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Analysis of Mechanical Properties and Reduced Weight of Composite Materials Leaf Spring using Ansys

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ABSTRACT

This study presents the investigation of mechanical properties of composite materials. The aim of this thesis is static investigation consequences of existing leaf spring made of EN 45 steel material with three different sort of composite material leaf spring. There are the plan requirements to stress, deflection and weight decrease. The plan particular of composite material leaf spring is taken same as the regular steel leaf spring. Different types of composite material are used such as fiber glass material with epoxy resin, carbon/epoxy and Kevlar/epoxy material. This composite material leaf spring demonstrated on CATIA V5 and, investigated it on ANSYS 14.0. Comparing with steel spring result with composite spring result we have seen that the wt. of the composite material leaf spring made of Kevlar/epoxy fiber, is diminished by 6.01%, by utilizing material E-glass/epoxy Fiber it is diminished by 59.1% and by utilizing material carbon/epoxy fiber it is diminished by 63.7%.

Keywords – Parabolic leaf spring, Mechanical properties, Composite materials, CATIA,

1. INTRODUCTION

There are two major issues in the automobile industry today, for example, fuel efficiency and emission gas guidelines based on the Greenhouse gas protocol. To combat this, automobile manufacturers are developing new vehicles that can provide higher efficiency at a lower cost. One of the most effective ways to improve fuel efficiency is to reduce the weight of automobiles. Weight reduction can be achieved by using good materials, improving plans, and employing the most efficient manufacturing processes. The achievement of weight reduction with improved mechanical properties has been made possible by composite material, which is a generally excellent substitute material for traditional steel material. A spring is an elastic object/body whose primary function is to store energy (mechanically). A spring is a coil, leaf, volute, or compression that stores potential energy when loaded in compression, extension, or torsion. Spring applications are widely used in brakes, clutches, toys, and clocks. By allowing contact between two parts, the spring also controls the motions of the cams and followers.

A leaf spring is the most basic and oldest type of spring used in vehicle suspension. It is also known as a laminated or carriage spring. It is also known as elliptical, semi-elliptical, and cart spring in technical terms. A leaf spring in the form of a slender arc shaped in the most widely recognized setup, the centre arc gives the axle location, while loops formed either rear end to link the chassis vehicle. A leaf spring can be made for extremely heavy vehicles by stacking a few leaves on top of one another.

2. PROBLEM IDENTIFICATION

The majority of the papers are concerned with reducing the weight and increasing the strength of leaf springs. Some of them are carbon fibre and glass fibre reinforced with Epoxy resin, and for testing the samples, the ASTM D638 standard is used. Various mechanical tests have been carried out. According to the results, carbon fibre epoxy and glass fibre epoxy have the highest tensile strength and weight reduction of 69.4% and 75%, respectively. Several materials are used, including EN45, glass fibre, carbon fibre, and reinforced materials such as epoxy and S-epoxy. The leaf spring also includes mathematical calculations, and a mono leaf spring is designed and tested.

3. OBJECTIVES

The goal of this proposal is to reduce the stress acting on the leaf spring in order to reduce vehicle vibration. This can be accomplished by selecting appropriate composite materials. The primary goals of this work are to fabricate leaf springs and composite leaf springs for element analysis of springs using FEM on ANSYS-14 software packages. Third, the ideal explanatory leaf spring with less stress was chosen. As we depict the problem and techniques for solving it through various activities, the goal of this research is to replace the current one with a composite material that is lighter and stronger.

4. RESULT AND DISCUSSION

Fig.4.1 depicts a stress vs. load graph, and it is clear that as the load increases, so does the stress in the material. Here, we discover that the generally von-mises stresses are used to determine whether the design is capable of carrying a load. If the most extreme measure of the aftereffect of stress investigation in material is more significant than the strength. The spring demonstrated the greatest stress at fixed ends in this study. If the spring strength is less than the yield strength, the design is suitable for use.

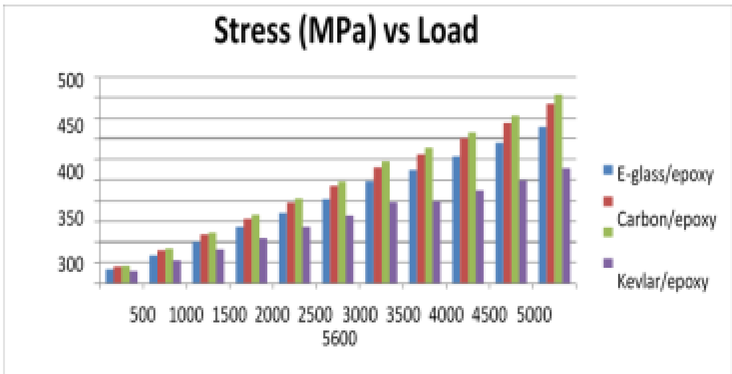

Figure: 4.1 Stress vs Load

The strength, fracture energy, and stiffness are all determined by the subsequent load deformation. The deformity in composite material leaf springs is more noticeable than in steel overlaid spring conditions. Because epoxy has the properties to resist deformation when loaded, e-glass/epoxy showed the greatest deformation at all points. Steel exhibits less deformation under all loads due to its lower ductile properties. As shown in Fig. 4.2, the second position acquired during deformation is carbon/epoxy and Kevlar/epoxy.

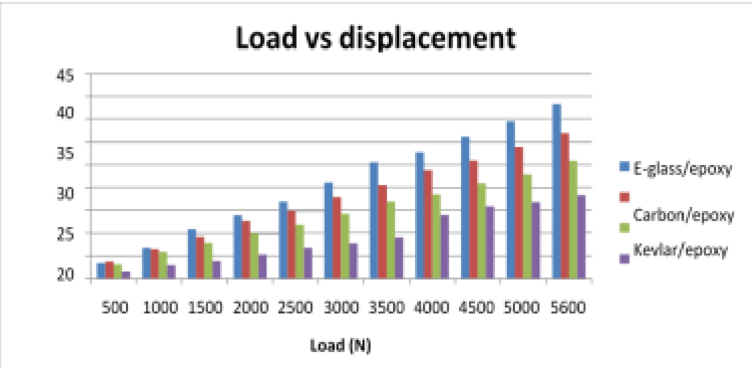

Figure: 4.2 Load vs Displacement

In Fig. 4.3, the principal stress increases as the load increases from 500N to 5600 N. When the load is 500 N, E-glass/epoxy has the lowest principle stress, and when the load is 5600 N, Kevlar/epoxy has the highest principle stress. In all load positions, the highest stresses are shown for Kevlar/epoxy, followed by carbon/epoxy, E-glass/epoxy, and finally steel EN45.

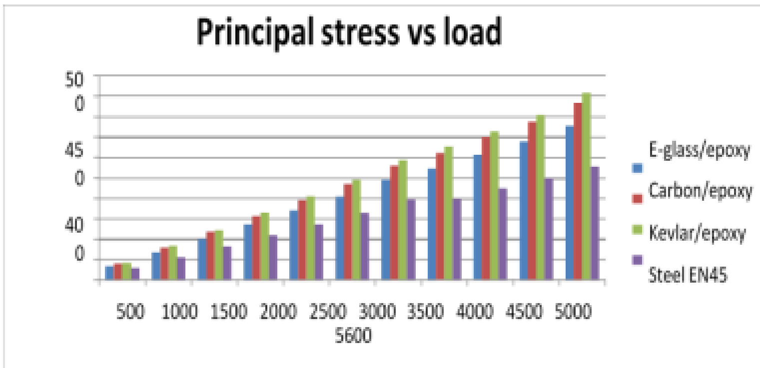

Figure: 4.3 Principal **stress vs load**

The load vs stiffness graph in Fig. 4.4 clearly shows that stiffness is greatest for the steel EN5. In comparison to the previous graph, Kevlar or E-glass had higher magnitudes, but steel took first place in stiffness. For steel, the magnitudes range from 500 N to 3500 N. When we needed elasticity, it had a low modulus.

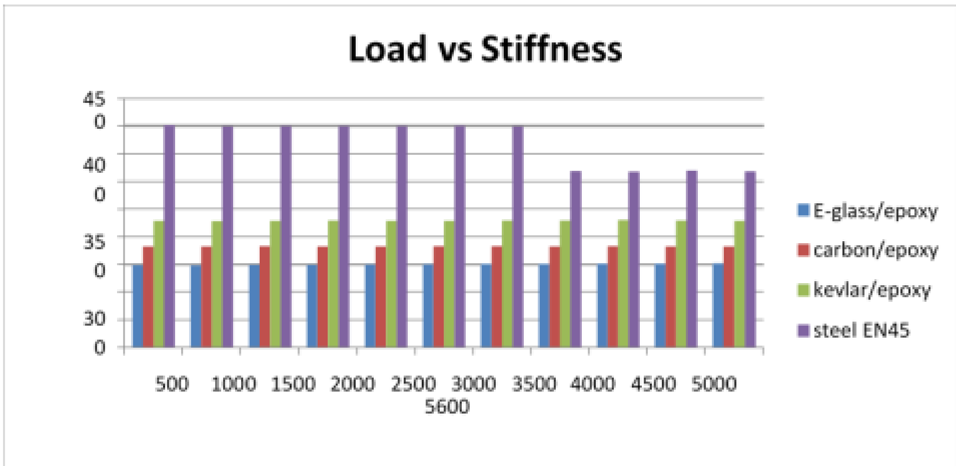

Figure: 4.4 Load vs stiffness

5. CONCLUSION

The mechanical properties of a mini-loaded truck are determined using a parabolic leaf spring in this analysis. The above analysis assists the designer in selecting the appropriate materials (E-glass/epoxy, Kevlar/epoxy, carbon/epoxy, and conventional steel EN 45) for the leaf spring requirement. All mathematical and theoretical calculations for spring parameters such as span, camber, thickness, and number of leaves have been completed. The leaf spring is designed to carry a load of 5600 N and is subjected to static and fatigue analysis. The analysis also shows that the weight percentage of materials saved is reduced by 6.01% for Kevlar/epoxy, 63.7% for Carbon/epoxy, and 59.1% for E-glass/epoxy when compared to conventional steel EN 45. According to the findings, for static analysis, all composite materials springs are much lighter than steel EN 45, and maximum deflection is found for composite spring material rather than steel. The fatigue analysis is also investigated using CAE to predict. Composite materials have higher deflection and strain energy than steel. Researchers also chose E-glass/epoxy materials for springs because their stresses are lower than those of the other two composite materials, Kevlar/epoxy and Carbon/epoxy.

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