Structural Design and Analysis of Suspension Leaf Spring for Automobiles using Mono- Leaf Composite materials

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Abstract

The suspension of leaf spring, a potential component, is used to reduce unused weight in automobile. The used component reduces around ten to twenty percentage of the un-sprung weight. The use of composites leads to better suspension system with a better ride in automobile. Springs are known for their ability to absorb and store energy. The relationship between the particular strain energy and spring design can be described. The comfortable suspension system is guaranteed by the capacity to store and absorb more strain energy. It is obvious that materials with lower densities and moduli will have higher specific strain energy capacities. The use of composite materials decreases the weight of leaf spring weight without affecting the load. Composite is a very effective substitute material for traditional steel due to the achievement of weight reduction and adequate improvement of mechanical properties. Cost and material strength are taken into account while choosing a material. Leaf steel springs are being replaced with mono-leaf composite springs because composite materials have a higher strength to weight ratio and better elastic strain energy storage capacity than those made of steel. This study uses CATIA software to conduct a finite element analysis of the structural and mechanical characteristics of composite leaf spring suspension on cars and along with their benefits.

Keywords: Leaf Suspension Spring, Composite material, Finite Element Analysis

1. Introduction

The suspension of leaf spring, a potential component, is used to reduce unused weight in automobile. The used component reduces around ten to twenty percentage of the un-sprung weight. If it can be done without significantly raising costs or lowering quality and dependability, the use of composite materials in suspension system design helps create a better ride. Leaf spring absorbs and stores energy before slowly releasing it, the affiliation between the particular strain energy and the relationship can be represented. The suspension system is made comfortable by its capacity to store and absorb more strain energy [3]. The relationship between specific strain energy capacity and material modulus and density can be seen to be causal [4].

The advent of composite materials lightens the leaf spring without lowering the load. Composite becomes an effective substitute material for traditional steel and leads to the reduction in weight with an improvement in mechanical properties of leaf spring [4]. Cost and material strength are taken into account while choosing a material. Mono-leaf composite springs are used instead of leaf steel springs in

automobile. Mono-leaf composite springs possess higher strength to weight ratio and constitutes enhanced storage capacity of elastic strain energy compared to those made of steel.

Section 2, the study, which is organized as follows, examines the review of literature pertaining to the suggested analysis. The purpose of the research and its technique are presented in Section 3 with regard to finite element analysis of materials that enables modelling of the material utilising composite materials. In Section 4, the simulated analysis of the suggested research technique using the ANSYS software is presented in relation to the mechanical properties of the material. Section 5 concludes the task at the last place

2. Related work

In this section, finite element analysis of the suspension using CATIA[5] is carried out on the various composite materials and its properties. Further simulation analysis of those materials and its properties is evaluated using the ANSYS software [6].

2.1. FEA of Material Modification of Suspension using Leaf Spring with various composites

In this literature, FEA of Surface Modification of Suspension using carbon epoxy composite increase the stiffness and strength and weight of the material has been carried out on mechanical properties. Finite Element Analysis is also employed to analyze the stress and displacement in surface modifications of a suspension. The optimal surface modification to suspension is acquired depending on the stress distribution.

3. Proposed Methodology

In this section, definition of the composite material, Design of the life spring suspension using carbon fiber as composite materials has been carried out with following research objective. Further finite material analysis is carried out using CATIA design [8] is evaluated as simulation using the ANSYS.

3.1. Design Objectives of the Steel leaf spring suspension carbon Fiber composite material

- To reduce the suspension weight
- To increase the wear and corrosion resistance of the suspension Material
- To improve boundary conditions of piston Material
- To obtain the optimal input parameter to the composite material

3.2. Structural Design of the Leaf Spring Suspension using Composite material through CATIA

Structural Design of Suspension [9] using various structures is designed using various composite materials to meet the above-mentioned objectives. Composite material is a high precision material surface modification method. Design is carried out using CATIA software on modeling the design specification tree. Optimal Parameter to the composite material determines the model efficiency to withstand the material against large deformations. Suspension undergone surface modification to produce less weight and increase the speed 10]. Design Calculation of the leaf spring suspension using catia is as follows

Fixed Support

One of the leaf springs eye ends is connected to the car's chassis for the leaf spring analysis. Due to restrictions on X, Y, and rotation about that fixed point, fixed supports cannot be moved. Therefore, the leaf spring's fixed eye end has no degrees of freedom because it is immobile in all directions [11].

Load situation

Vehicle weight is 920 kg.

Maximum load bearing capability equals 5 times 100 kg.
Weight total: 920 + 500 = 1420 kg
Gravitational acceleration - g = 9.81 m/s2.
As a result, Total Weight (W) equals 1420 x 9.81 = 13931N.
Since the car has four wheels, a single leaf spring that corresponds to one of them weighs one-fourth of the entire thing.
There is a load of W=13931/4=3483N
On each wheel, Load on each eye of spring is 1742N

4. Simulation Analysis

In this section, finite element analysis of the various design structures of the leaf spring suspension material with carbon fiber material is analyzed using ANSYS software with respect to speed and weight [12]. Analysis includes selecting the material from the finite element methods to evaluate the mechanical properties of the composite material interface [13] for speed increasing on stress, strain and deformation.

Table 1: Finite Element Analysis of the Suspension with various composite material

Composite Material	Deformation(mm)	Stress(mpa)	Stiffness(N\mm)
Steel	0.142	18.8	1226.7
Multi layer Carbon Fiber	0.617	17.24	2809.6

Table 1 represents the finite element analysis of suspension with composite material such as steel and carbon fiber. Figure 1 represents the geometry, meshing and boundary condition of composite materials to suspension with steel and carbon fiber with loading and without loading

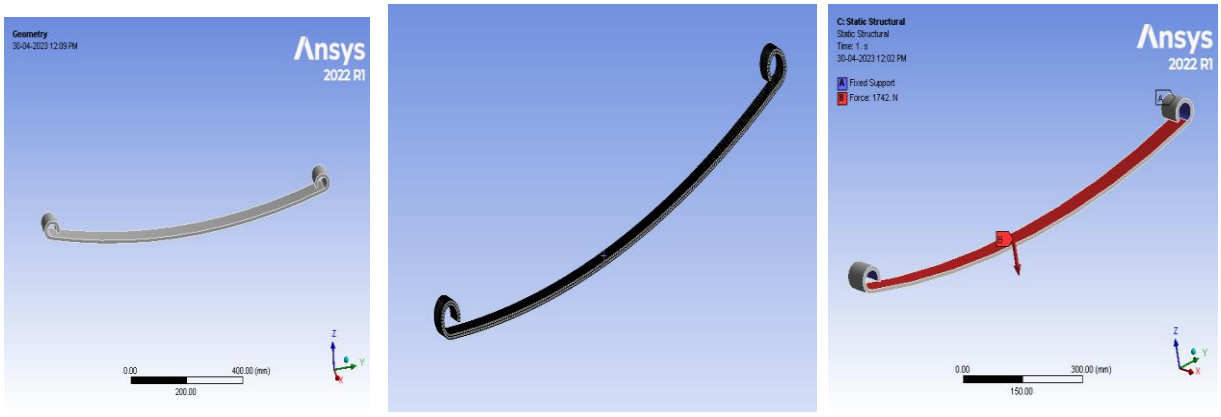

Figure 1: Design of the material with geometry, Meshing and boundary condition without loading

Evaluation of the coating material to suspension with loading as boundary condition is employed to the achieve speed, stiffness and reduced weight is carried out on the minimum and maximum of stress, strain and deformation is represented in figure 2.

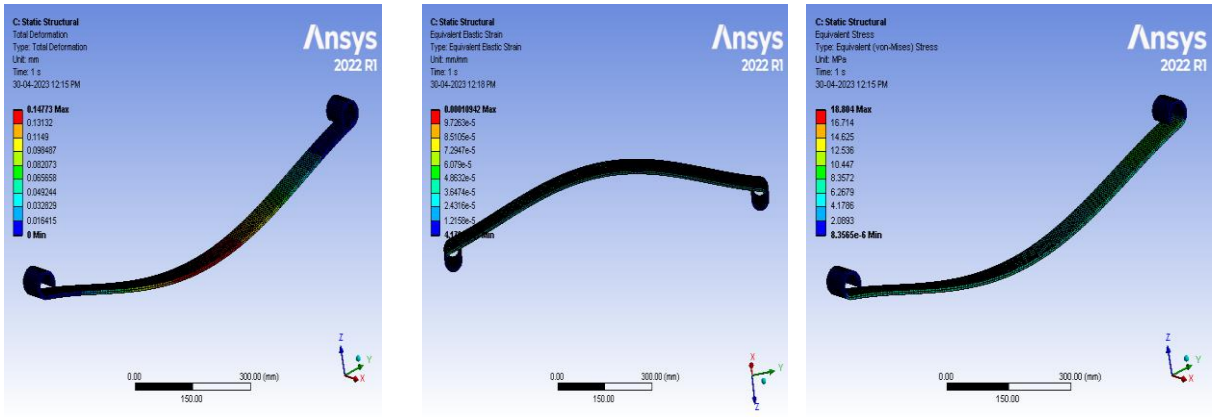

Figure 2: Design of the material with loading using steel material leaf spring

Evaluation of the coating material to suspension with loading as boundary condition is employed to the achieve speed, stiffness and reduced weight is carried out on the minimum and maximum of stress, strain and deformation is represented in figure 3. Steel leaf spring is applied with the load of 1742. The maximum deflection is observed at the centre of the leaf spring with the maximum value of 0.6.17 mm. Red zone is the area of maximum deflection and blue zone is the area of minimum deflection.

Stiffness =Force /displacement

=1742/0.6

=2809.6N/mm

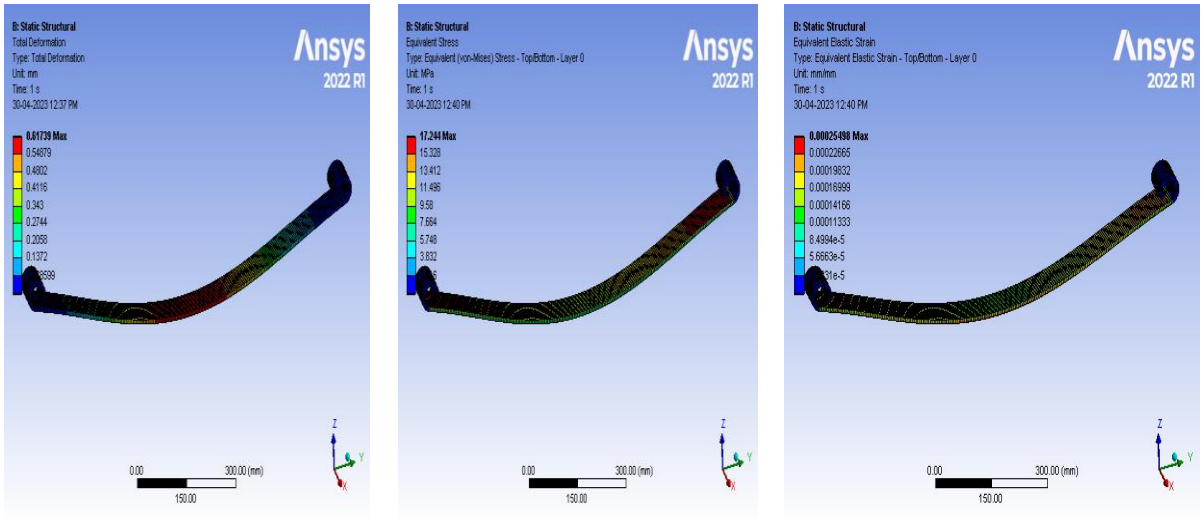

Figure 3: Design of the material with loading using Composite material carbon fiber to leaf spring

When finding the stiffness values,
Stiffness =Force /displacement
=1742/0.6
=2809.6N/mm

Conclusion

This article contains a structural analysis of a leaf spring made of steel and the design of a composite leaf spring. Comparing steel and composite leaf springs with the same load carrying capacity and design has been done. For steel leaf springs and composite leaf springs, the stress and displacement stiffness have been analytically computed using ANSYS. According to the findings of the static study, the steel leaf spring has a maximum displacement of 0.142 mm, and the comparable displacements in the combined carbon fibre are Epoxy Carbon Woven (395 GPa) and PrepregEpoxy Carbon Woven (230 GPa). 230 GPa PrepregEpoxy Carbon PrepregCarbon Fibre (230 GPa) had a diameter of.617mm and was oriented at a zero-degree angle.

According to the findings of the static analysis, the von-Mies stress in a steel leaf spring is 18.8 MPa, while the stress in a leaf spring made up of composite material is 17.244 MPa. Compared to traditional steel leaf springs, the composite leaf springs' entire material has less stress. Steel and composite leaf springs have been compared in terms of their force-to-displacement ratios, or stiffness qualities. Steel material has a 1226.7N/mm density while composite leaf springs have a 2809.6N/mm density. When compared to the other material, multilayer composites have higher rigidity and can withstand higher loads.

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