DESIGN AND ANALYSIS OF COMPOSITE LEAF SPRING BY USING CATIA AND ANSYS

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***Abstract*:**Our project is aimed to investigate the suitability of natural and synthetic fiber with reinforced composite material in composite leaf spring application. By using composite leaf spring, the cost and weight of the leaf spring has been reduced without reducing the quality. It is made by hand-lay method. It is also an eco-friendly method. Leaf spring is a simple form of suspension spring used to absorb vibration induced during the motion of the vehicle. The recent development shows increased interest in replacement of steel leaf spring with composite leaf spring. The design of leaf spring is done by using CATIA V5R20 and analysis is done in ANSYS 18.2 performing with different loads.In this project we designed leaf spring for the materials composite material by varying reinforcement angle. We studied the strength variations. Analysis is done on the leaf spring by using four composite materials. Modal and fatigue Analysis is also done. CATIA software is used for modeling and ANSYS is used for analysis.

I. INTRODUCTION

A spring is defined as an elastic body, whose function is to distort when loaded and recover its original shape whenthe load is removed. To apply forces as in brakes, clutches and spring-loaded valve.

II. PRINCIPLES OF LEAF SPRING

The leaf spring arrangements mounted a single leaf set running parallel to a live axle, but used it both as asuspension link and a spring element in an equivalent manner to the traditional arrangement. In vehicles withindependent suspension and a transverse leaf spring arrangement the leaf is not used to control the wheel'slocation and acts only as a spring element. In this arrangement double wishbones act to locate the wheel,while a single leaf or leaf set connected to the front or rear sub-frame in the middle of the vehicle and the lowerwishbone on each side provides the spring element. In some applications two transverse leaf springs are used ona single axle with each providing separate springing action to each wheel. In the past most, transverse leaf springsarrangements used multiple steel elements in a set similar to their traditional longitudinal counterparts, but mostmodern applications uses a composite (generally fiberglass) mono leaf element.

III. PARTS OF LEAF SPRING

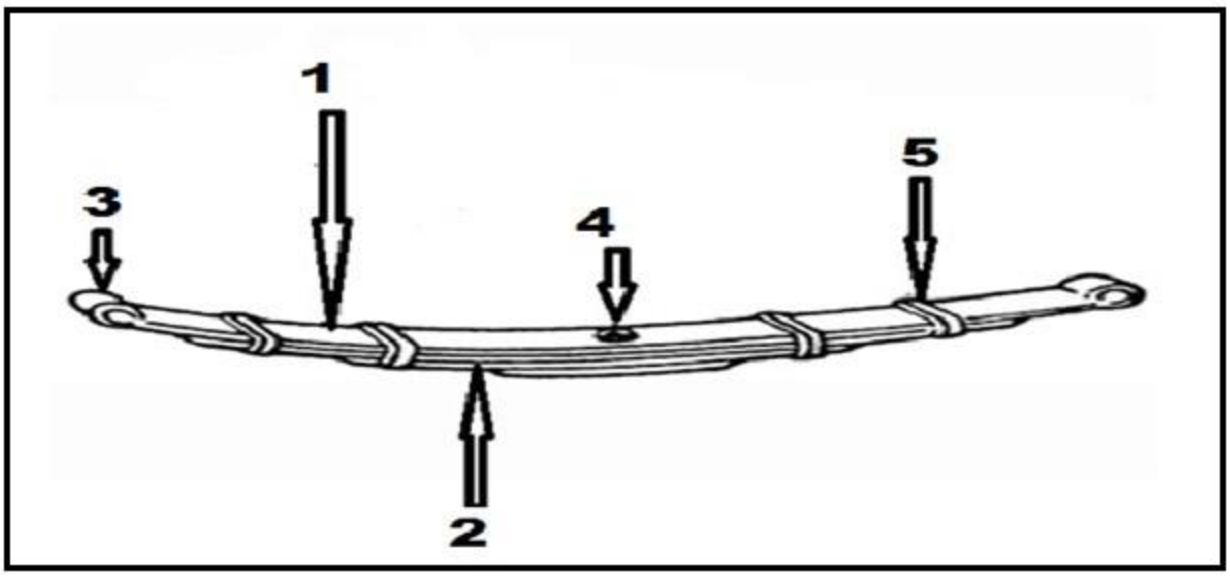


Figure 1: Leaf spring of Automobiles

1. Master Leaf

The longest leaf known as main leaf or master leaf has its ends formed in the shape of an eye through which the bolts are passed to secure the spring to its supports

2. Graduated Leaves

The other leaves of the springs are known as graduated leaves. In order to prevent digging in the adjacent leaves. It is usual to provide two full length leaves and the rest graduated leaves.

3.Eye

Usually the eyes, through which the spring is attached to the hanger or shackle, are provided with of bushing of some antifriction of material such as bronze or rubber.

4.Center Bolt

The leaves are held together by means of a band shrunk around them at the centre or by a bolt passing through the centre.

5.Rebound Clip

Rebound clips are placed intermediate positions of the leaf spring. These are joints the master leaf and graduated leaves of the leaf spring.

IV. LITERATURE REVIEW

Many early vehicles such as the ford model it used transverse leaf springs on both the front and rear suspension in conjunction with a live axle. In the early 1930s, Dante giocoso developed the fiat tapeline which used transverse steel leaf springs and double wishbones in an independent front suspension. The triumph motorcar company also developed a independent rear suspension with a transverse leaf spring arrangement for their line of small cars in the 1950s. The triumph arrangement, first seen on the 1959 herald was developed in an effort to introduce an inexpensive independent rear suspension. Results were mixed with considerable safety issues surrounding the vehicles tendency to snap into over steer.

Manaspatnaik, L.P. Koushik and Manoj Mathew has been carried out on a parabolic leaf spring of a mini loader truck. The spring has been analyzed by applying a load of 3800 N and the corresponding values of stress and displacement are computed. In this work, design of experiments has been applied under various has been is configurations of the spring (i.e by varying camber & eye distance). Camber and leaf span of a parabolic leaf spring was found for optimized stress and displacement value using artificial neural networks. Various networks with different architecture were trained and the network giving the best performance was used for optimization.

Bhushan, Deshmukh, Dr. Santosh and B. Jajuint j enggtechsci.weight reduction is now the main issue in automobile industries. The paper gives the brief look on the suitability of composite leaf spring on vehicles and their advantages. The objective of the present work is design, analysis and fabrication of mono composite leaf spring. The design constraints are stress and deflections. The finite element analysis is done using ansys software. The attempt has been made to fabricate the explian leaf spring economically than that of conventional leaf spring.

V. METHODOLOGY

Present work is related to the comparative study of "55 SI 7 steel and composite leaf spring" component details. Thecomponent details is studied and prepared 3-d model in catia V5R20 software. The component is studied for theoperation required to convey the different types of loads on it. Design the component in the required shape and dimensions and analyzed. Design calculations are carried for the component leaf spring with the help of material properties which are specified by the previous project. Analysis work is carried by importing 3-d model into ansys software. A fem model of leaf spring, only one leaf is created by using ansys processor. The material properties, loads and boundary conditions are also specified in the ansys processor. Analysis work is done by applying loads on the leafspring then the results such as stress, strain, total deformation are obtained. The results are compared withmaterial properties of the material used for the component. Then we find that results obtained by using fem are within the material properties. There we find that the component can withstand for given loads during operation.

5.1 STANDARD SEMI ELLIPTICAL LEAF SPRING

We have already discussed that the stress in the full-length leaves is 50% greater than the stress in the graduated leaves. In order to utilize the material to the best advantage all the leaves should be equally stress. By giving a greater radius of curvature to the full-length leaves than graduated leaves before the leaves are assembled to form a spring by doing so a gap or clearance will be left between the leaves.

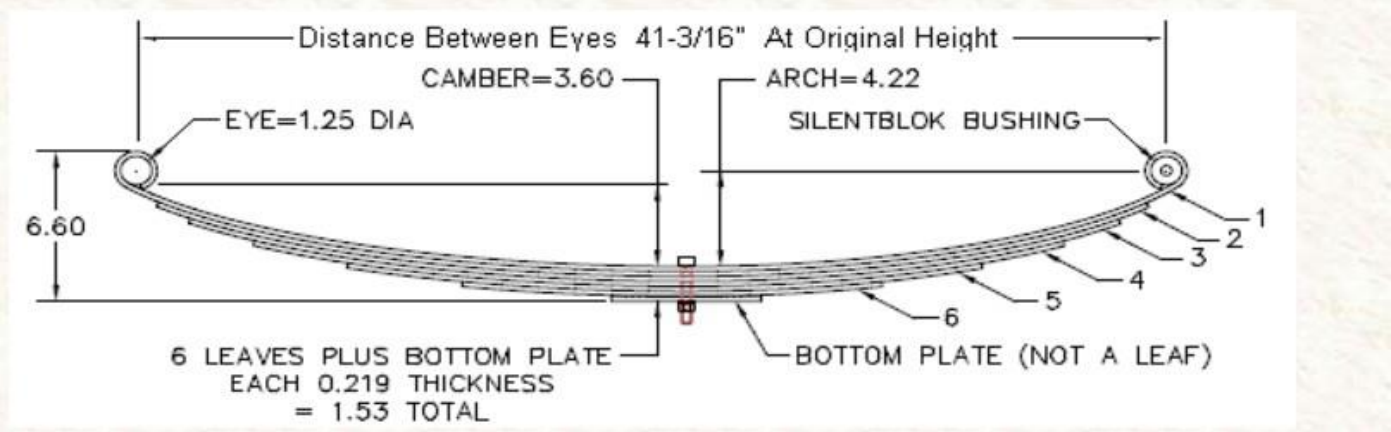


Figure 2: Standard semi elliptical leaf spring

Distance between eyes = 1100 mm
Camber = 96.8 mm
Height = 167.64 mm
For the leaf spring in original form,
Free Camber = 3.60" (factory specification)
Spring eye = 1-1/4"diameter(0.625"-radius)
Leaf thickness = 7/32"
Number of functional leaves = 6

VI.DESIGN OF LEAF SPRING IN CATIA V5R20

Start the catia V5R20 software by giving double click on the catia V5R20 icon on the desktop. click the start menu in the menu bar, select mechanical design and click sub menu sketcher. Click the XY plane. Draw the horizontal and vertical axis lines by selecting the infinite line option in the profile tool box. Draw the two lines parallel to the vertical axis line by the infinite line option. Give the distance between the two lines according to length of the leaf spring (1050 mm) and arc height at axel seat (170 mm) of the leaf spring requirement by the constraint option in the constraint tool box. Draw the inner (44 mm) and outer (55 mm) circles at both sides for required diameter of leaf spring by using point circle in the profile tool box. Join the inner and outer circles of both sides by using three-point arc starting with limit in the profile tool box. Arise the excess lines by quick trim option in the operation tool box. The 2D

sketcher diagram converted into 3D diagram by click the exit workbench option in the workbench tool box. Click the pad option in the sketcher tool box and enter the required length of the leaf spring (56 mm) and finally click ok.

6.1 Design Parameters of Leaf Spring

Total length of leaf spring (eye to eye)	1050 mm
Arc height at axle seat	170 mm
Thickness of leaf spring	6 mm
Width of leaf spring	56 mm
Outer diameter of eye	50 mm
Inner diameter of eye	44 mm

Table 1: Design parameters of leaf spring

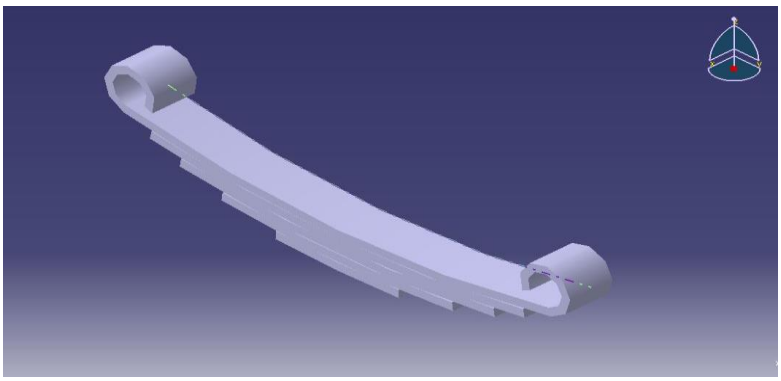


Figure 3: Leaf spring designed in catia V5R20

VII. ANALYSIS

7.1 Steel Leaf spring (55Si 7)

Young's modulus = 190-210 MPa
Poisson's ratio = 0.27-0.30
Tensile strength = 572.3 MPa
Density = 1000 kg/m3

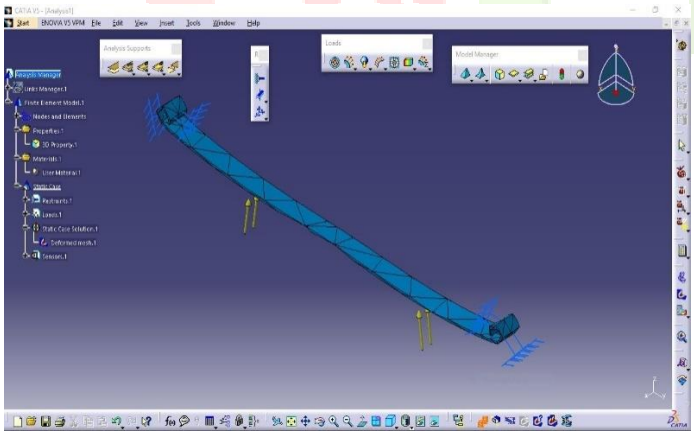


Figure 4 : Deformation

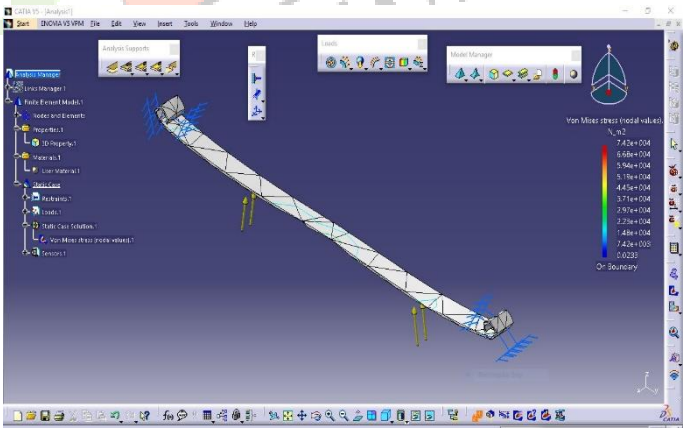


Figure 5 : Von mises stress

7.2 Jute/E-Glass/Epoxy Leaf spring

Young's modulus = 21000 MPa
Poisson's ratio = 0.22
Tensile strength = 185 MPa
Density = 1460 kg/mm^3

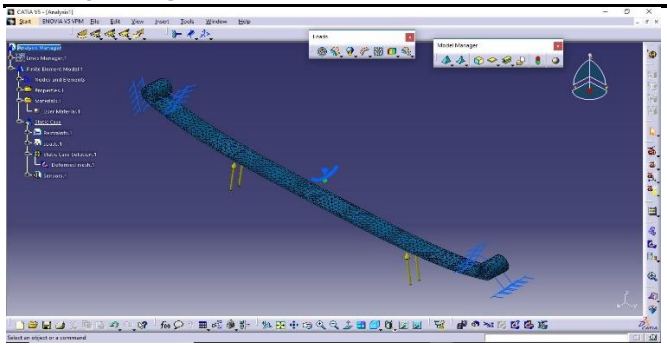


Figure 4 : Deformation

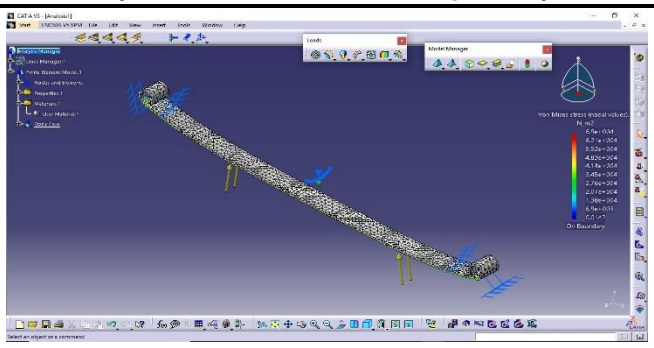
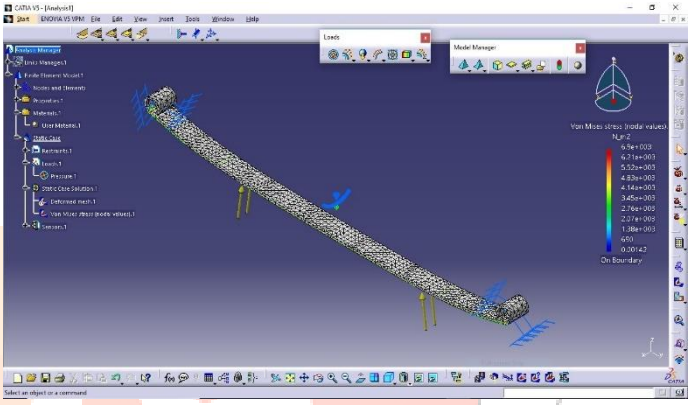


Figure 5 : Von mises stress

7.3 Jute/Luffa/E-Glass/Epoxy

Young's modulus = 20000 MPa
Poisson's ratio = 0.22
Tensile strength = 177MPa
Density = 1660 kg/mm^3



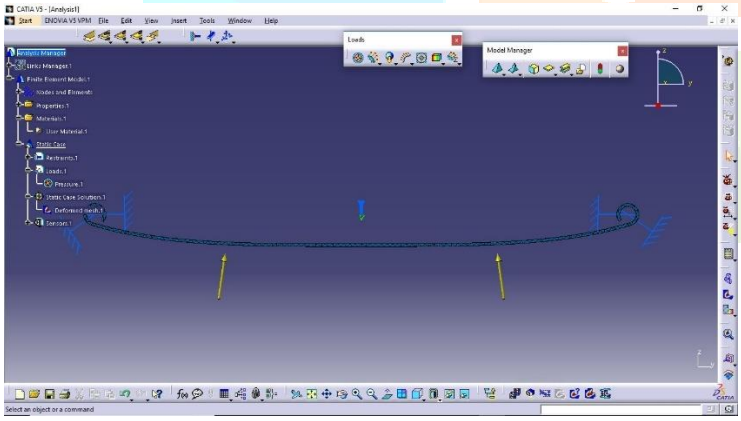


Figure 4 : Deformation

Figure 5 : Von mises stress

VIII.CONCLUSION

The 3-D modeling of both steel and hybrid composite materials of leaf spring is done and analyzed a comparative study has been made between composite and steel leaf spring with respect to deflection , strain energy and stresses. This project work provides optimum output for design parameters (leaf spring thickness and width) of hybrid composite leaf spring by using finite element analysis. Weight can be reduced from in 15kgs to 2kg if steel leaf spring is replaced by jute/luffa/e-Glass/epoxy hybrid composite leaf spring. Weight reduction reduces the fuel consumption of the vehicle. At various loading conditions, hybrid composite leaf spring is found to have lesser stresses and deflections as compared to conventional steel leaf spring. Jute/luffa/e-glass/epoxy hybrid composite has higher elastic strain energy storage capacity than both steel and jute/e-glass/epoxy composite because it has lower young's modulus and lower density as compared to both. Hence hybrid composite leaf spring can absorb more energy which leads to good comfortable riding. Jute/luffa/e-glass/epoxy hybrid composite leaf spring is foundto be more economical than spring steel leafspring as the cost of jute fiber is very much less ascompared to e-glass fiber and it is abundantly available innature.

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