Experimental investigation on the performance Analysis & Optimization of Conventional Leaf Spring

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Abstract

Increasing competition and innovation in automobile sector tends to modify the existing 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 one of the oldest suspension components that are being still used widely in automobiles. Weight reduction is also given due importance by automobile manufacturers. The automobile industry has shown increased interest in the use of composite leaf spring in the place of conventional steel leaf spring due to its high strength to weight ratio. The introduction of composite materials has made it possible to reduce the weight of the leaf spring without any reduction in load carrying capacity and stiffness. Therefore the objective of this paper is to present a general study on the performance comparison of composite (Glass Fibre Reinforced plastic-GFRP) leaf spring and conventional leaf spring. Leaf spring is modelled in Unigraphics NX4 software and it is imported in ANSYS 11.0. The conventional steel leaf spring and the composite leaf spring were analyzed under similar conditions using ANSYS software and the results are presented. An E glass/Epoxy composite leaf spring is fabricated using hand layup method. The composite and steel leaf spring is tested using universal testing machine and the results are compared.

Keywords:- Leaf spring, Composite, Glass Fibre Reinforced Plastic (GFRP).

I. Introduction

At first known as secured, a leaf spring is a direct sort of spring, generally utilized for the suspension in wheeled vehicles. It is also maybe the most prepared sort of springing, returning to medieval events. Once in a while insinuated as a semi-round spring or truck spring, it shows up as a thin curve formed. The point of convergence of the roundabout section offers region to the center point, while tie holes are offered at either end to associating with the vehicle body. For generous vehicles, a leaf spring can be created utilizing a couple of leaves stacked on head of each other in a couple of layers, often with intelligently shorter leaves. Leaf springs can serve finding & to some degree damping similarly as springing limits. While the interleaf granulating provides a damping action, it isn't all around controlled & realizes in the development of the suspension. Thus creators have attempted numerous things with mono-leaf springs. A leaf spring can either be added direct to the edge at the two terminations or joined really toward one side, regularly the front, with the furthest edge associated. [1]

There were a variety of leaf springs, customarily using "round". "Bended" or "full bended" leaf springs insinuated two round twists associated at their tips. This was joined to the edge at the top point of convergence of the upper round section, the base network was joined to the "live" suspension parts, for instance, a solid front rotate. Additional suspension parts, for instance, following arms, would be required for this arrangement, anyway not for "semi-round" leaf springs as utilized in the Hotchkiss drive. That utilized the lower roundabout section, thusly its name. "quarter-elliptic" springs routinely had the thickest bit of the heap of leaves stuck.. As a substitute for dampers (shields), a couple of creators laid non-metallic sheets in the metal leaves, for instance, wood. Normally whenever utilized in vehicle suspension the leaf the two support a center point & finds/not completely finds the rotate. This can provoke managing issues, (for instance, 'center drifter'), as the versatile thought of the spring makes careful control of the unsprung mass of the center point irksome. Some suspension plans which utilize leaf springs don't utilize the leaf to discover the center & don't have this drawback. The Fiat 128's back suspension is a model. [2]

Figure 1 A conventional leaf spring game plan.

2. Literature Review

M.L. Aggrawal et al. [2015] Fatigue of the leaf blowing condition from the beginning of the EN45 iron spring research office has been resolved. The basic level of testing is designed to reverse the state of fatigue by tightening the grip on the push field in this area that has been exposed to shooting through [1].

B. Vijaya Lakshmi, et. al [2016] looked at a passing stack on cutoff, intellectual property & weight resources for spring-loaded spring-loaded spring. C-GLASS / EPOXY, S-GLASS / EPOXY for unwanted spread. PC / Engine configuration programs are utilized for emergence & COSMOS is utilized for testing. Strict & robust spring strength testing of Leaf was performed using COSMOS [2].

Ashish V. Amrute et al. [2017] Supervising the installation of a standard spring (65si7) spring for a simple commercial vehicle with a leaf-bearing start using E-glass / Epoxy. The combination of a combined spring leaf should be taken as a similar measure of the traditional spring leaves. The goal is to look for a stack that conveys cutoffs, pesters & resources for spring leaf weight. The binding part from which the spring is tested is made. The spring-loaded CAE test is performed for loading & unloading under illustrated placement conditions. The hypothetical effects & CAE are painted down with the help [3].

Mininu Iwata et al. [2019] Introduced as a flexible & flexible structure in the polyimide chain using non-abrasive dianhydride & started late making polyimide have all this thermo pliability depletion. To determine the polyimide utilized late in radiation quality, they illuminated polyimide with a proton bar, studied its durability through mechanical properties, & isolated & became familiar with standard commercial polyimide. The basic departure occurred exactly as expected, they were able to determine the initial high radiation exposure of thermoplastic polyimide [4].

Parkhe Ravindra et. al [2019] Describes the design & testing of a mono leaf icon made of Carbon / Epoxy synthetic materials & became familiar with weight proximity as a metal spring. Chart requirements were victimized & redirected. Combined seedlings of mono leaves have been identified by Varying cross-locale, unidirectional [5].

Prof.A.V.Javir1 et al [2019] both are centers around the leaf blade where springs are one of the most frequently utilized parts of the suspension, especially in commercial vehicles. Previous demonstration studies show that leaf springs are well formed as they summarize the energy components where the position, speed & course of the increase in supply provides the ability to respond to the joint positions of the body. Another component to be protected, the automotive business has shown an increased enthusiasm for the extinction of the spring metal with a round leaf considering the maximum durability of the weight. In the same way, the composite material testing of the composite material up to the middle is similarly considering the lead of the Composite Leaf Spring. The purpose of this report is to present the appearance & analysis of the mono leaf spring (GFRP) leaflet & to consider its effects. Demonstration is complete using Pro-E 5.0 & Analysis is performed using ANSYS 13.0 software. [6]

K.Ashwini et. al. [2019] This study is relied upon to be a comprehensive hotspot to control leaf springs using a variety of features as Automobile organizations show a strong enthusiasm for installing steel leaf & spring leaf blend to ensure weight loss, is an amazing measure of weight protection as it reduces total fuel consumption [7].

Mayur D. Teli et. al [2019] The electric motor pack is far & away where it sees that excessive battery capacity (> 10% whenever weight undoubtedly) reduces the rate of development of electric vehicles. This heavy battery load creates a high load of resources & somehow clutters the open space of fixed travel which reduces the life of the suspension & the comfort of the trip. To address these issues, suspensions must be reconsidered in math & suspension objects. Considering the further changes in the suspension structure ,, the twisted one is made certain of the type. [8]

3. Methodology

3.1 Presentation

ANSYS is extensively helpful restricted part assessment (FEA) programming group. Restricted Element Analysis is a numerical procedure for deconstructing an erratic structure into small amounts (of customer relegated size) known as parts. The item completes conditions that manage the lead of these segments & lights up them all; making an exhaustive explanation of how the structure goes about by & large. These results by then can be presented in arranged, or graphical structures. This sort of examination is conventionally utilized for the structure & improvement of a system unnecessarily complex to separate by hand. Systems that may fit into this arrangement are unnecessarily awesome in light of their math, scale, or directing conditions. ANSYS is the standard FEA demonstrating gadget inside the Mechanical Engineering Department at numerous schools. ANSYS is moreover utilized in Civil & Electrical Engineering, similarly as the Physics & Chemistry workplaces. ANSYS provides a viable strategy to explore the display of things or strategies in a virtual circumstance. This sort of thing progression is named virtual prototyping. With virtual prototyping strategies, customers can rehash numerous circumstances to improve the thing some time

before the amassing is started. This engages a reduction in the level of danger, & in the cost of insufficient plans. The multifaceted thought of ANSYS moreover provides an approach to ensure that customers can see the effect of an arrangement with everything taken into account lead of the thing, be it electromagnetic, warm, mechanical, etc.

- Develop Geometry
- Portray Material Properties
- Produce Mesh
- Apply Loads
- Get Solution
- Present the Results
- Unequivocal Capabilities of Ansys
- Static Analysis
- Modular Analysis
- CAD MODELING
- Boundary Condition & Loading

4. Experimental Set up

4.1 Auxiliary Analysis of Master Leaf Spring At The Numerous Load

For the auxiliary examination of ace leaf spring, there are 03 kinds of material utilized & one sorts of burden extend is chosen for better development of the spring. In the current work aftereffect of all materials limited uniquely for greatest pressure incited during the investigation & most extreme distortion in leaf spring body.

4.2 Calculation:

Our specification
Full length leaf (n1) = 1015 mm,
First graduated leaf (n2) = 955 mm,
Second graduated leaf (n3) = 875mm,
Third graduated leaf (n4)= 765 mm ,
Fourth graduated leave (n5)= 675mm
Fifth graduated leaf (n6) = 575 mm,
Six graduated leaf (n7) = 475mm,
Seven graduated leaf (n8)= 375 mm
Thickness of leaves (t) = 11 mm
Width of leaf (b) = 59 mm
"U" bolt centre distance (l) = 135mm
Young modulus (E) = 210 GPa
= 2L1 = 101.5cm = 1015mm
Assuming factor of safety=1.33
Number of full length leaves = 1 = Nf
Number of graduated leaves = 7 = Ng
Number of springs = 08= (Ng+ Nf)
Load = Total load / No. of springs
Weight of vehicle (Gross Vehicle Weight) GVW= 3245 kg
Now 2W = weight of vehicle x 9.81/ No. of spring
2W = 3245x 9.81 / 04
W = 31833.45/ 08 = 31834/08
W = 3979.3 N or 4000 N
2L (Span) = Length of master leaf - 2/3 x U bolt centre distance
2L = 1015 – 2/3 x 135
2L = 925
L = 463 mm
Bending Stress (ϭ) = 18 W L/ bt2 (2 ng + 3nf)
= 18x 4000 x 463/ 59 (11)2 (2 x 7 + 3 x1)
= 3, 33, 36,000/ 123420
Bending Stress (ϭ) = 270.1 MPa
Deformation (ƍ) = 12WL3/ Ebt3 [2ng+3nf]
= 12 x 4000x (463)3 / 73000 x 103 x 59 x (11)3 (2 x 7 + 3 x1)
Deformation (ƍ) = 115 mm
Stiffness spring
K = 8 E n b t3/ 3L3
K = 8 x 210x103 x 59 x 11x8 / 3x (955)3
K = 404 N/mm

5. Result & Discussion

The deflection (mm) & maximum stress (MPa) on different material at 4750N. These analysis are done in ANSYS 19.2 & standard working conditions.

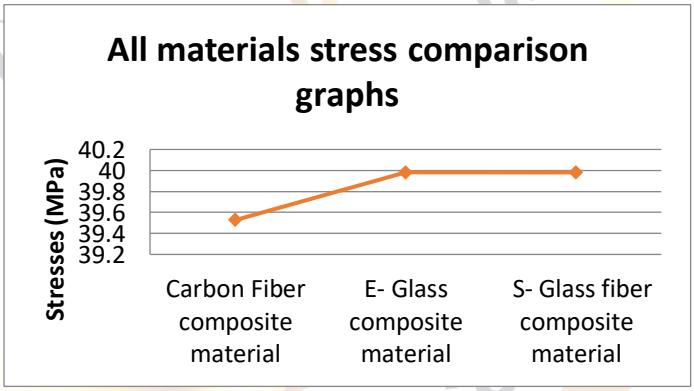

Figure. 2 All materials stress comparison graphs

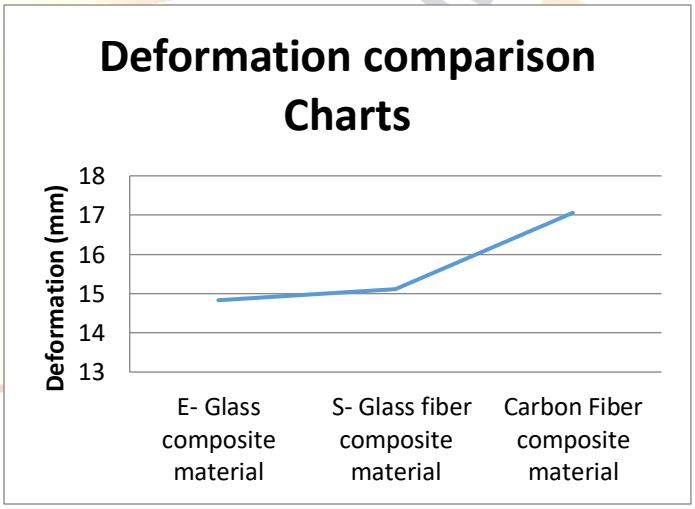

Figure. 3 All materials deformation comparison graphs

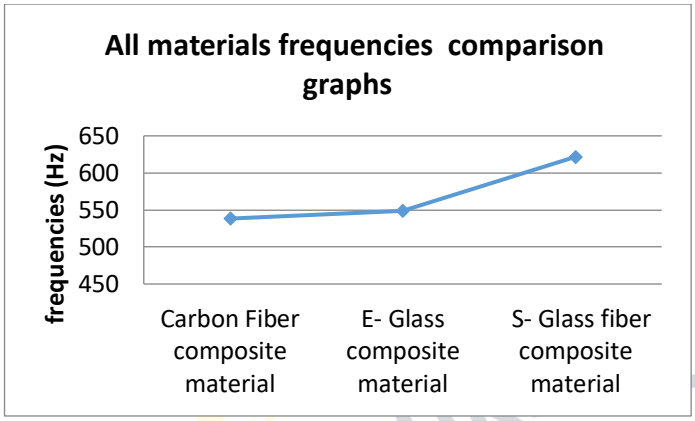

Figure. 4 All materials frequencies comparison graphs

6. Discussion

In our study we take exiting model materials Spring steel E glass composite materials which is using cars. Those load centre of spring is mounted 4500 N. Then we take our results for three materials E glass , S glass Carbon Fibre.

In this study find out stress, deformation , frequency & weight value with all three materials.

Find out stress value with all three materials likes E glass , S glass Carbon Fibre then stress value are respectively 39.982 MPa, 39.982 MPa & 39.5 MPa

Find out maximum deformation value with all three materials likes E glass , S glass Carbon Fibre then stress value are respectively 14.83mm, 15.12 mm & 17.06 mm.

Find out maximum frequency value with all three materials likes E glass , S glass Carbon Fibre then stress value are respectively 548.97 Hz, 621.62 Hz & 538.32 Hz

Find out maximum weight value with all three materials likes E glass , S glass Carbon Fibre then stress value are respectively 11 kg, 10 kg & 7 kg

In all results find out carbon fiber composite material is best comparison all, materials because its have less value of deformation at frequency with modal analysis . So this material can be suggested in future design.

7. Conclusion

The following conclusion can be drawn from above work:-

For E- Glass spring – the mean deflection developed in the master leaf spring at load of 4500 N is 14.85 mm at maximum frequency 548.97 Hz. So cause of vibration because level of frequency is more compared to Carbon fiber material.

Deflection developing is 17.06 mm which are too low at low frequency with 4 mode 538.32 Hz. which is also too low & this material can sustain the load as the conventional spring material but are thing is positive regarding weight because Carbon Fiber is light weight to steel 35 % weight reduction with E -Glass materials..

8. Future Scope of Work

1. Other new composites can be tried likewise to have more choices for the assembling of leaf spring.
2. This work can be stretched out by breaking down leaf spring under unique conditions, since just static stacking case is considered here.

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