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LEAF SPRING MADE BY COMPOSITE MATERIAL

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Abstract

The automotive industry is continually exploring innovative materials to enhance the performance and efficiency of vehicle components. The Automobile industry has shown keen interest for replacement of steel leaf spring with that of composite leaf spring, since the composite material has high strength to weight ratio, good corrosion resistance. Present study was to replace material for leaf spring.Traditional leaf springs are primarily made of steel, and while effective, they exhibit limitations in terms of weight, corrosion resistance, and design flexibility. This analysis will consider the impact on overall vehicle weight, fuel efficiency, and environmental sustainability. Additionally, the corrosion resistance of the composite material will be assessed to ensure durability and longevity in diverse operating environments. From the static analysis and
experimental results it is found composite leaf springs have lesser displacements and stresses than that of conventional steel leaf spring.A comparative study has been made between steel and composite leaf spring with respect to strength and weight.This survey is intended to be a far reaching source for design a leaf spring involving different composites as the Automobile ventures are showing strong fascination for supplanting steel leaf spring with that of a composite leaf spring to get decrease in weight, which is a compelling measure for energy preservation as it decreases generally fuel utilization of the vehicle.

1. Introduction

Nowadays, Better fuel efficiency, emission issues and reducing weight are become main focus area in automobile sector. In that issue, weight reduction can be done by implementing better material, optimizing an appropriate design & quality manufacturing. In automobile sector, Leaf spring is used as suspension in most of vehicles. So reducing weight of leaf spring get beneficial and can help to achieve the objective as per demands. For better material, composites are get closure to achieve weight reduction without any change in load carrying capacity, stiffness parameters

One critical aspect of a vehicle's suspension system is the leaf spring, traditionally crafted from steel. While steel has proven its reliability over the years, its inherent limitations in terms of weight, corrosion susceptibility, and design flexibility have prompted the exploration of alternative materials.

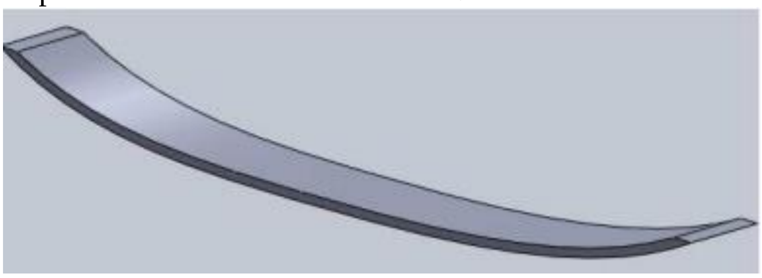

Fig. Composite leaf spring

Total length of spring =940mm
Free camber= 136mm
Thickness =20mm

The application of composite materials, such as fiberglass, carbon fiber, and epoxy resin, holds significant promise in revolutionizing the design and performance of leaf springs. These advanced materials offer a unique combination of high strength-to-weight ratio, corrosion resistance, and versatility in shaping, providing an opportunity to enhance the overall characteristics of leaf springs

As the automotive industry continues to evolve towards sustainable and efficient solutions, the outcomes of this investigation are anticipated to pave the way for the widespread adoption of composite leaf springs.

Increasing competition and innovations in automobile sector tends to modify the existing products or replacing old products by new and advanced material products. A suspension system of vehicle is also an area where these innovations are carried out regularly. Leaf springs are mainly used in suspension systems to absorb shock loads in automobiles like light motor vehicles.Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes.

2. Literature View

Conduct an extensive review of existing literature to gather insights into the use of composite materials in automotive applications, specifically focusing on leaf springs.

Identify key challenges, advantages, and methodologies employed in previous studies related to composite leaf springs.

To compare the load carrying capacity, stiffness and weight saving of composite leaf spring and conventional steel leaf spring. He calculate and compare mechanical properties like Young's modulus, Ultimate Tensile Strength, Yield Tensile Strength, Density and Thermal Expansion between conventional leaf spring of material 55si2Mn90 steel and composite leaf spring of material E glass/ Epoxy. The conventional steel leaf spring has weight 23 Kg where as E glass/Epoxy leaf spring has weight 3.59 Kg indicting reduction of 80% weight. **Dr. Amit Pradhan [1]**

Design and fabrication of GFRP composite leaf spring and laminated mild steel leaf spring. The objective is to compare the load carrying capacity, stiffness and weight saving of composite leaf spring with that of mild leaf spring. CATIA software is used for modelling and static analysis of 3-D model of conventional leaf spring is performed using ANSYS14.0. The composite leaf spring is manufactured by Hand lay- up process using vacuum press. Material for composite leaf is used epoxy resin with K6 hardener and fibre glass. For surface finishing of mold releasing agent gel/wax is used. Practical test is carried out on UTM machine. Deflection, stiffness and load carrying capacity is measured on UTM. **Akhil Mehndiratta [2]**

3.Proposed Methodology

Material Selection:

Evaluate and select appropriate composite materials, such as fiberglass, carbon fiber, and epoxy resin, based on their mechanical properties, weight characteristics, and suitability for leaf spring applications.

Consider factors such as cost, availability, and manufacturing feasibility in the material selection process.

Material Characterization:

Perform material testing to characterize the mechanical properties of selected composite materials, including tensile strength, flexural strength, modulus of elasticity, and impact resistance.

Utilize standard testing protocols and equipment to ensure accurate and repeatable results.

Composite Leaf Spring Fabrication:

Design and fabricate composite leaf springs based on the selected materials and the desired specifications. Employ advanced manufacturing techniques, such as lay-up processes or resin infusion, to ensure uniform distribution of materials and optimal structural integrity.

From last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have developed steadily, penetrating and conquering new markets continuously. Modern composite materials constitute a significant proportion of the engineering materials market ranging from everyday products to sophisticated niche applications.

While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry

Selection of Resins

In a FRP leaf spring, the inter laminar shear strengths is controlled by the matrix system used. Since these are reinforcement fibres in the thickness direction, fibre do not influence inter laminar shear strength. Therefore, the matrix system should have good inter laminar shear strength characteristics compatibility to the selected reinforcement fibre. Many thermo set resins such as polyester, vinyl ester,epoxy resin are being used for fibre reinforcement plastics (FRP) fabrication.


Fig. E-Glass

Among these resin systems, epoxies show better inter laminar shear strength and good mechanical properties. Hence, epoxide is found to be the best resins that would suit this application. Different grades of epoxy resins and hardener combinations are classifieds, based on the mechanical properties. Among these grades, the grade of epoxy resin selected is Araldyte LY556 and hardener used for this application is HY951. Araldyte LY556 is a solvent less epoxy resin. Which in combination with hardener HY951 cures into hard resin. Hardener HY951 is a low viscosity polyamine. Araldyte LY556, hardener HY951 combination is characterized by

i. Good mechanical and electrical properties.
ii. Good chemical resistance properties and
iii. Good thermal resistance

Table:3.1 Properties of epoxy resin

No.	Property	Value	Unit
1.	Elastic modulus	2.41	GPa
2.	Tensile strength	0.13	GPa
3.	Shear modulus	2.26	GPa
4.	Density	1.2	g/cm3
5.	Poisons ratio	0.37	-
6.	Flexural yield strength	0.125	GPa
7.	Compressive strength	0.19	GPa
8.	Viscosity	10000-12000	mPe s
9.	Glass transition temperature (Tg)	120-130	ºC

Fig. Epoxy Resin

Table:3.2. Properties of Composite.

Property	Value	Unit
Modulus of Elasticity	35000	MPa

4.Experimental Setup:

Develop a comprehensive experimental setup to simulate real-world conditions and operational stresses that leaf springs typically encounter.
Design testing protocols for static and dynamic loading conditions to assess the performance and durability of composite leaf springs.

5.Testing and Analysis:

Conduct a series of tests on both composite and traditional steel leaf springs, including tension tests, flexural tests, and impact tests.
Record and analyze data on deformation, stress distribution, and failure modes to compare the performance of composite leaf springs with traditional steel leaf springs.

Weight Reduction Analysis:

Compare the weight of composite leaf springs with that of traditional steel leaf springs to quantify the potential weight reduction.
Analyze the impact of weight reduction on the overall vehicle weight, considering implications for fuel efficiency and dynamic performance.

Corrosion Resistance Testing:

Assess the corrosion resistance of composite leaf springs through accelerated corrosion tests, exposing the samples to corrosive environments.
Evaluate the visual appearance and structural integrity of the composite material after exposure to ensure long-term durability.

6. Conclusion:

Analyze the collected data using statistical methods and graphical representation.
Draw conclusions based on the experimental results, addressing the feasibility, advantages, and challenges of using composite materials for leaf springs in automotive applications.
The composite leaf spring is lighter than conventional steel leaf spring with similar design specifications but not always is cost- effective over their steel counterparts.
Composite materials have more elastic strain energy storage capacity and high strength to weight ratio as compared with those of steel
E-glass epoxy is better than using Mild-steel as however stresses are little bit greater than mild steel, E-glass epoxy is having good yield strength worth.
This project is very beneficial for reducing the overall all weight of Leaf spring. By changing a material the weight of system is reduced but the deformation is increased. But, there is no effect of it on overall all system. The Leaf spring is checked on UTM and is International Journal of Scientific Research in Science, Engineering and Technology observed that the system is safe .by plotting graph of load v/s deflection