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A Review - Structural design of leaf spring by using Hybrid Composite Material

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ABSTRACT
Weight reduction is now the main issue in automobile industries. In this work due to reduce the weight of steel spring with Hybrid composite leaf spring due to high strength ratio is need to improve. The main aim is to make a review on the load carrying capacity, stiffness and weight savings of composite leaf spring with that of steel leaf spring at rated-load and over-load condition. The analysis has been carried out for the leaf spring made up of steel and Composite materials. Composite specimens are fabricated with two different staking sequences like the (resin with clay and enhanced with Nanoparticles). The thickness and width for constant cross section is maintained on the moulding techniques. The design of multi leaf spring was modeled in ANSYS 14.5.the dimensions of an existing multi leaf spring is taken for modeling and analysis of a laminated composite multi leaf spring with different composite sequence materials subjected to the same load as that of steel spring.

Keywords: *Leaf Spring, Fluent Ansys, shear strain, equivalent stress, Deflection and principal stress.*

Introduction

A leaf spring is a simple form of spring commonly used for the suspension in wheeled vehicles. Leaf spring is very common in Light and Heavy duty vehicles in automobiles and more sophisticated suspension designs saw automobile manufactures use coil springs instead. A leaf spring takes the form of slender arc-shaped length of spring steel of rectangular cross-section. The center of the arc provides location for the axle, while tie holes are provided at either end for the attaching to the vehicle body. For very heavy vehicles, a leaf spring can be made from several leaves stacked on top of each other in several layers, often with progressively shorter leaves. Leaf spring can serve locating and to some extent damping as well as springing functions. While the interleaf friction provides a damping action, it is not well controlled and results in the motion of the suspension system. The manufactures have experimented with mono-leaf springs. Today leaf springs are still used in heavy commercial vehicles such as vans, cars, trucks and railway carriage. Leaf springs are also located the rear axle, eliminating the need for trailing arm and pan hard rod. There by saving cost and weight in a sample live axle rear suspension. A further advantage of a leaf spring over a helical spring is that the end of the leaf spring may be guided along a definite path. A more modern implementation is the parabolic leaf spring. This design is characteristic by fewer leaves whose thickness varies from centre to ends following a parabolic curve. Aside from a weight saving the main advantage of parabolic leaf spring is their greater flexibility which translates into vehicle ride quality the approaches that of coil springs. There is a trade-off in the form of reduced loads carrying capability. The characteristics of parabolic springs are better riding comfort and not as 'stiff' as conventional multi-leaf springs. It is widely used on buses for better comfort.

Literature Review: Literature Review has been classified into three categories. Leaf spring by Glass reinforced, Carbon reinforced and Hybrid composites. Each one is explained in brief below.

K. Ashwini (2018) This review is designed to be a comprehensive source for designing a leaf spring using various composites as the Automobile industries are showing keen interest for replacing steel leaf spring with that of a composite leaf spring to obtain reduction in weight, which is an effective measure for energy conservation as it reduces overall fuel consumption of the vehicle.

Chen Qian, Wenku Shi, (2017) The study of composite leaf springs has been popular in automotive light weighting. Particularly, the research on the fatigue reliability of composite leaf springs is crucial. This paper proposed the fatigue law inference of the parabolic composite leaf spring, which was validated by fatigue bench tests. On the bases of the ply scheme design method and the sandwich unit concept, the non-continuous layer section and the stacking order were presented. The stacking sequence was optimized using Genetic Algorithm. The production of composite leaf spring samples, on which the fatigue bench test was conducted, was based on the optimized ply scheme. Results indicate that the fatigue life of composite leaf springs can be improved by using the proposed ply scheme design method.

R. H. Patel, V. R. Sevkani (2016) Composite Materials are well known for their tailor-made properties. For the fabrication of composites different types of reinforcements are used for different applications. Sometimes for a particular application, one type of reinforcement may not fulfill the requirements. Therefore, more than one type of reinforcements may be used. Thus, the idea of hybrid composites arises. Hybrid composites are made by joining two or more different reinforcements with suitable matrix system. It helps to improve the properties of composite materials.

Y. S. Kong (2016) This paper analyzes the capability of various leaf spring eye designs to prevent failure under braking, cornering, and pothole striking loading conditions. A leaf spring is a vital suspension component of heavy trucks, such that the failure of leaf spring eyes could cause fatal accidents. However, the current design of leaf spring support eyes is solely estimated based on the maximum vertical loads exerted on the leaf spring. The actual torsion or shear loads exerted by the ground to the leaf spring eye extremely high, but the experimental proving ground methods are too expensive to perform load analysis. In this analysis, the forces exerted on the spring eye are simulated under extreme load cases, such as braking, cornering, and pothole striking. The magnitudes of the different loadings were extracted from a multibody dynamics model and were used as the load inputs to the finite element explicit simulation. The principal surface stresses of four different spring eye designs were obtained and compared to the material yield and the ultimate tensile strengths to evaluate the sustainability of the spring eye during extreme load cases. Results show that a minimum thickness of 17 mm is sufficient for the leaf spring eye design to prevent failure under extreme torsional loadings. This research provides insightful analysis of leaf springs to prevent the occurrence of failure during engineering design. Reinforcement have been used with a matrix triglycidyl ether of tris(m-hydroxy phenyl) phosphate epoxy resin using amine curing agent. Different physical and mechanical properties of the glass, carbon and glass/carbon fiber reinforced polymeric systems have been found out.

Irina M.M.W (2015) Traditional fiber reinforced polymer (FRP) composite that is often fabricated from single type of reinforcement has shown its ability to replace the conventional metallic material counterparts. However, due to several stringent requirements on ductility, this has affected the performance of FRP composites for the structural applications. Therefore, hybrid composites, which combine two or more fiber reinforcements, have been introduced in order to overcome the short of traditional FRP composites. This paper investigates the mechanical properties of three different arrangements of hybrid composites made from glass fiber (plain-woven and stitched bi-axial ±45°) and plain-woven carbon fiber. Vacuum assisted resin transfer moulding method was employed to fabricate the hybrid composite panels. Mechanical properties such as tensile strength, flexural strength and volume fraction of the hybrid composites were determined per ASTM standards. Experimental results indicate that the [CWW]6 arrangement, where C and W are weaved carbon fiber and glass fiber respectively, were superior in terms of mechanical properties.

Sushil B. Chopade (2015) The main weightage of investigation is to reduce the weight of product while upholding its strength. To solve problem in this regard composite materials play an important role. In this paper decreasing the weight of light vehicle is considered. The foremost component of the

suspension system of vehicle is leaf spring, it has substantial amount of weight, and it is necessary it would have ample strength because it needs to resist vibrations and jolts during its working. The prominence of the paper is to reduce the overall weight of suspension system and improve load carrying capacity of the leaf spring by using the composite material. The design considerations for this study are stress and deflection. The work also gives focus on the application of FEA concept to compare two materials for leaf spring and propose the one having higher strength to weight ratio. Two materials used for comparison are; conventional steel and composite E-Glass/Epoxy. In the present work deflection and bending stresses induced in the two leaf springs are compared The solid modelling of leaf spring is done in CATIA V5 and analysed using ANSYS 14.5.

Y. S. Kong (2014) Parabolic leaf spring experiences repeated cyclic loading during operating condition. Fatigue life assessment of the parabolic leaf spring is a significant aspect during the component design stage. This paper serves to simulate the fatigue life of a parabolic leaf spring design under variable amplitude loading (VAL). VALs carry the road signal that provokes fatigue failure on leaf spring. In order to seek for comprehensive leaf spring fatigue assessment, VALs signal were gathered through measurements from various road conditions such as highway, curve mountain road and rough rural area road. Subsequently, fatigue life of particular leaf spring design was predicted using finite element (FE) stress–strain model together with VALs signal as load input. For more conservative way, Morrow and Smith Watson Topper (SWT) mean stress correction methods were also applied. The results indicate that fatigue life of leaf spring is lowest during rough road mission, followed by curve mountain road and smooth highway road respectively. Additional design modification to prolong the fatigue life of the parabolic leaf spring is compulsory. The road VALs has provided even more realistic fatigue life estimation of parabolic leaf spring design when compared to traditional controlled laboratory method.

Abdul Awal (2013) The tensile strength of unsaturated polyester based glass–carbon woven fabric hybrid composites with plain woven fabric of glass fibers and combination of glass and carbon fibers were examined. The tensile strength of the plain woven glass fiber composites has been found to be higher than that of the matrix. A combined effect of glass and carbon fibers on the mechanical properties of the hybrid composites has also been studied. Significant improvement in tensile strength of the glass-carbon fibers hybrid composites has been observed compared to glass fiber composites and the matrix. The morphological changes of the composites and the matrix were studied by scanning electron microscopy.

Methodology: In this study a Design model of mono leaf spring designed in ANSYS Fluent 14.5 by using design modular. The meshing of the model will be done in ICEM Meshing. By using desired Boundary conditions the analysis will have done.

Conclusion: In this analysis, the compression of mono hybrid composite leaf spring has been done with the structural steel mono leaf spring. The deformation, principal stress , strain are comprises and weight optimization have been done.

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