DESIGN AND ANALYSIS OF HELICAL SPRING USING COMPOSITE MATERIALS

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Abstract - *Helical springs are one of the oldest suspension components they are still frequently used, especially in two wheeler vehicles. The past literature survey shows that helical springs are designed as generalized force elements where the position, velocity and orientation of the mounting gives the reaction forces in the fork attachment positions. Another part has to be focused, is the automobile industry has shown increased interest in the replacement of steel spring with composite helical spring due to high strength to flexible ratio. Therefore, analysis of the composite material becomes equally important to study the behavior of Composite helical spring. The objective of this paper is to present modeling and analysis of composite helical spring using the composite material e-glass fiber and sisal fiber to compare it result with existing steel materials (ASTM A227). Three dimensional Modeling is done using CREO and Finite Element Analysis is carried out by using ANSYS software. Further the prototype model is fabricated according to the design specification for the different composite materials and the experimental analysis (tensile, compression and wear & tear) is to be done with reference of results taken from the finite element analysis for the same load condition. The compared results are charted for both the results of analysis for better understanding.*

Key Words*: *Analysis, design, composite materials, coil spring, suspension system.

1. INTRODUCTION

Ever increasing demands of high performance together with long life and light weight necessitate consistent development of almost every part of automobile. Increasing competition and innovations in automobile sector tends to modify the existing products or replacing old products by new and advanced material products. A suspension system of vehicle is also an area where these innovations are carried out regularly. Helical 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 helical 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 helical springs for light weight vehicles and meet the requirements, together with substantial weight savings. The introduction of composite materials was made it possible to reduce the weight of helical spring without any reduction on load carrying capacity and flexible. Since, the composite materials have more elastic strain energy storage capacity and high strength-to-weight ratio as compared to those of steel. Increasing competition an innovations in automobile sector tends to modify the existing products or replacing old products by new and advanced material products. A suspension system of vehicle is also an area where these innovations are carried out regularly. More efforts are taken in order to increase the comfort of user. Appropriate balance of comfort riding qualities and economy in manufacturing of helical spring becomes an obvious necessity. To improve the suspension system many modification have taken place over the time. Inventions of helical spring, use of composite materials for these springs are some of these latest modifications in suspension systems. This project is mainly focused on the implementation of composite materials by replacing steel in conventional helical springs of a suspension system. Automobile-sector is showing an increased interest in the area of composite material-helical springs due to their high strength to weight ratio. Therefore analysis of composite material helical springs has become essential in showing the comparative results with conventional helical springs. Advantages of helical spring are that the ends of the springs are guided along a definite path so as to act as a structural member in addition to shock absorbing device. This is the reason why leaf springs are still used widely in a variety of automobiles to carry axial loads, lateral loads and brake-torque in the suspension system.

2. LITERATURE SURVEY

The present scenario the world trending towards existing steel (ASTM A227) helical spring and implementations it necessary to trend up in automobile field. However, we used to replacement of existing steel helical spring with composite helical spring. It normally reduces spring weight in addition to resistance raise under the effect of applied loads. The main objective is to compare the load carrying capacity, stiffness and weight savings of composite helical spring with that of steel helical spring. In our project we provide helical spring analysis by using composite materials. The material properties of all materials considered from design considerations. The analysis carried out by using ANSYS.

The existing steel (ASTM A227) which was used for reference purpose. The composite material used Glass fibers, Sisal fibers,

3. COMPOSITE MATERIAL:

A composite material is defined as a material composed of two or more constituents combined on a macroscopic scale by mechanical and chemical bonds. Typical composite materials are composed of inclusions suspended in a matrix. The constituents retain their identities in the composite. Normally the components can be physically identified and there is an interface between them. Many composite materials offer a combination of strength and modulus that are either comparable to or better than any traditional metallic materials. Because of their low specific gravities, the strength weight-ratio and modulus weight-ratios of these composite materials are markedly superior to those of metallic materials.

The primary phase, having a continuous character, is called matrix. Matrix is usually more ductile and less hard phase. It holds the dispersed phase and shares a load with it. The second phase is embedded in the matrix in a discontinuous form. This secondary phase is called dispersed phase. Dispersed phase is usually stronger than the matrix, therefore it is sometimes called reinforcing phase. Many of common materials (metal alloys, doped Ceramics and Polymers mixed with additives) also have a small amount of dispersed phases in their structures, however they are not considered as composite materials since their properties are similar to those of their base constituents (physical properties of steel are similar to those of pure iron). The reinforcing phase provides the strengthened stiffness. In most cases, the reinforcement is harder, stronger, and stiffer than the matrix. The reinforcement is usually a fiber (or) a particulate. Particulate composites dimensions are approximately equal in all directions. They may be spherical, platelets, or any other regular or irregular geometry. Particulate composites tend to be much weaker and less stiff than continuous fiber composites, but they are usually much less expensive. Particulate reinforced composites usually contain less reinforcement (up to 40 to 50 volume percent) due to processing difficulties and brittleness. A fiber has a length that is much greater than its diameter. The length-to-diameter (l/d) ratio is known as the aspect ratio and can vary greatly. The type and quantity of the reinforcement is determined final properties of the composites. In the present work an attempt is made to evaluate the suitability of composite material such as natural fibers for the purpose of automotive transmission applications. A composite drive shaft for rear wheel drive automobile was designed optimally by using GA for natural fibers. The main objective of the project is reduced weight in which subjected to the constraints such as torque transmission, torsion Buckling strength capabilities and natural bending frequency.

Table -3.1: Material properties of ASTM A227

S.NO	PARAMETER	UNITS	VALUE
1.	Material selected steel	-	STEEL(ASTM 304)
2.	Young's Modulus (E)	N/mm^2	196500
3.	Modulus of rigidity (G)	N/mm^2	78600
4.	Poisson's ratio	-	0.25
5.	Density	g/cm^3	7.86

Table -3.2: Material properties of SISAL

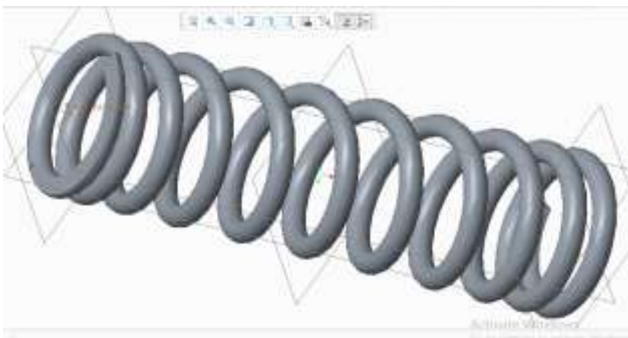
S.NO	PARAMETER	UNITS	VALUE
1.	Material selected	-	SISAL
2.	Young's Modulus (E)	N/mm^2	22000
3.	Modulus of rigidity (G)	N/mm^2	48360
4.	Poisson's ratio	-	0.23
5.	Density	g/cm^3	1.5

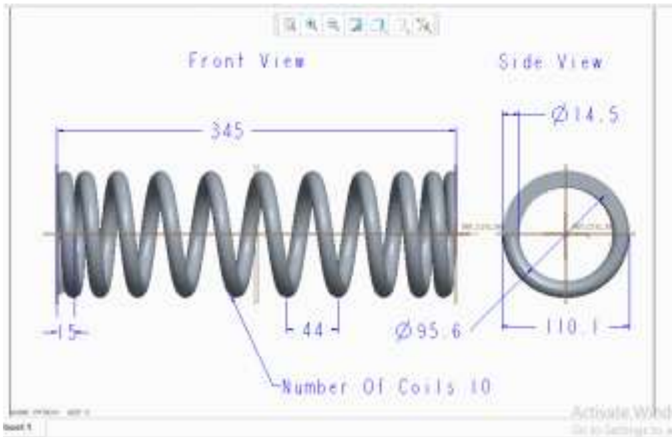
Table -3.3:Material properties of GFRP

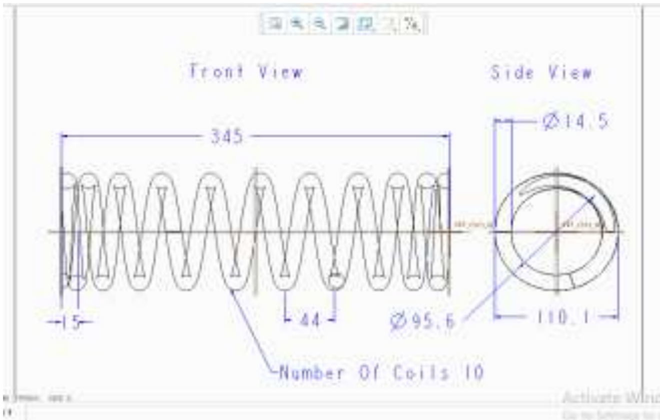
S.NO	PARAMETER	UNITS	VALUE
1.	Material selected	-	E-Glass
2.	Young's Modulus (E)	N/mm^2	80000
3.	Modulus of rigidity (G)	N/mm^2	36000
4.	Poisson's ratio	-	0.22
5.	Density	g/cm^3	2.580

4. MODELING OF HELICAL SPRING:

A coil spring is designed by using Creo as per the specifications and analyzed by ANSYS software. In this the spring behavior will be observed by applying different materials loads, to optimum stresses and the result shows best material. Model of the spring will be first created by using Creo. Begin by drawing a line of 345 mm length and it is the free height of spring. The line is at a distance of 55 mm from vertical axis and it is outer diameter of the coil. Next enter the pitch of spring. Pitch is calculated by free height of coil the spring divided by the number of turns. In this 315/8= 39.3mm. Create the circle of wire diameter 14.5mm of spring and create Solid model of helical spring as shown in figure.







DESIGN CALCULATION

Assume the load considerations of 500N for Two wheeler suspensions.

$$\tau = \frac{K_s\, 8pD}{\pi d^3}$$

τ = Shear stress Kgf/cm^2

D= mean diameter of spring

d = diameter of wire of spring / cm

Ks = wahl stress factor

$$K_s = \frac{4C-1}{4C-4} + \frac{0.615}{C}$$

C = Spring index (D/d)

$$= \frac{95.6}{15}$$

C = 6.37

Ks = 1.2

τ = 43.2 kgf/cm²

Y = deflection of spring

$$Y = \frac{8pc^3n}{Gd}$$

Y = 8.72 cm

Q = spring rate (or) stiffness

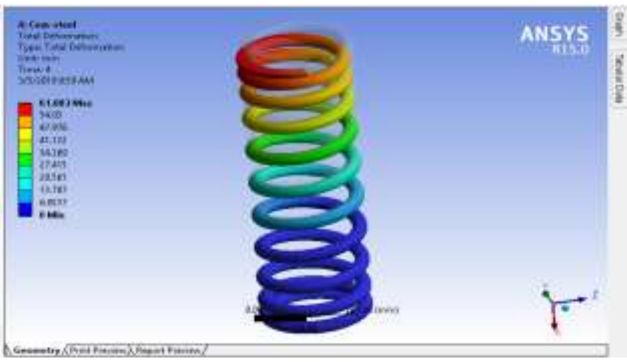
$$Q = \frac{Gd}{8c^3n}$$

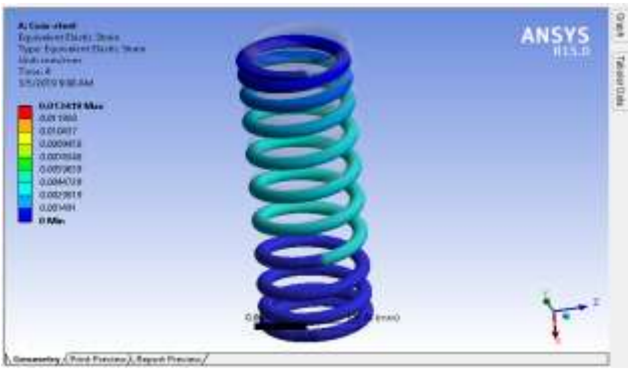
Q = 57.3 kgf/cm

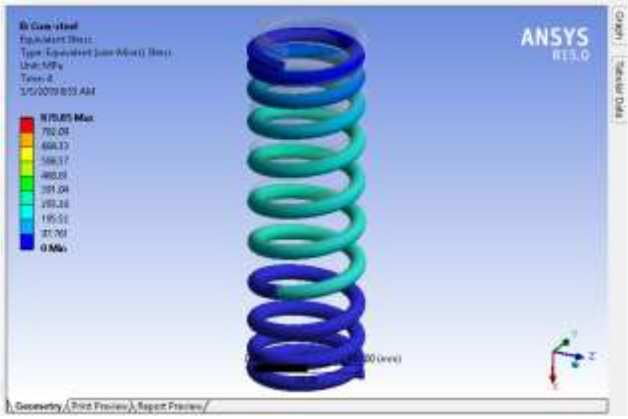
5. RESULT AND DISCUSSION

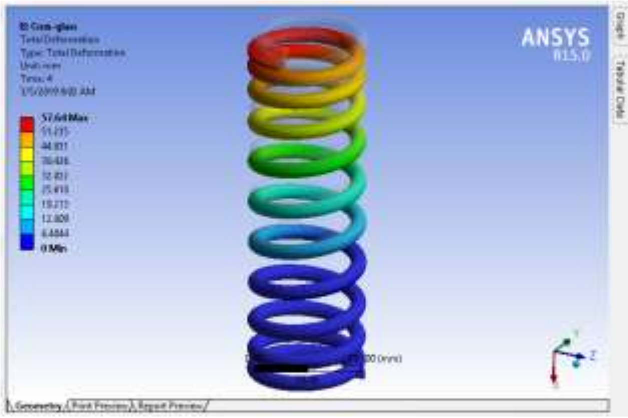
Displacement, stress intensity, strain, von-misses intensity values of different materials are plotted in below table. The displacement taken place in suspension spring is due to applied load is small than other materials as the ANSYS Result shows... the E-glass material has max stress intensity and its von-misses stress also has maximum than the other material...The compared result is tabulated below.

ANSYS RESULT IMAGES






ANSYS
R15.0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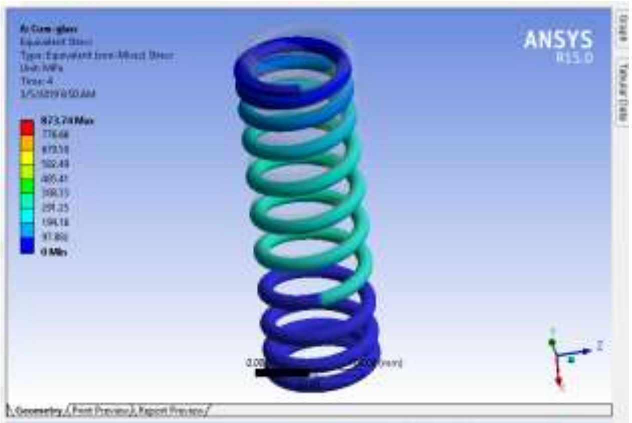
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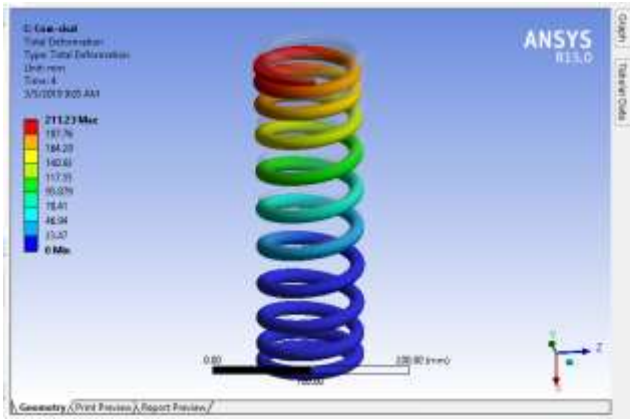
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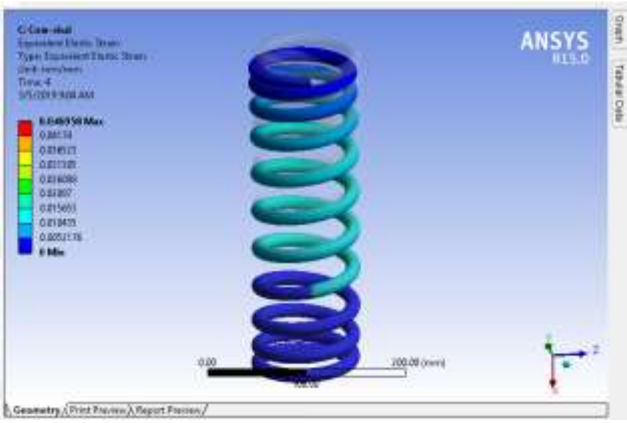

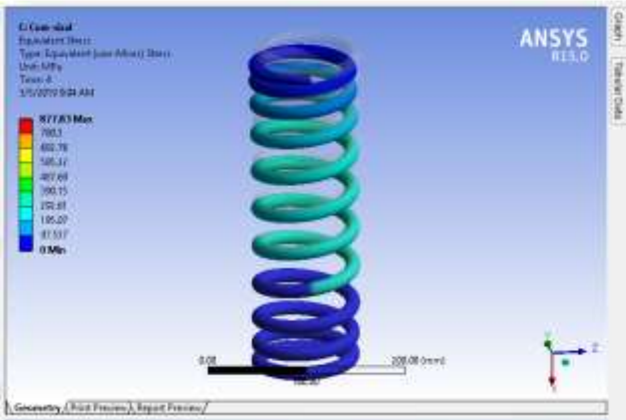

6. CONCLUSION

By conducting analysis on existing material and different composite materials result are

- **Steel** material has maximum deformation **61.683mm**, Stress Intensity **879.85Mpa**,
- **Sisal** material has maximum deformation **211.23mm**, Stress Intensity **877.83Mpa**,
- **E-glass material** has maximum deformation **57.64mm**; stress intensity **873.74Mpa**,

By the obtained results it can be conclude that the stresses induced in all the materials are within their allowable limits. And it also observed that the E-glass materials which develop less deformation than the other material. Though deformation is small when load is given to E-Glass material is best in making suspension spring.

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