DESIGN AND OPTIMIZATION OF COIL SPRING USING NYLON 66 MATERIAL

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***Abstract*— Cup making and automobile companies are facing problems of improvement in efficiency and quality of springs as well as automobile components with reducing in weight and cost of spring and components. By using alternative materials in design procedure which outputs in improve the strength, stiffness to weight ratio. In this paper there is reviewed some papers on the Design and Optimization of cup making and Automobile Suspension helical Coil Spring to Study the steel Behavior and coating used as spring material over conventional spring. Design of coil spring is firstly checked for the conventional plain steel material and then compared with that of coating material by using ANSYS v 14.5 to study the Behavior of plain steel and coating over the spring material to optimize conventional spring. Also we are used the Prototype of suspension system has been built up by using coating material and tested and checked to compare results with ANSYS v 14.5 analysis to optimize design of conventional spring.**

***Index Terms*—Nylon 66 coating materials, Prototype spring, Coil spring, spring design and analysis, Spring testing.**

I. INTRODUCTION

Cup making suspension system is one of the important segments of the cup making companies. The vehicle chassis is mounted on axles not directly connected but through some form of suspension springs in different forms of spring. This is for to isolate automobile body from shocks came from roads and vibrations otherwise it is transferred to the occupants; it may be in the form of bounce, roll or pitch. Due to these problems give rise to ride with uncomfortable and it also appear extra stresses and strains in vehicle frame and body. All these parts which have performing the function of isolating the vehicle from the shocks of road thus it is collectively called as suspension system. It also includes the devices of spring used and different mountings for same. As we aware about the coil spring in suspension system acts an important role for smooth and easy riding. So that it is required to design the coil spring correctly. In the suspension system spring is a flexible component. Usually modern Passenger vehicles are use light weight coil springs. Generally springs are made up of hardened steel and are used in automobile suspension system. Uses of conventional steel in spring raise the weight. Now in present scenario the vehicle manufacturers are continuously trying to increase efficiency of fuel of automobile vehicles. Efficiency of the fuel of automobiles can be done maximized by lowering the weight of vehicle. Using of conventional steel in spring raising the weight.

II. COMPOSITE MATERIAL

Coating is defined as wounding the material over any core material. Composite is a combination of materials which is multiphase material, differing in form or composition, which remain bonded together, but retains their properties and identities and without going into any chemical reactions. The components do not completely merge. They are maintaining characteristics of an interface between each other and act in concert to provide improved, specific or synergistic characteristics not obtain by any of the real components acting singly constitute of composite material:- 1) Matrix**:** Matrix is also known as binder material. It provides shape to the composite material, Makes the composite material generally resistant to adverse environments and Protects reinforcement material from adverse environments. The materials which constitute matrix of composite materials are plastics, metals, ceramics and rubber.2) Reinforcement: Reinforcement material which basically gives strength, stiffness, and other mechanical properties to the composite material. It is generally in the form of fibers, whiskers, filaments and includes Glass fiber, Carbon fiber, Kevlar fiber, Boron filament/ fiber, Asbestos fiber, etc.

The important benefit of composite material is their specific strength as well as specific stiffness is more than other materials. Another advantage of composites is their flexibility related with designing method because of they can be molded to form various shapes and sizes. Composites with proper composition and manufacturing can capable high temperature environments and corrosive condition. This high strength to weight ratio and all other advantages liable to think why the conventional materials have not replaced by composites; for this in this paper we discussed about the current material used in suspension system of automobile and the advantages of proposed composed materials over the conventional steel material are discussed here.

III. LITERATURE REVIEW

Satbeer Singh Bhatiia ,Ajeet Bergalay has done analysis of design of helical compression spring to study and analysis the behavior of steel and composites used as spring materials. He found that weight saving of conventional helical compression spring made up with carbon /epoxy and E glass/epoxy was 97.96 % and 83.734% respectively as compared to conventional steel (IS 4454 Grade 3). He found that stresses induced in composed material were much lower than conventional steel (1).

An exhaustive literature review is carried out to understand the present practices and theories in shock absorber design. It will also help to obtain a better understanding of how individual internal components and internal flows had been designed and modeled in the past. In all industrial and automobile applications, springs those have high potential energy reserving capacity have undeniable role. So many researchers have concentrated on optimization of design and use of different materials to get effective results. Rupa Dasgupta has done the finite element analysis of aluminum alloy based metal matrix composite to find the potential of material for wear resistance application(2).

Chang Hsuan Chiu et al conducted study on four different types of helical compression spring made up of unidirectional laminates (AU) rubber core unidirectional; laminate with a braided outer layer (BU). The results indicate that helical compression spring with rubber core has 12% more load bearing capacity while spring with BUR failure load in compression to 18% along with improvement of 16% in spring constant.(3)

Del LIano-Vizcaya et have applied the multi axial fatigue criteria to the analysis of helical compression springs wherein fatigue experimental lives are compared with multi axial fatigue criteria predictions performed on n code. The location of the most damaged zone was identified by the numerical analysis (4)

IV PROBLEM STATEMENT

The main objective of the present work is to design, analyze, optimize and testing of unidirectional Glass Fiber/Epoxy 221 totally mono composite spring without end joints and composite spring using bonded end joints using hand-layup technique. The automobile industry has shown increased interest in the replacement of steel spring with Fibre glass reinforced Composite springs. Therefore, the aim of this project is to present a general study on the analysis, design and fabrication of composite springs. This is an alternative, efficient and economical method over wet filament-winding technique from this view point, the suspension spring was selected as a prototype. The analysis will be performed in ANSYS software.

V. EXPERIMENTAL SET-UP

The experiment set up of project as shown in figure. This set up is used for checking deflection plain carbon steel as well as composite spring. The spring is holed in bottom and top spring holder. Check the power supply and voltage by voltage regulator. For deflection purpose we apply load with the help of motor. While pressing red color button load can be apply over the spring. Motor shaft is connected to the output pulley. We are using here speed reduction set-up for application of cup making machine. Here we used five time reduction of speed. Steel bar is used for avoiding buckling of spring. We used rack and pinion arrangement for compressing spring. As pinion rotate rack also move downwards to compress the spring and the deflection is measure with help of Vibrometer. Similarly procedure is follow regarding composite spring.

Fig. Experimental set up.

VI.SPRING DESIGN

Material Properties:-

Plain Spring (Plain Carbon Steel AISI 1095)
Density-7.85 g/cm^3
Melting point-1515°
Tensile strength-685 Mpa
Yield strength-525Mpa
Bulk modulus-140 Gpa
Shear modulus-80 Gpa
Elastic modulus-190-210 Gpa
Poisson's ratio-0.27-0.30
Hardness-197

Composite Spring (Nylon 66):
Density-1183 g/cm^3
Oxygen index-4589%
Tensile stress-527 Mpa
Compressive stress-604 Mpa
Rockwell hardness-2039
Surface resistivity-60093 Ω

Spring Dimensions:

Type: Helical coil spring
Spring End Condition: Squared And Ground.
Rod Diameter: 6.4 Mm
Mean Coin Diameter: 42.4 Mm
Inner Diameter = 36mm
Outer Diameter = 48.8 Mm
Number of Turns = 23
Free Length = 355 Mm

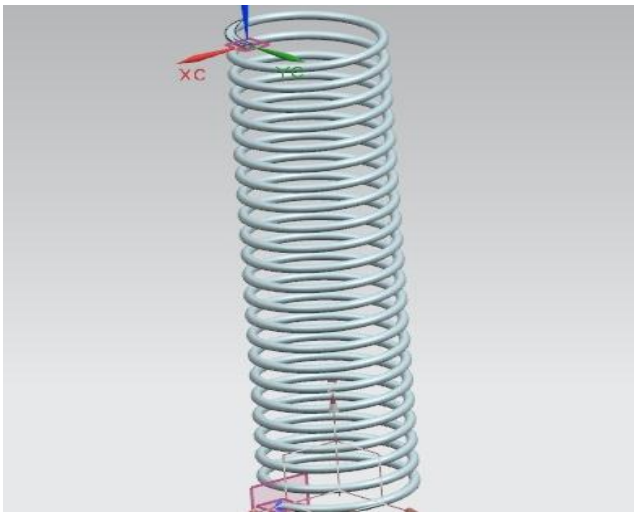

Fig.1 Plain steel spring

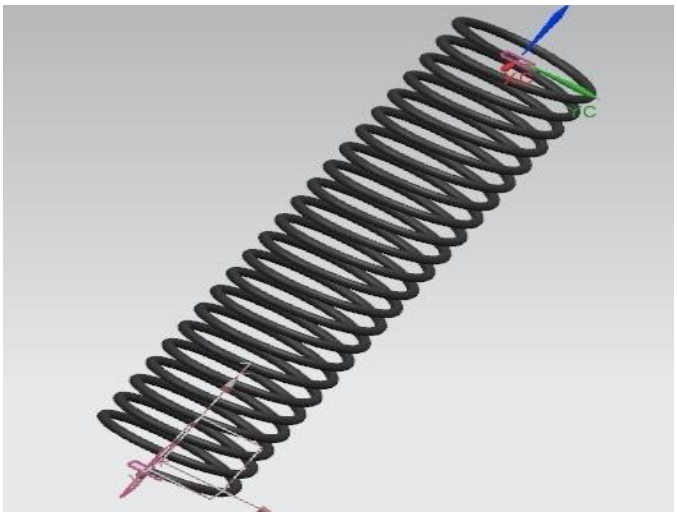

Fig.4 Composite steel spring

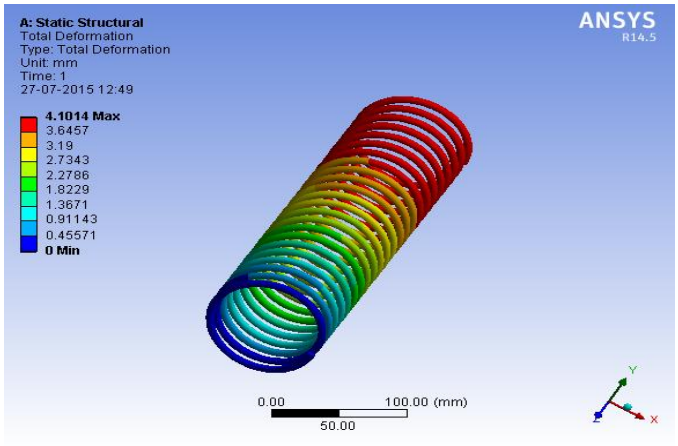

Fig.2 Total Deformation of Plain steel spring

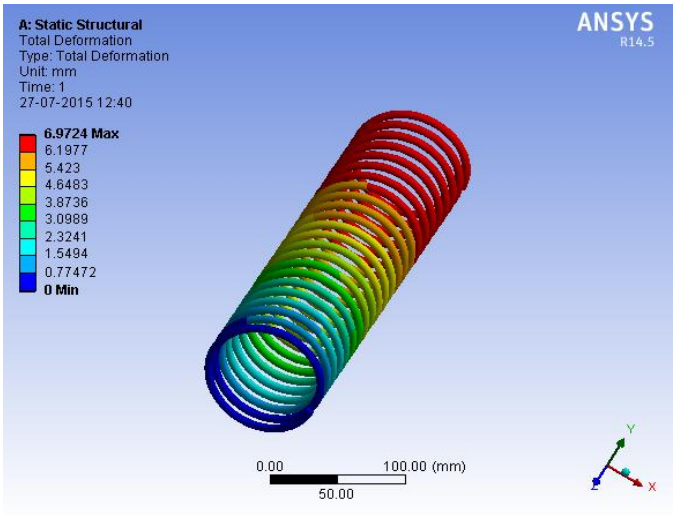

Fig.5 Total Deformation of Composite steel spring

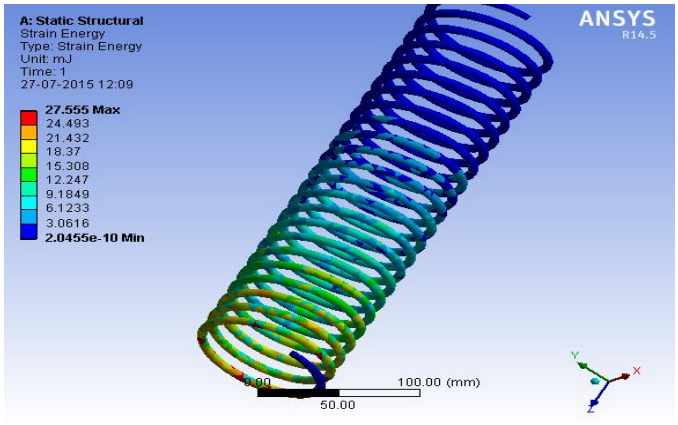

Fig.3 Strain Energy of Plain steel spring

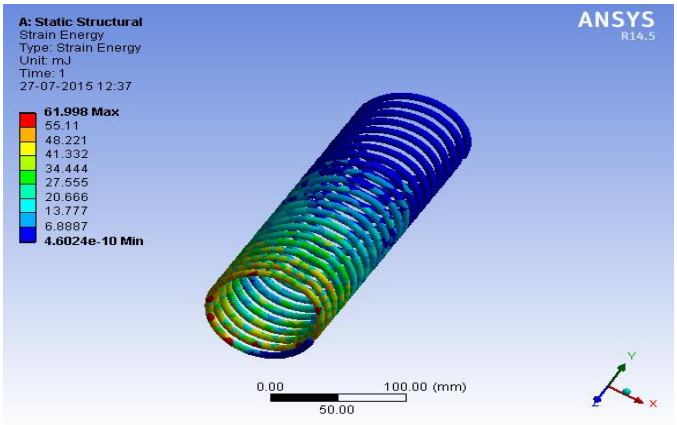

Fig.6 Strain Energy of Composite steel spring

VII. RESULT & DISCUSSION

Table No.1: Result table for 20N load

Spring type	Total deformation	Equivalent Stresses	Plastic strain	Strain energy
Plain spring	4.101 mm	11.784 MPa	0	27.55 mJ
Composite spring (Nylon 66)	6.972 mm	5.213 MPa	0	61.99 mJ

Table no.2: Result table for 15N load

Spring type	Total deformation	Equivalent Stresses	Plastic strain	Strain energy
Plain spring	2.29 mm	8.57 MPa	0	18.8 mJ
Composite spring (Nylon 66)	4.47 mm	4.285 MPa	0	35.82 mJ

DISCUSSION:-

Result as shown above that is total deformation, elastic strain, plastic strain and strain energy in composite material spring is greater than that of plain carbon steel. Strain energy in composite material spring is 97% greater than that of plain steel. So better resilience as compared to plain spring hence it is more suitable for application. As the total deformation is high in composite material spring so the shock absorption capacity is also high.

VIII. CONCLUSION

Normal plain steel can be replaced by composite material of Nylon 66. Use of composite material is beneficial if it can increases the efficiency of the spring and vehicle and hence overcome the cost of material.

The propose work attempts to analyses the design of helical compression spring used in cup making machine spring, suspension system of a motor bike and four wheeler used in Indian vehicles .The behavior of helical coil spring made up with conventional steel sprig and composite spring is analyzed using ANSYS 14.5 The present paper proposes a new model of suspension system with composite spring. The prototype of the suspension system with different composite material has been built and tested. The result of test are compared with FEA results

1. Strain energy in case of composite spring is greater than that of plain spring so the composite spring shows better resilience as compared to plain spring hence is more suitable for application.
2. Elastic strain is greater in case of composite spring which will result in lesser stress for the same equivalent deformation so the composite spring is less likely to failure as compared o plain spring.
3. Total deformation of composite spring is more than that of plain spring so better shock absorbing capacity is observed in case of composite spring.
4. Plastic strain in either case is zero indicating no permanent deformation is seen.

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