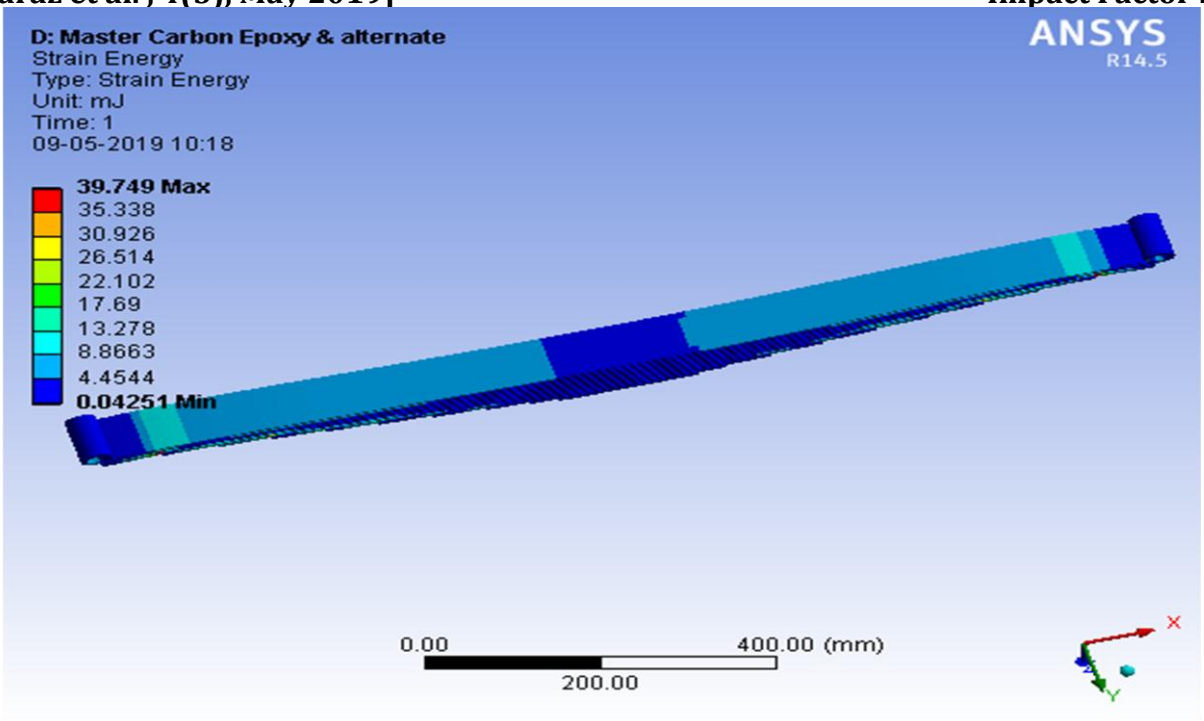


Strain Energy stored in Carbon Epoxy at 10914 N



Energy Stored in Master leaf of Carbon Epoxy with alternate plate of SUP9 at 10914 N

ISSN : 2455-9679
Impact Factor : 2.865



Energy Stored in Master leaf of Glass Epoxy with alternate plate of SUP9 at 10914 N

VII. RESULTS

.The analysis of leaf spring for various considerations and two different loading conditions are done. The results for the leaf spring assembly for various considerations are as shown below:

Sr. No.	Material & Combination of plates	Weight of leaf spring (Kg)	Load (N)	Equivalent Stress (Mpa) (Max.)	Total Deformation (mm)	Strain Energy (mJ)
1	SUP 9	35.70	10914	99.838	1.684	2.99
			8608.3	78.746	1.328	1.86
2	Master leaf of SUP 9 and alternate leafs of Glass Epoxy	23.44	10914	118.26	3.2957	10.974
			8608.3	93.28	2.56	6.8272
3	Master leaf of SUP 9 and alternate leafs of Carbon Epoxy	22.605	10914	108.26	3.082	12.733
			8608.3	85.386	2.431	7.9211
4	Master leaf of Carbon epoxy and alternate leafs of SUP 9	20.37	10914	162.07	3.942	39.75
			8608.3	127.83	3.1094	24.728
5	Master leaf of Glass epoxy and alternate leafs of SUP 9	21.35	10914	188.29	4.717	37.52
			8608.3	148.51	3.7205	23.24

ISSN : 2455-9679
Impact Factor : 2.865

VIII. CONCULISION

A comparative study has been made between laminated composite leaf spring and steel leaf spring with respect to weight, stress, deformation and strain energy. By employing a composite leaf in sandwich pattern with SUP9 for the same load carrying capacity, there is a reduction in weight of 34%~43%,and total deformation is little higher and strain energy stored is higher in all considerations with respect to SUP 9. Based on the results, it was inferred that Master leaf of Carbon epoxy and alternate leafs of SUP 9 has superior strength and strain energy and lesser in weight compared to SUP 9 and other composite materials considered in this investigation. From the results, it is observed that the laminated composite leaf spring is lighter and more economical than the conventional steel spring with similar design specifications.

Therefore, it is concluded that Master leaf of Carbon epoxy and alternate leafs of SUP 9 is an effective replacement for the existing steel leaf spring in automobile.

Future scope:

- Transient analysis of leaf spring
- Manufacturing of composite leaf spring.
- Experimental results for composite leaf spring.
- Residual stress calculation using FEA

REFERANCES

1. V.K. Aher et. al. “Fatigue Life Prediction of Multi Leaf Spring used in the Suspension System of Light Commercial Vehicle”, International Journal on Theoretical and Applied Research in Mechanical Engineering (IJTARME), 2012.
2. Shishay Amare Gebremeskel. Design, simulations, and prototyping of single composite Leaf Spring for Light Weight Vehicles. Global Journal of Researches in Engineering Mechanical and Mechanics Engineering Volume 12, Issue 7, Version 1.0, Year 2012.
3. Mr. AnandKumar A. Satpute, Prof. S.S Chavan. Mono Composite Leaf Spring – Design and Testing. INDIAN JOURNAL OF APPLIED RESEARCH. Volume: 3 | Issue: 7 | July 2013.
4. Malaga. Anil Kumar, T.N.Charyulu, Ch.Ramesh. Design Optimization of Leaf Spring. IJERA, Vol. 2, Issue 6, November- December 2012.
5. Senthilkumar Mouleeswaran. Design, Manufacturing and Testing of Polymer Composite Multi-Leaf Spring for Light Passenger Automobiles - A Review. www.intechopen.com.
6. M. M. Patunkar, D. R. Dolas. Modelling and Analysis of Composite Leaf Spring under the Static Load Condition by using FEA. International Journal of Mechanical & Industrial Engineering, Volume 1 Issue 1 -2011
7. R.B Charde, Dr.D.V. Bhope. Investigation of stresses in master leaf of leaf spring by FEM and its experimental verification. IJEST, Vol.4 No.02 February 2012.
8. Mahmood M. Shokrieh, DavoodRezaei. Analysis and optimization of a composite leaf spring.Elsevier Science Ltd. Vol. 60, 2003.
9. M.Venkateshan, D.Helmen Devraj, “Design and Analysis of Leaf Spring in Light Vehicles”, IJMER 2249-6645 Vol.2, Issue.1, pp.213-218, Jan-Feb 2012.
10. V Pozhilarasu and T Parameshwaran Pillai, “Performance Analysis of Steel Leaf Spring with Composite Leaf Spring and Fabrication of Composite Leaf Spring”, IJERST - ISSN 2319- 5991 Vol. 2, No. 3, August 2013.
11. Manjunath H.N, Manjunath.K, T.Rangaswamy, “Static Analysis and Fatigue Life prediction of Composite Leaf Spring for a Light Commercial Vehicle (TATA ACE), IJER ISSN:2319- 6890)(online),2347-5013(print), Volume No.3, Issue No.7, pp : 422-425 01, July 2014.
12. Mr. Nisar S. Shaikh, Prof. S.M. Rajmane, “Modelling and Analysis of Suspension System of TATA SUMO by using Composite Material under the Static Load Condition by using FEA, IJETT- ISSN: 2231 -5381, Volume 12 Number 2, Jun 2014.
13. Mahdi, E. O.M.S. Alkoles, A.M.S. Hamouda, B.B. Sahari,"Light Composite Elliptic Springs for Vehicle Suspension", Journal of composite structure 2006, (75), pp.24-28.

14. Ashok Kumar T.N.et.al,"Design and Material Optimization of Heavy Vehicle Leaf Spring International Journal of Research in Mechanical Engineering & Technology", Vol. 4, Issue 1, April 2014, pp. 80-88.
15. Mahammad Ashiqur Rahman, Mahammad Tareq Siddique, Mahammad Arfin Kowser,"Design and Non- Linear Analysis of a Parabolic Leaf Spring", Journal of Mechanical Engineering 2007, (3), pp.47-51.
16. Simran Jeet Singh, Meenu Gupta,"Comparison of Particle Swarm Optimization and Simulated Annealing for Weight Optimization of Composite Leaf Spring", International Journal of Computational Engineering & Management, Vol. 16 Issue 4, July 2013 pp. 14-23.
17. Pozhilarasu V. T Parameshwaran Pillai Comparison of Performance of Glass Fibre Reinforced Plastic Leaf Spring With Steel Leaf Spring", International Journal of ChemTech Research CODEN(USA): 2013, 5 (3), pp. 1339-1345.
18. Qureshi. H.A. Al.,"Automobile leaf spring from composite materials", Journal of Material Processing Technology 2001 (118), pp. 58- 61.
19. Mouleeswaran Senthil Kumar, Sabapathy Vijayarangan, "Analytical and Experimental Studies on Fatigue Life Prediction of Steel and Composite Multi-Leaf Spring for Light Passenger Vehicles Using Life Data Analysis, Journal of Material Science 2007, 13 (4) , pp. 141-144.