ISSN : 2455-9679
Impact Factor : 2.015

IJRTSM
INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"Design & Static Analysis of Leaf Spring using FEA Method By ANSYS"

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ABSTRACT

In this research work an attempt has been made to check the suitability of composite materials like Carbon Fiber /EN 45 Spring Steel for light commercial vehicle leaf spring. First the static analysis is carried out for steel and different composite leaf spring using FE solver ANSYS V17.0 and modeling has done by CATIA V5R20 The obtained results are compared with theoretical values and observed that they have good agreement with each other. From the results it can be concluded that Carbon Fiber materials are best suitable composite material for leaf spring.

Keyword: *EN45, Carbon Fiber, ANSYS, CATIA, Leaf spring, Steel*

I. Introduction

Mechanical framework which comprises of springs and safeguards. The car suspension is mounted on the axles, not coordinate but rather some type of springs. This is done to separate the vehicle body from the street stuns, which might be as bob, pitch, roll or influence. These inclinations offer ascent to an uncomfortable ride furthermore cause extra stretch in the vehicles outline anyone. In suspension framework the vitality of street stun cause the spring sway. These motions are limited to a sensible level by damper which is all the more ordinarily called a safeguard.

A leaf spring is a straightforward type of spring regularly utilized for the suspension as a part of wheeled vehicles initially called a covered or carriage spring, and here and there alluded to as a semi – curved spring or truck spring or level plate. The configuration of leaf spring should be possible in two ways one the mono leaf spring or the multi leaf spring.

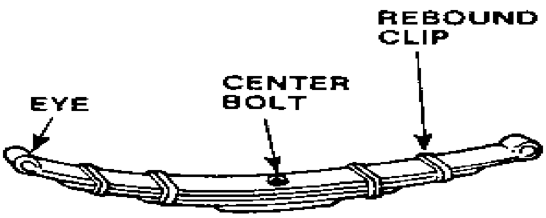

Figure.1

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II. PROBLEM IDENTIFICATION

As weight plays an important role in deciding the efficiency of an automobile. The leaf spring used generally is made of steel which are quite bulky and one of the potential items for weight reduction in automobiles because it accounts 10-20% spring weight carried by its own. To avoid this disadvantage and comfort riding qualities an attempt is to be made in replacing the material with advanced materials like composite materials. This work is mainly focused on the implementation of Thermoplastic polyimide with 30% carbon fiber reinforced (composite material) by replacing steel En 45 in conventional leaf springs of a suspension system to reduce product weight, improving the safety, comfort and durability.

III. OBJECTIVES

The main objective of present work is to investigate the best suitable composite material for automobile leaf spring application.

- To compare the load carrying capacity, stresses, deflection and weight saving at same load applied to composite leaf spring with that of conventional leaf spring.
- The present work also concentrate on the implementation of composite material by replacing steel in conventional leaf springs of a suspension system to reduce weight, improving safety, comfort and durability.
- To design and evaluate the composite leaf spring for automobile suspension system under the condition of static load

IV. SPECIFICATION

4.1 Tavera Car Specifications

Sr. NO.	Parameter	Values
1	Total Length of the spring (Centres of Eye to Eye)	1200 mm
2	Free Camber (At no load condition)	240 mm
3	No. of full length leave (Master Leaf)	01
4	No. of full Graduated leave (Master Leaf)	04
5	Graduated first leave	1000mm
6	Graduated Second leave	900mm
7	Graduated Third leave	700mm
8	Graduated Fourth leave	575mm
9	Thickness of leaf at centre	08 mm
10	Distance between U bolt	80mm

Sr. NO.	Parameter	Values
11	Width of leaf spring	60 mm
12	Kerb Weight of vehicle (Tavera Car)	16600 N
13	Max. Load given on spring	23750 N
14	Young's Modulus of the spring	210x 10^3N/mm^2

Figure 4.1 Tavera Car

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4.2 Materials properties of conventional Leaf Spring

Table 4.2 Materials Properties
(EN 45 springs steel 55 Si2Mn90)

Parameters	Specification
Material	EN 45 (**55 Si2Mn90**)
Tensile Ultimate Strength	2000Mpa
Tensile Yield Strength	1500 Mpa
Density	7860 kg/m^3
Poisson's Ratio	0.3
Young's Modulus	210 x 10^3 Mpa

Table 4.3 New materials Carbon Fiber Mechanical Properties

Material Field Variable	Value	Units
Density	1950	Kg/m^3
Young's modulus	300000	Mpa
Poisson Ratio	0.3	
Tensile Strength	5090	Mpa
Compressive Strength	1793	Mpa

V. ANALYTICAL CALCULATIONS

Our specification

Full length leaf (n_1) = 1200 mm,
First graduated leaf (n_2) = 1000mm,
Second graduated leaf (n_3) = 900mm,
Third graduated leaf (n_4)= 700mm ,
Fourth graduated leave (n_5)= 575mm
Thickness of leaves (t) = 8 mm
Width of leaf (b) = 60mm
"U" bolt centre distance (l) = 80mm
Young modulus (E) = 210 GPa
Car Gross weight (Tavera Car) = 2375 kg = 2375 x 9.81 = 23298 N
Centre load = Total load/ No. of Spring
2W = Gross weight/ No. of Springs
2W = 23298/5
W = 4750 N

Now

2L (Span) = Length of master leaf - 2/3 x U bolt centre distance
2L = 1200 – 2/3 x 80 = 1146

L = 574 mm

$(\sigma) = 18 \times 2375 \times 574 / 60 \times (8)^2\ [2\times4 + 3\times1]$
$(\sigma) = 49077000/19800 = 569$ MPa
$\delta = 12WL^3 / Enbt^3\ [2n_g+3n_f] = 12\times 2329\times (574)^2 / 210\times10^3\times60\times(8)^3 [\ 2\times4 + 3\times1]$

δ =74mm

Radius of curvature (R) = $(L_1)^2/2y$
R = $(600)^2/ 2\times240 = 750$ mm

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VI. MODELING & SIMULATION

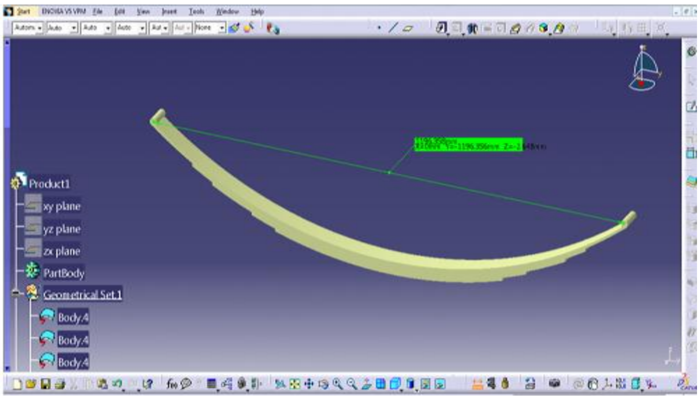

Figure6.1 CATIA Modeling leaf spring

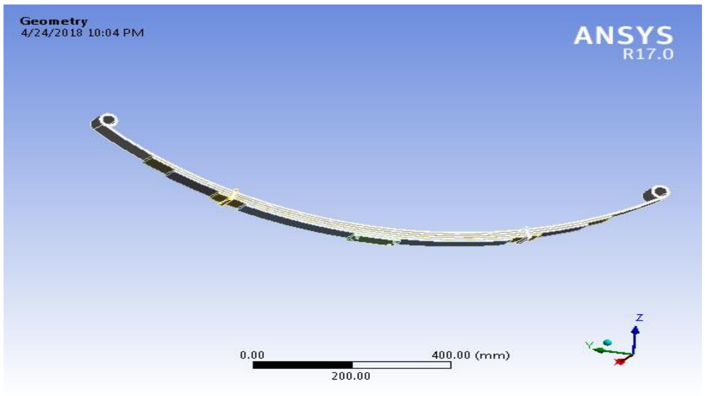

Figure6.2 Model import in ANSYS for simulation

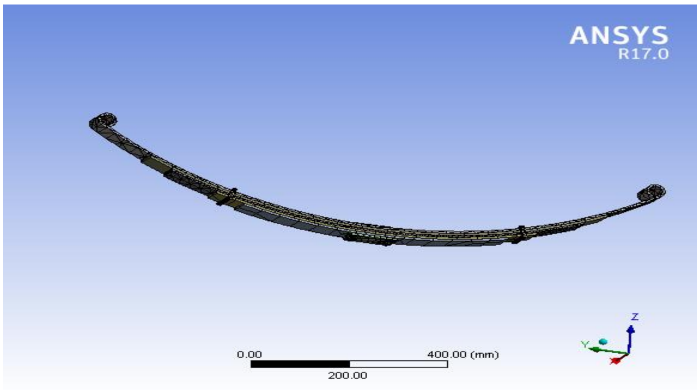

Figure6.3 Meshing Leaf spring model

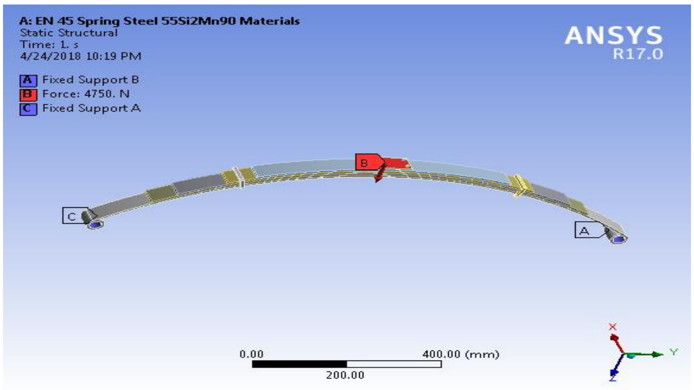

Figure6.4 Boundary condition applied

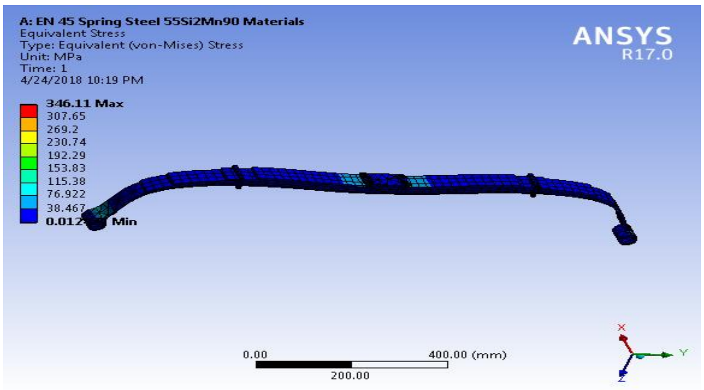

Figure 6.5 Von misses stress for EN 45 materials

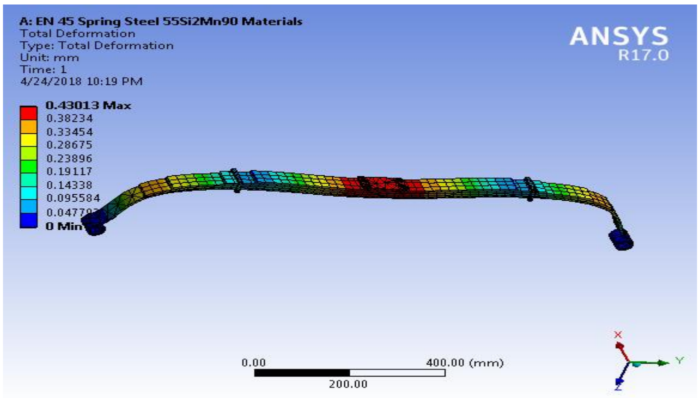

Figure 6.6 Deformations for EN 45 materials

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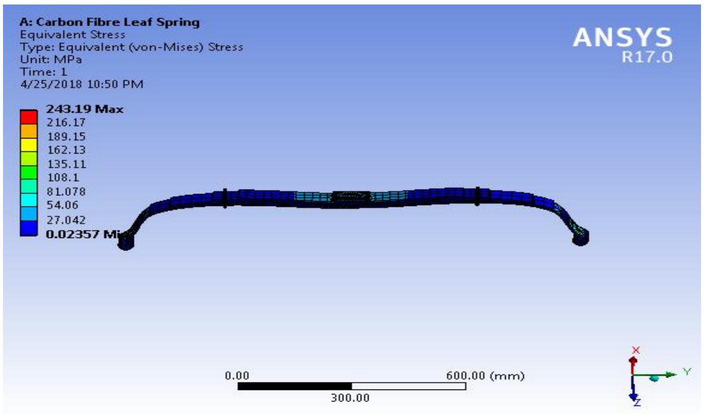

Figure 6.7Von misses stresses for Carbon Fiber materials

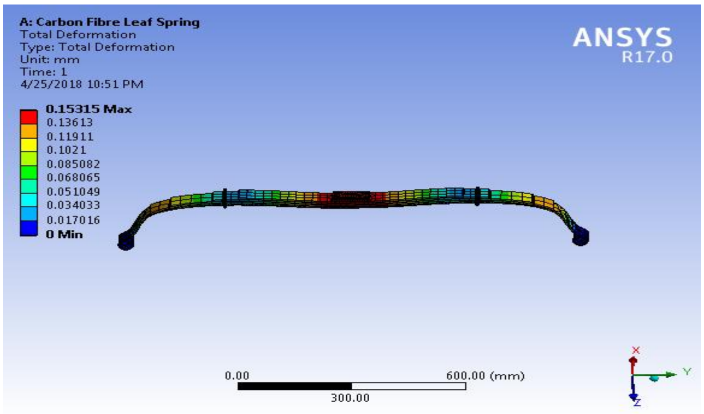

Figure 6.8 Deformation for Carbon Fiber materials

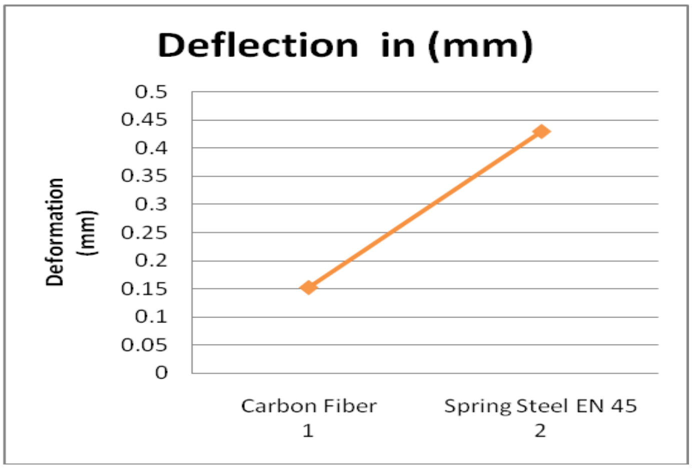

Figure 6.9 Deflection comparison between materials

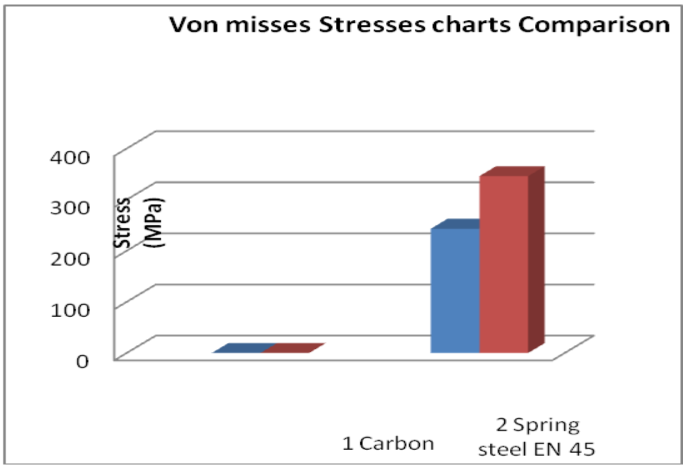

Figure 6.10 Stresses comparison between materials

VII. RESULT & DISCUSSION

In our study we take exiting model materials Spring steel EN 45 which is using cars and we take here Tavera Cars spring with 2375Kg gross load. Those load centre of spring is mounted 4750N. Then we take our results for two materials EN45 and Carbon Fiber.

For EN 45 spring steel – the mean deflection developed in the master leaf spring at load of 4750 N is 0.43 mm deflection and maximum stress is 346.11 Mpa, and stress is safe in all respect and when we used new materials a Carbon Fiber 0.153 mm deflection and maximum stress is 243.19 Mpa, and stress is safe in all respect and but the weight of the this material will be light weight, hence design is safe expect weight**.**

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VIII. CONCLUSION & FUTURE SCOPE

- For EN 45 spring steel – the mean deflection developed in the master leaf spring at load of 4750 N is 0.43 mm and maximum stress is 346.11 Mpa, the deflection and stress is safe in all respect.
- Carbon Fiber with 20% glass fiber the max. Deflection developing is 0.153 mm which are too low and the max. stress is 243.11 MPa which is also too low and 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 2/3 weight of steel.

FUTURE SCOPE OF WORK

- Other new composites can be tested in a similar way to have more alternatives for the manufacturing of leaf spring.
- This work can be extended by analyzing leaf spring under dynamic conditions, since only static loading case is considered here.
- The design of leaf spring can also be optimized by using either "Constant width and varying thickness design" or "Constant thickness and varying width design" as well as in Multiple leaf spring.
- In future this kind of spring can be used in the vehicles, which are more efficient and responsive.

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