Problems of Practices
Of
Mechanics of Solids
16- Springs

Prepared By

Brij Bhooshan
Asst. Professor
B. S. A. College of Engg. And Technology
Mathura, Uttar Pradesh, (India)

Supported By:
Purvi Bhooshan

Please welcome for any correction or misprint in the entire manuscript and your valuable suggestions kindly mail us brijrbedu@gmail.com.

1. In leaf springs for automobiles a number of thin strips are used. Why do not we use a single thick strip?

2. A truck weighing 2500 kgf and moving at 2.5 m/sec has to be brought to rest by a buffer. Find how many springs each of 25 coils will be required to store energy of motion during compression of 20 cm. The spring is made of 25 mm diameter steel rod coiled to a mean diameter of 20 cm. ($N = 1 \times 10^6$ kgf/cm^2).

3. A close coiled helical spring is of 80 mm mean coil diameter. The spring extends by 37.75 mm when loaded axially by a weight of 500 N There is an angular rotation of 45° when this spring is subjected to an axial couple of magnitude 20.0 Nm. Determine the Poisson's ratio for the material of the spring.

4. A helical spring *B* is placed inside the coils of a second helical spring *A*, having the same number of coils and free axial length and of same material. The two springs are compressed by an axial load of 210 N which is shared between them. The mean coil diameters of *A* and *B* are 90 mm and 60 mm and the wire diameters are 12 mm and 7 mm respectively. Calculate the load shared by individual springs and the maximum stress in each spring.

5. The spring load against which a valve is opened is provided by an inner helical spring arranged within and concentric with an outer helical spring. The free

length of inner spring is 6mm longer than the outer. The outer spring has 12 coils of mean diameter 25 mm, wire diameter 3 mm, and initial compression5 mm when the valve is closed. Find the stiffness of the outer spring if the greatest force required to open the valve by 10 mm is 150 N. If the radial clearance between the springs is 1.6 mm, find the Wire diameter of the inner spring if it has 10 coils. For both springs, G = 82,000 N/mm^2.

6. Two springs, outside diameters 45 mm and 65 mm respectively are made with a steel wire of diameter 5 mm and are placed coaxially. Both the springs have 25 active coils but the outer spring is 27 mm longer than the inner one.
Find the compression of the inner spring when a load of 15 Kgf is placed on a plate supported initially by the outer spring. G for spring wire = 8×10^5 Kgf/cm^2.

7. A coil spring of stiffness 'k' is cut to two halves and these two springs are assembled in parallel to support a heavy machine. What is the combined stiffness provided by these two springs in the modified arrangement?

8. A close-coiled helical spring has coil diameter D, wire diameter d and number of turns n. The spring material has a shearing modulus G. Derive an expression for the stiffness K of the spring.

9. A Close-coiled helical spring has coil diameter to wire diameter ratio of 6. The spring deflects 3 cm under an axial load of 500 N and the maximum shear stress is not to exceed 300 MPa. Find the diameter and the length of the spring wire required. Shearing modulus of wire material = 80 G.

10. In a compound helical spring the inner spring is arranged within and concentric with the outer one but is 15 mm shorter. The outer spring has 12 coils of mean diameter 30 mm and the diameter of wire is 3 mm. Find the stiffness of the inner spring is an axial load of 120 N causes the outer one to compress 25 mm. If the vertical clearance between the two springs is to be 2 mm, find the diameter of the wire of the inner spring when it has 8 coils. Take G = 80 GPa for both springs.

11. A close coiled helical spring made of wire diameter d has mean coil radius R, number of turns n and modulus of rigidity G. The spring is subjected to an axial compression W.

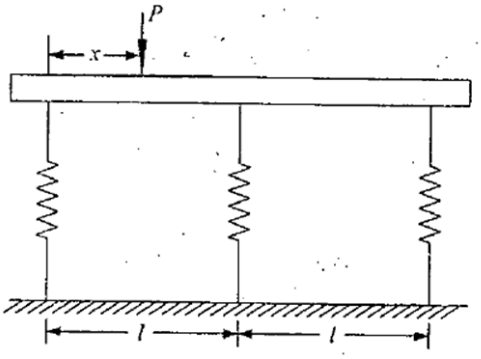
(i) Write the expression for the stiffness of the spring.

(ii) What is the magnitude of the maximum shear stress induced in the spring wire neglecting the curvature effect?

12. A hollow steel rod 200 mm long is to be used as torsional spring. The ratio of inside to outside diameters is 1 : 2. The required stiffness of the spring is 100 N.m/degree. Determine the outside diameter of the rod. Value of G is 8×10^4 N/mm^2.

13. A close coiled spring has coil diameter to wire diameter ratio of 6. The spring deflects 30 mm under a load of 500 N and the maximum shear stress is not to exceed 350 MPa. Find the diameter and length of wire required. Modulus of rigidity of wire material = 80 GPa.

14. A stiff bar of negligible weight transfers a load P to a combination of three helical springs arranged in parallel as shown in the above figure. The springs are made up of the same material and out of rods of equal diameters. They are same free length before loading. The number of coils in those three springs are 10, 12 and 15 respectively, while the mean coil diameters are in ratio of 1 : 1.2 : 1.4 respectively. Find the distance 'x' as shown in figure, such that the stiff bar remains horizontal after the application of load P.



15. A close coiled helical spring is subjected to axial load. Shear stress is developed in spring wire. Why the resultant shear stress at inner coil radius is more than the resultant shear stress at outer coil radius?

16. Two close coiled helical springs *A* and *B* made of the same wire show axial compressions of 8 mm and 3 mm, respectively, when they are subjected to the same axial load. The spring *A* has 9 coils of mean diameter of 80 mm, while the spring *B* has 8 coils. Determine the mean coil diameter of the spring *B*.

17. A hoisting drum, carrying a steel wire rope, is mounted at the end of a cantilever beam as shown in Fig. 1. Determine the equivalent spring constant of the system when suspended length of the wire is *l*. Assume that the net cross-sectional diameter of the wire is *d* and the Young's modulus of the beam and wire rope is *E*.

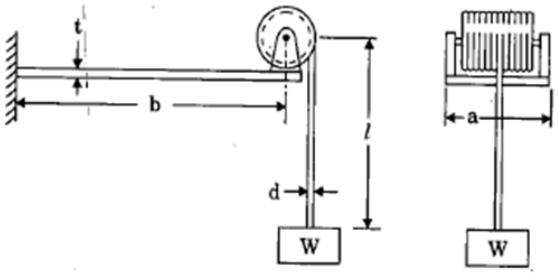


Fig. 1

18. A close coiled helical spring made of 8 mm diameter wire has 16 coils. Each coil is 80 mm mean diameter. If the maximum allowable stress in the spring is 150 MPa, determine (i) the maximum allowable load on the spring, (ii) the elongation of the spring and (iii) stiffness of the spring. Take G = Shearing modulus = 82 GPa.

19. Determine the load required to produce an extension of 8 mm on an open-coiled helical spring of 10 coils of mean diameter 76 mm, with helix angle of 20° and manufactured from wire of 6 mm diameter. What will then be the bending and shear stresses in the surface of the wire? For the material of the spring, $E = 210 \times 10^9$ N/m^2 and $G = 70 \times 10^9$ N/m^2. What would be the angular twist at the free end of the above spring when subjected to an axial torque of 1.5 N-m?