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DETERMINATION OF MECHANICAL PROPERTIES OF EPOXY BASED COMPOSITE LEAF SPRING

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***Abstract*:-In automobile industry there is a trend in steel leaf spring with coconut fiber composite leaf spring inorder to get more performance with less weight. In this paper it deals with the use of coconut fiber composite leaf spring instead of conventional leaf spring. To fabricate the special die we can use steel leaf spring of a light commercial vehicle. This is further used to manufacture the composite leaf spring. Epoxy based polymer materials have high strength to weight ratio and good corrosion resistance. That is why it is used for epoxy based polymer composite with reinforced material of coconut fiber. The composite leaf spring material is fabricated by using hand layout technique and is tested using universal testing machine(UTM). By using this method load per deflection and maximum load that a leaf spring can withstand can be measured.**

Keywords:- Epoxy resin, coir fiber, composite material ,coconut fiber

I INTRODUCTION

Now a days weight reduction is the main aim of automobile industry. This can be done by the introduction of good quality material, good production processes and design optimization. Suspension leaf spring is one of the most important item for reducing weight. It ranges from 10%-20% of the unstrung weight. This makes the vehicle more fuel efficiency and improved riding qualities. Here composite materials are used to reduce the weight of the leaf spring without any reduction on load carrying capacity.

In this paper I used a material with maximum strength and minimum modulus of elasticity . Here I tried to replace the existing mono steel leaf spring used in maruti 800 car with a laminated composite mono steel leaf spring made of epoxy coconut fiber . Here number of steel leaf spring and laminated composite leaf springs are same.

Now a days the use of composite material is increasing because of its less weight and cost. Here green coconut is used because it have white fibres . It is harvested after 12 months in the plant. If it is fully mature coconuts we will get brown fiber. Coconut fiber is strong shock absorbing mesh that protect the seed from damage.

Composites:-Composite material is made up of two or more materials to give unique property.

Composites Properties:- Instead of using glass fibers ,now a days we are using Natural fibers because of low cost, high strength etc..

Reinforcement :- Reinforcement is to improve the mechanical properties of resin system.

leaf springs

Leaf springs are made with flat plates. Leaf springs can be made by using two methods.

1. Multi leaf
2. Mono leaf

Leaf spring is used to carry bump loads, break torque, etc.Multi-leaf spring is made with several steel plates while Mono leaf spring is made with single steel plate. When road irregularities occur the spring will compresses to absorb the read shock.

Material of leaf spring

Leaf springs are made up of carbon steel having 0.90% -1.0% carbon. The leafs are first going through heat treatment process and the produced spring steel has greater strength and greater load capacity.

II COMPOSITE MATERIALS

Composite materials is a combination of two or more materials with different chemical and physical properties. Composite material have higher strength and modulus to weight ratio than traditional materials. Thus the weight of the material can be reduced by 20-30%. Thus we can save energy and can improve the performance. One of the major advantage of composite material is that we can mould them into any shape, thus it offer great design flexibility. In composites we have an option to select the constituents and can mould them to any shape and to any required properties.

Composite material is also known as Fiber reinforced polymer (FRP) composites made from man made or natural fiber. Examples of natural fibers are coir, jute, bagasse etc. Coir is a natural fiber made from mesocarp tissue or husk of coconut fruit. This is also known as "golden fiber

In traditional method of coir fiber extraction, husk are separated from the coconut and soaked in water up to 10 months. But this is very time consuming process. When submerge in the water husk become soften and separate because of anaerobic fermentation. After that the separated fiber is washed , dried and cleaned. Thus we will get the highest quality white fiber ,which is used for spinning and weaving.

Instead of using traditional hand method by using mechanical techniques we can reduce the time of soaking. can broken up. Here drums are used to separate the fiber. After that it is washed , dried, cleaned and brushed. Thus we can make high quality products with less time. The quality of fiber is measured based on type of wet processing method used. The length of the fiber is measured between 50-150mm. They have the stretching capacity beyond their elastic limit without breakage. Coir fiber is strongly resistant to degradation and salt water. Another important character of coir fiber is their high internal damping capacity. This make it better energy absorption and thus results in reduced transmission of noise to neighboring structures.

Specification of existing leaf spring

The following table shows the specifications of mono leaf steel spring of a maruti 800 passenger vehicle. The chemical composition of the material is :

Carbon	0.565
Silicon	1.8%
Manganese	0.7%
Phosphorus	0.045%
Sulphur	0.045%

Serial Number	Parameters	Value
1	leaf thickness	10mm
2	Free camber	68mm
3	Maximum load on spring	800N
4	Total length of spring (Eye to Eye)	965mm
5	No.of full length leaf (Master leaf)	1
6	leaf spring Young's Modulus	$3.1x10^5$
7	leaf spring width	51 mm

Table1: Specifications of Mono leaf steel spring

III EXPERIMENTAL

In this project I selected a Coconut fiber (coir) and epoxy resin, then it is fabricated according to the ASTM standard(D3039). As per the dimension epoxy composite and coconut fiber is manufactured. The prepared specimen is then tested using Universal Testing Machine(UTM).

Tensile testing

Tensile test is also known as tension test, which is most common type of mechanical testing. It is the process that gives the information about tensile strength, yield strength and ductility and metallic material. It also measures the force required to break the composite material and the extent to which specimen stretches to the breaking point.

Fig 1 Universal testing Machine

Brinell hardness test

Brinell hardness test is used to test materials that are too rough or too coarse. In this test a constant load is applied in a range of 500-3000N for a specified time period 10-30s using 5 or 10mm diameter hardened steel on the flat surface of work piece.

Fig 2 Brinell Hardness testing machine

Brinell Hardness number (HB)is :

$$HB=\frac{2P}{\pi D(D-\sqrt{D^2-d^2})}$$

P=3000kg

D=10mm

d1=d2=d=3.2mm

B.H.N=363.39

Izode & Charpy impact test

Izode & Charpy impact testing is a popular method to find impact strength or toughness of a material. We make a specimen of 48 x 24 mm and making grew on the specimen at centre.

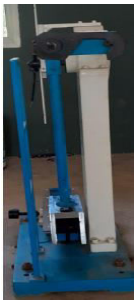


Fig 3 Izode & Charpy impact test

IV MATERIALS

Preparation of fiber:- The coir fiber is made from coconut husk, which is dried under sunlight and fibers were extracted manually from the coconut husk. To ensure interaction between fiber and matrix material, the outer most wax layer of the coconut fiber was removed and soaking the coir in hot water.

Fig 4 Coconut fiber

Material property	**value**
Density	1.2gm/cm^2
Elongation	30%
Young modulus	4.6Gpa

Fig 5 Epoxy resin and Hardner

Mould preparation : The standard size of a mould box is 250 x 110 x 3 mm dimension according to ASTM standard. The base surface of the mould is made up of Thermopolis and side boundary by plywood. The surface of the mould is covered with Tape inorder to avoid leakage of epoxy resin.

Testing :- Tensile strength of the specimen is tested in UTM machine. Here after preparation, the specimen are fixed in the Universal Testing Machine. After that the load is applied to the specimen. The load is applied gradually on the specimen. For each 5 divisions (0.2KN) we note down the corresponding deflection until the specimen breaks.

Fig 6 Tested test piece

Properties of composite for 15mm length of coconut fiber

SL.No	Properties	Value
1	Density(K g/m^3)	1800.5
2	Tensile strength (Mpa)	45
3	Youngs Modulus(Mpa)	1300.22

4	Tensile strain at a break	0.04112
5	Elongation at break (mm)	10.1
6	Load at break(N)	2900

For 15mm length of fibers in the composite, the ultimate load was 3KN and the corresponding deflection was 11.8 mm. From this it is clear that with increasing the length of fiber the deflection also increases.

15mm length of Fibers Tensile Strength	
3.3	22.6
6.8	26
9.9	28.9
12.9	33
16.8	36.2
19.8	38.7

Load and deflection reading composite coconut fiber

Load(KN)	Deflection (mm)
0.2	0.5
0.4	0.75
0.6	0.9
0.8	2.4
1	3.5
1.2	4.2
1.4	4.5
1.6	5.25
1.8	5.75
2	6.1
2.2	6.5
2.4	7.25

V FINITE ELEMENT ANALYSIS OF LAMINATED EPOXY WITH COCONUT FIBRE COMPOSITE LEAF SPRING

In this project instead of using steel leaf spring , coconut fiber laminated composite leaf spring were used. Its dimension is same. Its orientation angle is 0 degree fiber orientation and four lamina (each lamina thickness of of 2.5 mm). width of the leaf is 50mm. A 3-D model of leaf spring is used in the analysis of ANSYS 10.0 because its properties may vary with directions of fiber. Here we are assuming that the loading condition is static . it is assumed to be 6 degrees of freedom in each node. Both translation and rotations take place in the nodes x, y and z directions. The elements are allowed up to 250 layers. The finite element analysis is conducted on both mono steel leaf spring as well as composite mono leaf string. From the result obtained, maximum distortion criterion (Von-mises stress or Equivalent Tensile stress) and also found the displacements.

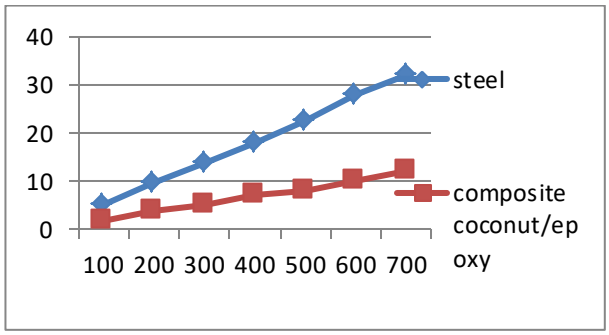
Sl.No.	Parameter	Steel Spring	Laminated Composite leaf spring
1	Weight(kg)	4	1.2
2	Stress(N/mm^2)	500.12	255.06

Comparative Analysis of steel leaf spring and coconut fiber laminated composite mono leaf Spring

The given below graph shows the variation of deflections and stresses induced in steel spring and coconut fiber laminated composite leaf spring with respect to the variation of load.

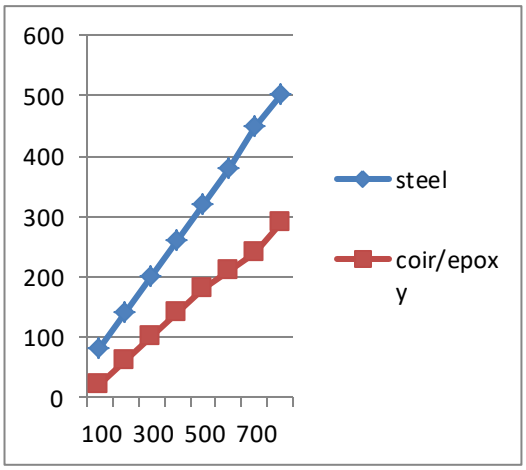
Load (N)	Deflection in steel	Coir/epoxy
100	5.2	2
200	9.2	4
300	13.5	6
400	17.6	7
500	22.6	9
600	28.6	8
700	32.5	11

Load- Deflection curves for steel and Laminated composite leaf spring.



Load- Von-Mises stress for steel and laminated Composite leaf spring.

Load (N) steel	Stress Mpa steel	Stress coconut fiber
100	80	20
200	140	60
300	200	100
400	260	140
500	320	180
600	380	210
700	450	240
800	500	290



VI CONCLUSIONS

A Comparative study has been conducted to find weight, stiffness and strength between coconut fiber laminated composite leaf spring. By using coconut fiber laminated composite leaf spring, we can reduce the weight up to 80% . Natural frequency of coconut fiber laminated composite leaf springs are 25%- 65% higher than steel leaf spring. comparing the stiffness of coconut fiber laminated composite leaf spring, it is 25% -67% stiffer than the steel leaf spring. Based on the above conclusions, we can say that coconut/epoxy laminated composite mono leaf spring has more strength and stiffness and has lesser weight compared to steel and other composite materials. From the above observations, it is clear that the coconut fiber laminated composite leaf spring is lighter and more economical than the steel leaf spring.

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