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DESIGN AND ANALYSIS OF COMPOSITE LEAF SPRING USING ANSYS

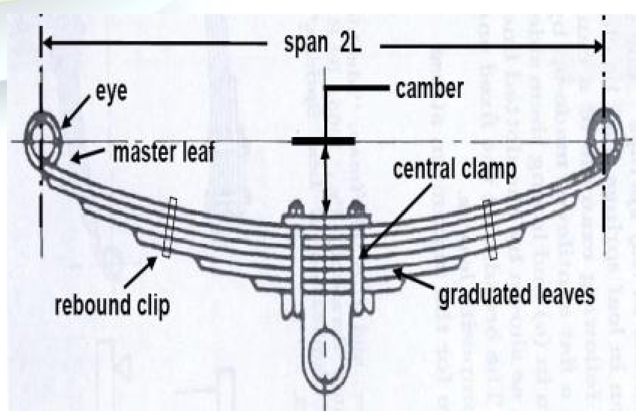
V.Prabhu[1]
S.A ENGINEERING COLLEGE, POONAMALLE

Abstract :

This system. results to better vibration energy absorption within the material and results in reduced transmission of noise and vibration to neighboring structures. High damping capacity of composite materials can be beneficial in many aerospace, automotive applications in which noise, vibration, strength and hardness is a critical issue for passenger comfort. Among the other environmental factors that may cause degradation in some of the mechanical properties of some polymeric matrix composites are elevated temperatures, corrosive fluids, and ultraviolet rays. In many metal matrix composites, oxidation of the matrix well as adverse chemical reaction between fibers and matrix are of great concern at high temperature applications.

I. INTRODUCTION

Leaf springs are mainly used in suspension systems to absorb shock loads in automobiles like light motor vehicles, heavy duty trucks and in rail systems. It carries lateral loads, brake torque, driving torque in addition to shock absorbing [1]. The advantage of leaf spring over helical spring is that the ends of the spring may be guided along a definite path as it deflects to act as a structural member in addition to energy absorbing device. According to the studies made a material with maximum strength and minimum modulus of elasticity in the longitudinal direction is the most suitable material for a leaf spring [3].To meet the need of natural resources conservation, automobile manufacturers are attempting to reduce the weight of vehicles in recent years [4]. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. The suspension leaf spring is one of the potential items for weight reduction in automobiles un sprung weight. This achieves the vehicle with more fuel efficiency and improved riding qualities. The introduction of composite materials was made it possible to reduce the weight of leaf spring without any reduction on load carrying capacity and stiffness [5].For weight reduction in automobiles as it leads to the reduction of un-sprung weight of automobile. The elements whose weight is not transmitted to the suspension spring are called the un-sprung elements of the automobile. This includes wheel assembly, axles, and part of the weight of suspension spring and shock absorbers. The leaf spring accounts for 10-20% 0f the un-sprung weight [6]. The composite materials made it possible to reduce the weight of machine element without any reduction of the load carrying capacity. Because of composite material's high elastic strain energy storage capacity and high strength-to-weight ratio compared with those of steel [7],[8]. FRP springs also have excellent fatigue resistance and durability. But the weight reduction of the leaf spring is achieved not only by material replacement but also by design optimization. Weight reduction has been the main focus of automobile manufacturers in the present scenario. The replacement of steel with optimally designed composite leaf spring can provide 92% weight reduction. Moreover the composite leaf spring has lower stresses compared to steel spring. All these will result in fuel saving which will make countries energy independent because fuel saved is fuel produced.



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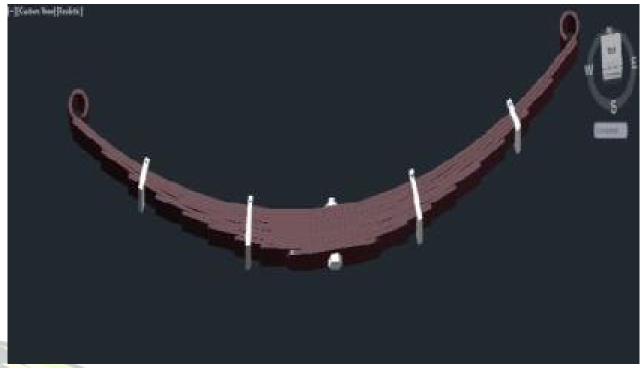
II. METHODOLOGY

Leaf springs are crucial suspension elements used on light passenger vehicle necessary to minimize the vertical vibrations impacts and bumps due to road irregularities by means of variations in the spring deflection so that the potential energy is stored in spring as strain energy and then released slowly so increasing the energy storage capabilities of a leaf spring and ensures a more compliant suspension

III.**COMPOSITE MATERIAL**

A composite material is defined as a material composed of two or more constituents combined on a macroscopic scale by mechanical and chemical bonds. Composite materials are composed of inclusions suspended in a matrix. The constituents retain their identities in the composite. In general the components can be physically identified and there is an interface between them. Some of the composite materials offer a combination of strength and modulus that are either comparable to or better than any traditional metallic materials which we have earlier. Because of their low specific gravities, strength weight-ratio and modulus of elasticity. These composite materials are better than those of metallic materials. The fatigue strength and weight ratios as well as fatigue damage tolerances of composite laminates excellent. For this reasons, fiber composite have emerged as a major class of structural material and are either used or being considered as substitutions for metal in many weight-critical components in aerospace, automotive and other industries. Some other characteristic of many fiber reinforced composites is their high internal damping. This system. results to better vibration energy absorption within the material and results in reduced transmission of noise and vibration to neighboring structures. High damping capacity of composite materials can be beneficial in many aerospace, automotive applications in which noise, vibration, strength and hardness is a critical issue for passenger comfort. Among the other environmental factors that may cause degradation in some of the mechanical properties of some polymeric matrix composites are elevated temperatures, corrosive fluids, and ultraviolet rays. In many metal matrix composites, oxidation of the matrix well as adverse chemical reaction between fibers and matrix are of great concern at high temperature applications. Christo Ananth et al.[2] discussed about E-plane and H-plane patterns which forms the basis of Microwave Engineering principles.



INTRODUCTION OF FINITE ELEMENT SOFTWARE

The Basic concept in FEA is that the body or structure may be divided into smaller elements of finite dimensions called "Finite Elements". The original body or the structure is then considered as an assemblage of these elements connected at a finite number of joints called "Nodes" or "Nodal Points". Simple functions are chosen to approximate the displacements over each finite element. Such assumed functions are called "shape functions". This will represent the displacement within the element in terms of the displacement at the nodes of the element. Mathematically, the structure to be analyzed is subdivided into a mesh of finite sized elements of simple shape. Within each element, the variation of displacement is assumed to be determined by simple polynomial shape functions and nodal displacements. Equations for the strains and stresses are developed in terms of the unknown nodal displacements. From this, the equations of equilibrium are assembled in a matrix form which can be easily be programmed and solved in software. After applying the appropriate boundary conditions, the nodal isplacements are found by solving the matrix stiffness equation. Once the nodal displacements are known, element stresses and strains can be calculated.

IV. DESIGN AND FEA ANALYSIS

The leaf spring model is created by modelling in pro-E and it is imported in to the ANSYS software. In this study all models are designed for factor of safety 3. As FEA is a computer based mathematically idealized real system, which breaks geometry into element. It links a series of equation to each element

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and solves simultaneously to evaluate the behavior of the entire system. This tool is very useful for problem with complicated geometry, material properties and loading where exact and accurate analytical solution is difficult to obtain.

1. Meshing

Discretising of model into the small sections called as the element. Mesh element for this analysis was tetrahedron.

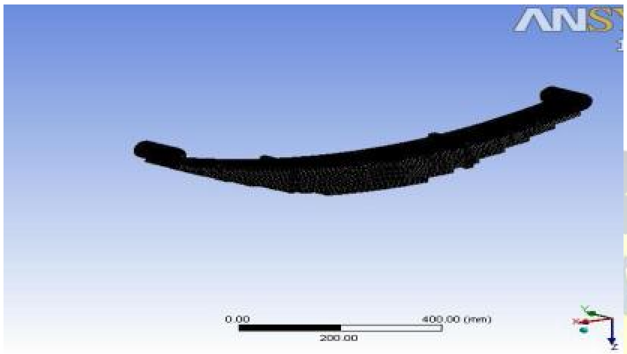

Fig 1. Meshing of leaf spring.

Fig. 1 shows the meshed model of multi-leaf spring in which mesh has been selected considering the concept of grid independence shows the best suited size of mesh with an element size of 5 mm brick mesh.

2. Loading & Boundary Conditions:

2.1. Fixed Support

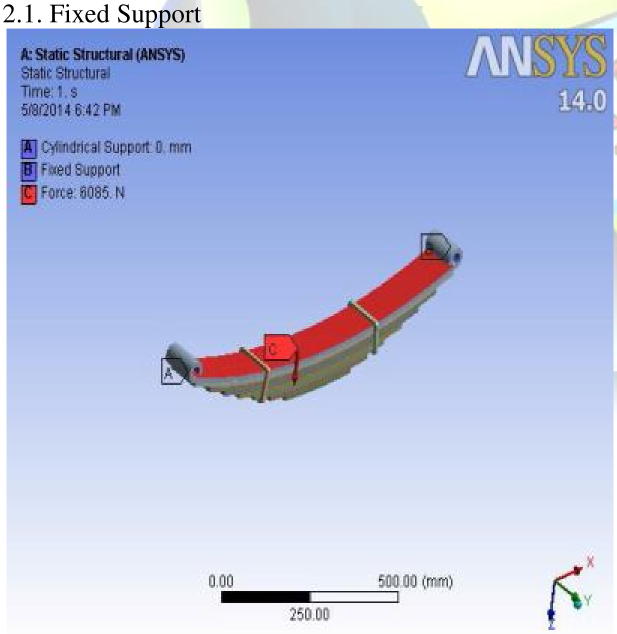

Fig 2. Boundary conditions for leaf spring.

For the leaf spring analysis one of the eye ends of the leaf spring is fixed to the chassis of the vehicle. Since fixed support has restriction to move in X and Y direction as well as rotation about that fixed point. So this fixed eye end of the leaf spring cannot move in any of the directions i.e. for this eye end degrees of freedom is zero.

2.2. Cylindrical support

Since the leaf spring has to translate in one plane and other movements are restricted to move as there is shackle provided at other end of the leaf spring. Therefore a cylindrical support is applied to the other eye end of leaf spring model. This support provides the movement of the leaf spring in X axis, rotation about Z axis and fixed along Y axis. The load is uniformly distributed on the leaf spring. In this study uniformly distributed load of 6085N is applied on the leaf spring model. The uniformly distributed load is shown in Fig. 6

V. RESULT AND DISCUSSION

1. Total Deflections:

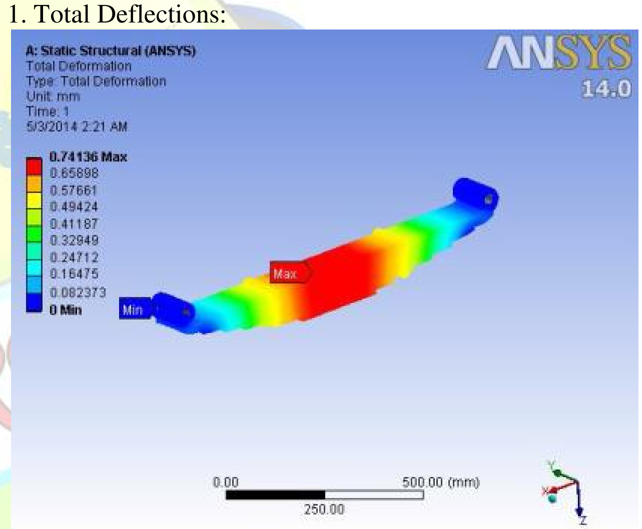

Fig 3. Deflection for Model 1

Fig. 3 shows the deflection of model 1 in which all steel leaves are used. Steel leaf spring is loaded under the application of 6085N load. The maximum deflection is at the centre of the leaf spring its maximum value is 0.74 mm. Red zone indicates the area of maximum deflection and blue zone indicates the area of minimum deflection. Whereas analytically deflection is 1.09 mm

VI. CONCLUSION:

The 3-D modelling of multileaf spring is done and analyzed for different arrangements of steel leaves with composite leaves. A comparative study has done for four models for Deflection and stresses. Same models are designed for factor of safety of 2.5. Leaf spring is analytically designed and shows factor of safety 2.8. Four models are analysed in ANSYS and maximum deflection, stress and ultimate strength are calculated. Model 4 showing factor of safety 4.1 which is close to FOS of steel i.e model 1 of FOS 4.5, nevertheless model 2 also showing FOS of 4.08. Model 2 and model 4 shows less static deflection and less stress compare to model 3, in which six composite leaves are used and only two steel leaves are used. It denotes that alternate placing of composite leaves provides similar strength as that of conventional steel leaves with additional advantages. Also implementation of three steel leaves instead of four leaves, gives better results than alternate arrangement of steel and composite leaves. Fourth model arrangement shows better result than other two arrangements. It is observed that the composite material arrangement shows more deflection and stress than that of steel material leaf spring but the model 4 gives considerable reduction in weight and whose FOS is also 4.1 close to steel leaf springs FOS of 4.5.

REFERENCES

[1]. M.Venkateshan , D.Helmen Devraj, "design and analysis of leaf spring in light vehicles", IJMER 2249-6645 Vol.2, Issue.1,pp.213-218, Jan-Feb 2012.

[2]. Christo Ananth, S.Esakki Rajavel, S.Allwin Devaraj, M.Suresh Chinnathampy. "RF and Microwave Engineering (Microwave Engineering).", ACES Publishers, Tirunelveli, India, ISBN: 978-81-910-747-5-8, Volume 1,June 2014, pp:1-300.

[3]. U. S. Ramakant & K. Sowjanya, "Design and analysis of automotive multi leaf springs using composite material", IJMPERD 2249-6890 Vol. 3, Issue 1,pp.155-162, March 2013,

[4]. Rajendran I., Vijayarangan S., "Design and Analysis of a Composite Leaf Spring"Journal of Institute of Engineers, India ,vol.-8,2-2002

[5]. Dakshraj Kothari,Rajendra Prasad Sahu and Rajesh Satankar Comparison of Performance of Two Leaf Spring Steels Used For Light Passenger Vehicle, VSRD-MAP 2249-8303 Volume2 (1), 9-16, 2012

[6]. Mr. V. Lakshmi Narayana, "Design and Analysis Of Mono Composite Leaf Spring For Suspension in Automobiles" IJERT 2278-0181, Vol. 1 Issue 6, August – 2012

[7]. Shishay Amare Gebremeskel, "Design, Simulation, and Prototyping of Single Composite Leaf Spring for Light Weight Vehicle", Global Journals Inc. (USA) 2249-4596, Volume 12 Issue 7, 21-30, 2012

[8]. Manas Patnaik, NarendraYadav, "Study of a Parabolic Leaf Spring by Finite Element Method & Design of Experiments" , IJMER 2249-6645, Vol.2, 1920-1922, July-Aug 2012

[9]. Kumar Krishan, Aggarwal M.L, "Computer Aided FEA Comparison of mono steel and mono GRP leaf spring", IJAERS 2249–8974, vol. 1 issue 2, pp. 155-158, jan- march 2012

[10]. Mr. V. K. Aher *, Mr. P. M. Sonawane , Static And Fatigue Analysis Of Multi Leaf Spring Used In The Suspension System Of LCV, (IJERA) 2248-9622 Vol. 2, Issue 4, pp.1786-1791, July-August 2012

[11]. B. Raghu Kumar, R.VijayaPrakash and N. Ramesh, Static analysis of mono leaf spring with different composite materials" JMER , 2141-2383, Vol. 5(2), pp.32-37, February 2013

[12]. Y. N. V. Santhosh Kumar & M. Vimal Teja,Design and Analysis of Composite Leaf Spring International Journal of Mechanical and Industrial Engineering (IJMIE), ISSN No. 2231 –6477, Vol-2, Issue-1,pp. 97-100, 2012

[13]. Deshmukh.et.al, Design and analysis of fibber reinforced polymer (FRP) leaf spring-A review, International journal of engineering technology and science, Vol.2(4), pp 289-291, 2011.

[14]. William D. Callister Material science and engineering.

[15]. Robert C. Juvinall, Kurt M. Marshek fundamentals of machine component design.