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EXPERIMENTAL INVESTIGATION AND ANALYSIS OF LEAF SPRING USING BAMBOO WITH EPOXY RESIN

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Abstract

In present year's natural fibre composite material plays a major role in industries like aerospace and automobile. The natural fibre is amplified by hookup with plastics. Variety of natural fibres such as coir, Bamboo and Coconut fibre, ramie, sisal, jute, banana, bagasse etc are preferred for cheap. Common matrix materials include epoxy, phenol, polyester, polyurethane vinyl ester etc. The composites formed by fibres gained attention due to their low cost, light weight, renew-ability, low density, high specific strength, none abrasively, non-toxicity and biodegradability etc. Leaf springs are one of the oldest suspension components they are still frequently used, especially in commercial vehicle. This work is carried out on multi leaf spring consist three full length leaves in which one is with eyed ends used by a light commercial vehicle. This work deals with replacement of conventional steel leaf spring of a light commercial vehicle with composite leaf spring using E-glass/Epoxy. In this paper discussed the Composite material Plate by using Bamboo and Coconut fibre with Epoxy composite and to evaluate the Mechanical properties of leaf spring (Tensile strength, Hardness, Toughness Examination).

Keywords: Epoxy, composite, Leaf spring, yield strength

1. Introduction

Ever increasing demands of high performance together with long life and light weight necessitate consistent development of almost every part of the automobile. Increasing competition and innovations in the automobile sector tends to modify existing products or replace old products by new and advanced material products. A suspension system of vehicles is also an area where these innovations are carried out regularly. 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. 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. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. The study demonstrated that composites can be used for leaf springs for light weight vehicles and meet the requirements, together with substantial weight savings.

The introduction of composite materials made it possible to reduce the weight of leaf spring without any reduction on load carrying capacity and stiffness. Since, the composite materials have more elastic strain energy storage capacity and high strength-to-weight ratio as compared to those of steel. A composite material is the combination of two or more materials that produce a synergistic effect so that the combination produces aggregate properties that are different from any of those of its constituents independently. Upon those products leaf spring is the focus of this project for which researchers are running to get the best composite material, which meets the current requirement of strength and weight reduction in one, to replace the existing steel leaf spring.

1.1 LEAFSPRING

The suspension leaf spring is one of the potential items for weight reduction in automobiles as it accounts for ten to twenty percent of the unsprung weight. The introduction of composites helps in designing a better suspension system with better ride quality if it can be achieved without much increase in cost and decrease in quality and reliability. In the design of springs, strain energy becomes the major factor. It can be easily observed that material having lower modulus and density will have a greater specific strain energy capacity. The introduction of composite materials made it possible to reduce the weight of the leaf spring without reduction of load carrying capacity and stiffness due to the following factors of composite materials as compared to steel.

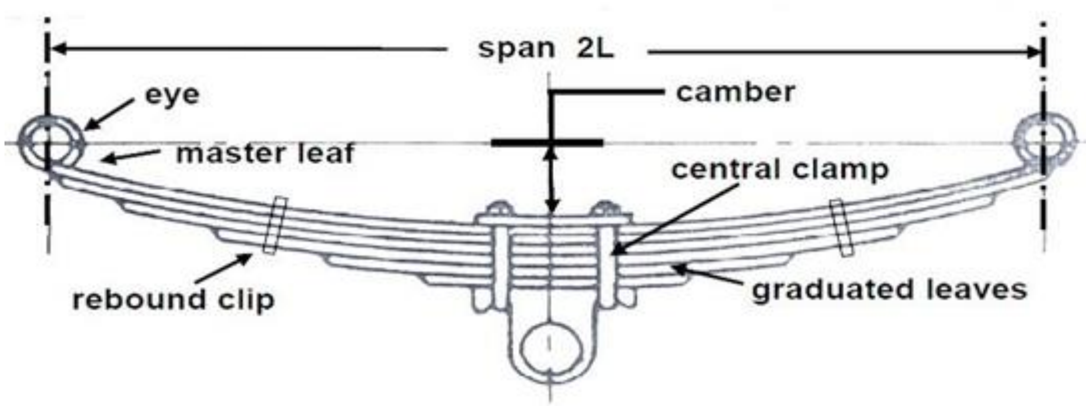

Fig.1 **Structure of leaf spring**

The material used for leaf springs is usually a plain carbon steel having 0.90 to 1.0% carbon. The leaves are heat treated after the forming process. The heat treated steel spring products greater strength and therefore greater load capacity, greater range of deflection and better fatigue properties. Carbon/Graphite fibre. Their advantages include high specific strength and modulus, low coefficient of thermal expansion and high fatigue strength. Graphite, when used alone, has low impact resistance. Its drawbacks include high cost, low impact resistance and high electrical conductivity. The main advantage of Bamboo fibre over others is its low cost. It has high strength, high chemical resistance and good insulating properties. The disadvantages are low elastic modulus poor adhesion to polymers, low fatigue strength and high density, which increase leaf spring weight and size. Also crack detection becomes difficult.

Typically when used in automobile suspension the leaf supports an axle and locates/ partially locates the axle. This can lead to handling issues (such as 'axle tramp'), as the flexible nature of the spring makes precise control of the unsprung mass of the axle difficult. Some suspension designs use a Wattslink (or a Panhard rod) and radius arms to locate the axle and do not have this drawback. Such designs can use softer springs, resulting in better ride. The various Austin-Healey 3000's and Fiat 128's rear suspension are examples. Natural fibres, often referred to as vegetable fibres, are extracted from plant and will be classified into three categories, depending on the part of the plant they are extracted from. Fruit fibres are extracted from the fruits of the plant, they are light and hairy, and allow the wind to carry the seeds. Bast fibres are found in the stems of the plant providing the plant its strength. Usually they run across the entire length of the stem and are therefore very long.

They are very easy to obtain, extensively available material in nature. They reveal some outstanding material properties like biodegradability, low cost per unit volume, high strength, and specific stiffness. Composites made of NF reinforcements seem to carry some diverse properties over synthetic fibres, such as reduced weight, cost, toxicity, environmental pollution, and recyclability.These economic and environmental benefits of NF composites make them predominant over synthetic fibre-reinforced composites for modern applications. Depending on the type, natural fibres have similar structures with different compositions. The inclusion of long and short natural fibres in thermoset matrices has manifested high-performance applications.

The use of natural fibres for technical composite applications has recently been the subject of intensive research in the industrial world. Many automotive components are already produced in natural composites, mainly based on

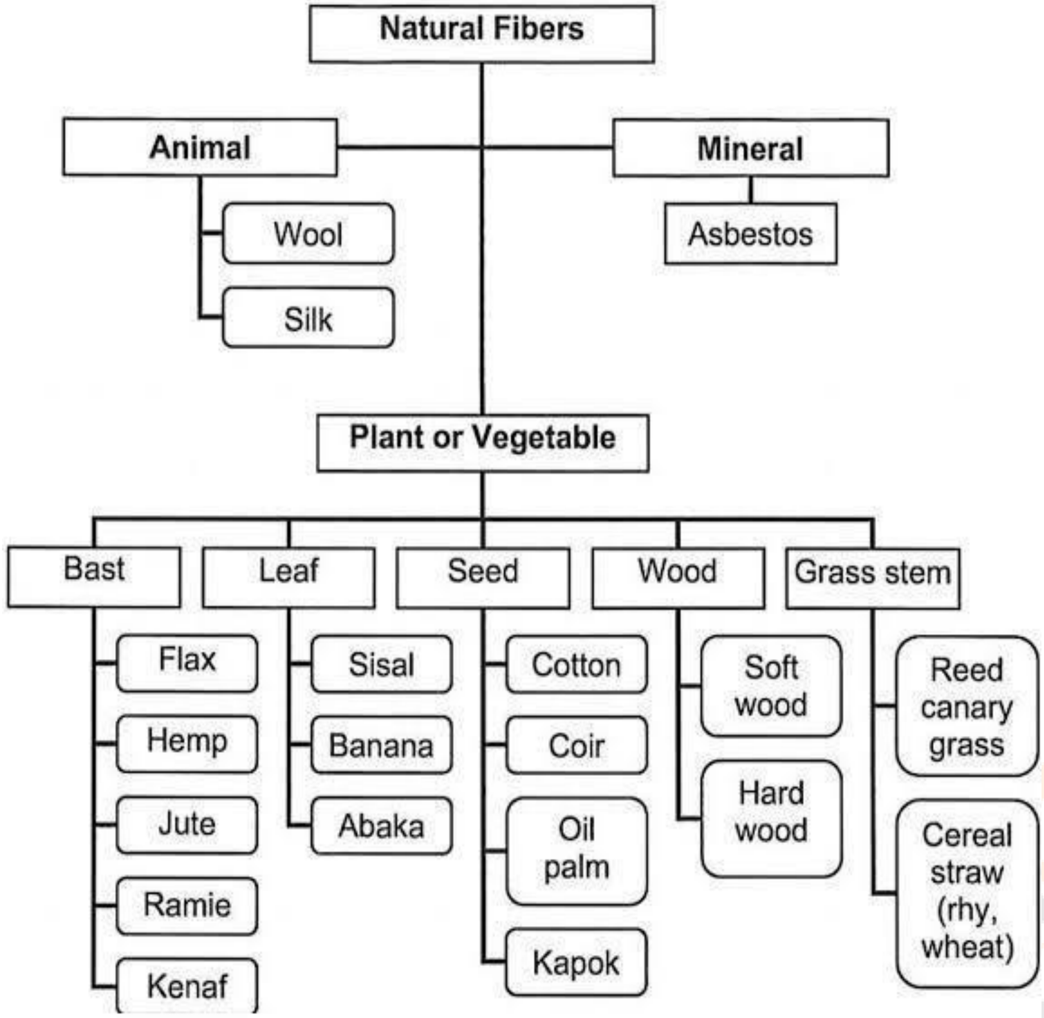

Fig. 1.2 Classification of natural fibres

Marketing ('processing renewable resources') rather than technical demands. The range of products is restricted to interior and non-structural components like door upholstery or rear shelves.

Many researchers, in all continents, now work on bamboo and are trying to explore its wider application and utilization. Not everyone has sufficient knowledge and experience to appreciate the limitations of bamboo as for any other natural raw material.All these literature report that the cost of composite; leaf spring is higher than that of steel leaf spring. Hence an attempt has been made to fabricate the composite leaf spring with the same cost as that of steel leaf spring.

i. Natural fibre Composites and Their Applicationspublished by P Pecas and H Solomon (2017) made a comprehensive review about the properties of natural fibres used as composite materials reinforcement is presented, aiming to map where each type of fibre is positioned in several properties.

ii. The Potential of Natural Fibres for Automotive Sectorspublished by MS Fogorasi (2017) focuses on development in the sustainable material also progresses. This change leads to enhancement in the efficiency of the product. Novel sustainable material is the need of the hour for the future development.

iii. F.O. Tesoro and Z.B. Espiloy has studied Anatomical Properties and Chemical Properties of Bamboos in the Philippines. They have stated that the fibre length of 13 species ranged from 1.36 to 3.78 mm.It is reported that the length and percentage composition of fibres varied in the horizontal and vertical directions within the inter nodes as well as from the base, middle to top portions of the culm.

iv. Development of Eco-composites using Natural Bamboo Fibre and their Mechanical Properties published by T. Shito, K. Okubo & T. Fujii focused as a substitution of glass fibre, because these fibres have adequate mechanical properties in spite of low density.

v. Anurag Nayak, Arehant S Bajaj, Abhishek Jain, Apoorv Khandelwal, Hirdesh Tiwari, published on IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) on Replacement of Steel by Bamboo Reinforcement Volume 8, Issue 1 (Jul. - Aug. 2013), PP 50-61. In this study, the effect of replacement of steel reinforcement by bamboo reinforcement, designs have been conducted.

vi. Atul agarwal and Damodar maity (2009) they studied axial compression and bending test was performed on Plain, Steel & Bamboo reinforced members. As explained in there experimental program, For example, a total of 12 columns (150x150x1000mm) were casted using design mix (M20) as per IS code

vii. Jayaramudu, Agwuncha, Ray, Sadiku, and Rajulu et. al.studied with Natural Polyalthiacerasoide woven fabrics mixing with epoxy composite. The woven fabrics extracted from bark of the tree to make hybrid composites. The hand lay-up technique was used to fabrication of hybrid composite at room temperature.

viii. Sreejarani and Suprakas (2011) published a review on Epoxy-based Carbon Nanotubes Reinforced Composites in which he explained various techniques for characteristic features, various techniques for synthesis of carbon nanotubes and their incorporation onto epoxy resin.

ix. S. Requile et. al. concluded that at the Microscopic Level Hygromechanical Nature of a Single Hemp/Epoxy Interface was researched via its properties. Curiously a decent discussion of bond quality at internal faces also friction and delamination characteristics in addition to the entire scope of RH.

x. M. M. Patunkar, D. R. Dolas, they have selected EGlass/Epoxy material for Modeling and Analysis of Mono Leaf Spring (GFRP). Also, they have given a comparison results for various loading condition. Their work approach was related to minimise weight of leaf springs.

xi. Erol Sancatkar, Mathieu Gratton they have discussed about Manufacturing of a Composite Leaf Spring for a Light Vehicle run on Solar Energy. This paper have objective to give brief information regarding designing, numerically analysis and physical testing for future use of composite material for leaf spring.

xii. Mouleeswaran Senthil Kumar, Sabapathy Vijayaranganin this Paper, author have made Experimental and Analytical Investigationwas made forFatigue Life Prediction of Steel and Composite Multi Leaf Spring by using Data Analysis. The author has concluded that, fatigue life of composite leaf spring was more than that of conventional steel leaf springs.

xiii. Dushyant Kumar, Pankaj Saini, Ashish Goel, etc. studied on Design and Analysis of Composite Leaf Spring for Light Vehicles. Main objective of this work is to compare the stresses and weight saving of composite leaf spring with that of steel leaf spring.

2. Materials and Methods

Fig. 7.1 Bamboo fibre specimen 8mm (left) and 6mm (right)

3. Results and discussion

4.1 MODEL DESIGN

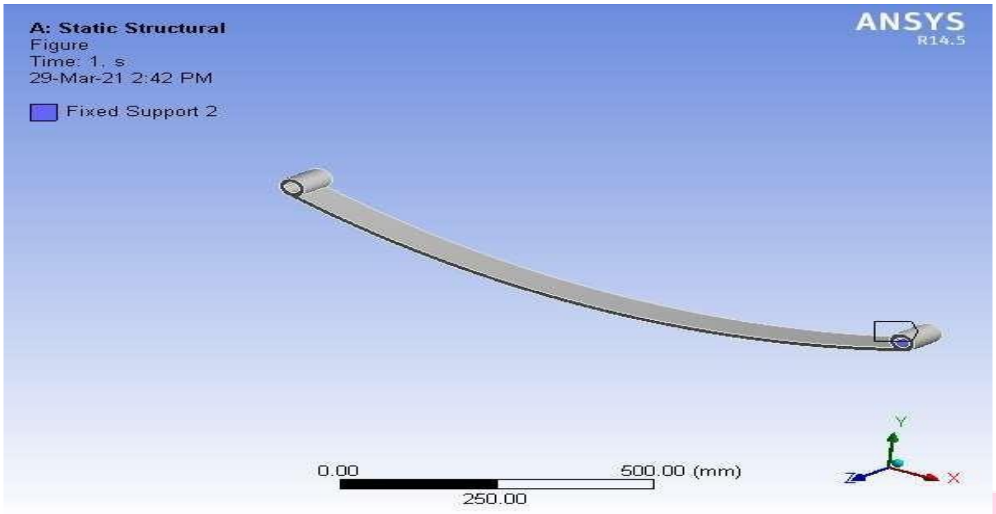

Fig. 4.1 Model of the leaf spring

4.2 FORCES APPLIED

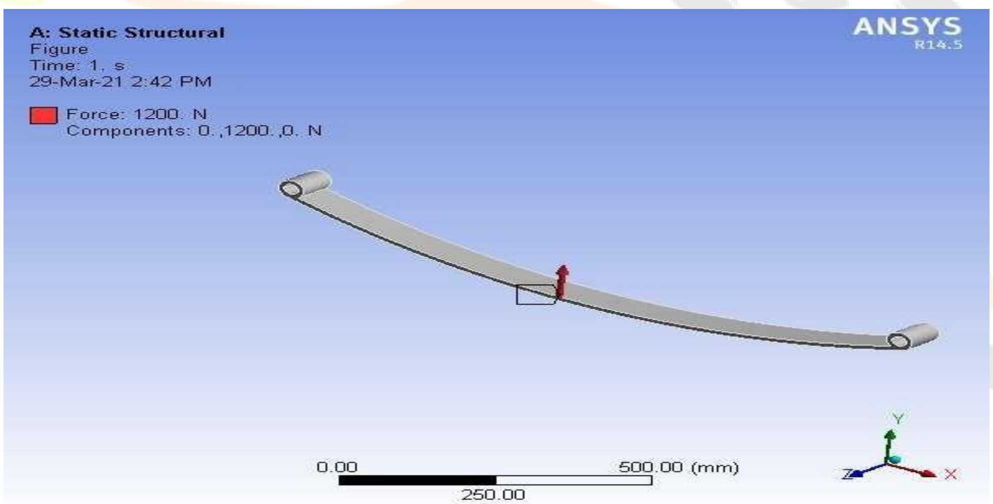

Fig. 4.2 Forces applied on the leaf spring

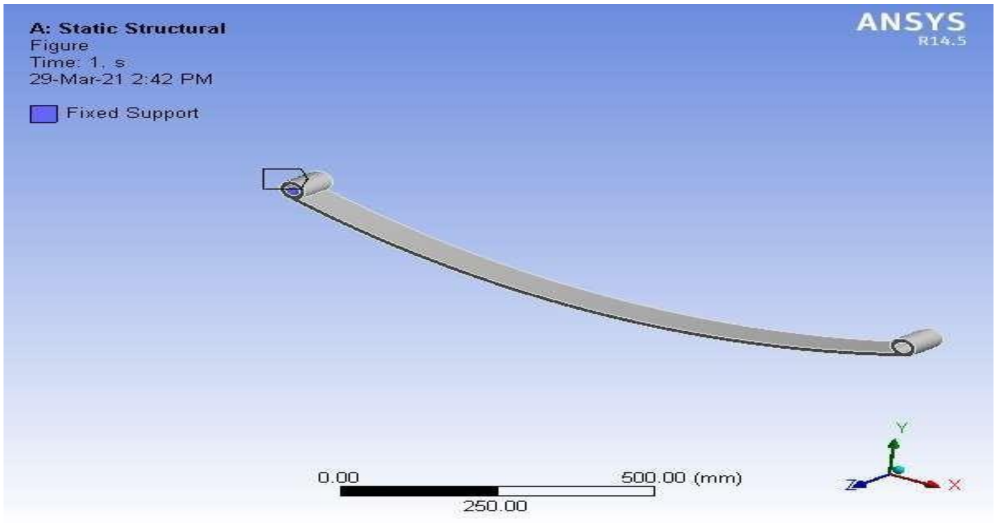

Fig. 4.3 Fixed support on the leaf spring.

4.3 FIXED SUPPORTS

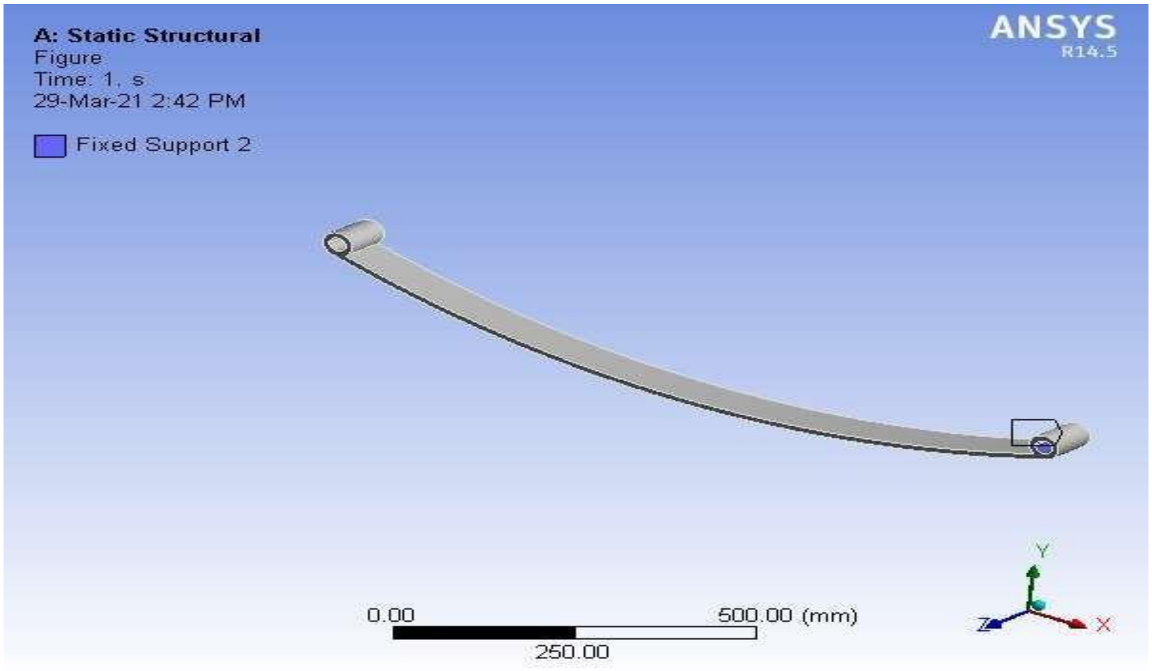

Fig. 4.4 Fixed support on the leaf spring.

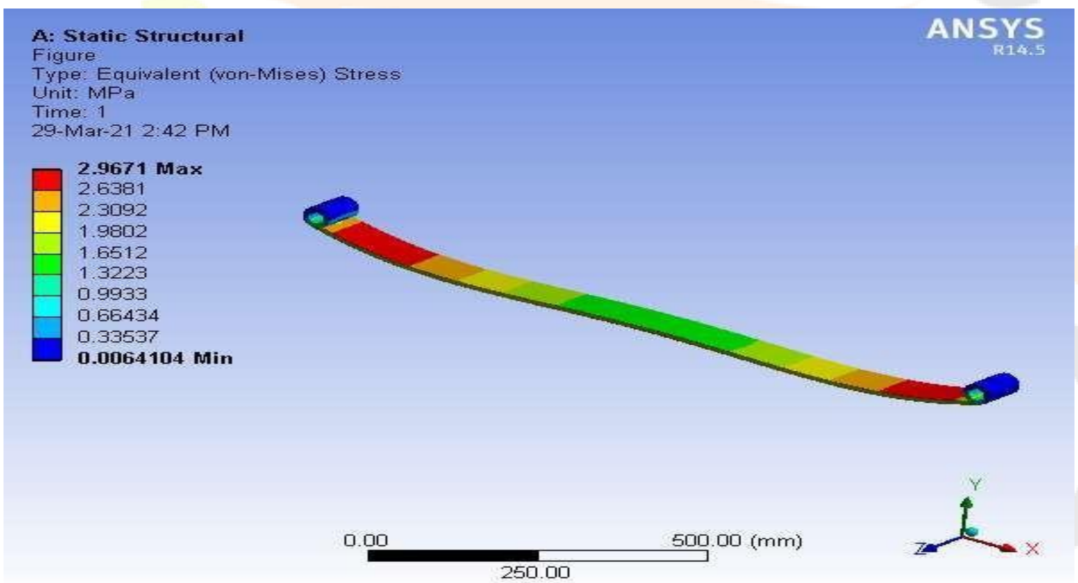

Fig. 4.5 Equivalent (von-mises) Stress

4.5 STRAIN RESULT

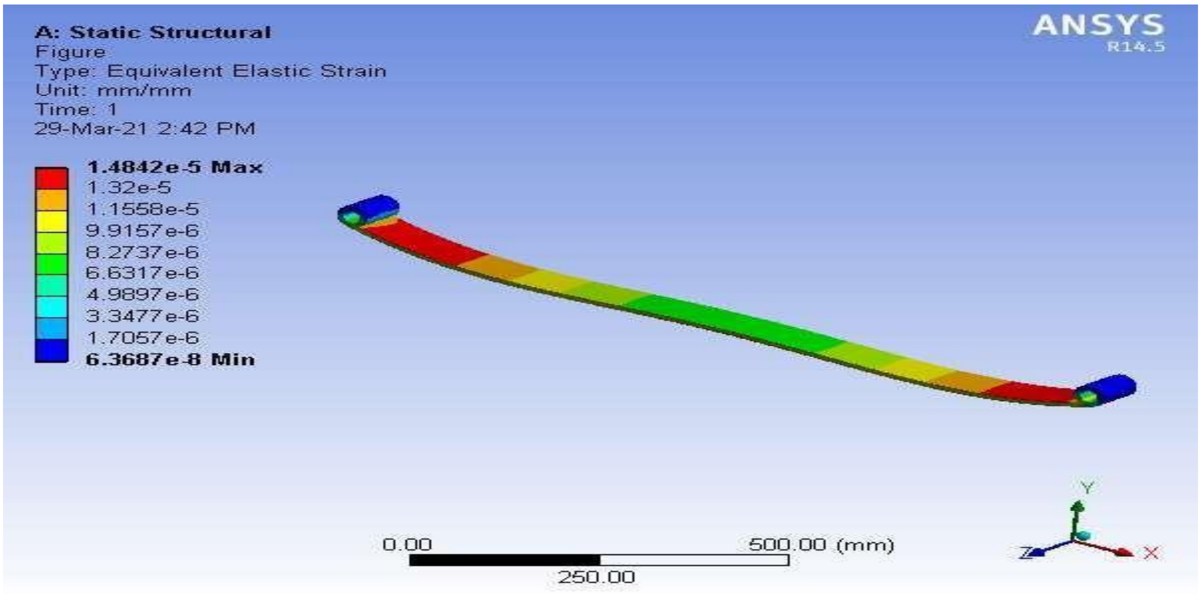

Fig. 4.6 Equivalent elastic strain

Tensile testing, also known as tension testing, is a fundamental materials science and engineering test in which a sample is subjected to a controlled tension until failure. Properties that are directly measured via a tensile test are ultimate tensile strength, breaking strength, maximum elongation and reduction in area. From these measurements the following properties can also be determined Young's modulus, Poisson's ratio, yield strength, and strain- hardening characteristics. Uniaxial tensile testing is most commonly used for obtaining the mechanical characteristics of isotropic materials. Tensile test specimens are prepared in a variety of ways depending on the test specifications. The most commonly used specifications are BS EN ISO 6892-1 and ASTM E8M. Most specimens use either a round or square standard cross section with two shoulders or a reduced section gauge length in between. The shoulders allow the specimen to be gripped while the gauge length shows the deformation and failure in the elastic region as it is stretched under load. The reduced cross section gauge length of specific dimensions assists with accurate calculation of engineering stress via load over area calculation.

YIELD STRENGTH

The yield strength is the point at which plastic deformation occurs under stress. This is determined during testing over a measured gauge length via the use of devices known as extensometers. The devices may be either be mechanical clip on or video where non-contact is a limitation, e.g. elevated temperature testing.

ULTIMATE TENSILE STRENGTH (UTS)

The UTS is the maximum stress that a specimen is exposed to during testing. This may differ from the specimen's strength when breaking depending on if it is brittle, ductile or has properties of both. These material properties can change depending on environment, for example in extreme hot or cold.

DUCTILITY

Ductility relates to the elongation of a tensile test. The percentage of elongation is calculated by the maximum gauge length divided by the original gauge length.

MODULUS OF ELASTICITY

The modulus of elasticity also known as Young's modulus measures the stiffness of a specimen whereby the material will return to its original condition once the load has been removed. Once the material has been stretched to the point where it no longer returns to its original length and permanent deformation is shown, Hooke's Law no longer applies. This is known as the elastic or proportional limit (also the yield strength).

4. Conclusion

As reducing weight and increasing strength of products are high research demands in the world, composite materials are getting to be up to the mark of satisfying these demands. In this paper reducing weight of vehicles and increasing the strength of their spare parts is considered. As leaf spring contributes considerable amount of weight to the vehicle and needs to be strong enough, a single composite leaf spring is designed and it is shown that the resulting design and simulation stresses are much below the strength properties of the material satisfying the maximum stress failure criterion. From the results of static analysis of steel leaf spring, it is seen the deformation of leaf spring is which is well below the camber length of leaf spring. It is seen that the maximum bending stress is about, which is less than the yield strength of the material.

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. R.S.Khurmi and J.K.Gupta Machine Design chapter 23.
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, March2013,
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.

16. www.auto-data.net