DESIGN AND ANALYSIS OF AOTOMOBILE LEAF SPRING USING ANSYS

Dev Dutt Dwivedi[1], V. K. Jain[2]
[1]P. G Scholar, Mechanical Engineering, IPS College of Technology Management
[2] HOD, Mechanical Engineering, IPS College of Technology Management, Gwalior MP India
Email: Dev.dwivedi182@gmail.com[1], profvkjain@gmail.com[2]

ABSTRACT

Design and analysis of composite leaf spring has been done in the present paper. ANSYS 14.5 has been used to conduct the analysis. Static structural tool has been used of ANSYS. A three layer composite leaf spring with full length leave. E-Glass/epoxy composite material has been used. Conventional steel leaf spring results have been compared with the present results obtained for composite leaf spring. E-glass/epoxymaterial is better in strength andlighter in weight as contrast with conventional steel leaf spring. A wide amount of study has been conducted in this paper to investigatethe design and analysis of leaf spring and leaf spring fatigue life.

Introduction

A spring is an elastic body, whose expand in size when load applied and regain its original shape when removed. Leaf spring is the simplest form of spring used in the suspension system of vehicle.It absorbs automobile vibrations, shocks and loads by springing action and to some extend by damping functions.It absorbs energy in the form of potential energy. Springs capacity to absorb and store more strain energy makes the suspension system more comfortable. Most widely used leaf spring type is semi-elliptic inheavyand light automobile vehicles. The multi leaf spring comprises of various steps called blades while mono leaf spring is of only one step. Number of steps increases the spring absorbing capability.For heavy vehicles multi leaf spring are used while light vehicle mono leaf spring can be used.

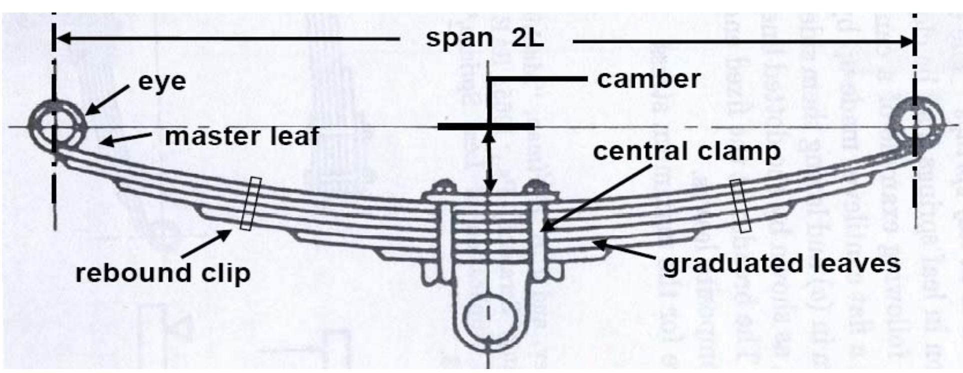


Fig. 1 Schematic of Laminated semi-elliptic leaf spring

The master leaf spring is the longest and has eyes at its end while remaining steps of spring are called graduated leaves.Types of different leaf springs are shown in figure 2.

Springs initially given a camberso they will have a tendency to bend under loading condition. The leaf spring works under two hypothesis uniform strength and uniform width.

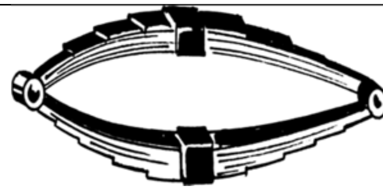
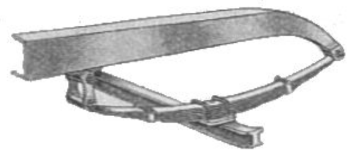
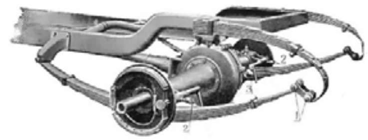
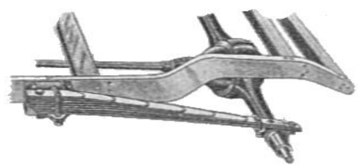
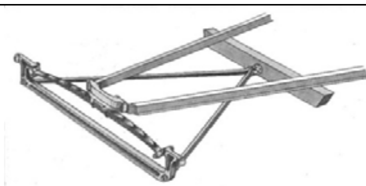
Elliptic	
Semi elliptic	
Three quarter elliptic	
Quarter elliptic	
Transverse leaf spring	

Figure 2 Types of leaf spring

Literature review

C.Madan Mohan Reddy,D.RavindraNaik, Dr M.LakshmiKantha Reddy[1] conducted study on analysis and testing of two wheeler suspension helical compression spring. They focused their study on suspension system springs modelling, analysis and testing. They try to replace the steel helical spring in automobiles. They carried a comparative study. They calculate the stress and deflection of helical spring. They compared their FEA results with experimental values.The found chrome vanadium steel spring has 13-17% less maximum stress and 10% less specific weight compared to steel spring. They validate their FEA results with the experimental values and found excellent similarity of 95% in deflection and of 97% in shear stress pattern. AjitabhPateriya, Mudassir Khan [2] studied dynamic characteristics of spring loaded using ANSYS. Fluid-solid interaction mesh deformation between the valve disc and surrounding fluid has been used to study the motion of the valve disc for different materials. Differentmaterials have been used considering similar boundary condition for finding the best suitable material. FEM analysis result shows that $La_2Zr_2O_7$ is best suitable material. Maximum shear stress considered is 0.20395 MPa which is greater for Aluminium alloy. For weight and cost comparison the Aluminiumalloy material should be preferred.

Pozhilarasu V. and T ParameshwaranPillai [3] studied analysis of steel and composite leaf spring. They compared the conventional leaf spring and composite (Glass fibre reinforced plastic – GFRP) leaf spring. They used ANSYS software for studying conventional steel leaf spring and composite leaf spring for similar conditions. They fabricated a glass/epoxy composite leaf spring using hand layup method. The universal testing machine has been used to test the results of conventional steel and composite leaf spring.

Composite material

A composite material is characterized as a material made out of two or more constituents joined on a naturally visible scale by mechanical and chemical bonds. Composites are blends of two materials in which one of the materials is known as the "matrixphase" and is implanted in the other material called the "reinforcing stage". Numerous composite materials offer modulus that is either equivalent or superior to any metals. In light of their low specific gravities, the strength to weight-proportion and modulus to weight-proportions of these composite materials are better than those of metallic materials. The fatigue quality weight proportions and fatigue damage tolerance of numerous composite overlays are fantastic. Thus, fibre composite have risen as a noteworthy class of basic material, are either utilized or being considered as substitutions for metal in numerous weight-basic parts in aviation, car and different businesses. High internal damping limit is another advantage. This prompts better vibration energy and results in decreased noise to neighbouring structures. High damping limit of composite materials can be advantageous in numerous car applications in which noise, vibration, and hardness is a basic issue for travellercomfort.

Building geometry in Design Modular

Figure 3 shows the sketch of the leaf spring designed in ANSYS. Dimensions of the spring have been shown in table 1.

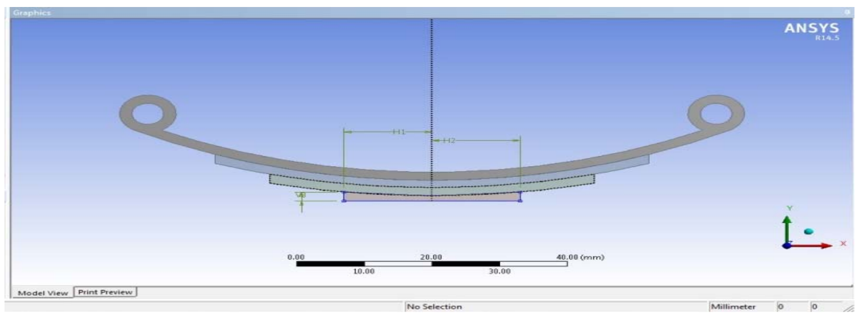


Fig. 3 Model of leaf spring designed in ANSYS

Table 1 Details about the leaf spring

Leaf Spring Part	Top part	Bottom part	Radius	Vertical Distance
Eye outer part			4.2mm	
Eye inner part			2.3mm	
Master leaf	40mm	45mm		
Graduated leaf 1	32mm	32mm		2mm
Graduated leaf 2	24mm	24mm		2mm
Bottom leaf	17mm	17mm		2mm
Load applied	40N			
Span (Eye centre to centre)	85mm			
No of graduated leafs	3			
Width of leafs	6mm			

Meshing of Leaf Spring

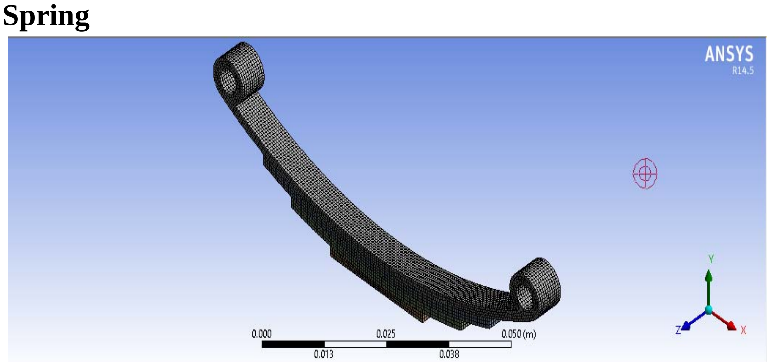


Fig.4 Meshing of leaf spring designed in ANSYS

Results

From the results it can be observed that the total deformation for E-Glass/Epoxy material is less compared to conventional steel leaf spring material. Equivalent stress generated in the composite E-Glass/Epoxy leaf spring is less compared to steel leaf spring. Less maximum shear stress and maximum principal stress have been found in E-Glass/Epoxy material compared to conventional steel leaf spring.

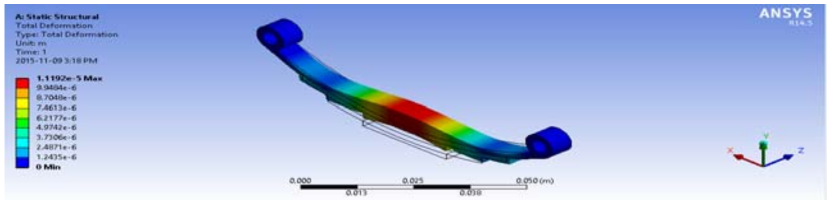


Fig.5Total Deformation steel

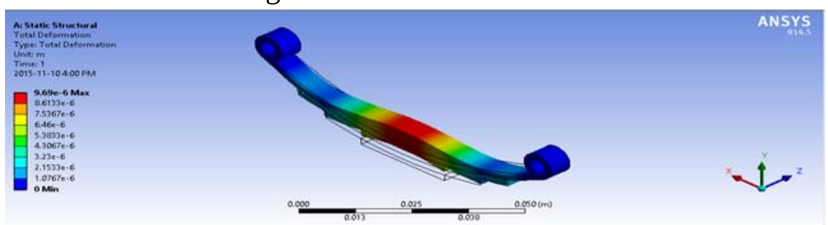


Fig.6Total Deformation E-Glass/Epoxy

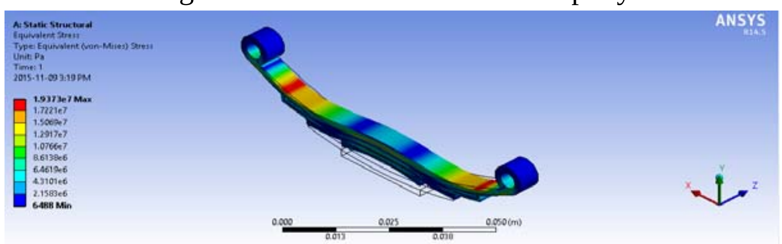


Fig.7Equivalent stress of steel

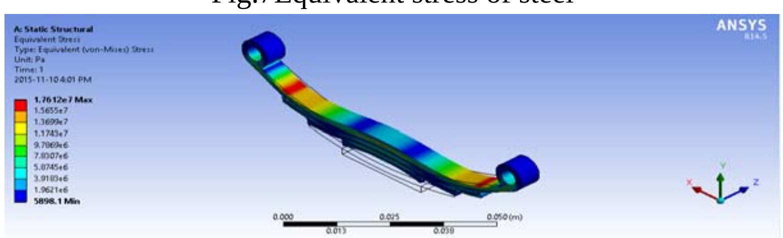


Fig.8Equivalent stress of E-Glass/Epoxy

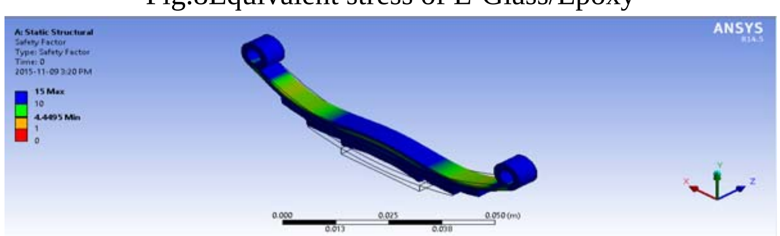


Fig.9Safety factor of steel

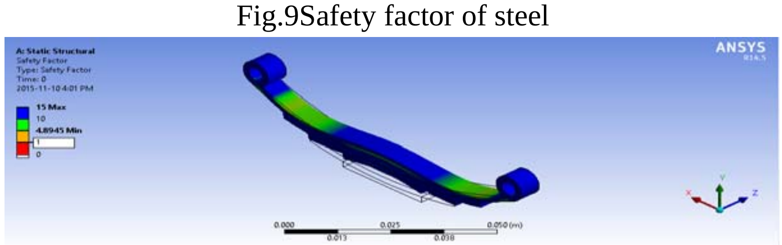


Fig. 10Safety factor of E-Glass/Epoxy

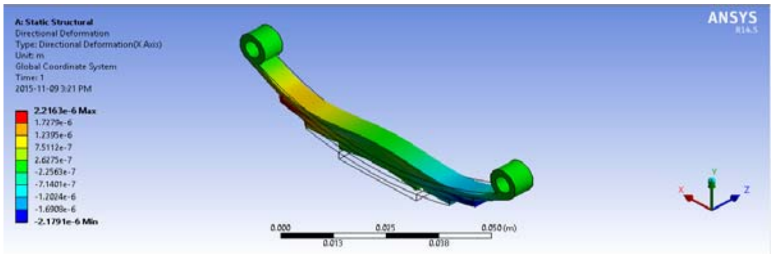


Fig. 11Directional deformation of steel

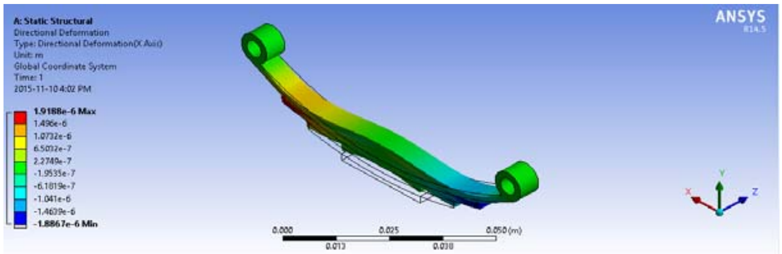


Fig. 12Directional deformation of E-Glass/Epoxy

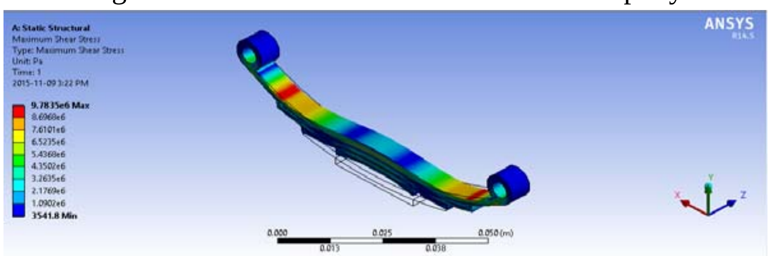


Fig. 13Maximum shear stress of steel

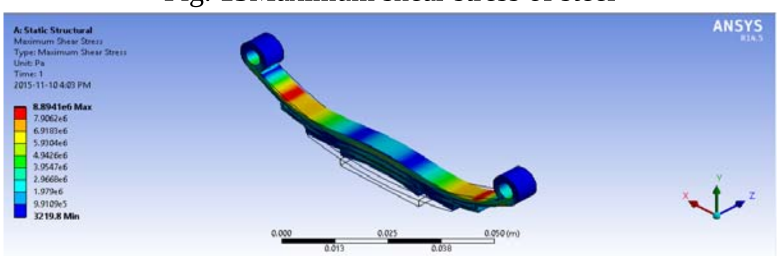


Fig. 14Maximum shear stressof E-Glass/Epoxy

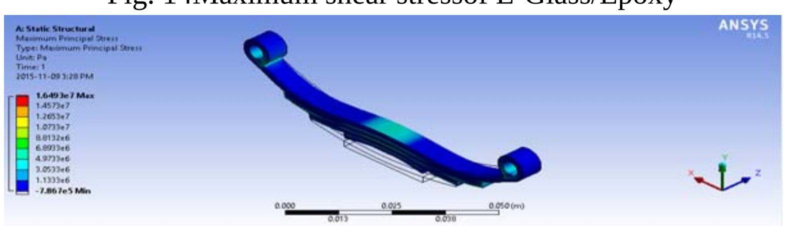


Fig. 15Maximum principal stress of steel

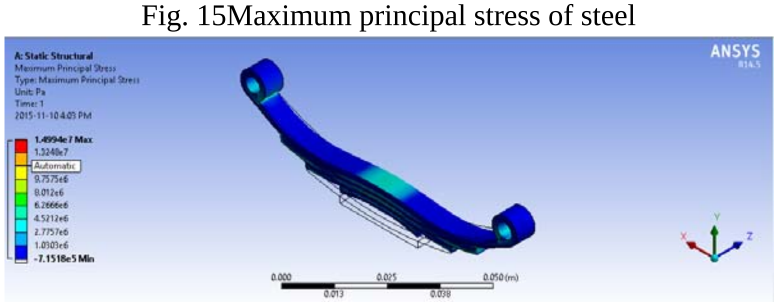


Fig. 16Maximum principal stress of E-Glass/Epoxy

Table 2 Comparison of steel and E-Glass/Epoxy results

Parameters	Conventional steel leaf spring	E-Glass/Epoxy composite leaf spring
Total Deformation (maximum)	$1.1192e^{-5}$	$9.69e^{-6}$
Equivalent stress (maximum)	$1.9373e^{7}$	$1.7612e^{7}$
Directional deformation (maximum)	$2.2163e^{-6}$	$1.9188e^{-6}$
Maximum shear stress (maximum)	$9.7835e^{6}$	$8.8941e^{6}$
Maximum principal stress (maximum)	$1.6493e^{7}$	$1.4994e^{7}$

Conclusion

1. Results demonstrate that composite leaf spring deflection for a particular load is less compared to conventional leaf spring.
2. Stress generated in the E-Glass/Epoxy leaf spring is lower than steel leaf spring.
3. Composite (E-Glass/Epoxy) leaf spring directional deformation is low compared to steel leaf spring.
4. Composite leaf spring is lighter in weight compared to conventional steel leaf spring.

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