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Analysis of Open Coil Helical Spring Used in Vehicles

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Abstract: **In this paper suspension loading etc spring of a 160cc 2-wheeler is analyzed and optimized for its performance. For this study the diameter and the material of the coil wire for suspension is changed and its effect is noted. In this study three materials were studied that is ASTM A227 hard drawn spring steel material, carbon fibre Material and titanium alloy. The results were obtained for all of these materials and based on the results it can be said that spring made of carbon fibre material gives the best results. The springs were tested under both static as well as dynamic loading, and in all of the tests Carbon fibre spring proved to be best.**

Keywords: Suspension, Open coil spring, Carbon fiber, Dynamic.

I. INTRODUCTION

Springs are mechanical shock absorber system. A mechanical spring is defined as an elastic body which has the primary function to deflect or distort under load and to return to its original shape when the load is removed. Springs are mainly used in the industry for absorbing shock member energy and for resetting the part at its initial position upon displacement for a given function.

Helical Compression springs are helical coil springs that resistance to a compressive force. Helical Compression springs having shapes like cylindrical, conical, tapered, concave or convex etc. Coil compression springs are wound in a helix usually out of round wire. The springs are designed to withstand the cycle of loading or unloading during operation.

The front suspension helical coil compression spring used for three wheeler front suspension has high in weight so it

Using modeling software solid works completed the modeling and by using Ansys software meshing and post processing of spring was done. For validation purpose comparison of software and theoretical values was done.

For this load verses deflection values were calculated. The main aim of this paper is to suggest the alternate minimum number coils for helical compression spring which used for three wheeler and reduce the weight of the existing coil spring.

finite element analysis of helical compression spring used for front suspension in a three-wheeler transport vehicle so as to reduce the weight needs to optimize in weight. Therefore in this present work it is proposed to carry out the numerical design and.

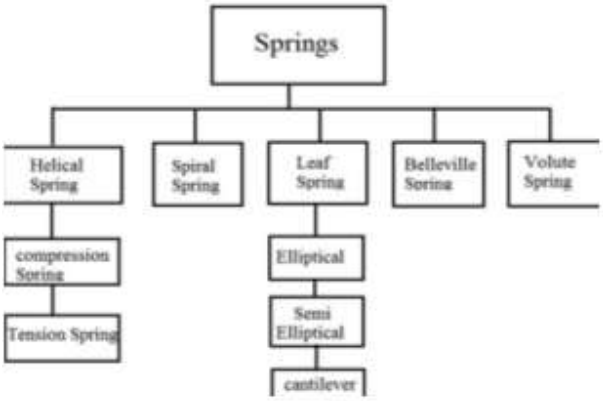

Figure 1: Different Types of Spring

II. METHODOLOGY

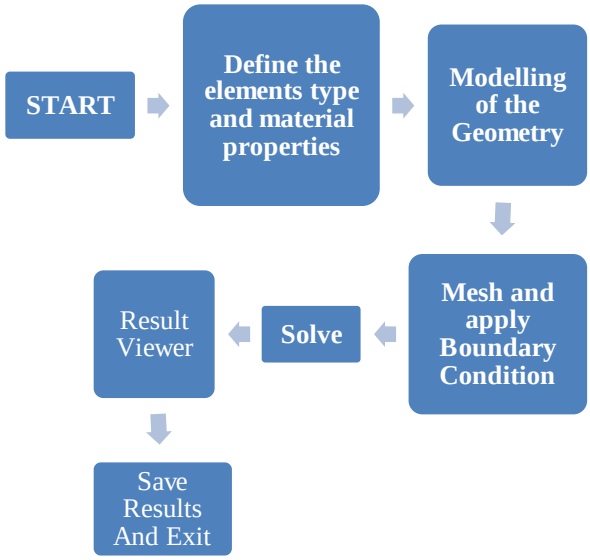

Figure 2 : Setup of Working

S.No	MATERIAL	Young's Modulus (EX)(MPa)	Poisson's Ratio (PRXY)
1	Hard Drawn Spring Steel	1.965E+05	0.25
2	Carbon Fiber	1.23E+05	0.282
3	Titanium Alloy	9.6E+10	0.36

Figure 3: Setup of Working

GOVERNING EQUATIONS

Material 1: Spring Steel (Modulus of Rigidity) G = 78600n/Mm^2

Mean diameter of a coil, D=33.3mm

Diameter of wire, d = 6.7mm

Total no of coils, n1= 17

Height, h = 210mm

Outer diameter of spring coil, D0 = D +d =40mm

No of active turns, n= 15

Weight of bike = 113kg

Let weight of 1person = 75Kg

Weight of 2 persons = 75×2=150Kg

Weight of bike + persons = 263Kg

Rear Suspension = 65%

65% of 263 = 171Kg

Considering dynamic loads it will be double

W = 342Kg = 3355N

For single shock absorber weight = w/2= 1677N = W

We Know that, compression of spring (δ) = (WD^3 n)/(Gd^4)

C = spring index = D/d = 5

(δ) = 46.91

Solid length, Ls =n1×d=17×6.7=113.9mm

Free length of spring,

Lf = solid length + maximum compression + clearance between adjustable coils

= 113.9 + 46.91 + (46.91 ×0.15) = 167.8mm

Spring rate, K = W/ δ = 35.74

Pitch of coil, P = (Lf – Ls)/ n1+ d

Stresses in helical spring: maximum shear stress induced in the wire

τ = (Ks × 8WD)/ □.d3

Ks = (4C-1)/ (4C-4) + 0.615 /C = 1.3105

τ = 619.62

Buckling of compression spring:

Crippling load under which a spring may buckle

KL = 0.1 (for hinged end spring)

The buckling factor for the hinged end and built -in end spring

Wcr = q × KL × Lf = 35.74 × 0.1× 167.8 = 599.71N

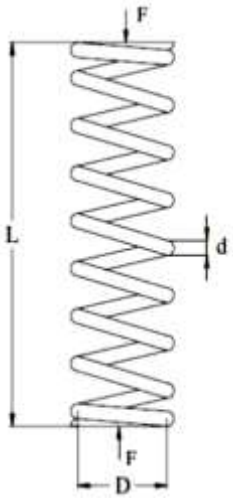

Figure 4: Helical Spring with Axial Load

III. RESULTS AND DISCUSSION

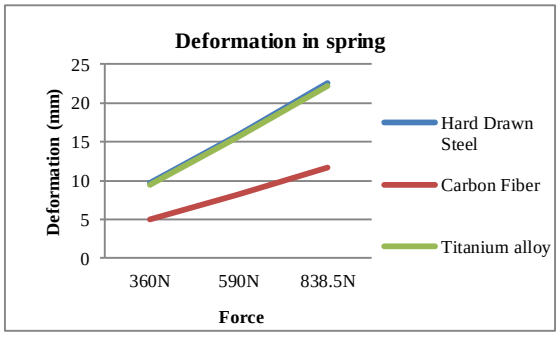

Figure 5: Deformation in springs

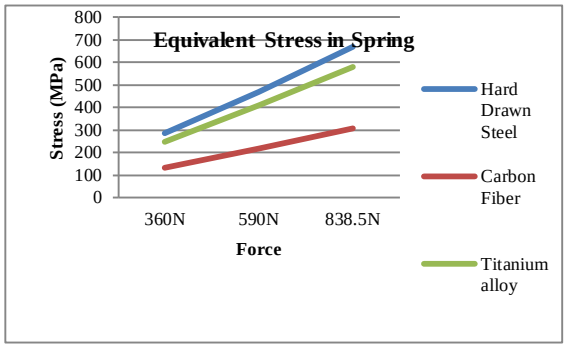

Figure 6: Equivalent Stress in Springs

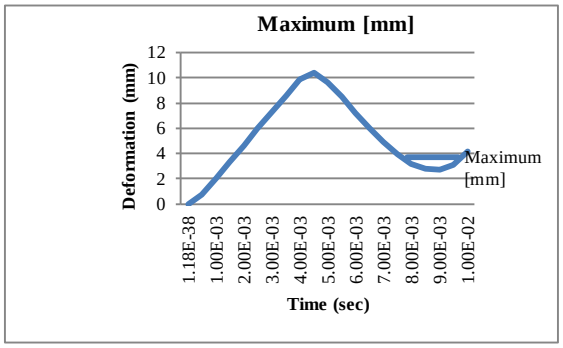

Figure 9: Deformation obtained in Proposed Design-1 Spring under Dynamic Loading

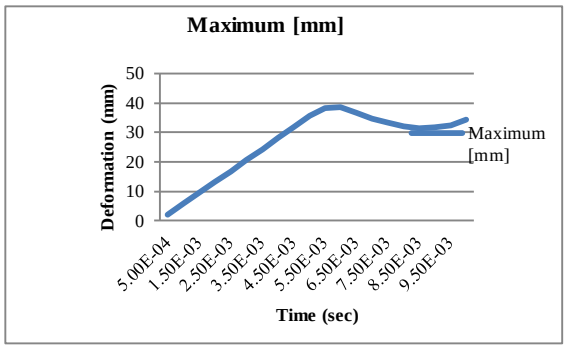

Figure 7: Deformation obtained in original Spring under Dynamic Loading

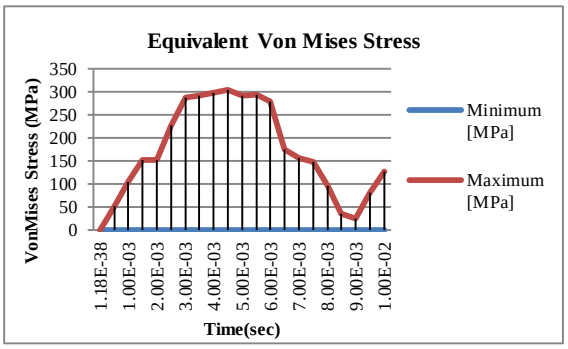

Figure 10: Von-Mises Stress obtained in Proposed design-1 Spring Under Dynamic Loading

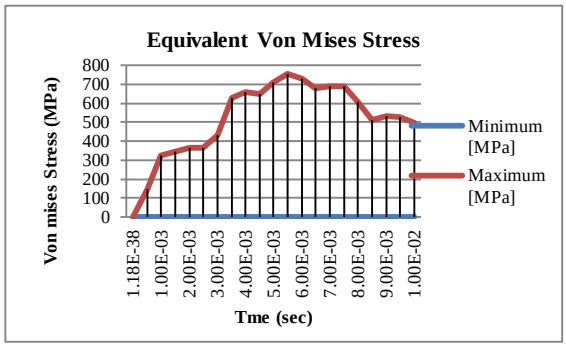

Figure 8: Von-Mises Stress obtained in original Spring Under Dynamic Loading

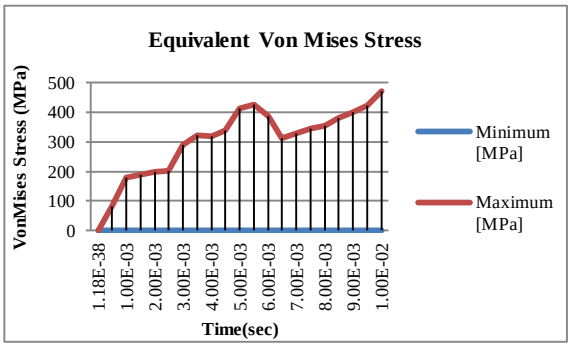

Figure 11: Von-Mises Stress obtained in Proposed design-2 Spring

IV. CONCLUSION

1. For the purpose of analysis 3 models of Suspension Spring were Successfully developed
2. Suspension spring with carbon fiber material showed the least deformation for all the load condition
3. The deformation in titanium alloy spring and ASTM a227 spring is same but equivalent stress in the titanium alloy spring is much lower than those of ASTM a227 spring
4. The results of the dynamic analysis showed that the Spring with ASTM a227 and Titanium alloy showed buckling at the center at the maximum load but that is not the case with Carbon fibre spring,

5. Also the deformation showed by the Carbon fibre spring under dynamic load is much less compared to other springs.
6. Though the diameter of the Carbon Fiber spring coil is greatest but it's weigh is lowest among all the three models followed by Titanium alloy spring and the heaviest being ASTM a227 spring
7. Based on the results it can be concluded that the suspension spring made of carbon fiber is the best suitable alternative to be used in the bike suspension system.

V. FUTURE SCOPE

Though the research is carried out with utmost accuracy, then also there is scope for some further improvement. Some of them are listed below:

- For this research work only the suspension spring was considered, research can be further extended by using the whole suspension assembly.
- Dynamic analysis on the spring were performed for maximum load condition in this study, the behavior of the spring under other loads can be studied further.

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