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DESIGN AND ANALYSIS OF COMPOSITE LEAF SPRING USING COMPOSITE MATERIAL FOR LIGHT VEHICLE-AREVIEW

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ABSTRACT

In this modern world containing light weight with growing strength of equipment is increasing importance in research area. The convention all leaf spring draw backs are introducing today therefore the increasing advantages of composite material and find the solution on all drawbacks. This paper describe by us design and analysis of composite leaf spring by using composite material for light vehicle. The objective is to compare between the steel leaf spring and composite leaf spring according to weight saving and stresses. The increasing advantages of composite leaf spring like weight saving ,increasing load carrying capacity, high strength with respect to weight and have good corrosion resistance the Automobile industry has great interest for use of composite leaf spring instead of steel leaf spring. The material selected was Glass Fiber Reinforced plastic-GFRP(E-glass/epoxy), is used instead of conventional steel. The designs parameters are selected and analyzed with the aim of reduce weight of the composite leaf spring with compared to the steel leaf spring. The leaf spring model is modeled in3D model using CATIA and the analysis was done using ANSYS10.0 software.

Keywords: *-steel leaf spring,compositeleaf spring,, 3D model usingCATIA,ANSYS10.0.*

I. INTRODUCTION

As we know that the Leaf springs are mostly use in all load vehicles, truck sand railway for great suspension and absorb shock loads in automobiles. It carries lateral loads, brake torque, driving torque in addition to shock absorbing. 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 as it accounts for 10%-20% of the un strung 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 the leaf spring without any reduction on load carrying capacity and stiffness. 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 actas astructuralmemberinadditiontoenergy absorbing device. According to the studies madea material with maximum strength hand minimum modulus of elasticity in the longitudinal direction is the most suitable material for a leaf spring. To meet the need of natural resources conservation, automobile manufacturers are attempting to reduce the weigh to fvehiclesin recent years. 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 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 . 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 properly designed composite leaf spring can provide 92% weight reduction. Moreover the composite leaf spring has lower stresses compared to steel spring. All these advantages are useful for fuel saving which will make energy produce by saving fuel.

II. AIMAND SCOPE OFTHEWORK:

The objective of the work is to design, analyze and select the method of fabrication of composite material leaf spring for automobile suspension system. This modern method helps in the replacement of conventional steel leaf springs with composite leaf spring with better riding quality. For getting maximum weight reduction in the suspension system possible by replacing steel leaf spring with composite leaf spring.

III. LITERATURE SURVEY

As we know that composite materials have more elastic strain energy capacity and high strength with respect to weight as compared to the conventional steel. By using of composite materials the weight of the leaf spring reduces without any reduction on load carrying capacity and stiffness can also be achieved. Therefore analysis of composite material leaf springs has become very important in showing the comparative results with conventional leaf springs.

(1)Venkatesan ,D.HelmenDevaraj have Prepared a design and experimental analysis of composite leaf spring made of glass fiber reinforced polymer. The objective is to compare the load carrying capacity, stiffness and weight savings of composite leaf spring with that of steel leaf spring.

(2) Mr. ShishayAmareGebremeskel In this paper reducing weight of vehicles and increasing or maintaining the strength of their spare parts is considered.

(3) M.Raghvedra ,Syed AltafHussain ,V.Pandurangadu, K.Palani Kumar have used laminated composites as a replacement to conventional steel and have studied the three composites subjected to the loads.Material properties of composite structures have been reported in many literature works .Recently emphasis is been given on mass reduction and development of alternate materials and processing technology in the vehicle equipment manufacturing industry

(4)By using the results of conventional leaf spring Mahmood M. Shokrieh, Davood designed and optimized composite one made from fiberglass with epoxy resin using ANSYS. Main consideration was given to the optimization of the spring geometry

(5)PankajSaini, AshishGoel, DushyantKumar in this paper they present composite materials has high strength to weight ratio, good corrosion resistance. The material selected was glass fiber reinforced polymer (E-glass/epoxy), carbon epoxy and graphite epoxy is used against conventional steel.

(6)Tushar S. Karhale, Ajay N. Ingale , Bhushan B. Deshmukh analyzed the composite materials have more elastic strain energy storage capacity and high strength to weight ratio as compared with those of steel, so multi-leaf steel springs are being replaced by mono-leaf composite springs. The paper gives the brief look on the suitability of composite leaf spring on vehicles and their advantages. The objective of the present work is design, analysis and fabrication of mono composite leaf spring. The design constraints are stress and deflections. The material selected is glass fiber reinforced plastic (GFRP) and the epoxy resin can be used which is more economical to reduce total cost of composite leaf spring with similar mechanical and geometrical properties to the multileaf spring.

(7)U. S. Ramakanth& K. Sowjanya did work on multi leaf springs having nine leaves used by a commercial vehicle. A Finite element approach for analysis of a multi leaf springs using Ansys software is carried out. The model is generated using solid works and imported in Ansys. The material of the leaf springs is 65Si7 (SUP9), composite leaf springs and hybrid leaf springs. Fatigue analysis of leaf springs is carried out for steel leaf springs, and Static analysis for steel leaf springs, composite leaf springs and hybrid leaf springs

(8)B. Raghu Kumar , R. VijayaPrakash and N. Rameshpaper did the study of the best composite material for design and fabrication of complete mono composite leaf spring. A single leaf with variable thickness and variable width for constant cross sectional area of different composite materials, with similar mechanical and geometrical properties to the multi leaf spring, were modeled and analyzed. The finite element results using ANSYS software showing stresses and deflections were verified with analytical results. The design constraints were stresses and displacement. Compared to the steel spring, the composite spring has stresses and deflection that are much lower, and the spring weight is nearly 78% lower.

(9) D.N.Dubey, S.G.Mahakalkar did work has been carried out on a mono parabolic leaf spring of a Maruti Omni Car. This paper describes design and experimental analysis of a conventional parabolic leaf and suggested compositematerial leaf spring .The composites used are HM and HS Carbon polymers .Finite Element analysis (FEA) is carried out at static condition of the spring model so that stress distribution can be observed for analysis of

high stress zones. CAD model is prepared in Pro-E .The analysis has been observed for various loading conditions and the overall stress distribution zones have been studied. The objective is to compare the load carrying capacity, stiffness and weight savings of composite parabolic leaf spring with that of a conventional steel leaf spring.

IV. DESCRIPTION OFTHEPROBLEM

The suspension leaf spring is one of the potential items for weight reduction in automobile as it accounts for 10 to 20% of the un-sprung 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 . The relationship of the specific strain energy can be expressed as it is well known that springs, are designed to absorb and store energy and then release it slowly. Ability to store and absorb more amount of strain energy ensures the comfortable suspension system. Hence, the strain energy of the material becomes a major factor in designing the springs.

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 more elastic strain energy storage capacity and High strength to weight ratio.

A.LIMITATIONS OF CONVENTIONAL LEAF SPRING

i. Increased weight or heavyweight increases fuelconsumption.
ii. Steel leaf springs haveless damping capacity.
iii. Theyhaveless specificmodulus andstrength.
iv. Conventionalleafspringsareusually manufacturedandassembledby usingnumberofleafs madeof steeland hencetheweightis more.
v. Its corrosion is morecompared to compositematerials.

B. ADVANTAGES OF COMPOSITE LEAF SPRING OVER CONVENTIONAL LEAF SPRING

i.Duetolaminatestructureandreducedthicknessofthecompositeleafspring,theoverall weight would beless.
ii.TheyhaveLongerfatiguelife.
iii.Theyhavegoodcorrosionresistance.
iv.Reduced weight.
v. Dueto weight reduction, fuel consumption would bereduced
vi.Theyhavehigh specificmodulus and strength.
vii.Theyhavehigh damping capacity; henceproduceless vibration andnoise.

V.METHODOLGY

In this paper, a comparative analyst is of virtual model of conventional steel leaf spring is done with a virtual model of a composite leaf spring under static load condition. Varying loads are applied and the results have been studied for various loading condition. Two eye ends are fixed and loads have been applied at the center of the arc in upward direction. The spring is loaded maximum load of 1200 N is applied to all the three materials. Further loads of 800N and 400N are applied subsequently and the values are studied. A static analysis determines stresses, strains, displacements and forces in the structure. The parameters like material properties, loading conditions, support conditions are specified for the pre-processing analysis. The boundaryconditions are applied bytakinginto consideration experimental loadingconditions.

VI. MATERIALSFORLEAFSPRING

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 treatment of spring steel products greater strength and therefore greater load capacity, greater range of deflection and better fatigue properties. Carbon/Graphite fibers: 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. Glass fibers: The main advantage of Glass fiber 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 .

Steel Leaf Spring

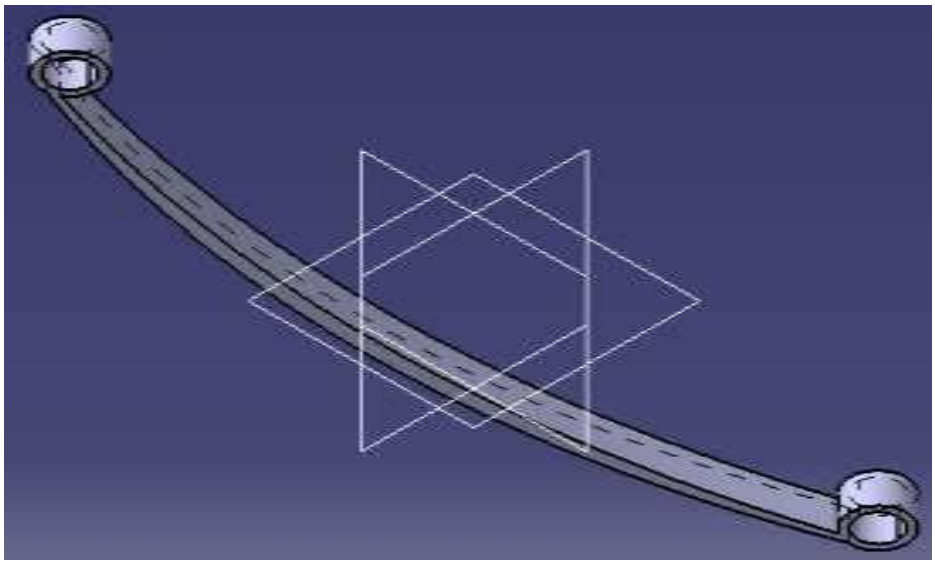

Fig.1:-Solid model ofsteel leaf spring created inCATIA

CompositeLeaf Spring

Fig.2:-Actual model of compositeleaf spring

VI. CONCLUSION

As reducing weight and increasing strength of products are high research demands in the world, composite materials are getting to be upto 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. Among the three composite leaf springs, only graphite/epoxy compositeleafspringhashigherstressesthanthesteelleafspring.E-glass/epoxy compositeleaf spring can be suggested for replacing the steel leaf spring from stress and stiffness point of view. Acomparativestudy has been made between steel and composite leaf spring with respect to strength and weight. Composite mono leaf spring reduces the weight by 81.22%forE- Glass/Epoxy, 91.95%for Graphite/Epoxy, and 90.51 %forCarbon/Epoxy over conventional leaf spring.

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