COMPARISION OF THE STATIC ANALYSIS OF COMPOSITE AND CONVENTION LEAF SPRING USING FEA PACKAGE

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Abstract— *Leaf springs are one in every of the oldest suspension parts they're still oftentimes used, particularly in industrial vehicles. the car business has shown accumulated interest within the replacement of steel spring with varied composite materials (structural steel al alloy grey iron atomic number 22 alloy) spring owing to high strength to weight magnitude relation. Composite materials are one in every of the fabric families that are attracting researchers and being solutions of such issue. This work is dispensed on multi spring consist 3 full length leaves during which one is with ox-eyed ends employed by a light weight industrial vehicle. This work deals with replacement of standard steel spring of a light weight industrial vehicle with composite spring mistreatment composite materials. Dimensions of the composite spring are to be taken as same dimensions of the standard spring. the target is to match the load carrying capability, stresses and weight savings of composite spring therewith of steel spring. The finite component modeling and analysis of a multi spring has been dispensed. The fuel-air explosive analysis of the multi leave spring is performed for the deflection and stresses below outlined loading conditions. The Theoretical and fuel-air explosive results are compared for validation...The analysis of the spring is finished mistreatment ANSYS package, that is user friendly.*

Introduction

To meet the needs of natural resources conservation, energy economy and improving the riding qualities, attempts are being made to reduce the weight of the vehicles in the recent years.

To reduce the vehicle weight, three techniques have been studied

1)Rationalizing the body structure
2)Decreasing the size of the vehicle
3)Utilizing the lightweight materials for parts.

The first two techniques are not preferable. So, the third one of utilizing the lightweight materials is taken up. Materials that can be considered for the above purpose are composite materials, high strength low alloy steels (HSLA) and plastics. Out of them, composite materials are chosen to replace steel because of their advantages like high strength-to-weight ratio, excellent corrosion resistance, high fatigue strength etc. Leaf springs account for ten to twenty percent of the unstrung weight of the suspension system. Hence there is a great scope for using the light weight composite materials. Depending up on the factors like cost, durability etc, E-glass is chosen for this purpose. The leaf spring behaves like a simply supported beam, which is subjected to both bending stress and transverse shear stress. Flexural rigidity is an important parameter in the leaf spring design and it should increase from the two ends to the center. This concept gives the constant cross-sectional area design. In this design, both the thickness and the width are varying throughout the leaf spring. The above design can be supported with some design

After designing the leaf spring, the static analysis is done using the ANSYS Package , which works on the basis of Finite Element Method.

NOMENCLATURE

Δ	=	Static deflection of the spring
W	=	Static load is applying on the spring
2L	=	Distance between the eyes
K	=	Spring rate
R	=	Reaction at bolted ends
L	=	Length of plate
A	=	Cross sectional area
E	=	Young's modulus of the material
I	=	Moment of inertia
n_G	=	Number of graduated leaves
n_F	=	Number of full length leaves
n_b	=	Number of bolts for fixing metallic eye
b_m	=	Width at middle
d_b	=	Bolt diameter
t_m	=	Thickness at middle
t_c	=	Thickness of leaf spring at bolt end
Σmax	=	Maximum allowable bending stress
Δmax	=	Maximum deflection allowable
b_c	=	Width of the leaf at end
Σmax	=	Allowable bending stress
F.S	=	Factor of safety

1.2 PROBLEM DEFINITION

Suspension leaf spring is one of the potential items for the weight reduction in the automobiles as it results in large unsprung mass of the automobiles Leaf spring accounts for 10 to 20 percent of the unsprung weight. This is because of the fact that steel is used as the material for the leaf spring, whose mass density is high.

1.3 OBJECTIVE OF THE PROJECT

The objective of this project is to find the suitable substitute to the conventional leaf spring, with higher strength-to-weight ratio, superior fatigue strength and high specific strain energy storage capacity.

For that we have to replace the materials (steel) that is used in conventional leaf spring with a composite material (various alloys). Then, the composite leaf spring must be designed such that the fabrication of the leaf spring must be easy. Thereafter, by using the ANSYS package the static analysis of the designed composite leaf spring is to be done.

LITERATURE SURVEY

SUSPENSION SYSTEM

Suspension system is one of the important systems in an automobile. It performs the function of isolating the automobile from the road shocks, which may be in the form of bounce, pitch, roll or sway.

Suspension system consists of a spring and a dumper. The energy of the road shock causes the spring to oscillate. These oscillations are restricted to a reasonable level by the damper, which is more commonly called a shock absorber.

2.2.1 OBJECTIVES OF SUSPENSION

- To prevent the road shocks from being transmitted to the vehicle components.
- To safe guard the occupants from the road shocks.
- To preserve the stability of the vehicle in pitching or rolling, while in motion.

2.2.1
2.2.2 BASIC CONSEDARETIONS

The following are the some of the basic considerations of the suspension system.

- Vertical loading
- Rolling
- Brake dip
- Side Thrust
- Unsprung weight

MATERAILS FOR LEAF SPRINGS

The materials used for leaf springs is usually a plain carbon steel having 0.09 to 1.0% carbon. The leaves are heat treated after the forming process. The heat treatment of spring steel produces greater strength and therefore greater load capacity, greater range of deflection and better fatigue properties. Silicon manganese steels & vanadium steels are also used.

According to Indian standards, the recommended materials are:

1.For automobiles:50Crl, 50CrlV23, 55Si2Mn90 all used in hardened and tempered state. 2.For rail road springs: C55 (water-hardened), C75 (oil-hardened),

40Si2Mn90 (water- hardened) and 55Si2 Mn90 (oil-hardened).

STRESS IN LEAF SPRINGS

Consider a single plate fixed one end and loaded at the other end. This plate may be used as a flat spring.

Let t = Thickness of plate,

B = width of plate and

L = Length of plate or distance of the load W from the cantilever end.

We know that the maximum bending moment at the cantilever end A.

M = W.L

and section modulus $Z = I/y = \frac{bt^3/12}{t/2} = \frac{bt^2}{6}$

Bending stress $\sigma = M/Z = \frac{6Wl}{bt^2}$

We know that the maximum deflection for a cantilever with concentrated load at the free end is given by $\delta = \frac{Wl^3}{3EI} = \frac{Wl^3}{3E*bt^3/12}$

It may be noted that due to bending moment, top fibers will be in tension and the bottom fibers are in compression, but the shear stress is zero at the extreme fibers and maximum

COMPOSITE MATERIALS

Composite material is a substance that is made up of a combination of two or more different materials. A composite material can provide superior and unique mechanical and physical properties because it combines the most desirable properties of its constituents. While suppressing their least desirable properties (for example, a glass-fiber reinforced plastic combines the high strength of thin glass fibers with the ductility and chemical resistance of plastic ,the brittleness that the glass fibers have when isolated is not a characteristic of the composite). The opportunity to develop superior products for the aerospace and motor vehicle industries, and recreational applications, has sustained the interest in advanced composites. Currently composites are being considered on broader basics for applications that include civil engineering structures such as bridges and motorway pillar reinforcement and for biomedical products, such as prosthetic devices.

Composite materials usually consist of synthetic fibers embedded within a matrix, a material that surrounds and is tightly bounded to the fibres.The most widely used type of composite material is polymer composites (PMCs). PMCs consist of fibers made of a ceramic material such as carbon or glass embedded in a plastic matrix. Typically, the fibers made up about 60% of a polymer matrix composite by volume. Metal matrices or ceramic matrices can be substituted for the plastic matrix to provide more specialized composite system called Metal matrix composites (MMCs) and Ceramic Matrix composites (CMCs) respectively.

The fibrous reinforcing constituent of composites may consist of thin continuous fibers or relatively short fiber segments. When using short fiber segments, however, fibers with a high aspect ratio (length-to-diameter ratio) are used .

Design requirements for composite leaf springs:

Continuous fiber composites are generally required for high performance structural applications. The specific strength (strength-to-density) and specific stiffness (elastic-modulus-to- density ratio) of continuous carbon fiber PMCs, for example, can be vastly superior to conventional metal alloys.

MATERIAL SELECTION

As there are large numbers of composites materials available, it is important to select a composite material that is suitable as per our requirement. The material selection must be based on the cost factor and strength. For that purpose both fiber and resin must be selected.

MATERIAL FOR CONVENTIONAL STEEL LEAF SPRING Conventional steel leaf springs are manufactured by EN45, EN45A, 60Si7, EN47, 50Cr4V2, 55SiCr7 and 50CrMoCV4 etc. These materials are widely used for production of the parabolic leaf springs and conventional multi leaf springs. In general terms higher alloy content is mandatory to ensure adequate harden ability when the thick leaf sections are used. Plain structural steel, Titanium alloy, alloy and gray

The maximum load action on the spring for two wheels = 5000N

The maximum deflection allowable δ_{max}=160mm

Static load in applying in the spring W=2500N

Static deflection of the spring δ =100mm

Distance between the eyes 2L =1153mm

Spring rate k =25KN/m

No of full leafs n_F=2

The

No if graduated leaf n_G=5

The above-mentioned values are that of a seven leaf spring (steel).Now the

Composite mono leaf spring is designed. The design calculations are given Below

STEP 1:

Assume reasonable corresponding values of nb, bm,tm,db.

Where

nb = no of bolts for fixing metallic eye. Db =

MODELING:-

Based upon the results, which obtained from the above calculations and the design concept of uniform cross-sectional area with linearly

cast iron are the typical materials that are used in the design of leaf springs.

bolt diameter

Bm= b = width Tm = t = thickness

Initially these values are considered nb = 3

Db = 6.35mm

Bm = 26mm

Tm = 28mm

Constant cross-sectional area = 26*28 = 728mm^2

Check for maximum deflection δ_{max} = 160 mm.

Maximum deflection of the spring permitted

$\delta_{max} \geq \delta = WL^3/6EI = 2500*576.5^3/6EI$

tensile modulus of the material E=35600 I=I_e + I_m/2

$= b_m t_m [t_m^2+t_e^2]/24$ mm^4

$=26*28*[28^2+6.73^2]/24$

=251552179mm^4

$\delta=WL^3/6EI$

$=2500*(576.5)^3/6*35600*25155.2179$

=89.15mm

varying thickness, hyperbolically varying width, composite leaf spring is modeled in 2-D sketch. *Design Specification of Composite*

Leaf Spring The leaf spring behaves like a cantilever beam. It is subjected to bending stresses, longitudinal and transverse shear stress. The spring is suitable and economical compared to filament winding technique as the cross-section area is constant throughout the leaf spring. The specification for the designed on the basis of constant width and Varying thickness. Leaf spring is manufactured by hand lay-up technique as shown in fig. 1. It is more spring is as follows: Total length of the spring is = 1010 mm, Thickness = 28, 30, 32 mm, Width = 45 mm.

	Boundary conditions		
Key points	X-coordinate	Y-coordinate	Z-coordinate
1	0	0	0
2	0	-28	0
3	240	26.06	0
4	240	9.72	0
5	438	89.37	0
6	438	82.25	0
7	576	160.1	0
8	576	152.6	0
9	0	0	26
10	0	-28	26
11	240	26.06	44.54
12	240	9.72	44.54
13	438	89.37	102.3
14	438	82.25	102.3
15	576	160.1	120
16	576	152.6	120

CONDITION	SPRING(material)	LOAD(newtons)	DEFLECTION(mm)
CASE : I	Structural Steel	2500N	1.72*10^-7
CASE : II	Al alloy	2500N	1.713*10^-7
CASE : III	Gray cast iron	2500N	2.11*10^-7
CASE : IV	Ti alloy	2500N	2.8*10^-7

CONCLUSIONS

After doing the analysis of the leaf spring the following conclusions can

be emphasized as

- The weight of the composite leaf spring is 60% to 70% less than the conventional leaf spring .To is more precious, the weight of a seven piece steel leaf spring is 15kgs when compared to the composite leaf spring which weights 4kgs.
- The deflection of composite leaf spring is less when compared to the conventional leaf spring. for example for a load of 2500N the deflection is plotted less (negligible) for the material al alloy .
- The spring rate of the composite leaf spring is where as that of conventional leaf spring is 25KN/mm.
- The following advantages which can be gained by using composite material in a place of steel for leaf springs are

1) High strength to weight ration
2) High fatigue strength
3) Excellent corrosive resistant
4) High specific strain energy storage capacity.

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