

e-ISSN: 2319-8753 | p-ISSN: 2347-6710

TEDIA

International Journal of Innovative Research in SCIENCE | ENGINEERING | TECHNOLOGY

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 7, July 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

## Impact Factor: 8.118

9940 572 462

6381 907 438

 $\bigcirc$ 



| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|

Volume 11, Issue 7, July 2022

DOI:10.15680/IJIRSET.2022.1107030

## Design and Analysis of Composite Material Leaf Spring

Mr.K Vinay Kumar<sup>1</sup>, N Dhanvi Reddy<sup>2</sup>, P Vaishnavi Reddy<sup>3</sup>, Thogani Supriya<sup>4</sup>

Assistant Professor, Department of Mechanical Engineering, Guru Nanak Institute of Technology, Ibrahimpatnam,

R.R. Dist, India

Department of Mechanical Engineering, Guru Nanak Institute of Technology, Ibrahimpatnam, R.R.Dist, India

ABSTRACT: Leaf springs are utilized in suspension frameworks. The automobile industries has shown expanded interest in the replacing of steel spring with composite leaf spring because of high solidarity to weight proportion, great consumption opposition and designer capable properties. A leaf spring is a most ordinary kind of spring used for suspension in significant vehicles. It is included different strips twisted to somedegreeupwardsandclampedtogetheroneover the other. These plates are joined to the body casing and hub of vehicle. The suspension system in a vehicle is basic to further develop the riding comfort and dependability of the vehicle. Leaf springs are regularly used in vehicle suspension system and are exposed to countless different tension cycles, prompting exhaustion disappointment; and it is essential to choose the sensible pressure and most noteworthy redirection to avoid failure. They are viewed as the expected materials for replacingthese traditionalmetallic leafsprings without giving up the strength and by diminishing the structural weight significantly. The leaf springs are designed as generalized force components where the position, speed and direction of the pivot mounting gives the reaction forces in the chassis connection positions. Here we have analysed the leaf spring with different materials along with traditional materials Stainless TitaniumAlloy, steel. The we used are Steel, Copper Alloy, AluminiumAlloy, GrevCastIron. Along these lines, analysis of the composite material turns out to be similarly essential to concentrate on the way of behaving. The leaf springs are displayed and the analysis is done utilizing programming to anticipate the way of behaving. Then correlation of static analysis results for different materials and complex composite material leaf spring are finished.

KEYWORDS: Leaf springs, Suspension, Solace, Exhaustion, composite Material

#### I. INTRODUCTION

A leaf spring is a simple type of spring, regularly utilized for the suspension inwheeled vehicles. The suspension of leaf spring is the region which necessities to concentration to work on the suspensions of the vehicle for solace ride. A spring is characterized as a versatile body, whose capacity is to contort when stacked and to recuperates its unique shape when the load is taken out. Initially Leaf spring called covered or carriage spring, a leaf spring is a straightforward type of spring, normally utilized for the suspension in wheeled vehicles.



Figure1.1LeafSpring[7]

Leaf springs are essentially utilized in suspension frameworks to ingest shock loads in cars like light engine vehicles, rock solid trucks and in rail frameworks. Semi-elliptic leaf springs are generally utilized for suspension in light and weighty business vehicles. For vehicles additionally, these are generally utilized in back suspension. The spring comprises of various leaves called edges. The blades are fluctuating long. The blades are typically given an initial



| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|

#### Volume 11, Issue 7, July 2022

#### DOI:10.15680/IJIRSET.2022.1107030

curvature or cambered so they will more often than not fix under the load. The leaf spring depends on the hypothesis of beam of uniform strength. Thelengthiestbladehaseyesonitsclosures. This blade is called main or master leaf, the leftover blades are called graduated leaves. Every one of the edges are bound together through steel lashes. The introduction of composites helps in designing a superior suspension framework with better ride quality in the event that it tends to be accomplished absent a lot of expansion incost and decline in quality and dependability. In the design of springs, strain energy turns into the main consideration. A leaf spring can either be connected straightforwardly to the casing atthetwoclosuresorappendedstraightforwardly toward one side, generally the front, with the opposite end joined through a shackle, a short swinging arm. The shackle takes up the propensity of the leaf spring to stretch when packed and consequently makes for milder springiness. The springs are at first cambered. More cambered leaf springs are having high firmness, so that gives hard suspension. Utilization of longer springs gives a delicate suspension, since when length builds the softness increases. Generally rare springs are kept longer than the front springs.

#### **II. LITERATURE REVIEW**

Leaf springs designing have involved engineering calculations, finite element simulations with extensive fatigue tests in reliability labs. In this section research papers are discussed related to the present work.

1. COMPOSITELEAFSPRINGSandeep Bhattacharjee<sup>1</sup>, Suyog Kanitkar<sup>2</sup>, Naveen Kalasapur<sup>3</sup>, Vivek Patel4,

International Research Journal of Engineering and Technology (IRJET)

In this paper, the aim is to review the paper about fabrication and analysis of composite leaf spring. The numerical analysis is carried via finite element analysis using ANSYS software. In the present work, the dimensions of an existing mono steel leaf spring of a Maruti 800 passenger vehicle is taken for modelling and analysis of a laminated composite mono leaf spring with threedifferent composite materials namely, E- glass/Epoxy,S-glass/Epoxyand Carbon/Epoxy subjected to the same load as that of a steel spring[1].

### 2. STUDY AND REVIEW ON THE ANALYSESOFLEAFSPRINGPulkit Solanki1 Dr. Ajay Kumar Kaviti2, IJSRD - InternationalJournal for Scientific Research & Development

In this paper authors reviewed some previous research work performed on the leaf spring by previous researchers for increasing theworking condition and capacity with load reduction. The paper based on material composition, experimental testing and load (Steady, Dynamic) study etc. The authors reviewed various papers on leaf springanalysis for improving the working conditions some of them includes weight reduction by using composite material like E-Glass/Epoxy composite which resulted in weight reduction and shear stress is much less than shear strength and the design is safe even forflexural failure etc.[2]

### 3. "FABRICATION OF HYBRID COMPOSITEMATERIALSLEAFSPRING", Ekhlas Edan Kader, Rania Adwan, Lutfi Yousuf Zedan.

The aim of this research is to investigate the structural properties of a hybrid leaf spring made of 95% Epoxy,5% carbon, 5% glassfibre, and 5% of hybrid composite of carbon and glass fibre. Hand layup was used in the fabrication due toits advantages over the other methods. The effectiveness of the proposed composite leaf spring was evaluated by implementing the mechanical tests. Tensile, Impact, Hardness and Flexural tests weredone. The experimental results showed an increase in Hardness, Impact, Tensile, and Flexural strength when the reinforcing fibres are applied. The best results of the mechanical test obtained when hybrid reinforcement was applied. [3]

#### III. MODELLING OF LEAF SPRING

CATIA is the one of the computer aided three dimensional interface application with help of module and tools by parametric condition we can create any 3d dimensional components

#### **Procedure Of Modelling Leaf Spring**

To create leaf springs go to CATIA and open it. Now go to start and select mechanical design- part design then we will enter into part design module. In part design - select sketcher in insert- and select xy plane.

> In sketcher module go to profile tool bar and create required profiles. Then click on exist in workbench. Then we will return to part design module.

> In part module and specify distance in length

> In sketcher module go to profile tool bar and select circle and specify radius. Then click on exist in workbench. Then we will return to part design module.



| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|

#### Volume 11, Issue 7, July 2022

#### DOI:10.15680/IJIRSET.2022.1107030

- > In part module and specify distance in length
- Similarly by using pad and pocket we will get the final shape of single leaf of spring
- > Byrepeatingtheprocessweobtainthe final leaf spring model



Figure 3.1 Full Elliptical Leaf Spring

#### IV. ANALYSIS OF LEAF SPRING

ANSYS a product of ANSYS inc. is a world's leading, widely distributed and popular commercialCAEpackage.Itiswidelyusedby designers/analysis in industries such as aerospace, automotive, manufacturing,nuclear, electronics, biomedical, and much more. ANSYS provides simulation solution that enables designers to simulate design performance directly on the desktop. In this way, it provides fastefficient and cost of product development from design concept stage to performance validation stage of product development cycle.

In ANSYS, the basics of FEA concepts, modelling and the analyzing of engineering problem using ANSYS workbench. Inaddition, describe of importance tools and concepts given whenever required this following simulation streams of ANSYS.

The leaf spring is subjected to static structural analysis and the resulted total deformation, equivalent stress and equivalent strain are studied and compared for different materials under same conditions for all materials

The materials chosen for studying are Structural Steel, Stainless Steel Aluminium Alloy, Titanium Alloy Grey Cast Iron, Copper Alloy.

The leaf spring made of this materials are subjected to the following loads for obtaining the total deformation, stress stain in the leaf spring and to study the results

abie+.1Loadiswith11file filterva	
Time	loads
1	4905.0
2	6131.2
3	7357.5
4	8583.7
5	9810

Table4.1LoadswithTime Intervals

#### V. RESULTS AND DISCUSSIONS

After the analysis is finished the obtained resultsarestudiedandcompared with each other among different materials.

#### 5.1. TotalDeformation





| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|

||Volume 11, Issue 7, July 2022||

DOI:10.15680/IJIRSET.2022.1107030



Figure 5.2 Total Deformation

The deformation of Grey Cast Iron is shown in figure (a) the total under application oftheloadsasperconsidered and itobserved that deformation obtained are 6.590800mm, 8.274300mm, 9.989400mm, 11.677000mm, 13.392000mmwhensubjectedtoloads 4090.5N,6131.2N,7357.5N,8583.7N,9810Nrespectively. The total deformation of Aluminium Alloy is shown in figure (b) under the application of the loads and it observed that deformation obtained are 3.5848mm, 4.4917mm, 5.4005mm, 6.316mm, 7.2322mm when subjected to loads 4090.5N, 6131.2N, 7357.5N,8583.7N,9810N respectively. The total deformation of Titanium alloy is shown in figure (c) under the application of the loads and it observed that deformation obtained are 7.4202mm, 9.3188mm, 11.257 mm, 13.163 mm, 15.105 mm, when subjected toloads4090.5N,6131.2N,7357.5N, 8583.7N,9810N respectively. The total deformation of Stainless Steel is shown in figure (d) under the application of the loads and it observed that deformation obtained are 3.7079 mm, 4.64625mm,.60046 mm,.5342 7. mm,4825mm when subjected to loads4090.5N,6131.2N,7357.5N,8583.7N,9810Nrespectively. The total deformation of Steel is shown in figure (e) under application of loads and it observed that deformation obtained the the are 10.185mm, 12.812mm, 15.461mm, 18.154mm, 20.867mm when subjected loads to 4090.5N,6131.2N,7357.5N,8583.7N,9810Nrespectively. The total deformation of Copper Alloy is shown in figure (f) under the application of the loads and it observed that deformation obtained are 6.4999mm, 8.1596 mm, 9.8251 mm,11.514mm,13.203mmwhensubjectedto loads4090.5N,6131.2N,7357.5N,8583.7N,9810Nrespectively

#### 5.2.1 Equivalent stress





| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|

||Volume 11, Issue 7, July 2022||

#### DOI:10.15680/IJIRSET.2022.1107030



The Equivalent stresses of Grey Cast Iron are shown in figure (g) when subjected the considered loads and it is observed that the equivalent stress produced in leaf spring under the loads 4090.5N, 6131.2N, 7357.5N, 8583.7N,9810Nare210.9300N/mm2,264.1800N/mm2,318.1800N/mm2, 371.0700 N/mm2,424.5700N/mm2respectively. The Equivalent stresses of Aluminium Alloy are shown in figure (h) when subjected the considered loads and it is observed that the equivalent stress produced in leaf spring under the loads 4090.5N, 6131.2N, 7357.5N, 8583.7N,9810Nare210.5200N/mm2,263.4400N/mm2,316.3400N/mm2, 369.4900 N/mm2,422.5500N/mm2respectively The Equivalent stresses of Copper Alloy are shown in figure (i) when subjected the considered loads and it is observed that the equivalent stress produced in leaf spring under the loads 4090.5N, 6131.2N, 7357.5N, 8583.7N.9810Nare211.7100N/mm2,265.1500N/mm2,318.5200N/mm2, 372.3800 N/mm2,426.0200N/mm2respectively. The Equivalent stresses of Stainless steel are shown in figure (j) when subjected the considered loads and it is observed that the equivalent stress produced in leaf spring under the loads 4090.5N, 6131.2N, 7357.5N, 263.6400N/mm2,317.3600N/mm2, 8583.7N,9810Nare210.6700N/mm2, 369.7900 N/mm2,422.9000N/mm2respectively. The Equivalent stresses of Steel are shown in figure (k) when subjected the considered loads and it is observed that the equivalent stress produced in leaf spring under the loads 4090.5N, 6131.2N, 7357.5N, 8583.7N, 9810N are 212.2900N/mm2, 266.0500 N/mm2, 319.9400N/mm2,374.2300N/mm2, 428.5600 N/mm2respectively. The Equivalent stresses of Titanium Alloy are shown in figure (1) when subjected the considered loads and it is observed that the equivalent stress produced in leaf spring under the loads 4090.5N, 6131.2N, 7357.5N, 8583.7N,9810Nare212.3000N/mm2,265.9100N/mm2,320.3400N/mm2, 373.5800 N/mm2,427.5400N/mm2respectively

#### 5.3 Equivalent Strian

The Equivalent Strain of Grey Cast Iron are shown in figure (m) when subjected the considered loads and it is observed that the equivalent strain produced in leaf spring under the loads 4090.5N, 6131.2N, 7357.5N, 8583.7N,9810Nare0.00197N/mm,0.00247 N/mm,0.00298N/mm,0.00347N/mm 0.00397N/mmrespectively. The Equivalent Strain of AluminiumAlloy are shown in figure (n) when subjected the considered loads and it is observed that the equivalentstrainproducedinleafspringunder theloads 4090.5N,6131.2N,7357.5N, 8583.7N,9810Nare0.00308N/mm,0.00386 N/mm0.00464N/mm, 0.00543N/mm,0.621N/mmrespectively. The Equivalent Strain of Copper Alloy are shown in figure (o) when the considered loads and it is observed that the equivalent strain produced in leaf spring under the loads 4090.5N, 6131.2N, 7357.5N, 8583.7N,9810Nare





| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|

|Volume 11, Issue 7, July 2022||

#### DOI:10.15680/IJIRSET.2022.1107030



Figure5.13Equivalent Strain

0.002978N/mm,0.003482N/mm,0.003984N/mmrespectively. The Equivalent Strain of Stainless Steel are shown in figure (p) when subjected the considered loads and it is observed that the equivalent strain produced in leaf spring under the loads 4090.5N, 8583.7N,9810Nare0.00108N/mm,0.00135 N/mm,0.00163N/mm,0.0019N/mm 6131.2N, 7357.5N, 0.00217N/mmrespectively. The Equivalent Strain of Steel are shown in figure (q) when subjected the considered loads and it is observed that the equivalent strain produced in leaf spring under the loads 4090.5N, 6131.2N, 7357.5N, 8583.7N, 9810N are0.00112N/mm,0.00141N/mm,0.00169 N/mm, 0.00197 N/mm ,0.00225 N/mm respectively. The Equivalent Strain of Titanium Alloy are shown in figure (r) when subjected the considered loads and it is observed that the equivalent strain produced in leaf spring under the loads 4090.5N. 6131.2N. 7357.5N. 8583.7N.9810Nare0.00227N/mm,0.00285N/mm,0.00343N/mm,0.004N/mm,0.00458 N/mmrespectively

#### VI. DISCUSSIONS

Thetotaldeformationcausedinleafspringsof different materials (Structural Steel, Stainless Steel Aluminium Alloy, Titanium Alloy Grey Cast Iron, Copper Alloy) under the cyclic loads (4090.5N, 6131.2N, 7357.5N, 8583.7N,9810N)arestudiedandcomparedamongeach other is shown in graph 5.1. It is observed that the total deformation in leaf spring is likely to lessinStainlessSteelleafspringoncomparing to the other material leaf springs.



Graph5.1Total Deformation

The equivalent stress caused in leaf springs of different materials (Structural Steel, Stainless Steel Aluminium Alloy, Titanium Alloy Grey Cast Iron, Copper Alloy) under the cyclicloads(4090.5N,6131.2N,7357.5N,8583.7N,9810N) are studied and compared among each other is shown in graph 5.2. It is observed that the equivalent stress in leaf spring is likely to lessinStainlessSteelleafspringoncomparing to the other material leaf springs



Graph5.2Equivalent Stress

The equivalent strain caused in leaf springs of different materials (Structural Steel, Stainless Steel Aluminium Alloy,



| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|

#### |Volume 11, Issue 7, July 2022|

#### DOI:10.15680/IJIRSET.2022.1107030

Titanium Alloy Grey Cast Iron, Copper Alloy) under the cyclicloads(4090.5N,6131.2N,7357.5N,8583.7N, 9810N) are studied and compared among each other is shown in graph 5.3. It is observed that the equivalent stress in leaf spring is likely to lessinStainlessSteelleafspringoncomparing to the other material leaf springs



Graph5.3Equivalent Strain

#### VII. CONCLUSION

The conclusion of the work is that byanalyzing and studying the total deformation, equivalentstressandequivalentstrain characteristics of the leaf springs made of different materials (Structural Steel, Stainless Steel Aluminium Alloy, Titanium Alloy Grey Cast Iron, Copper Alloy) subjected under the cyclic loads (4090.5N, 6131.2N, 7357.5N, 8583.7N, 9810N). By the comparison of the total deformation, equivalent stress and strain under similar conditions for all materials it is observed that stainless steel is having less deformation, stress and strain with respect to Structural Steel, Aluminium Alloy, Titanium Alloy, Grey Cast Iron, Copper Alloy. We can replace the convectional steel by stainless steel is an option for obtaining weight reduction and achieving high fuel efficiencies and good comfort without compromising the properties of leaf spring

#### REFERENCES

[1]."COMPOSITELEAFSPRING"Sandeep Bhattacharjee<sup>1</sup>, Suyog Kanitkar<sup>2</sup>, Naveen Kalasapur<sup>3</sup>, Vivek Patel4, International Research Journal of Engineering and Technology (IRJET)

[2]."STUDY AND REVIEW ON THE ANALYSESOFLEAFSPRING"**Pulkit Solanki1 Dr. Ajay Kumar Kaviti2**, IJSRD - InternationalJournal for Scientific Research &Development

[3]"FABRICATION OF HYBRID COMPOSITEMATERIALSLEAFSPRING", Ekhlas Edan Kader, Rania Adwan, Lutfi Yousuf Zedan, Journal of Mechanical Engineering Research and Developments

[4]"DESIGN AND ANALYSIS OF LEAF SPRINGBYUSINGCOMPOSITE MATERIAL", Ajahar Sayyad1, Rahul Kulkarni2, Alimoddin Patel3, Umesh Jadhav4, International Research Journal of Engineering and Technology (IRJET)

[5]"DESIGN AND ANALYSIS OF LEAF SPRING USING COMPOSITE MATERIALS", Ganesh R. Chavhan1\*, Pawan V. Chilbule2, International Journal of Engineering Research & Technology (IJERT)

[6]"DESIGN AND ANALYSIS OF LEAF SPRINGBYUSINGCOMPOSITE MATERIALS", Prof. Pranija Bartere1, Muneer Byari2, Vikrant Chitte3, Shantanu Baikar4, Shripad Amle5, IJSRD - International Journal for Scientific Research & Development

[7]"PARAMETRIC ANALYSIS OF COMPOSITELEAFSPRING", BhaumikA. Bhandari, Bhavesh C. Patel, IJSTE–International Journal of ScienceTechnology&Engineering

[8]"MODELLING AND STRUCTURAL ANALYSIS OF LEAF SPRING USING FINITEELEMENTMETHOD"**M.Sai kumar1, Dr C. Bhaskara Reddy2,** International Research Journal of Engineering and Technology (IRJET)

[9]DESIGNANDANALYSISOFLEAF SPRINGSFORWEIGHTREDUCTIONBY USINGNATURALFIBRECOMPOSITES INSTEAD OF STEEL", Y. Sai Bhargav

USINGNATUKALFIBKECUMPUSITES INSTEAD OF STEEL, Y. Sai Bhargav

[10]."DESIGNANDANALYSISOFLEAFSPRINGFORHEAVYWEIGHTVEHICLESUSINGCOMPOSITEMATERIALS", A. Raveendra, Mohammed Abdul Mubashir , International Journal of<br/>InnovativeTechnology and Exploring Engineering (IJITEE)International Journal of





Impact Factor: 8.118





# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY





www.ijirset.com