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Design and Experimental Analysis of Leaf Spring Using Composite Materials

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ABSTRACT-

The objective of this present work is to estimate the deflection, stress and mode frequency induced in the leaf spring of a sumo design by the ordinance factory. The emphasis in this project is on the experimental and computer aided analysis using finite element concept. The component chosen for analysis is a leaf spring which is an automotive component used to absorb vibrations induced during the motion of vehicle. It also acts as a structure to support vertical loading due to the weight of the vehicle and payload. Under operating conditions, the behaviour of the leaf spring s complicated due to its clamping effects and interleaf contact, hence its analysis s essential to predict the displacement, mode frequency and stresses. The leaf spring, which we are analyzing, is a specially designed leaf spring used in sumo. A model of such sumo has been shown in this project report. In analysis part the finite element of leaf spring is created using solid tetrahedron elements, appropriate boundary conditions are applied, material properties are given and loads are applied as per its design, the resultant deformation, mode frequencies and stresses obtained are reported and discussed. There are 3 different sample 40% epoxy-60% E-fiberglass and 60% epoxy - 40% E-fiberglass, 70% epoxy - 30% E- fiberglass

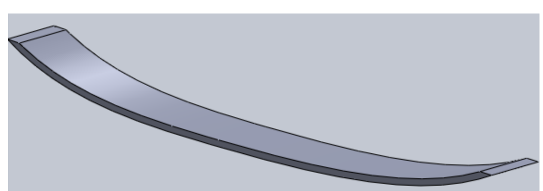
INTRODUCTION

Several papers have been published denoting the application of composites in leaf spring. Other conventional suspension systems work on the same principles as a conventional leaf spring. However leaf springs use excess material when compared to other suspension systems for the same load and shock absorbing performance which makes it heavy. This can be improved by composite leaf springs Considering the fact that the conventional leaf spring is one of the potential components for weight reduction it has been an area of interest for automobile industries The various advantages possessed by the composite materials make this an attractive alternative material for the designers. In an experimental investigation comparison between
the single leaf spring of variable thickness composite spring of fibre glass reinforced fibre with mechanical and dimensional properties similar to the conventional steel leaf spring wasdone by Al-Qureshiet al with mechanical and dimensional properties similar to the conventional steel leaf spring was done.

MATERIAL PRPPERTIES OF E GLASS /EPOXY

Sl.No	Properties	Value
1	Tensile modulus along X-direction (Ex), MPa	34000
2	Tensile modulus along Y-direction (Ey), MPa	6530
3	Tensile modulus along Z-direction (Ez), MPa	6530
4	Tensile strength of the material, Mpa	900
5	Compressive strength of the material, Mpa	450
6	Shear modulus along XY-direction (Gxy), Mpa	2433
7	Shear modulus along YZ-direction (Gyz), Mpa	1698
8	Shear modulus along ZX-direction (Gzx), Mpa	2433
9	Poisson ratio along XY-direction (Nuxy)	0.217
10	Poisson ratio along YZ-direction (NUyz)	0.366

COMPOSITE MONO LEAF SPRING



Camber = 78mm Span = 900mm Thickness = 11mm Width = 107mm

FABRICATION OF COMPOSITE SAMPLES

Layup Selection

The amount of elastic energy that can be stored by a leaf spring varies directly with the square of maximum allowable stress and inversely with the

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modulus of elasticity both in the longitudinal direction. Composite materials like the E-Glass/ Epoxy in the direction of fibres have good characteristics for storing strain energy. So, the layup is selected to beunidirectional along the longitudinal direction of the spring. The unidirectional layup weaken the spring at the mechanical joint area and require strengthening the spring in thisregion.DiGlycidyl Ether of Bisphenol A was used as epoxy resin and Tri-Ethylene Tetra-Amine was used as hardener. E-Glass fibres were used as reinforcements.

HAND LAYOUT MOULDING

Hand lay-up moulding is the method of laying down fabrics made of reinforcement and painting with the matrix resin layer by layer until the desired thickness is obtained. This is the most time and labour consuming composite processing method, but majority of aerospace composite products are made by this method in combination with the autoclave method. Due to the hand assembly involved in the lay-up procedure, one can align long fibres with controlled directional quality. Another advantage of this method is the ability to accommodate irregular-shaped products. Such advantages are utilized in low performance composites including fibre - glass boat and bath tub manufacturing. An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it. Hand lay technique was used to manufacture the fibre glass reinforced specimen. For this an E - fibreglass material was used with the diameter of the fibreglass approximately epoxy (DiGlycidyl Ether of Bisphenol A) and a hardener (Tri-ethylene Tetra-amine).

Three samples of the fibre glass reinforced plastic were prepared:

1. 40%-60%:-40% epoxy and 60% E-fibreglass
2. 60%-40%:-60% epoxy and 40% E-fibreglass
3. 70%-30%:-70% epoxy and 30% E-fibreglass

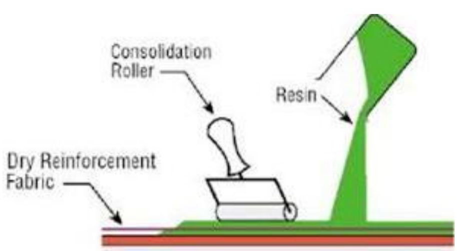


Fig .1- hand lay up method

SAMPLE

1 60% eglass & 40% Epoxy

2 40% eglass & 60% Epoxy

3 30% eglass & 70% Epoxy

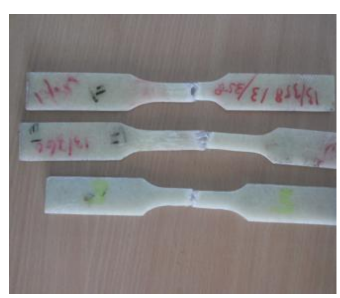
EXPERIMENTAL WORK

TESTING OF MECHANICALPROPERTIES

Tensile test

The tensile test was carried out using an universal testing machine. The test specimen is prepared according to ASTM D standard. The tensile strength is calculated according to the following formula

$\sigma_t = P / bh$

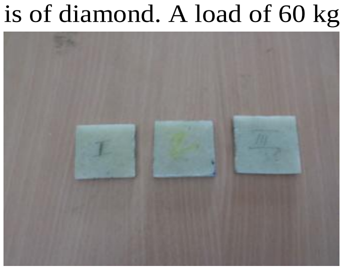


Flexural test

The flexural test is carried out using the universal testing machine. The test specimen was prepared according to ASTM D standard. The flexural strength is calculated according to the following formula
Flexural strength: $\sigma f = 3PL/2bh^2$

Hardness test

The test was conducted using Rockwell L-scale, which is especially for plastic materials, Bakelite and vulcanized rubber. The indenter chosen is of diamond. A load of 60 kg was used for the test.



RESULT OF EXPERIMENTAL WORK

TENSILE TEST

Sl.no	parameter	60% and 40%	40% and 60%	70% and 30%
1.	Fmax	6500	5280	3250
2.	Tensile strength	107 Mpa	92.2Mpa	46 Mpa

Flexural test

1.

Sl.no	parameter	SPECIMEN I 60% and 40%(EXP)	60% and 40% (FEA)
1.	Fmax	1000	1000
2.	Bending stress	442	341
3.	displacement	7.5	10.21

2.

Sl.no	parameter	SPECIMEN II 40% and 60%(EXP)	40% and 60% (FEA)
1.	Fmax	800	800
2.	Bending stress	330	237
3.	displacement	7	6.85

3.

Sl.no	parameter	SPECIMEN III 30% and 70%(EXP)	30% and 70% (FEA)
1.	Fmax	800	800
2.	Bending stress	330	213
3.	displacement	6.3	5.95

HARDNESS TEST

Sl.no	SPECIMEN I 60% and 40%	SPECIMEN II 40% and 60%	SPECIMEN III 30% and 70%
1.	5	4	3
2.	4	3	3
3.	5	3	4

DYNAMIC ANALYSIS

The analysis of a structural system as a function of displacement under transient loading conditions

MODAL ANALYSIS

Modal analysis is the study of the dynamic properties of structure under vibration excitation.
The modal analysis are carried out to determine the natural frequency and modal shape of the leaf spring

Experimental analysis

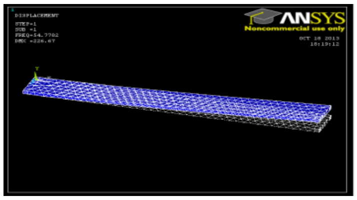
Sl.no	60% and 40%	40% and 60%	30% and 70%
1.	34	35	39
2.	234	242	263
3.	543	600	694

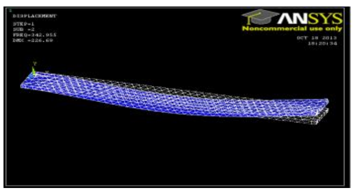
FEA Analysis

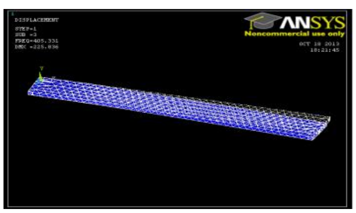
Sl.no	60% and 40%	40% and 60%	30% and 70%
1.	54	68	71
2.	342	413	381
3.	405	428	447

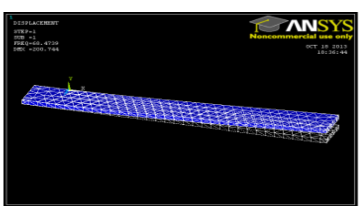
MODAL ANALYSIS

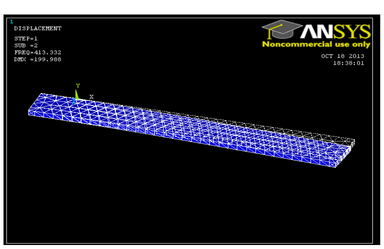
Different mode shape condition of various Composition

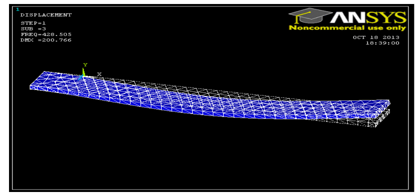


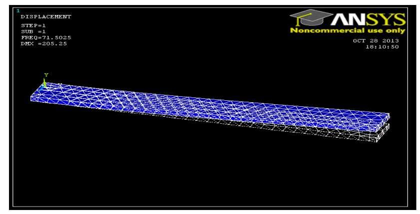


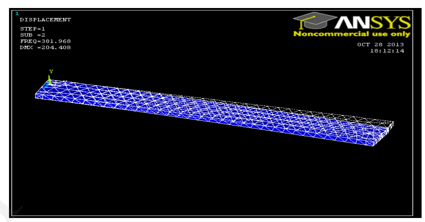


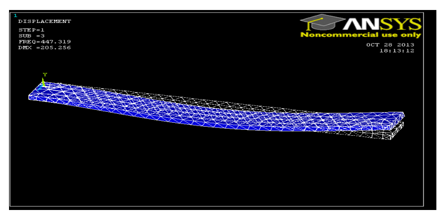




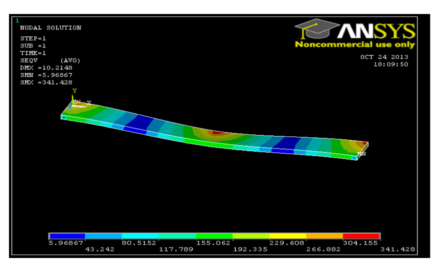


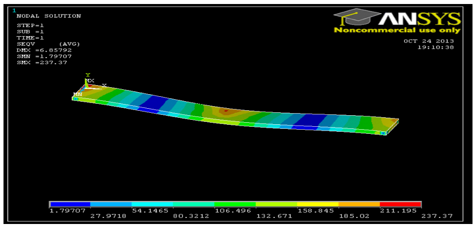


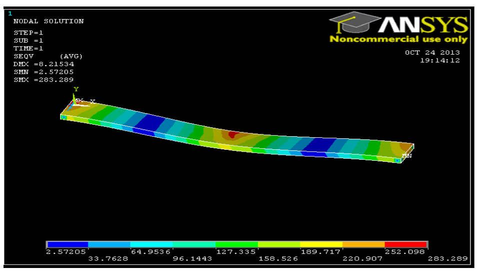




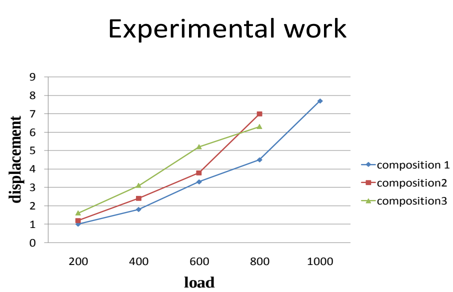
STRESS ANALYSIS

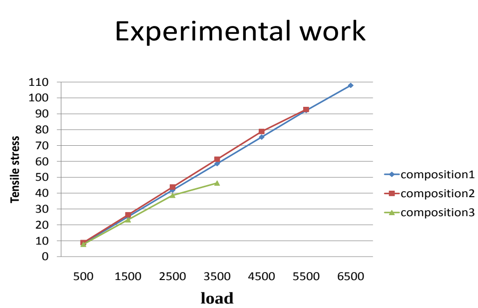


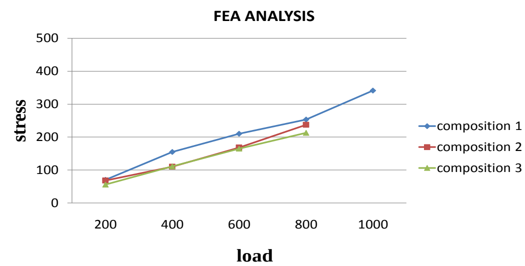


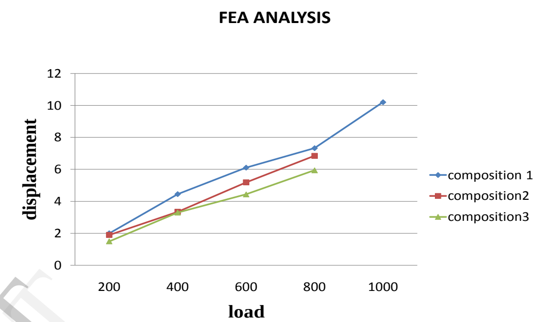


RESULTS AND DISCUSSION









CONCLUSION

Thus we compare the composite material Eglass /epoxy various composition. Which one the best composition of experimental work and analysis for various mechanical test and vibration test .

1. Eglass 60% and 40% epoxy
2. Eglass 40% and 60% epoxy
3. Eglass 30% and 70% epoxy

E glass 60% and 40% epoxy is the best of tensile and bending stress, deformation, and natural frequency compare the other composition. The natural frequencies of various parametric combinations are compared with the excitation frequency for different road irregularities. The strength to weight ratio is higher for composite leaf spring than conventional steel spring with similar design.

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