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ANALYSIS AND DESIGN OF HELICAL COMPRESSION SPRING USING ANSYS

R.J.Hire , Raj Patil, Akash Mishra, Sourabh Kulkarni
(Department of Mechanical Engineering, RMDSSOE, Warje,Pune)

ABSTRACT
Suspension spring is the spring shock absorbs and linkage which are used to connect vehicle and allow relative motion between them, spring is an important element in rear suspension system. During loaded condition the weight of the vehicle acts on the spring, pushes it down where its springing action enables it to come back to its normal position and hence provide stability to vehicle and comfort to rider. The suspension system reduces the amplitude of disturbance by absorbing and handling shock impulses and dissipating kinetic energy generated due to improper road conditions and bumps where the design of spring plays a crucial role. The project work is based on design and 3D 8modelling of helical compression spring used in suspension system of vehicle. The statistical structure analysis would be done by Finite Element Analysis method in Ansys for different spring material and varying wire diameter of spring. The result would be compared and discussed to conclude the better one

Keywords:
Helical spring, Finite Element Analysis, New Material, Static Analysis

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INTRODUCTION

Spring is an elastic or resilient body, whose function is to deflect or deform when load is applied and recover its original shape when load is removed. Spring has a multiple area of application, with their different types. They are widely used for diff-diff purpose, their basic types are given below as follows,

1. Helical spring
2. Conical or volute spring
3. Disc or Belleville springs
4. Leaf or laminated spring

Among all these types of springs, leaf springs and helical springs are mostly used in automobile suspension system. Out of which helical spring is mostly used in motorcycle suspension because the coil spring are used to deliver more comfort as compared to leaf spring and the load on two wheelers or the motorcycle is less comparing to the heavy vehicle.

In the suspension system of two-wheeler, damper is used along with the helical coil spring. When the load or shock vibrations are exerted on the spring it compresses and absorbs the vibration and reduces the amplitude of disturbances. As a result of absorption of shock vibration, the spring in turn starts to oscillate and here the damper is used for progressively diminishing these oscillations of the spring or else it will continuously oscillate.

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Assumptions

For the purpose of force calculation we assume that our vehicle is in motion and then the base is considered to be excited by a sinusoidal motion of y=Y sin ωt. The material that is being used in manufacturing of spring is carbon spring steel so we will find the forces and the stresses that are induced in carbon steel material which we will use to apply on other material springs. Also, while calculating the theory as well as practical calculations, there is no load i.e., free loading condition is considered

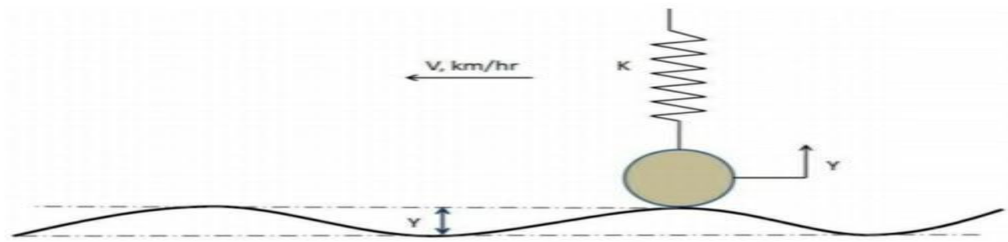

Fig 1: Assumptions made

Theoretical Calculations

Dimensions of the Helical Compression Springs:

- Length of Spring (L)=22.6 cm
- Coil diameter (D) = 49.80 mm
- Wire diameter (d) = 7.1 mm
- ❖ According to the test conducted the material confirms to Carbon Spring Steel En 42.

1.0 Chemical Composition
(By OES)

Sr. No.	Sample Identification	Chemical Composition, %					
		C	Mn	Si	S	P	Ni
1	Spring	0.80	0.71	0.17	0.020	0.025	0.086

Remark : Material confirms to Carbon spring steel En 42

2.0 Load Vs Deflection

Fig 2: Confirmation of Spring Metal

- Modulus of rigidity (G) = 81 MPa
- Damping Ratio= 0.5
- Amplitude (Y) = 1 mm
- Number of turns (n) = 17

Following formulas were used to calculate the required factors:

1. Spring constant(K) $=Gd^4\ 8nD^3$
2. $\omega = 2\pi f$; $f = v/\lambda$; $\omega n = \sqrt{(k/m)}$; $r = \omega/\omega n$

Vol-05 Issues 06, June-2021 ISSN: 2456-9348
Impact Factor: 5.004

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3. Amplitude ratio or Displacement transmissibility(X): $X = \sqrt{1 +(2*r)^2} / \sqrt{\{(1-r^2)^2 + [2*r]^2\}}$
4. $F=\xi G d^4 / 8nD^3$

Consider the velocity v = 15 km/hr

Frequency is given by $f = v/ \lambda = 4.1667/1 = 4.167$
$\omega = 2* 3.14 * f = 2*3.14* 4.167 = 26.167$ rad/sec

The natural frequency is given by
$\omega n = k^{(1/2)}$
Frequency ratio (r) = $\omega / \omega n = 26.167/35.338 = 0.7405$

Now, the amplitude ratio or Displacement transmissibility (X) is given by,
$X =\{ [1 + (2*r)^2]^{1/2} / \{[1 – r^2]+ [2*\xi*r]^2 \}^{1/2} \} * Y$
X = 0.01434 m

Now the force exerted on the spring will be,
$F = [\zeta* G * d^4] / [8*D^3 * n] = [0.81*10^5 * 0.01434* 10^8 * 7.14] / [8 * 49.803 * 17]$ F = 175.728 N

Practical Calculations

The Helical Compression Springs were bought from Sachin Autoworks, Dattawadi, Pune.
They were tested in Praj Metallurgical Laboratory,Kothrud, Pune

Carbon spring steel En 42

2.0 Load Vs Deflection

Sr. No.	Deflection in mm	Observed load in N
1	10.0	223.44
2	20.0	461.58
3	30.0	698.74
4	40.0	937.86
5	50.0	1174.04
6	60.0	1426.88
7	70.0	1790.46
8	80.0	2204.02
9	90.0	2637.18

Note : **Stiffness : 23.716 N/mm**

Fig 3: Practical Test Report

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Ansys Results

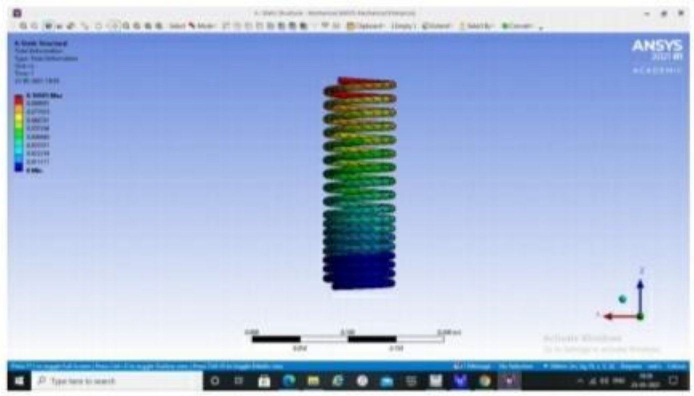

Fig 4 : When the speed is 10 km/hr the deformation and shear stress.

CONCLUSION

From the obtained result of the analysis on Ansys and the graphs we can conclude the safe speed for riding a vehicle, while still keeping the Helical Compression Spring safe so, that it the Spring would be safe. According to the Deflection vs Speed graph, as the speed of the vehicle increases, the deflection of the Helical Compression Spring also increases. This also helps in the process of selecting a suitable material for the Helical Compression Spring. With this we can also calculate deflection and shear stress using different loading conditions and using different materials.

ACKNOWLEDGEMENT

Every orientation work has imprint of many people and this work is no different. This work gives me an opportunity to express deep gratitude for the same. While preparing seminar report received endless help from number of people this report would be incomplete if I don't convey my sincere thanks to all those who were in involved First and foremost, I would like to thank my respected guide Mrs. R. J. Hire and H.O.D. Dr. M.V Nagarhalli for giving me an opportunity to present this seminar and his indispensable support, priceless suggestions and valuable time. I wish my express my appreciation to Mrs. R. J. Hire

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who helped me to overcome my doubts in doing this seminar. Last but not least I wish to thank my friends and my family for being supportive of me, without whom this seminar would not have seen the light of day.

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