MODELLING AND ANALYSIS OF A HELICAL SPRING FOR TWO WHEELER

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ABSTRACT:

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.

In this work the helical spring is modelled in CREO Software and the structural analysis is done using the Finite Element Analysis Software (ANSYS) and a C Programming code is written to calculate the Deflection, shear Stress and Free Length of the spring.

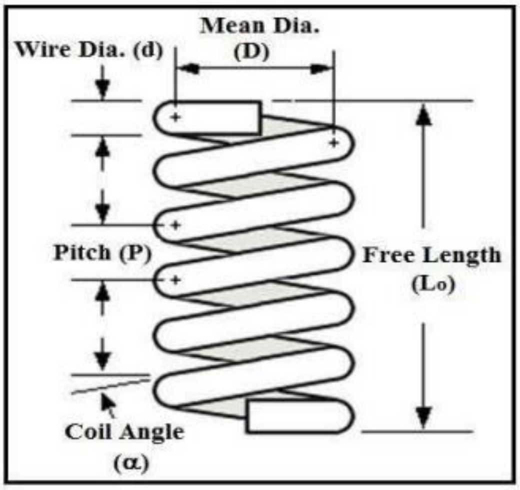
INTRODUCTION

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 different- different purpose; their basic types are given below as follows: Helical spring, Conical or volute spring, Disc or Belleville springs, 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 compared 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 this oscillation of the spring or else it will continuously oscillate.

NOMENCLATURE

Various mathematical equations have been developed to describe the properties of springs, based on such factors as wire composition and size, spring coil diameter, the number of coils, and the amount of expected external force. These equations have been incorporated into computer software to simplify the design process



C=Spring Index D/d

d = wire diameter (m)

D = Spring diameter (m)

Di = Spring inside diameter (m)

E = Young's Modulus (N/m2)

F = Axial Force (N)

G = Modulus of Rigidity (N/m2)

K = Wahl Factor = [(4C-1)/(4C+5)}] + (0,615/C)

L 0 = Free Length (m)

L_s = Solid Length (m)

n t = Total number of coils

n = Number of active coils

p = pitch (m)

y = distance from neutral axis to outer fibre of wire (m)

τ = shear stress (N/m2)

τ_{max} = Max shear stress (N/m2)

θ = Deflection (radians)

Materials and Methods:

S. No	Material	Density (Kg/m^3)	Young's Modulus MPa	Poison's Raito	Shear Stress MPa	Tensile Strength MPa
1	CHROME VANADIUM	7850	2.07*10^5	0.3	0.793*10^5	1310-2069
2	CARBON STEEL	7750	210000	0.27-0.3	0.81*10^5	525
3	PHOSPHOR BRONZE	8860	1.03*10^5	0.19	431*10^5	724-1000

DIMENSIONS OF THE SPRING:

Coil diameter = 58mm

Wire diameter =12mm

Pitch of the coil=30mm

Length of the spring=210mm

Base plate width = 70mm

Base plate thickness =5mm

Total Number of coils (n)= 12

Number of active coils (n1) = 10

We consider static load condition, weight of the bike 148kg and two-person weight 60kg.

Total load (W)=148+2x60 =268kg =2630N

Helix angle α =Tan-1(π*d/p) =Tan-1(π*12/30) =51.48.

MODEL CALUCULATION:

1. CHROME VANADIUM

a. Deflection

$\Delta = (8WD^3n)/(Gd^4) = (8x2630x58^3x10)/(0.75x10^5x12^4)$

$= 26.39mm$

b. Free length = Δ+ n1d+0.15Δ =26.39+12x12+0.15x26.39

= 175.40mm

c. Stress = $(8WD)/(\Pi d^3)$ = $(8x2630x58)/(\Pi x12^3)$

=224.79 N/mm^2

d. shear stress =K x $(8xWxD)/(\Pi xd^3)$

K = (4C-1/4C-4) +(0.615/C)

C= D/d= 58/12 =4.83

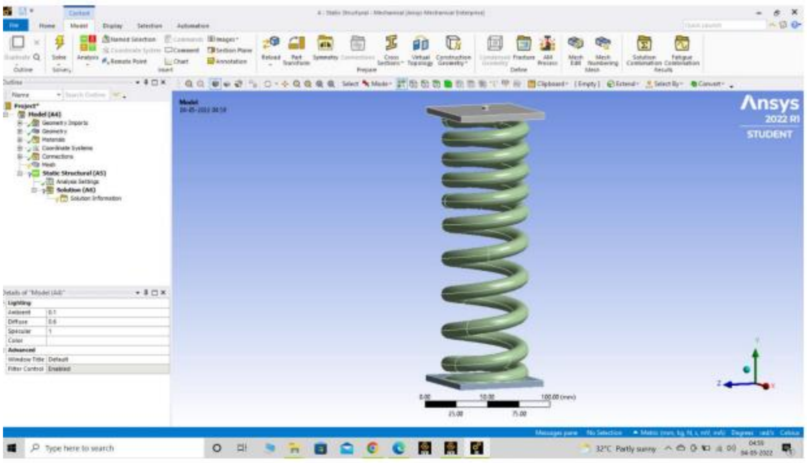
K = ((4x 4.83-1)/ (4x 4.83-4)) + (0.615/4.83) = 1.32

Shear Stress = 1.32 x $((8x2630x58)/ (\Pi x12^3))$

=297.17 N/mm2.

MODELING OF PARTS IN CREO:

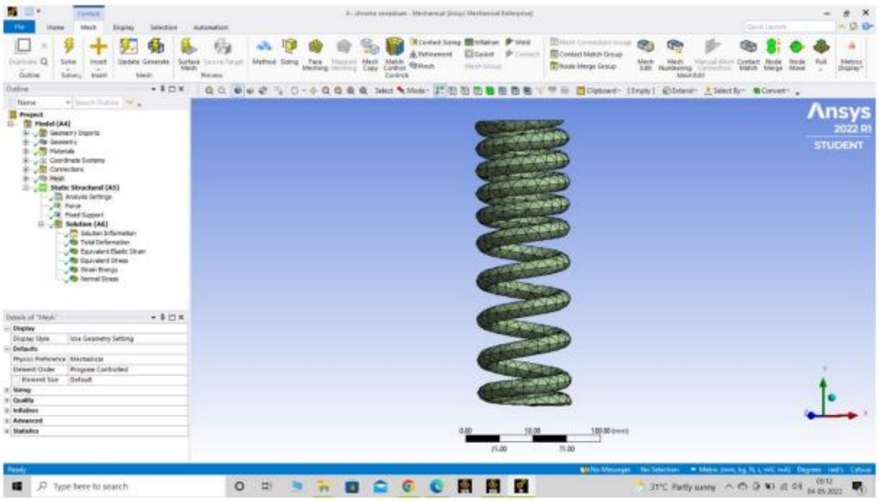
Helical spring of a two wheeler is modelled in CREO by considering the following parameters such as Free length of the spring, pitch and coil diameter using the helical sweep command.



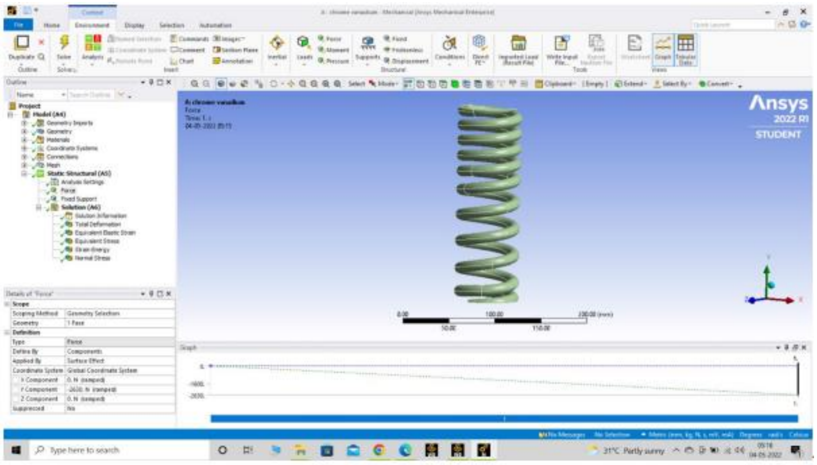
ANALYSIS IN ANSYS

Static Structural analysis is performed for the modelled spring to find the deflection and maximum shear stress by varying the materials. The modelled spring saved in the igs format is imported into the structural analysis.

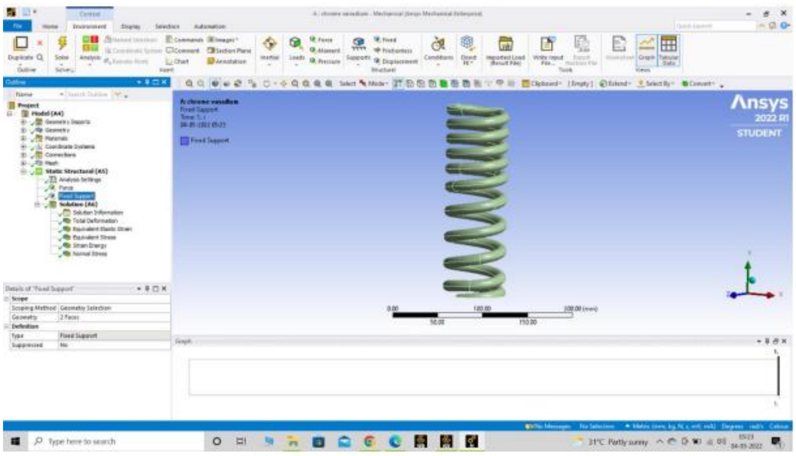
Meshing of spring



Application of Loads

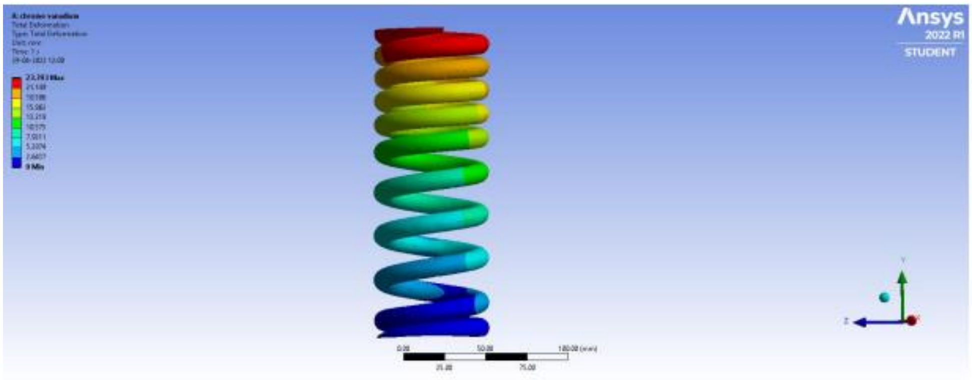


Applying Fixed Supports:

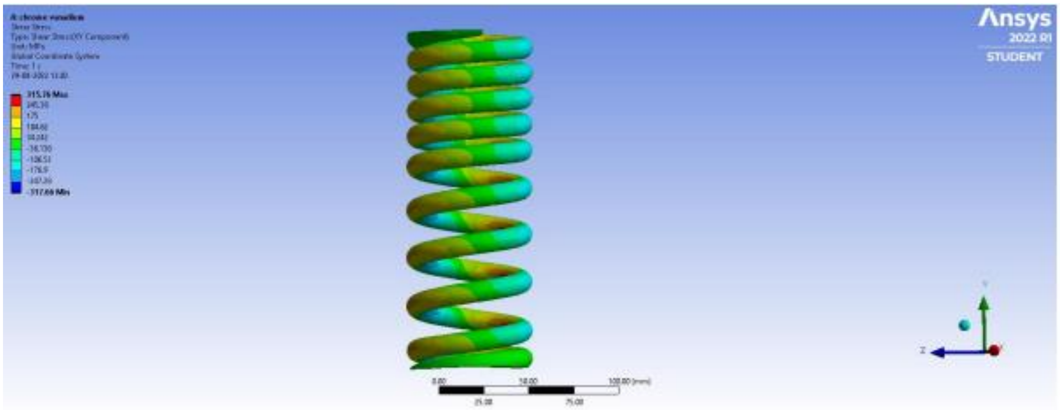


Results:

Total Deflection and Maximum Shear Stress for the Chrome Vanadium Material

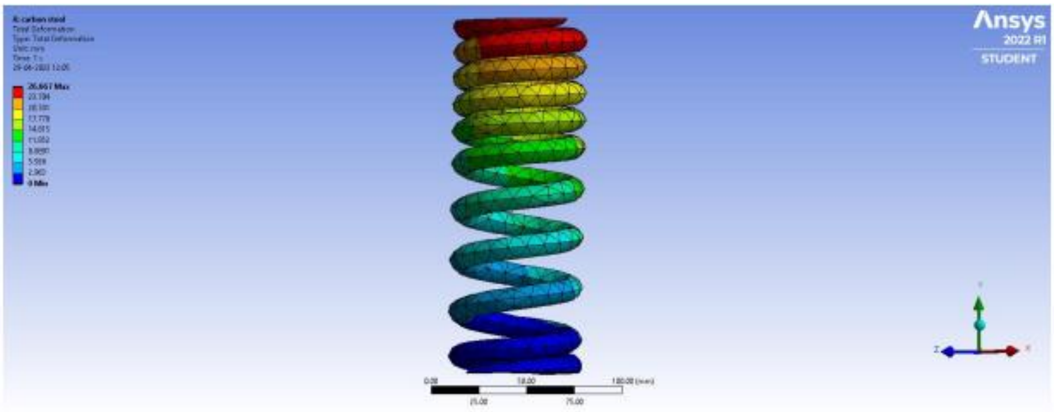


Deflection

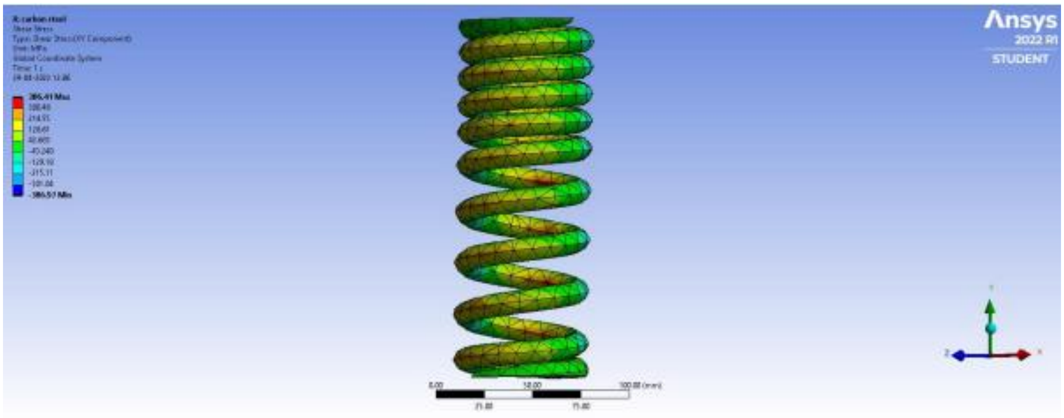


Maximum Shear Stress

Total Deflection and Maximum Shear Stress for the Carbon Steel Material

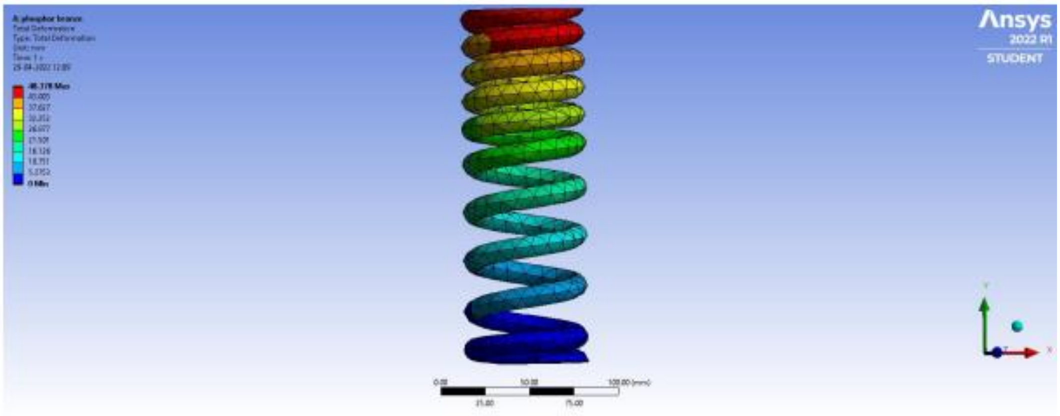


Deflection

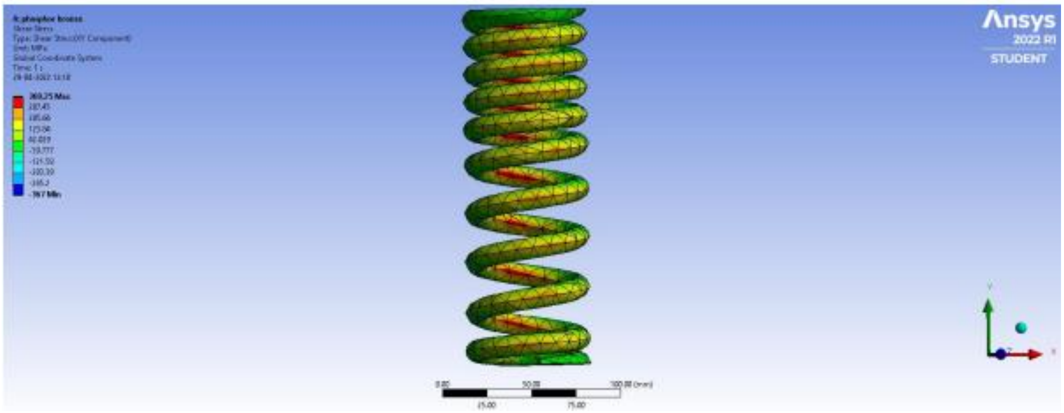


Maximum Shear Stress

Total Deflection and Maximum Shear Stress for the phosphor bronze Material



Deflection



Maximum Shear Stress

Results and Discussion:

The maximum deflection and shear stress are calculated for the modelled spring manually as well as by using FEA Software, the results are tabulated. Comparison is made for both the theoretical and FEA results and it is found that the theoretical and FEA results are almost similar.

	Chrome vanadium		Carbon steel		Phosphor bronze	
	Theoretical	Ansys	Theoretical	Ansys	Theoretical	Ansys
Deflection	26.39mm	27.07mm	24.44mm	26.65mm	48.28mm	48.37mm
Stress	224.79 N/mm^2	252.7 N/mm^2	224.79 N/mm^2	337.83 N/mm^2	224.79 N/mm^2	318.4 N/mm^2
Shear stress	297.17 N/mm^2	315.76 N/mm^2	297.17 N/mm^2	386.4 N/mm^2	297.17 N/mm^2	369.25 N/mm^2

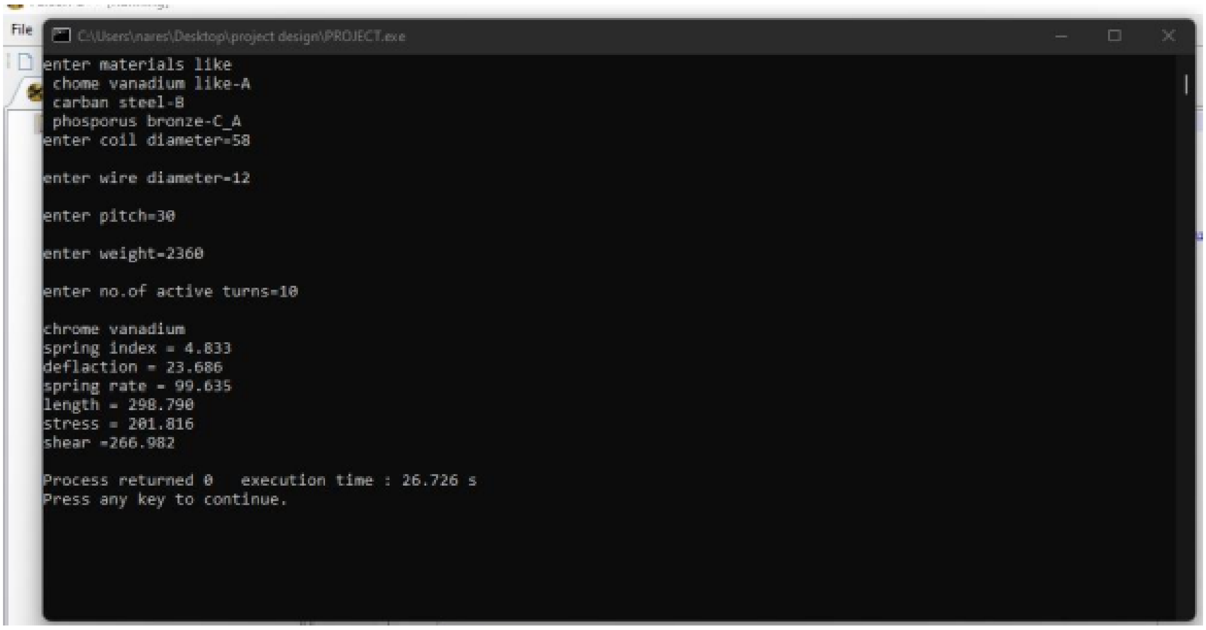
C PROGRAM

A simple code is generated to calculate the total deflection and maximum shear stress using C Programing by giving the input parameters as load, material, no of turns and pitch.

```
#include <stdio.h>
int main () {
 float D, d,p,w, n, n1;
 char a;
 printf ("enter materials like\N chome vanadium like-A\ncast steel-B\n phosporus bronze-C_");
 scanf ("%c",&a);
 printf ("enter dia=");
 scanf("%f",&D);
 printf ("\nenter coil dia=");
 scanf ("%f",&d);
 printf("\nenter pitch");
 scanf ("%f",&p);
 printf("\nenter weight");
 scanf ("%f",&w);
 printf ("\nenter no.of active turns");
 scanf("%f",&n);
 printf ("\nenter no.of turns");
 scanf ("%f",&n1);
 switch (a)
 {
 case 'A':
 {
 float G=75000;
 float c=D/d;
float def=((8*w*D*D*D*n)/(G*d*d*d*d));
 float spr=w/def;
 float len=(n1+def*d+(0.15*def));
 float str=((8*w*D)/(3.14*d*d*d));
 float sta=0.15*w*def;
```

```
float k=(((4*c-1)/(4*c-4))+(0.615/c));
float sh=k*str;
printf ("spring index = %0.3f \n",c);
printf ("deflaction = %0.3f \n",def);
printf ("spring rate = %0.3f \n",spr);
printf ("length = %0.3f \n",len);
printf ("stress = %0.3f \n",str);
printf ("strain =%0.3f \n",sta);
printf ("shear =%0.3f \n",sh);
printf("spring rate =%0.3f \n",k);
break ;
}
case 'B':
{
float G=81000;
float c=D/d;
float def=((8*w*D*D*D*n)/(G*d*d*d*d));
float spr=w/def;
float len=(n1+def*d+(0.15*def));
float str=((8*w*D)/(3.14*d*d*d));
float sta=0.15*w*def;
float k=(((4*c-1)/(4*c-4))+(0.615/c));
float sh=k*str;
printf ("spring index = %0.3f \n",c);
printf ("deflaction = %0.3f \n",def);
printf ("spring rate = %0.3f \n",spr);
printf ("length = %0.3f \n",len);
printf ("stress = %0.3f \n",str);
printf ("strain =%0.3f \n",sta);
printf ("shear =%0.3f \n",sh);
printf("spring rate =%0.3f \n",k);
break ;
}
case 'C':
{
float G=41000;
float c=D/d;
float def=((8*w*D*D*D*n)/(G*d*d*d*d));
float spr=w/def;
float len=(n1+def*d+(0.15*def));
float str=((8*w*D)/(3.14*d*d*d));
float sta=0.15*w*def;
float k=(((4*c-1)/(4*c-4))+(0.615/c));
float sh=k*str;
printf ("spring index = %0.3f \n",c);
printf ("deflaction = %0.3f \n",def);
printf ("spring rate = %0.3f \n",spr);
printf ("length = %0.3f \n",len);
printf ("stress = %0.3f \n",str);
```

```
 printf ("strain =%0.3f \n",sta);
 printf ("shear =%0.3f \n",sh);
 printf("spring rate =%0.3f \n",k);
 break;
 }
 default :
{
printf("material not found ");
}
49
 }
 return 0;
}
```



CONCLUSION

This work is based on design and Analysis of helical compression spring used in suspension system of two-wheeler vehicle, in this work we have done the Model of the helical spring in CREO and analysis of the spring is done in Finite Element Analysis Software (ANSYS) by varying the materials for the spring as Chrome Vanadium, Carbon Steel and Prosper Bronze to find the strength of the spring. In the analysis it is found that Carbon steel has the greatest strength than the other two materials. A sample program has been done to find the theoretical calculation of the helical spring by using the C-Program language.

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