SHEET (5)
SPRING

1. Derive an expression for the resultant spring rate k when three springs with spring rates k_1, k_2 and k_3 are connected: (a) in series, (b) in parallel.

2. A compression spring is to be made of a 3-mm diameter wire with 10 active coils and a 25-mm mean diameter of helix. Commercial limits for the wire diameter are 2.95 mm and 3.05 mm. The helix mean diameter may vary from 24.5 mm to 25.5 mm. The number of active coils may vary from 9.75 to 10.25. The modulus of rigidity may vary from 78 GPa to 82 GPa. Find the spring rate when:
   (a) all variables tend to give the weakest spring.
   (b) all variables tend to give stiffest spring.

3. A helical spring is capable of exerting a force of 665 N after being released 10 mm from its most highly compressed position. The wire diameter is 6 mm. The spring index is 6. The loading is static and the maximum stress is 410 MPa. Find the required number of active coils. $G_1 = 80$

4. Two concentric helical compression springs are to carry a load of 450 kN. The outer spring has 200-mm outside diameter, 40-mm wire diameter, total number of coils of 5.5, and 200-mm free length. The inner spring has 115 mm outside diameter, 25-mm wire diameter, total number of coils of 7, and 190-mm free length. The length of both springs is 170 mm when carrying the rated load.
   (a) Determine the load carried by each spring.
   (b) Determine the stresses in each spring.

5. At the bottom of an elevator shaft, a group of 8 identical springs are set in parallel to absorb the shock of the elevator in case of failure. The elevator weighs 30 kN. Assuming that the elevator has a free fall of 1.2 m from rest, determine the maximum stress in each spring. The springs are made of 25-mm diameter rod, have an index of 6, and have 15 active turns. $G_1 = 80$

6. Design a round-wire helical spring to work in a 55-mm diameter hole. During action, the spring is subjected to a minimum load of 750 N and a maximum load of 2500 N. The spring rate is to be approximately 30 kN/m. It is to have squared and ground ends, and a life of 200000 load applications.

7. The springs specified below are available in stock :
Material : Chrome vanadium, unpeened.
Wire diameter : 10 mm.
Outside coil diameter : 60 mm.
Number of effective coils : 13
It is desired to use these springs in a service having the following conditions:
Loading : Alternating with a maximum value four times the minimum value.
Number of load applications : 10^7 .
Survival rate : 95%
Determine the maximum permissible load . The factor of safety based on endurance or yield should not be less than 1.5 .

8. A torsion helical spring is subjected to a twisting moment T. The spring has a wire diameter of 4 mm, an index of 4, and 2.5 active coils. The maximum bending stress in the wire is not to exceed 1050 MPa. Find the spring rate and the twisting moment T.

9. A compression spring will be used in a service where the maximum value of the varying load is three times the minimum value. The spring specified below is available in stock, and a check of the capacity under these load conditions must be made to determine whether it is suitable. The spring specifications are:

- Material: oil-tempered carbon steel, S_{ys} = 700 MPa
- Mean coil diameter = 50 mm
- Wire size = 10 mm
- Number of active coils = 13
- Free length = 175 mm

A factor of safety of 1.3 may be used. What is the peak value of the load to be transmitted?

10. The free end of a horizontal constant- strength steel flat cantilever leaf spring is directly over and in contact with a vertical helical spring as shown in Fig. 5.1.
The width of the leaf at its fixed end is 600 mm, and its thickness is 12 mm. The helical spring has 10 active coils of 12.5-mm diameter wire and has an outside diameter of 100 mm. Both springs are made of chrome- vanadium steel.

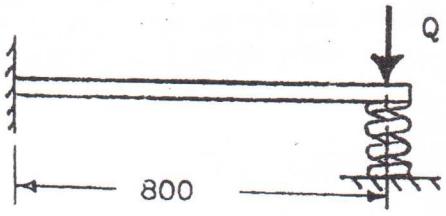

Fig. 5.1

(a) What force Q, if applied to the end of the flat spring is required to cause a deflection of 40 mm
(b) What is the maximum bending stress in the flat spring?
(c) How much energy is absorbed by the helical spring?