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A Review Paper on Master Leaf spring

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A B S T R A C T

We already know that the spring is an essential part of every automobile's. One of most popular form of suspension system, it's having feature like light in the weight and use for commercial vehicles. Leaf springs are widely used in numerous automobiles.

1. Load distribution that is uniform
2. A lower price
3. Roughly applied
4. The working structure is tightly connected.

Every automobile manufacturer today is looking to enhance efficiency by reducing weight without sacrificing load carrying capacity. In this article, like to go over some of the previous studies that have been done on the leaf spring in order to improve its operating condition and capability under high load. The article is based on a variety of factors, includes material composition, experimental investigation, and load (Static, Dynamic) evaluation.

Keywords: Leaf spring, Material Compositions, Mathematics, Experiments, ANSYS

1. INTRODUCTION

A leaf spring is a simple form of spring that is extensively used in transportation vehicles for stability. Leaf springs are generally made of steel, however most automotive manufacturers now use composite materials to make leaf springs. Composite materials include E-Glass/Epoxy, Graphite/Epoxy, and Carbon/Epoxy. Leaf springs came in a variety of shapes and sizes, including elliptical, semi-elliptical, three-quarter elliptical and quarter elliptical. A leaf spring's main components are the Master leaf, Middle bolt, Main clamp, Eye, and Rebound clip.
So, in this article, try to review all of these prior journals in order to have a better understanding and optimal solution evaluation. Previous research has used analysis and algorithm to calculate load carrying capabilities. Lightweight vehicle transformation under various operating conditions loading situations employed for working and evaluating load durability, a material-based research is used. The document also contained the following:

LITERATURE REVIEW

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

Analysis of leaf spring on the basis of Material and its compositions

K.M.Vinayet.al [1]this section will investigate the advantages of adopting a low-cost base and lightweight materials for auto leaf spring suspension. We compare standard steel 65Si7 leaf springs with half and half composite leaf springs, such as Epoxy/E- Glass/Viscose staple fiber, in terms of disfigurement, flexibility, determination, strain energy putting away limit, cost viability, and mass reduction (40 percent:45 percent:15 present). Static analysis was used to explore the properties of half and half composite materials for leaf spring suspension models in the automobiles, and the results

show that Epoxy/E-Glass/Viscose staple fibre is the stunning excess creation. When compared to conventional steel 65Si7 suspension systems, the usage of Epoxy/E-Glass/Viscose staple fibre (40 present: 45 present: 15 present) resulted in a weight reduction of 76.37 present.

Shrivastava, A. K., Pandeyet.al [2]A leaf spring is a basic type of spring that is frequently used in vehicle suspension. Furthermore, E-Glass for spring is most probably the earliest type of spring. - The expert leaf's spring-blade has a mean direction of 14.85 mm at 4000 N. The maximum frequency is 548.97 Hz. As a result, the recurrence level cause of vibration varied substantially from the fibre properties. The avoidance of the avoidance is 13.48 mm with a repetition reduction of 538.32 Hz, which is fairly low. Which is also extremely cheap, and this product can support a lot like ordinary spring materials, but it is advantageous in terms of weight as carbon composite is lighter. It is also low and of this type.it is also low and such type of material support the load capacity as standard spring metal and polymer composite material but the load strength is good thing in terms of weight because Carbon Fibre does not have a reduced weight with 35% weight loss material with E-Glass materials.

Table .1 Deformation & Maximum stress at 4000 N [3]

S. No.	Materials	Deflection (mm)	Maximum Stress (Mpa)	Frequency (Hz)	Weight (Kg)
1	E- Glass composite material	14.85	35.54	548.97	11.14
2	S- Glass fiber composite material	15.12	35.54	621.62	10.7
3	Carbon Fiber composite material	13.48	41.73	538.32	7.1
4	EN 45 springs steel 55 Si2Mn90 Leaf springs	8.58	35.15	533.4	33.16

AkashChauhanet.al [3]the automobile industry is focusing on hybrid composite leaf springs to replace traditional leaf springs. The present study's purpose is to build polymer (epoxy)-based hybrid composites for light commercial vehicles and assess their flexural strength and wear behaviour as a reaction. Hand lay-up was used to make two hybrid composites with variable thicknesses (3 mm and 4 mm) consisting of carbon, kevlar, and jute fibres. Furthermore, the hybrid composite samples were subjected to a three-point bending test in line with ASTM D7264 and compared to standard leaf spring material (Steel). The wear behaviour of both samples was then evaluated. The data showed that hybrid composites had 44 percent and 173 percent increased flexural strength for 3 mm and 4 mm thick hybrid composites, respectively. respectively, in comparison to conventional material, as well as a weight reduction of 44 percent and 173 percent for 3 mm and 4 mm thick hybrid composites, respectively.

Khatkar, V., & Behera, B. Kal [4]The 3D orthogonal reinforced composite leaf spring outperformed in terms of cyclic flexural and creep performance, while the 3S1B stufferbinder combination outperformed in terms of initial flexural strength, cyclic flexural strength decrease, and creep resistance. The characteristics of UD-based composite leaf springs were equivalent to those of 3S1B-based composite leaf springs. The surface degradation caused by cyclic flexural pressure on composite leaf springs was investigated further. The structural diversity of a 3D structure reinforced leaf spring has a major impact on its failure morphology. From the standpoint of cyclic flexural strength, creep resistance, stiffness retention, and failure morphology, a 3D woven composite with a low binder tow % (3S1B) might be a suitable material for automobile leaf springs.

Shishay Amare Gebremeskel et.al [5] every industrial process relies heavily on material. The study also discusses and resolves the key challenges of vehicle weight by the usage of composite material E-Glass/Epoxy composite. Their work focuses on design, weight reduction, and constant cross section design. The result reveals that shear stress is substantially less than shear strength (= 3mpa), and the design is safe even in the event of flexural failure. They concentrate on their work on the design of the leaf spring utilised in three-wheelers.

Experimental analysis of Leaf springs

Vinkel Arora et.al [6] Leaf springs are used to provide suspension for the rear and front wheels. The work done on the front end leaf spring of a commercial vehicle is the topic of this study. The model is made up of 37 components, and the leaf spring is made of 65SI7 material. The design is created on a CAD model created using CATIA, and the analysis is done with ANSYS software. The outcomes of this computational study were afterwards compared to the experimental values presented in Tables 2 and 3. The calculation and analysis findings reveal that the design is more effective and safe, since the maximum equivalent stress for full and half loaded leaf springs is 172.5 Mpa and 86.29 Mpa, respectively.

Table. 2 Experimental and CAE results for 35KN [7]

Parameters	Exp. Results	CAE Results	Variation
Deflection	158 mm	156.15 mm	1.17%
Bending Stress	126 Kgf/mm2	141.56 Kgf/mm2	12.30%
Spring rate	221.5 N/mm	224.5N/mm	1.35%

Table. 3 Experimental and CAE results for17.5KN [7]

Parameters	Exp. Results	CAE Results	Variation
Deflection	79 mm	78.07 mm	1.1%
Bending Stress	221.5 N/mm	224.5 N/mm	1.35%
Spring rate	48 Kgf/ mm2	53.77 Kgf/ mm2	12.02%

Anand Kumar et.al [7] the primary difficulty in all vehicles is weight reduction while ensure proper functioning. The material used in this study is 55SI2MN90 for steel leaf and Glass-fibre 7781 for composite leaf spring. The work consists of a hand layup method and a mathematical calculation. The study also describes the production of a leaf spring, which is done using a wooden design. The pattern is constructed in accordance with the design dimensions. The hand layup approach was used to create the mono composite illustrated in Fig. 2.

Fig. 2 Final layout of Leaf [8]

Study of leaf spring on the basis of Mathematics and computational analysis

Anil Kumar et.al [8] the study done on the traditional steel leaf spring with varied composite materials such Graphite, Carbon, and E-Glass/Epoxy, as illustrated in Fig.3 and Fig.4, is included in the paper. The many impacts that occur on the operating state of a leaf spring are examined here using mathematics and the Ansys programme. The experiment is carried out with the assistance of ten leaf springs, two of which are full length and eight of which are graded. The stress-based analysis and modal analysis are carried out using the ANSYS programme, as illustrated in the figure below. According to the findings, the static analysis of steel leaf spring displacement is 92.59mm, which is less than the chamber length of the leaf spring and stiffness is 35.60mm.

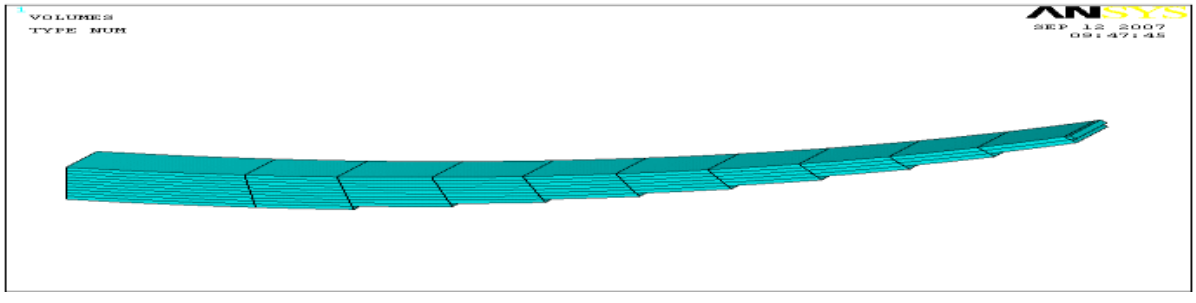

Fig. 3 Solid Model of Steel Leaf Spring [9]

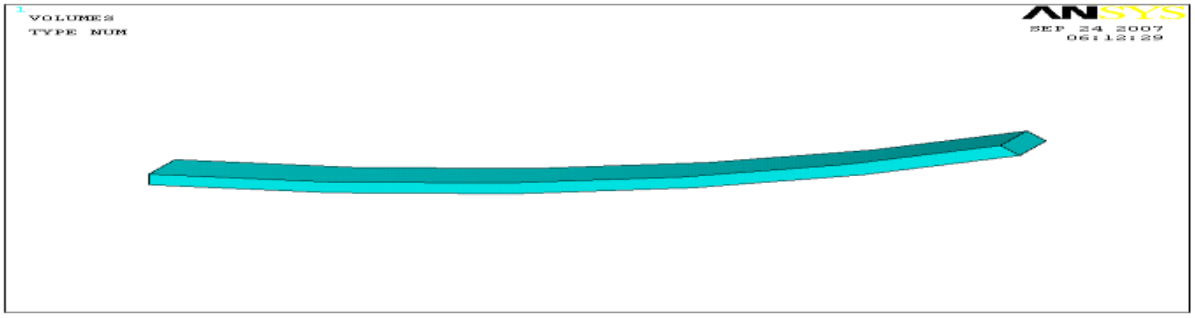

Fig. 4 Solid Model of E-Glass/Epoxy Mono Composite Leaf Spring [9]

Senthilkumar Mouleeswaran et.al [9] Because of load anomalies, the leaf spring exhibits vertical vibrations. A leaf spring accumulated potential energy in the form of strain energy, which it progressively released. As a result, maintaining the leaf spring material is an essential element, such as lowering the elastic properties in the longitudinal direction and increasing the strength.

Fig. 5 Electro-hydraulic leaf spring test rig. [10]

The work done here comprises of a study of the fatigue failure behaviour of a composite material under load. All of the analyses in this section is carried out using experimental and computer simulation. The electro hydraulic leaf spring test shown in Fig. 5 is carried out using steel and composite material variations under static load conditions. The results also showed that the natural frequency of the composite material leaf spring is 41.5Hz, which is 3.46 times higher than the load frequency, and that resonance would not occur.

M.M Patunkar et.al [10] A leaf spring is mostly used in commercial vehicles for suspension. The report here displays the investigation using static stress tests and the findings being recreated with a virtual model leaf spring constructed of composite material. The design is created using a virtual model created in Pro-E 5.0 CAD software and analysed in ANSYS 10.0. 60SI7 (BIS) is the material used for standard leaf springs, whereas Glass/Epoxy is utilised for composite leaf springs. A finite element analysis is being performed here to investigate cyclic creep and cyclic deformation of both kinematic and dynamic types, as indicated in the figure below. The findings indicated that, under the same conditions, the deflection of a composite leaf spring is less than that of a traditional leaf spring.

2. CONCLUSION

1. The research presented here provides a review of prior papers and journals based on various concepts and adaptations using mathematics, experimentation, and computational approaches. Now, in this section, we completed the important parameters analysed by us from the preceding papers' investigation.
2. The major section focuses on the materials used in the manufacture of leaf springs. Nowadays, composite materials are employed extensively as leaf spring materials in place of steel.
3. The primary components utilised in the manufacture of composite leaf springs are E-Glass/Epoxy, C-Glass/Epoxy, and S-Glass/Epoxy for weight reduction in comparison to standard steel leaf springs.
4. The major benefit of employing a composite material is that it increases the strength to weight ratio and has a stronger corrosion resistance.
5. Composite materials are more elastic than traditional materials (Steel).
6. The papers also demonstrate a significant amount of work done with the assistance of computational tools in order to save time and money while maintaining high accuracy.
7. The articles utilised here concentrate on various computational software's such as ANSYS, N-code design, and COMSOL for analysis and software's such as CATIA, CAD, and PRO-E for design. The study here presents a method named hand layup for quick and desired results with minimum time.

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