Novateur Publication's
International Journal of Innovation in Engineering, Research and Technology [IJIERT]
ICITDCEME'15 Conference Proceedings
ISSN No - 2394-3696

REVIEW OF DESIGN AND ANALYSIS OF COMPOSITE MATERIAL MONO LEAF SPRING

Katu A.R.
Student of M.E. Design, Department of Mechanical Engineering,
SVERI'S College of Engineering, Pandharpur, Maharashtra.

Gund S.P.
Student of M.E. Design, Department of Mechanical Engineering,
SVERI'S College of Engineering, Pandharpur, Maharashtra.

Raut L.B.
Professor, Department of Mechanical Engineering,
SVERI'S College of Engineering. Pandharpur, Maharashtra.

ABSTRACT
Composite materials have attracted all researchers due to its light weight and high strength. Today's need of manufacturing industries is to make the automobiles fuel efficient. Overall Weight reduction of the vehicle is the main issue in automobile industries. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. The automobile industry has shown increased interest in the replacement of steel spring with composite leaf spring due to high strength to weight ratio. In this paper main focus is to review all such work in which the weight reduction of the vehicle was achieved by considering leaf spring. Many of authors suggested that weight reduction can be achieved by using composite material having suitable properties and capable of carrying such heavy load of the vehicle. Different methods for analysing and manufacturing for composite leaf spring are also discussed. It was shown that the weight reduction can be easily achieved but there are more aspects which should also be consider i.e. cost, strength, and new composite materials.

INTRODUCTION
In order to conserve natural resources and economize energy, weight reduction has been the main focus of automobile manufacturer in the present scenario. 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 automobile as it accounts for ten to twenty percentage of the unsprung weight. This helps in achieving the vehicle with improved riding qualities. It is well known that springs, are designed to absorb and store energy and then release it. Hence, the strain energy of the material becomes a major factor in designing the springs. The relationship of the specific strain energy can be expressed as

$$U = \sigma^2/\rho E$$

Where,
σ is the strength,
ρ is the density and
E is the Young's modulus of the spring material

It can be easily observed that material having lower modulus and density will have a greater specific strain energy capacity. The introduction of composite materials was made it possible to reduce the weight of the leaf spring withoutany 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 to those of steel.
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 are cost-effective over their steel counter parts. The leaf spring should absorb the vertical vibrations and impacts due to road irregularities by means of variations in the spring deflection so that the potential Energy is stored in spring as strain energy and then released slowly. So, increasing the energy storage capability of a leaf spring ensures a more compliant suspension system. According to the studies made a material with maximum strength and minimum modulus of elasticity in the longitudinal direction is the most suitable material for a leaf spring. Fortunately, composites have these characteristics.

A composite material is defined as a material composed of two or more constituents combined on a macroscopic scale by mechanical and chemical bonds. Many composite materials offer a combination of strength and modulus that are either comparable to or better than any traditional metallic metals. Because of their low specific gravities, the strength to weight-ratio and modulus to weight-ratios of these composite materials are markedly superior to those of metallic materials. The fatigue strength weight ratios as well as fatigue damage tolerances of many composite materials are excellent. For these reasons, fiber composite have emerged as a major class of structural material and are either used or being considered as substitutions for metal in many weight-critical components in aerospace, automotive and other industries. High damping capacity of composite materials can be beneficial in many automotive applications in which noise, vibration, and hardness is a critical issue for passenger comfort.

LITERATURE REVIEW

Mahmood M. Shokrieh et.al (2003) [1],in their work they focused on Analysis and optimization of a composite leaf spring. For this purpose a four-leaf steel spring used in the rear suspension system of light vehicles is analyzed using ANSYS V5.4 software. The finite element results showing stresses and deflections verified the existing analytical and experimental solutions. Using the results of the steel leaf spring, a composite one made from fiberglass with epoxy resin is designed and optimized using ANSYS. Main consideration is given to the optimization of the spring geometry. The objective was to obtain a spring with minimum weight that is capable of carrying given static external forces without failure.

J.P. Houet.al (2007) [2], in this work their focus is on "Evolution of the eye-end design of a composite leaf spring for heavy axle loads", This work presents the design evolution process of composite leaf spring for fright rail applications. Three designs of eye-end attachment for composite leaf spring are described.

ShishayAmareGebremeskel (2012) [3], In his work describe the Design, Simulation, and Prototyping of Single Composite Leaf Spring for Light Weight Vehicle reducing weight of vehicles and increasing or maintaining the strength of their spare parts is considered. As leaf spring contributes considerable amount of weight to the vehicle and needs to be strong enough, a single E-glass/Epoxy leaf spring is designed and simulated following the design rules of the composite materials considering static loading only. This particular design is made specifically for light weight three wheeler vehicles. Its prototype is also produced using hand lay-up method.

M. Raghavedra et.al (2012) [4], in their work describes Modelling and Analysis of Laminated Composite Leaf Spring under the Static Load Condition by using FEA, Weight reduction is now the main issue in automobile industries. 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 three different composite materials namely, Eglass/Epoxy, S-glass/Epoxy and Carbon/Epoxy subjected to the same load as that of a steel spring.

PankajSaini et.al (2013) [5],intheir wok they describe design and analysis of composite leaf spring. The objective is to compare the stresses and weight saving of composite leaf spring with that of steel leaf spring. The design constraint is stiffness. The Automobile Industry has great interest for replacement of steel leaf spring with that of composite leaf spring, since the composite materials has high strength to weight ratio, good corrosion resistance. The material selected was glass fiber reinforced polymer (E-glass/epoxy), carbon epoxy and graphite epoxy is used against conventional steel. The design parameters were selected and analysed with the objective of minimizing weight of the composite leaf spring as compared to the steel leaf spring.

B. Raghu Kumar et.al(2013) [6] , Their work is on Static analysis of mono leaf spring with different composite materials,The aim of this work is to suggest the best composite material for design and fabrication of complete mono composite leaf spring. A single leaf with variable thickness and variable width for constant cross sectional area of different composite materials, with similar mechanical and geometrical properties to the multi leaf spring, were modelled and analysed.
R D V Prasad et.al (2013) [7], their focus is on Design & Analysis of Mono Composite Leaf Spring, This work deals with development of analytical formulation for Composite leaf spring and comparing the obtained results with the Conventional Steel leaf spring with 4 leaves. Composite leaf spring in this project has been developed as a mono block construction with maximum thickness at the centre which is preferably glass fiber reinforced polymer.
Rajagopal D et.al (2014) [8], they have design Automobile Leaf Spring from Composite Materials.This work describes design and experimental analysis of composite leaf spring made of glass fiber reinforced polymer. The objective is to compare the load carrying capacity, stiffness and weight savings of composite leaf spring with that of steel leaf spring and describes the significant economic potential of polymer composite and to replace automobile components (leaf Spring) against the steel.
Nisar S. Shaikh et.al (2014) [9], they have carried out Modelling and Analysis of Suspension System of TATA SUMO by using Composite Material under the Static Load Condition by using FEA. The objective of this project is to present modelling and analysis of composite mono leaf spring and compare its results. Modelling is done using Pro-E (Wild Fire) 5.0 and Analysis is carried out by using ANSYS 10.0 software for better understanding. It is seen that the Composite leaf spring (CARBON FIBRE/E-POXY) weight is 2.7 times less as compared to steel leaf spring for same stiffness (same load carrying capacity).

CONCLUSION

As a lot of work has been done in designing of leaf springs which is discussed briefly in this text, on the basis of this study, problems in overall weight reduction by using composite materials are identified. Many of the authors suggested various methods of designing, manufacturing and analyses of composite leaf springs. After studying all the available literature it is found that weight reduction can be easily achieved by using composite materials instead of conventional steel, but there occurs a problem during the operation while using the composite leaf spring i.e. chip formation when the vehicle goes off road. Therefore there is an immense scope for the future work regarding use of composite materials in leaf springs to reduce the overall weight of the vehicle as well as the cost of the vehicle.

REFERENCES

1. Mahmood M. Shokrieh, et.al, "Analysis and optimization of a composite leaf spring",Composites Research Laboratory, Department of Mechanical Engineering, Iran University of Science and Technology, Narmak, Tehran 16844, Iran.Composite Structures 60 (2003) 317–325.
2. J.P. Hou et.al, "Evolution of the eye-end design of a composite leaf spring for heavy axle loads", Composite Structures 78 (2007) 351–358.
3. ShishayAmareGebremeskel "Design, Simulation, and Prototyping of Single Composite LeafSpring for Light Weight Vehicle",Global Journal of Researches in EngineeringMechanical and Mechanics Engineering,Volume 12 Issue 7 Version 1.0 Year 2012.
4. M. Raghavedra et.al, "Modeling and Analysis of Laminated Composite Leaf Spring under the Static Load Condition by using FEA.International Journal of Modern Engineering Research (IJMER) www.ijmer.com Vol.2, Issue.4, July-Aug. 2012 pp-1875-1879.
5. PankajSaini et.al, "Design And Analysis Of Composite Leaf Spring For Light Vehicles"International Journal of Innovative Research in Science, Engineering and TechnologyVol. 2, Issue 5, May 2013.
6. B. Raghu Kumar et.al, "Static analysis of mono leaf spring with different composite materials",Journal of Mechanical Engineering Research Vol. 5(2), pp. 32-37, February 2013.

7. R D V Prasad et.al, "Design & Analysis of Mono Composite Leaf Spring" International Journal of Scientific Research Engineering & Technology (IJSRET)Volume 2 Issue2 pp 103-107 May 2013.
8. Rajagopal D et.al, "Automobile Leaf Spring from Composite Materials", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-4 Issue-1, October 2014
9. Nisar S. Shaik et.al, "Modelling and Analysis of Suspension System of TATA SUMO by using Composite Material under the Static Load Condition by using FEA"International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-3, Issue-3, February 2014.