

Analysis And Testing Of Two Wheeler Suspension Helical Compression Spring

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Abstract: - The present work is carried out on modeling, analysis and testing of suspension spring is to replace the existed steel helical spring used in popular 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 determines the stress and deflections of the helical compression spring in finite element analysis. The testing proto type is used to test the spring under different loading conditions. Finite element analysis methods (FEA) are the methods of finding approximate solutions to a physical problem defined in a finite region or domain. FEA is a mathematical tool for solving engineering problems. In this the finite element analysis values are compared to the experimental values. A typical two wheeler suspension spring is chosen for study. The modeling of spring is developed on pro/E 5.0 analysis is carried out on ansys 14.

Keywords: - helical compression spring, stress, deflection, analysis, proe-5, ansys 14.

I. 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.

It is an elastic object used to store mechanical energy. Springs are usually made out of spring steel. Small springs can be wound from pre-hardened stock, while larger ones are made from annealed steel and hardened after fabrication.

Some non-ferrous metals are also used including phosphor bronze and titanium for parts requiring corrosion resistance and beryllium copper for springs carrying electrical current (because of its low electrical resistance). When a spring is compressed or stretched, the force it exerts is proportional to its change in length.

Types of springs

Though there are many types of springs, these are the main springs which we can see often.

1. Helical springs.
2. Conical and volute springs.
3. Torsion springs.
4. Laminated or leaf springs.
5. Disc or Belleville springs.

Helical springs

The helical springs are made up of a wire coiled in the form of a helix and are primarily intended for compressive or tensile loads. The cross-section of the wire from which the spring is made be circular, square or rectangular.



Helical springs.

The helical springs are said to be closely coiled when the spring wire is coiled so close that the plane containing each turn is nearly at right angles to the axis of the helix and the wire is subjected to torsion. In other words, in a closely coiled helical spring, the helix angle is very small, it is usually less than 10 degree. The major stresses produced in helical springs are shear stresses due to twisting. The load applied is parallel to or along the axis of the spring. In open coiled helical springs, the spring wire is coiled in such a way that there is a gap between the two consecutive turns, as a result of which the helix angle is large.

Helical springs are generally used in two different applications. The first is the role of compression spring which offers resistance to forces moving two components towards each other. Typical applications are car suspension and matters spring. Compression springs typically have their ends end and allowing for easy mounting.

The second common use for helical spring is as a tensioning element. Springs used in this role resists forces moving in two objects away from each other. A couple of common tension spring applications include spring scales and automatic door closers.

Dimension of helical spring

- Upper outer diameter : 45mm
- Lower outer diameter : 60mm
- Height of the spring : 240mm
- Diameter of spring wire : 6mm
- Pitch at start : 8mm
- Pitch at end : 16mm
- Pitch at the quarter middle : 13mm

II. HARD-DRAWN SPRING STEEL

High-carbon spring steels are the most commonly used of all springs materials. These materials is preferred to others because they are least expensive, readily available, easily worked, and most popular. These materials are not satisfactory for high or low temperatures or for shock or impact loading. Also this is the general purpose spring steels and should only be used where life accuracy and deflection are not too important.

Nominal Chemical Properties

Carbon (C)	Manganese (Mn)	Phosphorus (P)	Sulphur (S)	Silicon (Si)
0.48-0.85	0.30-1.30	≤ 0.04	≤ 0.05	0.15-0.30

Table: 1 nominal chemical properties.

Nominal Mechanical Properties

- Young's Modulus : 206000 MPa.
- Modulus of Rigidity : 85000 MPa.
- Density : 7800 kg/m³
- Poissons Ratio : 0.33

4.sample caluculation for the helical spring:

$$\text{Spring index, } C = \frac{D}{d}$$

$$= \frac{52.5}{6} = 8.75$$

$$\text{Wahl's stress factor, } k = \frac{4C-1}{4C-4} + \frac{0.615}{C}$$

$$= \frac{4 \times 8.75 - 1}{4 \times 8.75 - 4} + \frac{0.615}{8.75}$$

$$k = 1.167$$

$$\text{Maximum shear stress, } \tau = \frac{k \times 8WD}{\pi d^3}$$

$$= \frac{1.167 \times 8 \times 50 \times 9.81 \times 52.5}{\pi \times 6^3}$$

$$\tau = 354.287 \text{ MPa.}$$

$$\text{Deflection of spring, } \delta = \frac{8WC^3n}{Gd}$$

$$= \frac{8 \times 50 \times 9.81 \times 8.75^3 \times 16}{87500 \times 6}$$

$$\delta = 80.115 \text{ mm.}$$

Theoretical Results:

Sl No.	Load 'W'	Maximum Shear Stress ' τ '	Deflection ' δ '
1	50	354.287	80.115
2	60	425.135	96.138
3	70	495.993	112.161
4	80	566.851	128.184
5	90	637.708	144.207

Table : 2 stress and deflection of the spring material.

VANADIUM- CHROME STEEL

Vanadium- Chrome steel is an alloy steel which states that it contains one or more elements other than carbon in sufficient proportion to modify or improve substantially and positively some of its useful properties. They are most popular alloy spring for improved stress, fatigue, long endurance life conditions as compared to high carbon steel materials. Both chromium and vanadium increase the harden ability of steel. Important synergistic effects, not yet fully defined, can also occur when combinations are used in place of single elements. This is best suited for impact and shock loading conditions.

Nominal Chemical Compositions

Carbon (C)	Manganese (Mn)	Phosphorus (P)	Sulphur (S)	Silicon (Si)	Chromium (Cr)	Others (Ni, V etc.)
0.48-0.53	0.70-0.90	≤ 0.04	≤ 0.04	0.15-0.35	0.80-1.10	≤ 0.15

Table: 3 Nominal chemical compositions

Chromium brings resistance to corrosion and oxidation, high temperature strength and abrasion resistance. Vanadium inhibits grain growth during heat treating while improving toughness of hardened and tempered steels.

Nominal Mechanical Properties

Young's Modulus : 207000 MPa.
 Modulus of Rigidity : 87500 MPa.
 Density : 7800 kg/m³
 Poissons Ratio : 0.28

Testing of the spring for various loads:



Deflection of the spring for 50kgs



Deflection of the spring for 60kgs



Deflection of the spring for 80kgs



Deflection of the spring for 90kgs

Experimental results:

Sl. No.	Load 'W'	Maximum Shear Stress ' τ '	Deflection ' δ '
1	50	352.932	134.733
2	60	358.053	155.317
3	70	446.953	158.023
4	80	494.609	198.307
5	90	552.446	211.572

Table: 3 The deflections of the spring under various loads as follows

III. MODELING OF THE SPRING

The modeling of the spring is carried out on the pro-e wild fire 5.0

The tool used for the modeling of the spring is helical protrusion. This modeling is based on the variable pitch condition. The spring having variable pitches throughout the spring. The pitch of starting and ending of the spring is small and at middle it is high.

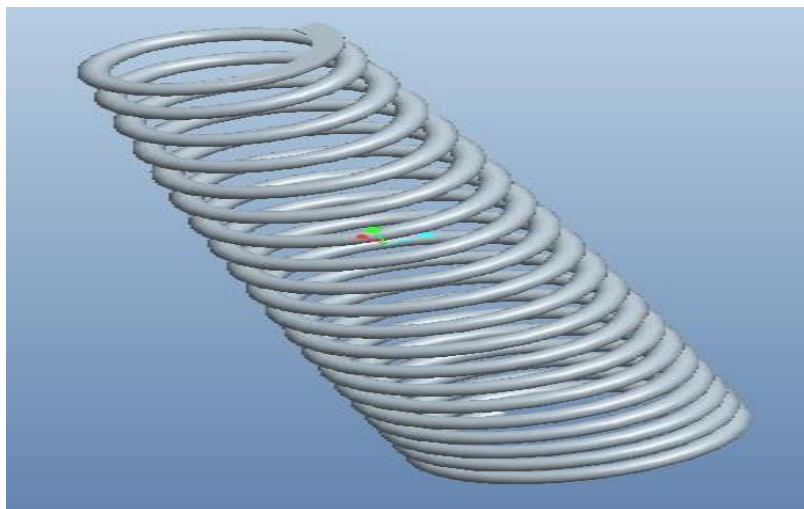


Fig: The Pro-E Model of The Spring

5. analysis of the springs: The analysis is carried out on ansys 14.0

The ansys results for hard drawn steel spring The results are obtained on ansys for spring

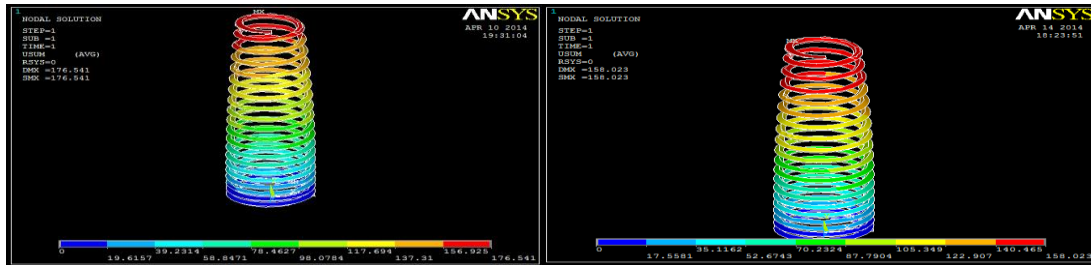


Fig1:Displacement pattern of hard drawn steel spring Fig 1:Displacement pattern of hard drawn steel spring

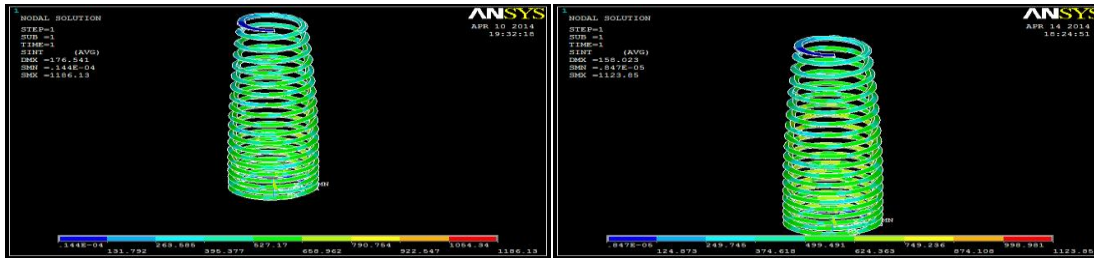


Fig2:stress intency of spring

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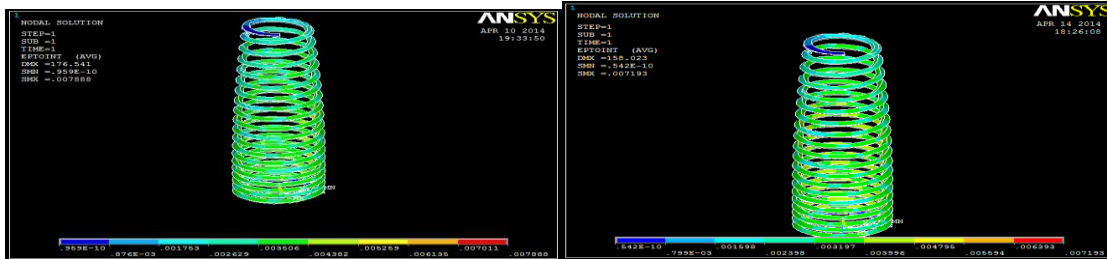


Fig3:total mechanical strain of the spring

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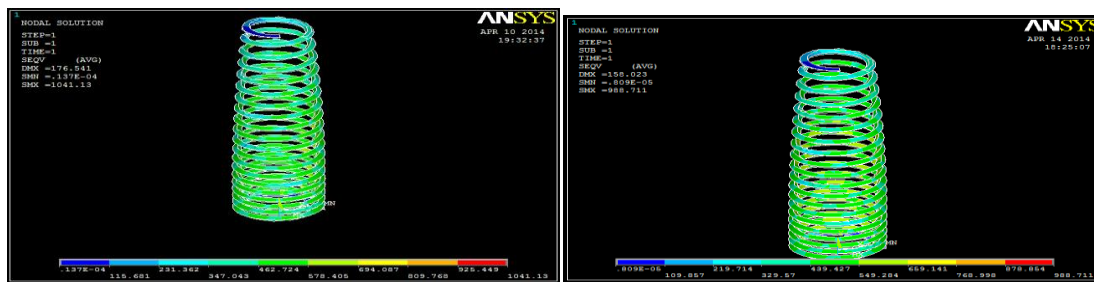


Fig4:vonmises stress of the spring

Fig4:vonmises stress of the spring

Results:

Sl No.	Load 'W' (kg)	Theoretical values		Experimental values		Analytical values	
		Max Shear 'δ' Stress 'τ'	Deflection (mm)	Max Shear 'δ' Stress 'τ'	Deflection (mm)	Max Shear 'δ' Stress 'τ'	Deflection (mm)
1	50	354.287	80.115	352.932	134.733	365.447	144.362
2	60	425.135	96.138	358.053	155.317	438.733	153.852
3	70	495.993	112.161	446.953	158.023	516.690	176.541
4	80	566.851	128.184	494.609	198.307	595.285	204.392
5	90	637.708	144.207	552.446	211.572	639.787	212.855

Table4: The comparison of theoretical values to the experimental values and analytical values of hard drawn steel

Sl. No.	Load 'W' (kg)	HARD-DRAWN SPRING STEEL		VANADIUM- CHROME STEEL	
		max Shear Stress ' τ ' (N/mm ²)	Deflection ' δ ' (mm)	max Shear Stress ' τ ' (N/mm ²)	Deflection ' δ ' (mm)
1	50	365.447	144.362	352.932	134.733
2	60	438.733	153.852	358.053	155.317
3	70	516.690	176.541	446.953	158.023
4	80	595.285	204.392	494.609	198.307
5	90	639.787	212.855	552.446	211.572

Table5: The comparison of analytical values of existed hard drawn steel to the proposed material of vanadium-chrome steel

IV. CONCLUSIONS

- The comparative study has been carried out in between the theoretical values to the experimental values and the analytical values.
- The maximum shear stress of chrome vanadium steel spring has 13-17% less with compare to hard drawn steel spring.
- The deflection pattern of the chrome vanadium steel spring 10% less at specified weight with compare to the hard drawn steel spring.
- It is observed that 95% of the similarity in deflection pattern and 97% similarity in shear stress pattern between experimental values to the analytical values.
- It is observed that 60% similarity in between theoretical values of deflection to the experimental values and 85% similarity in maximum shear stress of spring.

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