Analysis of two wheeler suspension Spring by Using FEA for Different Materials

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Abstract -
The present work is carried out on modeling, analysis and testing of suspension spring (helical coil spring) is to replaced by different material for two wheeler vehicle. The stress and deflections of the helical spring is going to be reduced by using the new material. The comparative study is carried out between existed spring and new material spring. Static analysis in FEA (workbench) determines the stress and deflections of the helical compression. Finite element analysis methods (FEA) are the methods of finding approximate solutions to a physical problem defined in a finite region. FEA (workbench) is a mathematical tool for solving engineering problems. In this the finite element analysis values are with different materials. A typical two wheeler helical compression spring is chosen for study. The modeling and analysis is carried out on ANSYS 14.
Keywords: - helical compression spring, stress, deflection, analysis, ANSYS 14 (Workbench)

INTRODUCTION

A spring is defined as an elastic body, whose function is to distort when loaded and to recover its original shape when the load is removed. This paper demonstrates by taking the combination of steel and composite material for design of helical compression spring. In this case instead of steel is used combination of steel and composite material Glass fiber/Epoxy because of low stiffness of single composite spring, which limits its application to light weight vehicle only. Composite material is light weight and corrosion resistance, it can withstand high temperature. It increase efficiency of vehicle and overcome the cost. He had concluded combination of steel and composite material can increase the stiffness which is the major requirement of regular vehicle due to higher weight this done by using the FEA.[1].This study investigates static behavior of helical structure under axial loads. In this paper, authors have taken two helical structure first one is single wire on which homogeneous theory applied and second is axial elastic properties of seven wire strand are computed. This approach, based on asymptotic expansion, gives the first-order approximation of the 3D elasticity problem from the solution of a 2D microscopic problem posed on the cross-section and a 1D macroscopic problem, which turns out to be a Navier–Bernoulli–Saint-Venant beam problem and result compared with reference results.**[**2] This paper researchers taken four composite material (structure)these are unidirectional laminates (AU), rubber core unidirectional laminates (UR), Unidirectional laminates with braided outer layer (BU), and rubber core unidirectional laminates with braided outer layer (BUR). They investigated effect of rubber core and braided outer layer on the mechanical properties of the above mentioned helical springs. According to the experimental results, the helical composite spring with a rubber core can increase its failure load in compression by about 12%; while the spring with a braided outer layer cannot only increase its failure load in compression by about 18%, but also improve the spring constant by approximately 16%. [3]This study deals with the stress analysis of a helical coil compression spring, which is employed in three wheeler's auto-rickshaw belonging to the medium segment of the Indian automotive market. This spring's have to face very high working stresses, so in this design of the spring both the elastic characteristics and the fatigue strength have to be considered as significant aspects. This done by using finite element analysis. These springs have to face very high working stresses. The structural reliability of the spring must therefore be ensured. [4]
It is observed from literature review that Analysis and modeling of helical coil spring by using FEA is not taken into consideration. Also results of helical coil spring design are to be optimized. Results will provide new material like epoxy and key to improve design of helical coil spring.

II .Finite element analysis of helical spring

Analysis has been carried out in ANSYS work bench. Constrained spring geometry is as shown in figure 2.1.

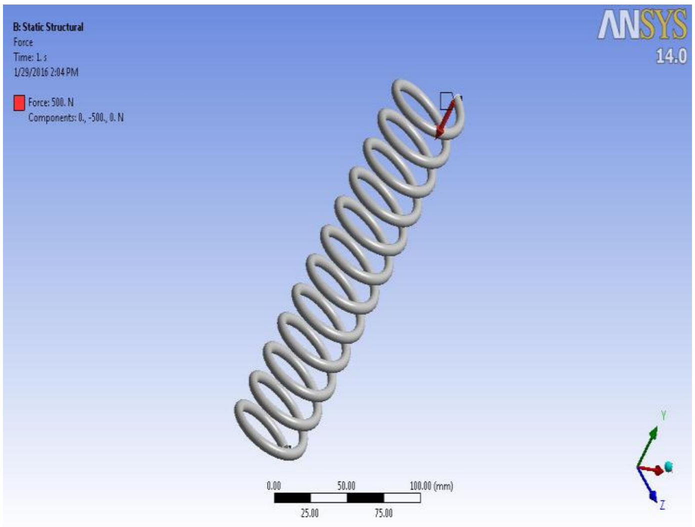


Fig.2.1 Geometry of the spring in ANSYS

Geometry is meshed by using brick element. Total number of nodes 24620 and elements 4950 are generated after meshing. One end of the spring is fixed in all direction while load is applied in Y direction at another end. It is shown in figure 2.2

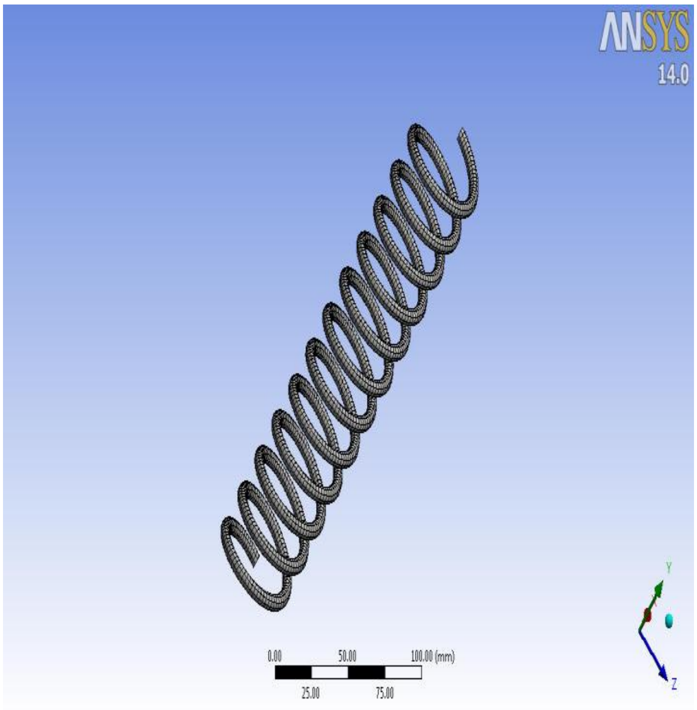


Fig.2.2 Meshed model of helical coil spring

Table No.1 Input parameters for Analysis of spring

Sr.No.	Parameters	Values
1	Height(mm)	225
2	Wire diameter(mm)	6
3	Turns(mm)	12
4	Coil diameter(mm)	30
5	Force (N)	1000

Table No.2 Material properties of spring for analysis (Epoxy)

Table 2.1 shows material properties in X, Y and Z directions which are used for analysis.

Sr. No.	Material Property	Value
1	Young's modulus (EX), MPa	34000
2	Young's modulus ((EY) MPa	6530
3	Young's modulus (EZ) MPa	6530
4	Shear modulus along XY-direction (Gxy), MPa	2433
5	Shear modulus along XY-direction (Gyz), MPa	1698
6	Shear modulus along XY-direction (Gzx), MPa	2433
7	Force on x direction, N	1000
8	Poisson ratio along XY-direction (NUxy)	0.217
9	Poisson ratio along YZ-direction (NUyz	0.366
10	Poisson ratio along ZX-direction (NUzx)	0.217

Table No.3 Spring properties for different materials

Sr. No.	Material	Nominal Analysis	Modulus of Elasticity (E)	Max. Operating Temp. (C)	Modulus Rigidity (G)
1	Oil Tempered Carbon Steel	C: 0.45-0.85%, Mn 0.60-1.30%	20700	150	79000
2	Epoxy	-			
3	Vanadium Chrome steel	C 0.48-0.53%, Cr 0.80-1.10%, V 0.15 min %	20700	220	79300
4	Hard-drawn spring steel	C 0.55-0.85%, Mn 0.60-1.20%	20700	250	79.3e10

As shown in the table No.2.4. For analysis of helical coil spring above properties are taken into considerations.

III .RESULTS AND DISCUSSION

1. Finite element results

In this chapter, analysis of helical coil spring by using the FEA (WORKBENCH) has been discussed. This analysis provides the results and under the loading condition, compression strength of helical coil spring is obtained. Stress distribution of helical coil spring is as shown below in figure 3.1.In this case, static analysis is done by using the finite element method, in the figure blue color indicates the minimum stresses 4.8243E6 acting on the turns and red color indicates maximum stresses 4.7278E9.

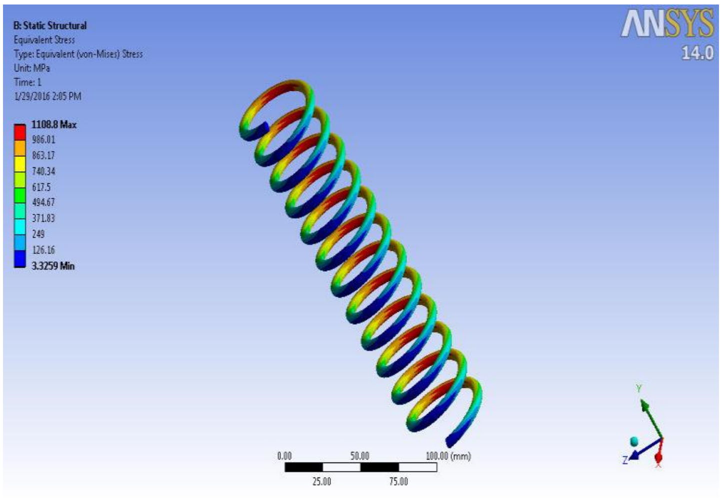
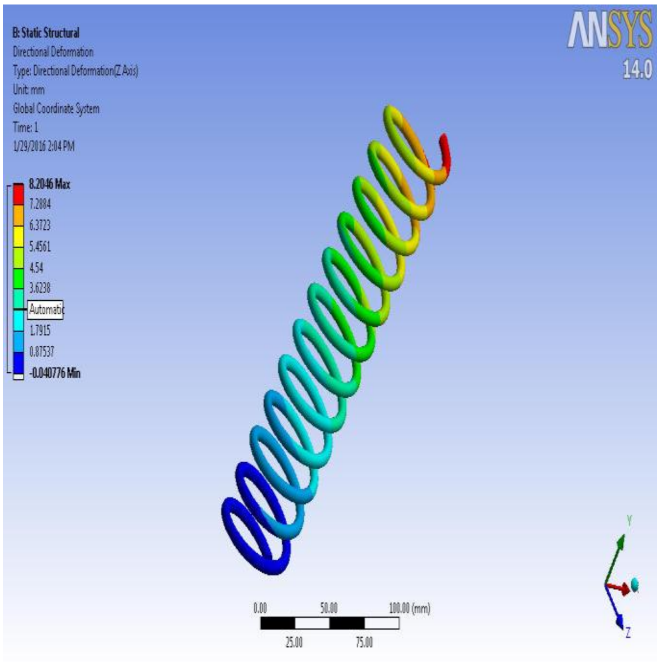


Fig.3.1. Equivalent stress of helical coil spring



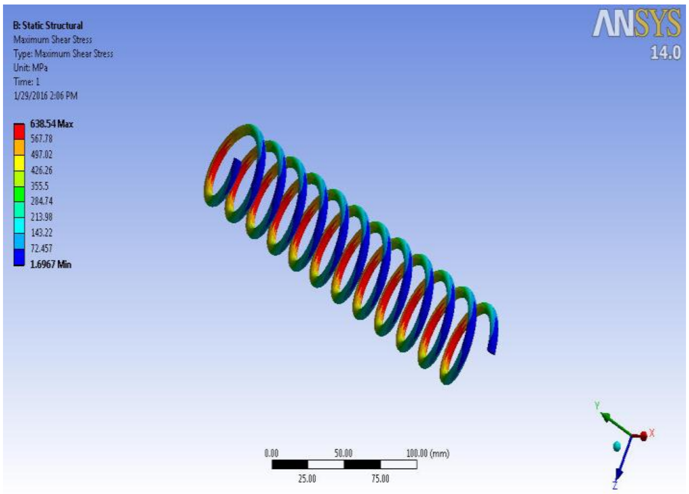


Fig.3.2. Total deformation of helical coil spring
Fig.3.3. Maximum shear stress of helical coil spring

Figure shows maximum shear stress, deformation and von mises stresses of helical compression spring.

2. Analysis of spring by FEA (Oil Tempered Carbon Steel)

Table No.4 Load verses Max. Shear stress

Load	Maximum Shear Stress For Oil Tempered Carbon Steel(N/mm²)	Deflection (mm)
500	345.56	130.89
600	427.51	146.8
700	507.48	165.41
800	582.33	197.53
900	621.5	202.97
1000	648.81	206.91

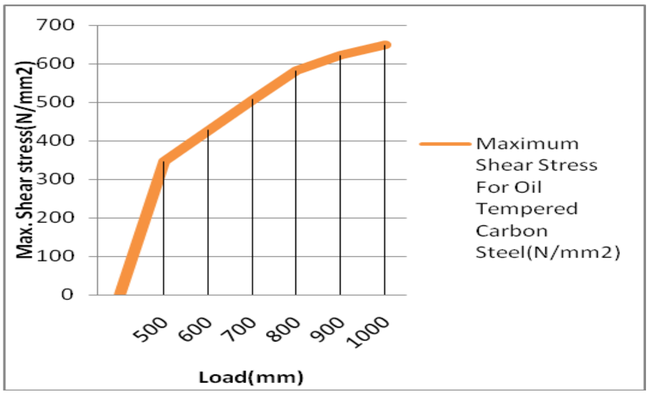


Fig. No.3.4 Load verses Max. Shear stress

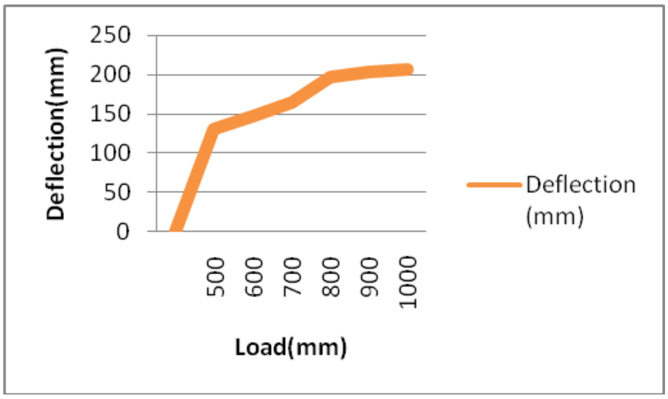


Fig. No.3.5 Load verses deflection

As shown in figure the load verses Max. shear stress, If load increases the deflection increases and vice versa.

Table No.4 Load verses Max. Shear stress and Deflection

Load(N)	Maximum Shear Stress for Epoxy(N/mm²)	Deflection (mm)
500	241.929	102.36
600	262.92	130.49
700	325.788	152.28
800	342.801	174.98
900	425.76	182.92
1000	454.68	189.38

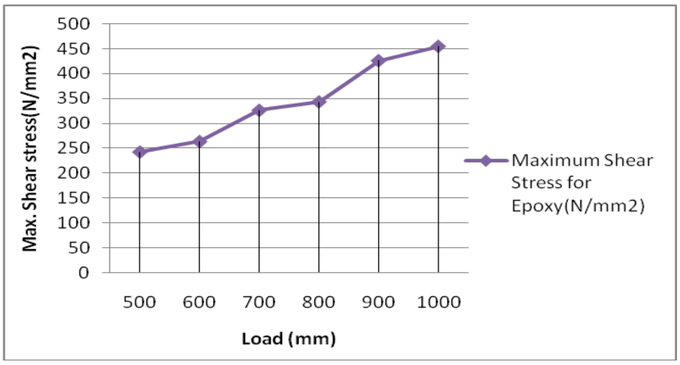


Fig. No.3.6 Load verses Max. Shear stress

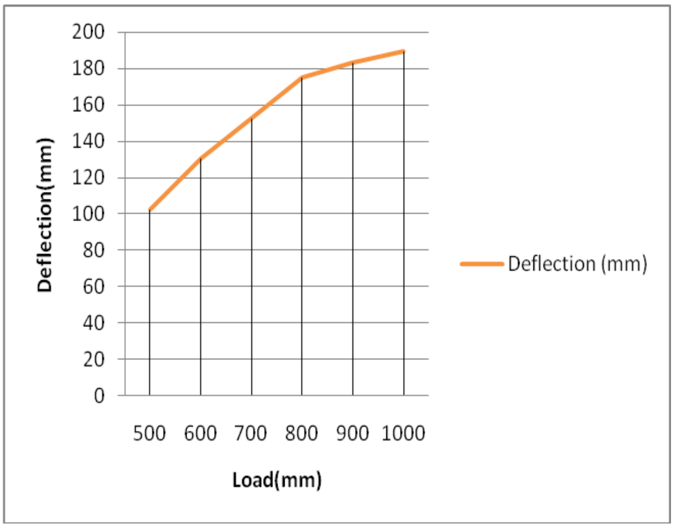


Fig. No.3.7 Load verses deflection

As shown in figure the load verses Max. shear stress, If load increases the Max. shear stress increases and vice versa

Table No.5 Load verses Deflection

Load	Deflection for Hard-drawn spring steel (mm)	Deflection For Oil Tempered Carbon Steel (mm)	Deflection for Vanadium Chrome steel (mm)	Deflection for Epoxy (mm)
500	142.36	130.89	132.18	102.36
600	151.98	146.8	153.14	130.49
700	173.54	165.41	156.45	152.28
800	201.58	197.53	193.98	174.98
900	209.38	202.97	207.47	182.92
1000	215.11	206.91	212.43	189.38

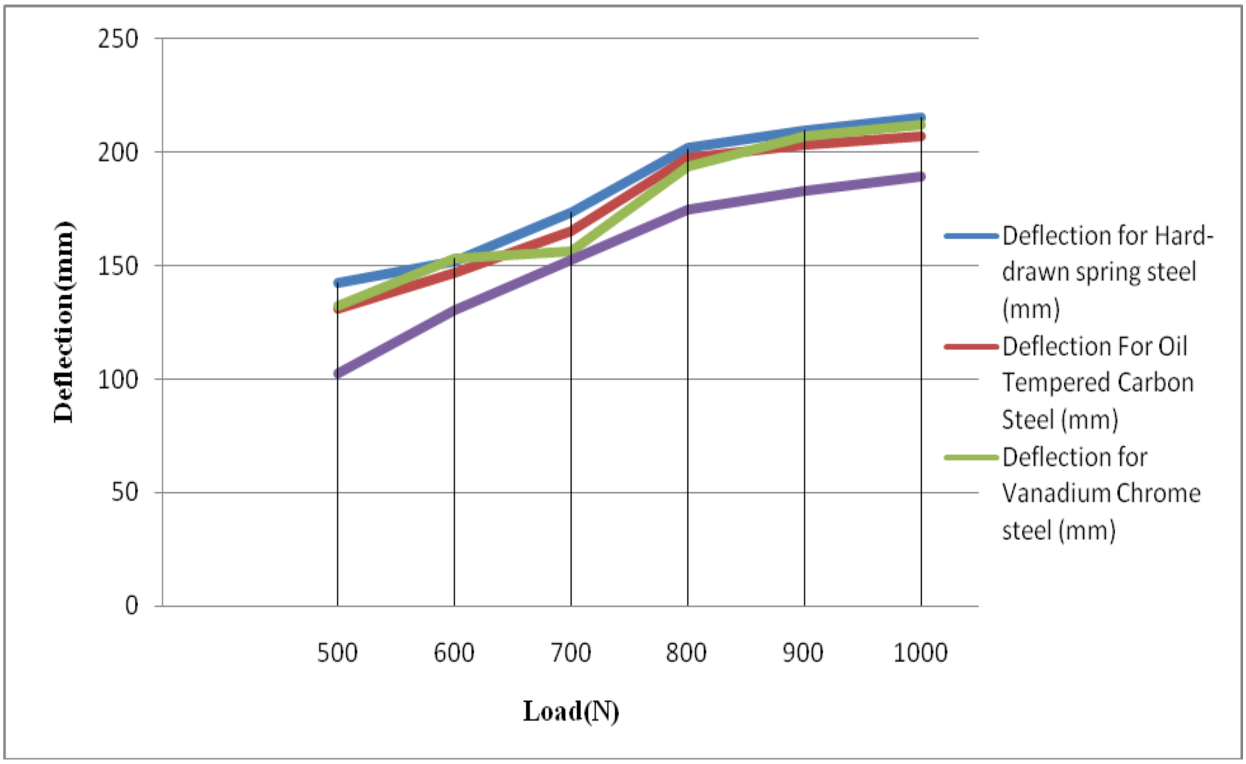


Fig. No.3.8 Load verses Deflection

A graph is plotted as shown in Fig.5.17 between load verses deflection. Load is taken on the X - axis and deflection is taken on the Y - axis. As figure shows the purple color (Epoxy) line shows less deflection than the other colors or materials.

Table No.6 Load verses Maximum Shear Stress

Load(N)	Maximum Shear Stress For Oil Tempered Carbon Steel(N/mm^2)	Max. shear stress for Hard-drawn spring steel (N/mm^2)	Maximum Shear Stress for Epoxy (N/mm^2)	Maximum Shear Stress for Vanadium Chrome steel (N/mm^2)
500	345.56	360.5	241.929	102.36
600	427.51	432.75	262.92	130.49
700	507.48	512.26	325.788	152.28
800	582.33	595.29	342.801	174.98
900	621.5	631.45	425.76	182.92
1000	648.81	677.23	454.68	189.38

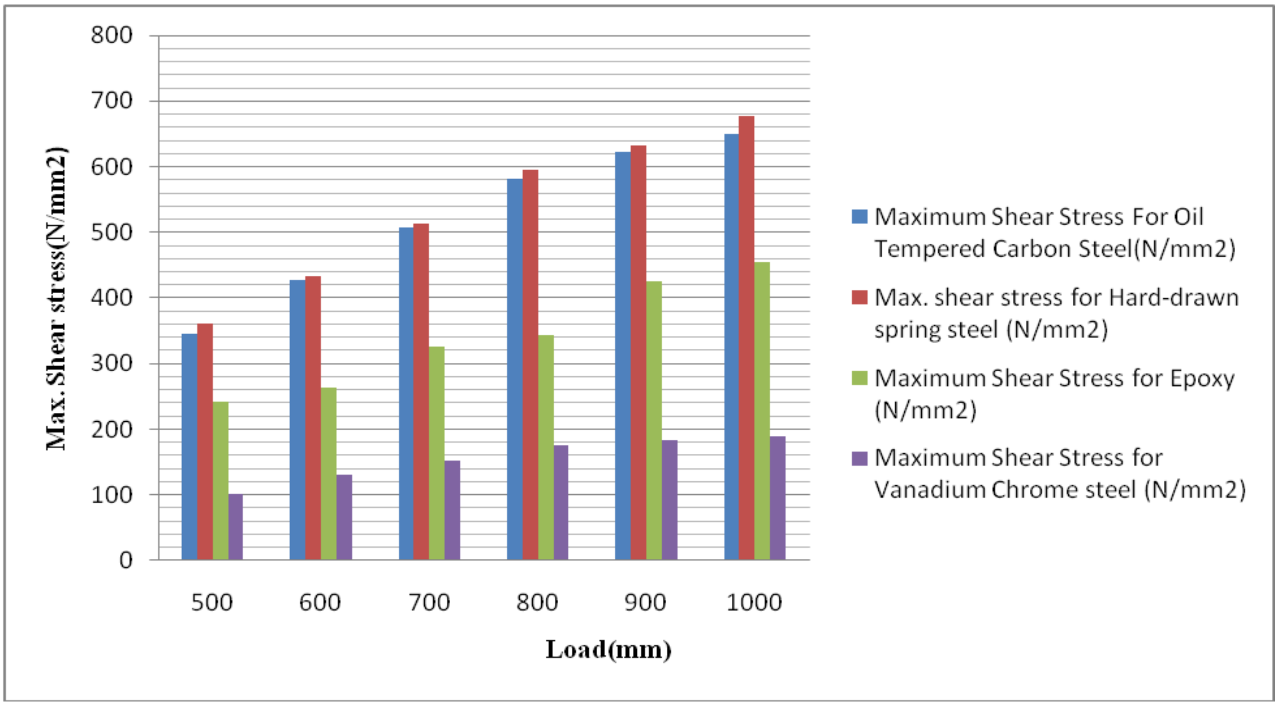


Fig. No.3.8 Load verses Max. shear stress

A graph is plotted as shown in Fig. 5.18 between load verses maximum shear stress of four different materials. Load is taken on the X - axis and max. shear stress taken on the Y - axis. It is seen in 5.17 graphs that, when load increases the shear stress increases linearly. Shear stresses on E-glass/epoxy are less than other as shown in fig. The E-glass fiber is a high quality glass, which is used as standard reinforcement fiber for all the present systems well complying with mechanical property requirements. Thus, E-glass fiber was found appropriate for this application.

IV. CONCLUSION

- The comparative study has been carried out in between the four different materials.

-It is observed that force and material property are significant parameters which affect compressive strength of helical coil spring.
-Finite element analysis of helical coil spring has been carried out.
-The maximum shear stress of Epoxy spring has 15-19% less with compare to hard drawn steel spring, chrome vanadium steel and oil tempered carbon steel.
-The deflection pattern of the Epoxy spring 15% less at same weight with compare to other three materials.

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