ANALYSIS OF HELICAL SPRING IN TWO WHEELER SUSPENSION FOR DIFFERENT MATERIALS

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***Abstract*:** A helical spring is a mechanical device which is used to absorb shocks and store maximum energy between contracting surface. They are made of an elastic material formed into the shape of a helix which returns to its natural length when unloaded. The aim of this project is to modeling and analysis of helical spring and to increase the stiffness and reduce the deformation of it by using the new materials to reduce the vehicle problem that happens while driving on bumping road condition. The comparative study is carried out between existed spring and new material spring. Static analysis determines the stress and deflection of the helical compression spring in finite element analysis (FEA). The model is used to analyze the spring on the ANSYS 16.2 under different materials conditions. Finite element analysis methods (FEA) are the methods of finding solution 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 compared to the experimental values. A two-wheeler suspension spring is chosen for study. The modeling of spring is developed on SOLIDWORKS and analysis is carried out on ANSYS 16.2.The suspension system allows the wheels to bounce up and down on rough roads while the rest remains fairly stead.The basic elements of a suspension system are springs and shock absorbers. This project is mainly based on spring.In this project, we have used three different materials like high carbon steel, chromium vanadium, Inconel X-718 for analyzing the stiffness and maximum shear stress of helical spring with a constant load of 1000 N. Among the above materials carbon steel material give the better maximum shear stress and stiffness values comparing to other materials. Mostly prefer high carbon steel material.

Keywords: Spring, Stress, Ansys, Catia.

1. Introduction

The suspension system is the main part of the vehicle, where the spring is designed to handle shock impulse and dissipate kinetic energy. In a vehicle, shock absorbers reduce the effect of traveling over rough ground, leading to improved ride quality and vehicle handling.The limiting excessive suspension movement is serves by the spring. Hysteresis is the tendency for elastic materials to rebound with less force. Hence, the designing of suspension system is very crucial. In modeling, the time is spent in drawing the helical coil spring model and the front suspension system, where the risk involved in design and manufacturing process can be easily reduced. So the modeling of the coil spring is made by using SOLID WORKS. Later the model is imported to ANSYS for the analysis work.

2. LITERATURE SURVEY

For providing the best design of spring coil to the suspension system of two wheeler vehicles, a lot of technical papers and review processes is studied before deciding the most feasible process for the work. The following list presents a gist of the main papers referred throughout the: [1] Dr A.Gopichand, In this a shock absorber is designed and a 3D model was developed in PROE. Later structural and static analysis was done by varying the materials as structural steel, chrome vanadium and AISI 1050 steel. Comparison is made by between the simulation, analytical and experimental values for deflection and maximum shear stress. [2] N.Lavanya, The present work is optimum design and analysis of a suspension spring for motor vehicle subjected to static analysis of helical spring the work shows the strain and strain response of spring behavior will be observed under prescribed or expected loads and the induced stress and strains values for low carbon structural steel is less compared to chrome vanadium material also it enhances the cyclic fatigue of helical spring.[3] Kommalapati. Rameshbabu, In this project they have designed a shock absorber used in a 150CC bike and modeled the shock absorber by using 3D parametric software Pro/Engineer. To validate the strength of design, structural analysis and modal analysis on the shock absorber was done. The analysis was done by varying spring material Spring Steel and Beryllium Copper. By observing the analysis results, the analyzed stress values are less than their respective yield stress values. The design is safe, by comparing the results for both materials, the stress value is less for Spring Steel than Beryllium Copper. Also the shock absorber design is modified by reducing the diameter of spring by 2mm and structural, modal analysis is done on the shock absorber. By reducing the diameter, the weight of the spring reduces. By comparing the results for both materials, the stress value is less for Spring Steel than Beryllium Copper. By comparing the results for present design and modified design, the stress and displacement values are less for modified design. So they concluded that as per our analysis using material spring steel for spring is best and also their modified design is safe. [4] C.Madan Mohan Reddy 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.[5] S. S. Gaikwad, To prevent the accident and to safeguard the occupants from accident, horn system is necessary to be analyzed in context of the maximum safe load of a helical compression spring. In the present work, helical compression spring is modeled and static analysis is carried out by using NASTRAN software. It is observed that the maximum stress is developed at the inner side of the spring coil. From the theoretical and the NASTRAN, the allowable design stress is found between the corresponding loads 3 to 6 N.It is seen that at 7N load, it crosses the yield stress (yield stress is 903 N/mm2). By considering the facitor of safety 1.5 to 2. It is obvious that the allowable design stress is 419 to 838 N/mm^2.So the corresponding loads are 3 to 6N.

3. MATERIAL USED FOR HELICAL SPRING:

The following materials used for this work:

- Carbon steel,
- Chromium vanadium,
- Inconel X-718

4. SOFTWARE (CATIA and ANSYS WORKBENCH)

CATIA is a multi-platform software suite for computer-aided design,computer-aided manufacturing,computer-aided engineering, PLM and 3D.With the use of CATIA software, suspension system has designed a helical spring with accurate dimensions which is taken from motor bike.The designed helical spring is imported to Ansys software for finding maximum shear stress and total deformation. Ansys is analysis software which develops finite element analysis software used to simulate engineering problems. Ansys software is analysed a maximum shear stress and Total deformation for three materials (Carbon steel, Chromium Vanadium and Inconel X-718). The analytical results conform to the simulation results from the ANSYS.

5. HELICAL SPRING DESIGN

The following are the factors are considered for design and explain in this section.

- Spring wire diameter (d) = 8 mm,
- Coil mean diameter (D) = 42 mm,
- Coil free height (h) = 200 mm,
- No. of active coils (n) =12,
- Pitch (P) =15 mm.

THEORITCAL CALCULATION :

W = load applied
D = Mean diameter
d = Spring wire diameter
G = Modulus of rigidity At Load = 850 N

At load = 1000N

Spring Index, (C) = D/d=42/8 = 5.25

Shear stress factor (K) = 1+1/2C

= 1+1/2*5.25

= 1.23

Maximum shear stress (τ) = K*8WD/πd^3

= 1.23*8*1000*42/π*8^3

T/J= τ/ (D/2) = GΘ/L

Θ= τ L/JG

J=polar moment of inertia of spring wire

$$J = (\pi/32)*d^4$$
$$= (\pi/32)*8^4$$
$$= 0.785\text{m}$$

Angular deflection , $(\Theta) = \tau L/JG$ (Where G= modulus of rigidity of the material)

$$\Theta = 256.93*200/(0.785*800000)$$
$$\Theta = 0.3598$$

Deflection of the spring $(\boldsymbol{\delta}) = \Theta*D/2$

$$(\boldsymbol{\delta}) = 0.3598*40/2$$
$$= 7.198 \text{ mm}$$
$$= 256.93\text{Mpa}$$

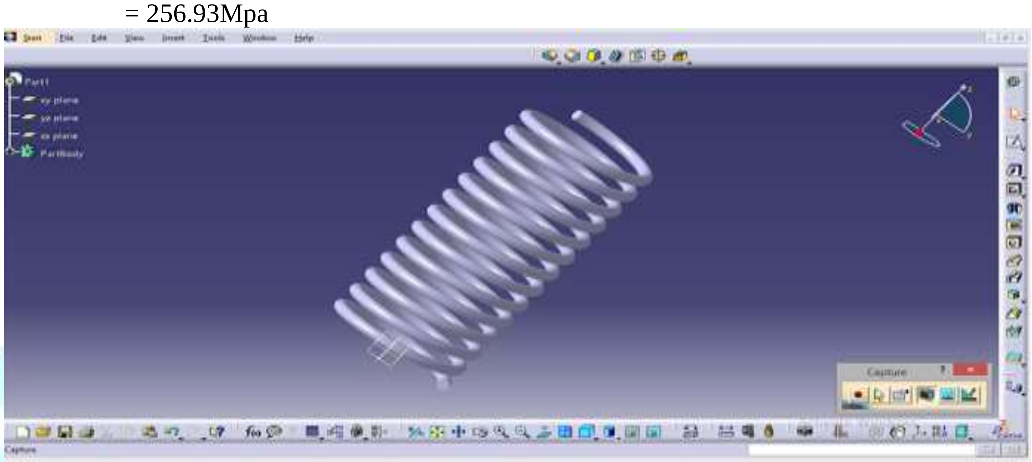

Fig 1. HELICAL SPRING DESIGN

As per the theoretical calculation spring has been designed and shown in figure 1.

6. RESULTS AND DISCUSSIONS

6.1.1 ANALYSIS OF CARBON STEEL: MAXIMUM SHEAR STRESS (AT 1000N)

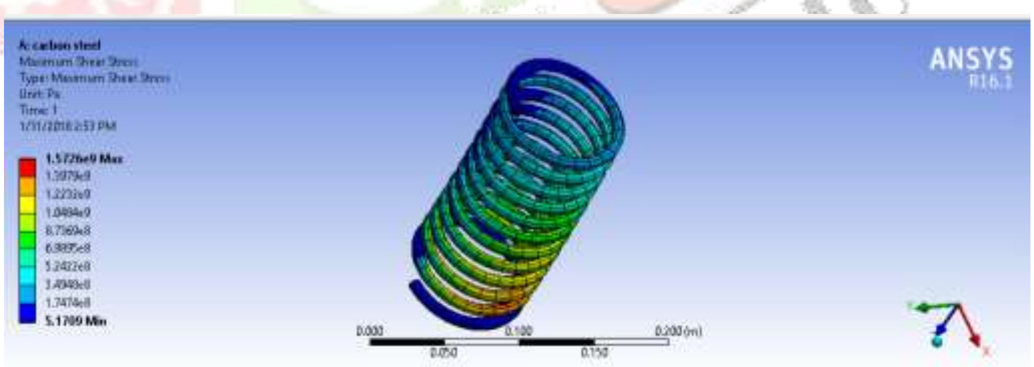

Fig 2. MAXIMUM SHEAR STRESS (AT 1000N)

6.1.2 TOTAL DEFORMATION (AT 1000N):

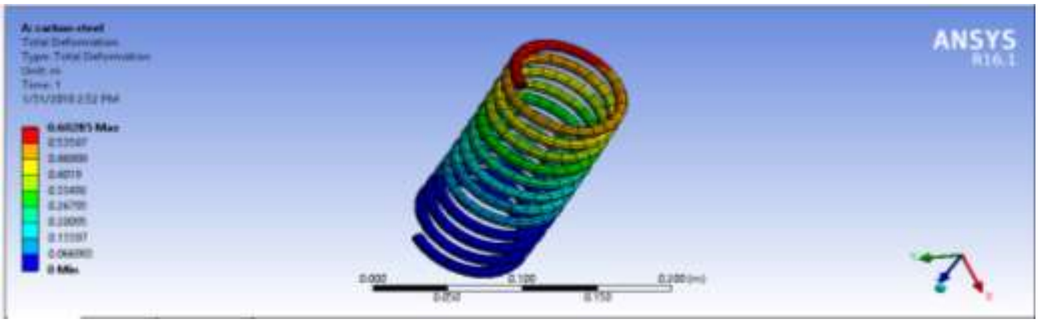

Fig 3.TOTAL DEFORMATION (AT 1000N)

For carbon steel at the load of **1000N**, the Maximum shear stress is **1.5726e9** and the Total deformation is **0.60285mm.**

6.2.1 ANALYSIS RESULT OF CHROME VANADIUM: MAXIMUM SHEAR STRESS (AT 1000N)

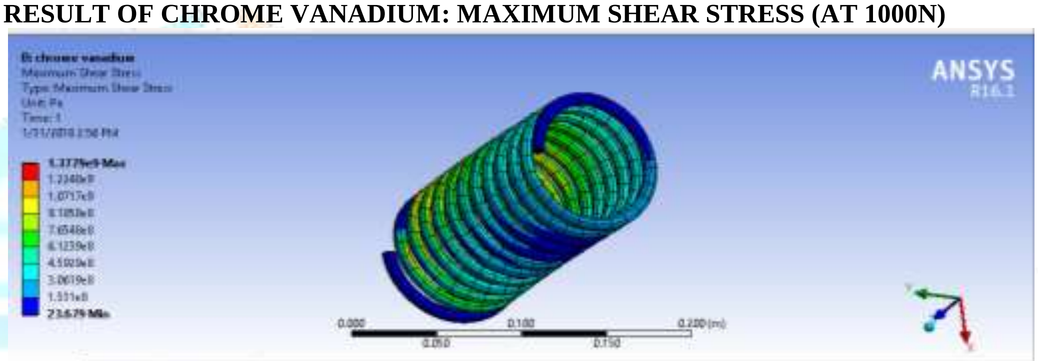

Fig 4. MAXIMUM SHEAR STRESS (AT 1000N

6.2.2 TOTAL DEFORMATION (AT 1000N)

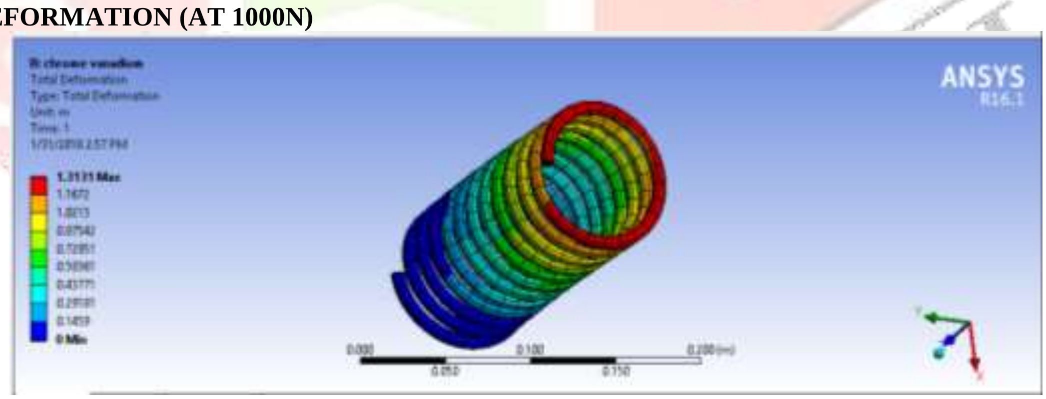

Fig 5.TOTAL DEFORMATION (AT 1000N)

For Chromium vanadium at the load of **1000N**,the Maximum shear stress is **1.3779e9** and the Total deformation is **1.3131mm**

6.3.1 ANALYSIS RESULT OF INCONEL X-718: MAXIMUM SHEAR STRESS (AT 1000N)

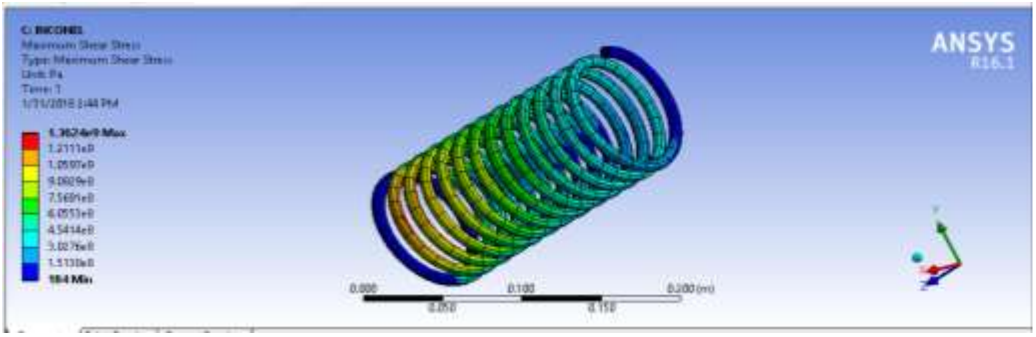

Fig 6. MAXIMUM SHEAR STRESS (AT 1000N)

6.3.2 TOTAL DEFORMATION (AT 1000N)

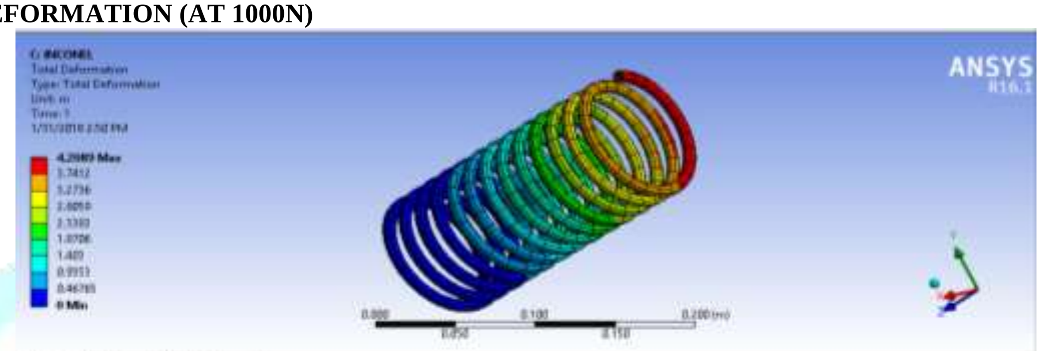

Fig 7.TOTAL DEFORMATION (AT 1000N)

For Inconel X-718 at the load of 1000N,the Maximum shear stress is **1.3624e9** and the Total deformation is **4.2089mm.**

7. CONCLUSION

In this study, the helical spring has been designed so that the stress acting on the spring is reduced. The proposed redesign will reduce the deformation and induced stress magnitude for the same applied loading conditions when compared with the existing design. This in turn increases the life of the spring, reduces the vibrations and noises to rider by reducing its failures. The analytical results conform to the simulation results from the ANSYS.

(i) STRESS

S.NO	MATERIAL	ANALYSIS OF HELICALSPRING (N/mm^2)
1	CARBON STEEL	1.5726e9
2	CHROMIUM VANADIUM	1.3779e9
3	INCONEL X-718	1.3624e9

(ii) TOTAL DEFORMATION

S.NO	MATERIAL	HELICAL SPRING (mm)
1	CARBON STEEL	0.60285
2	CHROMIUM VANADIUM	1.3131
3	INCONEL X-718	4.2089

Comparing all the three materials (Carbon steel, Chromium vanadium, and Inconel X-718) Carbon steel material has maximum shear stress and minimum deformation. So Carbon steel is best suitable material for manufacturing a helical spring which is proved by this work.

8.REFERENCES

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