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REVIEW ON DEVELOPMENT AND ANALYSIS OF HELICAL SPRING WITH COMBINATION OF CONVENTIONAL AND COMPOSITE MATERIALS

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ABSTRACT- Aim of this paper is to analyze feasibility of adopting composite material for design of helical coil spring. Combination of springs with steel and composite material i.e Glass fiber epoxy resin is to be used in place of conventional spring steel. The cause of implementing combination of steel and composite material is the low stiffness of single composite spring, which limits its application to light vehicles. Fuel efficiency of automobiles can be maximized by lowering the weight of the vehicle. The spring of the suspension system plays an important role for a smooth and jerk free ride. So it is required to design the springs very precisely. The use of conventional steel as spring increases the weight and manufacturing process energy required is more so manufacturers are willing to use composite materials light in weight and also have corrosion resistance, it can also withstand high temperature. Manufacturing composite material is quite costlier than the steel spring. The use of composite material is beneficial if manufacturing process is standardized it can increase the efficiency of the vehicle adherence overcome the material cost.

Keywords: Helical spring, composite material, Glass fibre, epoxy resin, stiffness, Fuel efficiency

INTRODUCTION

Spring is an elastic body whose function is to store energy when deflected by force and return equivalent amount of energy on being released. Helical compression springs are widely used for suspension in light vehicle and locomotives worldwide.

Generally springs made of hardened steel are used. Small springs can be wound from pre-hardened stock while larger ones are made from annealed steel and hardened after fabrication. Non-ferrous metals are also used such phosphor bronze and titanium for parts requiring corrosion resistance and beryllium copper for springs carrying electrical current because of its low electrical resistance.

The rate of spring is called the change in the force it exerts, to the change in deflection of the spring. On the basis of design and required operating environment, any material can be used to construct a spring , so long as the material has the required combination of rigidity and elasticity: technically, a wooden bow is a form of spring. In the present scenario the automobile industry is regularly trying to reduce the fuel consumption of the automobile vehicles. Fuel efficiency of automobiles can be maximized by lowering the weight of the vehicle. The suspension system of an automobile is one of the important segments of the automobile vehicle. The use of steel helical coil spring in suspension system is generally used by the automobile manufacturers. We know that, the spring of the suspension system plays an important role for a smooth and easy ride. So it required to design the springs very exactly. The use of conventional steel in spring increases the weight and with the current scenario the automobile manufacturers are interested in replacing steel springs with light weight composite materials.

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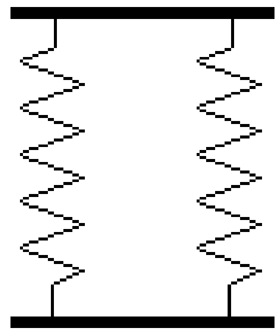

K=K1+K2

Figure1: Helical compression springs in parellel.

The following paragraph show the relevant result and the studies conducted on the performance and analysis done by them are describe in below paragraph of the literature

[1] **Abdul Budan, T.S.Manjunathathe** checked feasibility of replacing the metal coil spring with the composite coil spring. Three different types of springs were made using glass fibre, carbon fibre and combination of glass fiber and carbon fibre. The objective of the study was to reduce the weight of the spring. According to the experimental results the spring rate of the carbon fiber spring is34% more than the glass fiber spring and 45% more than the glass fibre/carbon fiber spring. The weight of the carbon fiber spring is18% less than the glass fiber spring, 15% less than the Glass fibre/carbon fibre spring and 80% less than the steel spring. Three types of composite coil springs have been developed in this study; they are lighter than steel spring and the stiffness achieved in these springs are less than the steel springs. (Spring rate of the same dimension steel spring is approximately 14 N /mm and weight of the steel spring is 1.078 kg). The following conclusions can be drawn from the analysis of experimental results of these springs. The weight of the springs manufactured from carbon fiber roving is less than the glass fiber and glass fiber/carbon fiber roving springs. The stiffness of the carbon fiber springs is greater than the other two types of composite coil springs. The springs developed from the glass fiber/carbon fiber roving does not exhibit a favourable results compare to other two types of springs.

The cost of the glass fiber springs are 25% more than the steel springs and the cost of the carbon fiber springs is 200%more than the steel springs. The selection of the glass fiber or a carbon fiber springs depends upon the cost and application of the spring which can be compensated by saving the fuel from weight reduction. As compared to steel springs of the same dimensions, the stiffness of composite coil springs is less. In order to increase the stiffness of the spring the dimensions of the composite spring is to be increased which in turn increases the weight of the spring. Hence the application of the composite coil springs can be limited to light vehicles, which requires less spring stiffness, e.g. electric vehicles and hybrid vehicles.

[2]Mehdi Bakhshesh and Majid Bakhshesh studied replacement of a helical steel spring by three different composite helical springs. Numerical results have been compared with theoretical results and found to be in good agreement. Compared to steel spring, the composite helical spring has been found to have lesser stress and has the most value when fiber position has been considered to be in direction of loading. Weight of spring has been reduced and has been shown that changing percentage of fiber, especially at Carbon/Epoxy composite, does not affect spring weight. Longitudinal displacement in composite helical spring is more than that of steel helical spring and has the least value when fiber position has been considered to be in direction of loading. The most safety factor is related to case that fiber position has been considered to be perpendicular to loading and it is for Carbon/Epoxy composite helical spring. Resin transfer moulding process is used for manufacturing spring.

Steel helical spring has been replaced by three different composite helical springs including E-glass/Epoxy, Carbon/Epoxy and Kevlar/Epoxy. The loading conditions are assumed to be static. Spring Shear stress has been obtained using FEM and has been compared with steel helical spring. Composite spring properties have been studied with changing fiber angle relative to spring axial. The element is SOLID 46, which is a layered version of the 8-nodes structural solid element to model layered thick shell or solids. The element has three degree of freedom at each node and allows up to 250 different material layers. From results it is concluded that Spring has the most Shear stress when fiber position has been considered to be in direction of loading. With changing fiber angle, Shear stress reduces so that it reaches the least value when fiber position has been considered to be perpendicular to loading.

[**3]Suresh.G, Vignesh.R, Aravinth.B, Padmanabhan.K, A.Thiagarajan** done design and experimental analysis of composite helical spring made of fiber reinforced polymer of Woven Roving Fiber (WRF), and Thermo set polymer (Epoxy

Resin) with Nano clay. The addition of nanoclay provides unique mechanical and tribological properties combined with low specific weight and a high resistance to degradation in order to ensure safety and economic efficiency. A

Comprehensive study was carried out a series of Nano composites containing varying amount of nano particles (Nano clay). The objective was to compare the load carrying capacity, stiffness and weight savings of composite helical spring with that of steel helical spring. The design constraints are stresses and deflections. The dimensions of an existing conventional steel helical spring of a light commercial vehicle are taken. Same dimensions of conventional helical spring are used to fabricate a composite spring.

The types of composite coil springs had been developed in this study; they are lighter than steel spring and the stiffness achieved in these springs are less than the steel spring. As compared to steel springs of the same dimensions, the stiffness of composite coil springs is less. In order to increase the stiffness of the spring the dimensions of the composite spring is to be increased which in turn increases the weight of the spring. Hence the application of the composite coil springs can be limited to light vehicles, which requires less spring stiffness, e.g. electric vehicles and hybrid vehicles. The manufacturing of the composite coil springs is also difficult and time consuming compare to steel spring, however with the use of CNC winding machine and automated process which can be made easy and also the manufacturing cost can be reduced if produced in mass.

[4]AHANA DWEEPAN studied material selection for conventional coil springs and found that use of composite material is beneficial if it can increase the efficiency of the vehicle and hence overcome the material cost. Other spring materials can be suggested for enhancements of fatigue life prediction. Modified design needs to be manufactured and tested for deformation and stress results. Model created in ProE is exported to ANSYS by converting it to IGES format. The imported model is meshed in ANSYS and boundary constrains are defined. With the Boundary constrains, the stresses and strain of the bone can be determined and the values are tabulated. And again by changing the material of the model the analyzing of the optimized model is done. Thus the investigation of stress and strain is carried out using ANSYS and better design is achieved.

[5]Saurabh Singh designed springs with composite and conventional materials. from thee result we can state that the stiffness can be increased in expense of manufacturing cost and material volume. However the ever demanding need of weight reduction of vehicles will be satisfied by employing this method. The weight reduction int his combination is about 21%.

Manufacturing cost of composite material increases due to the difficulty in manufacturing, and also it is a time consuming process. But however use of automated system can reduce the difficulty and time consumption. Production in mass can also reduce the manufacturing cost.

[6] Md Musthak and M. Madhavi developed high strength carbon epoxy spring with tape winding. Composite spring is manufactured using Carbon fiber in 45 degree orientation. Tests were conducted to study mechanical behaviour. Spring is tested on UTM machine to determine deflections for various loads.

A helical compression spring was developed for 1400N Payload and 30mm deflection. Three different types of spring were selected; glass fibre, carbon fibre and combination of both. The deflection and axial stresses are the design constraints for selection of fibre orientation in carbon pre-peg epoxy based spring. The results indicate that carbon pre-peg springs are superior in structural parameters. Load deflection results shows large variations in deformations reduced as there is lesser gap between coils. It is concluded that due to high strain energy capacity and corrosive resistance composite helical springs may be used for high strength engg application

CONCLUSION

Feasibility of composite materials is checked, composite helical springs can be easily replaced in light weight vehicles with slight sacrifice of the size. In regular vehicles, combination of springs with composite and conventional material can be used to overcome low stiffness of composite materials and weight of spring can be optimized.

OTHER RECOMMENDATIONS

We can also investigate on behavior of composite spring with different materials, different angles of fibres with matrix, .

We can further study on combination of spring in parallel two wheeler, three wheeler suspension and analyze efficiency & minimizing weight.

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