Design of Closely Coiled Helical Spring

Ex. Design the closely soiled helical concentric springs for the given conditions:

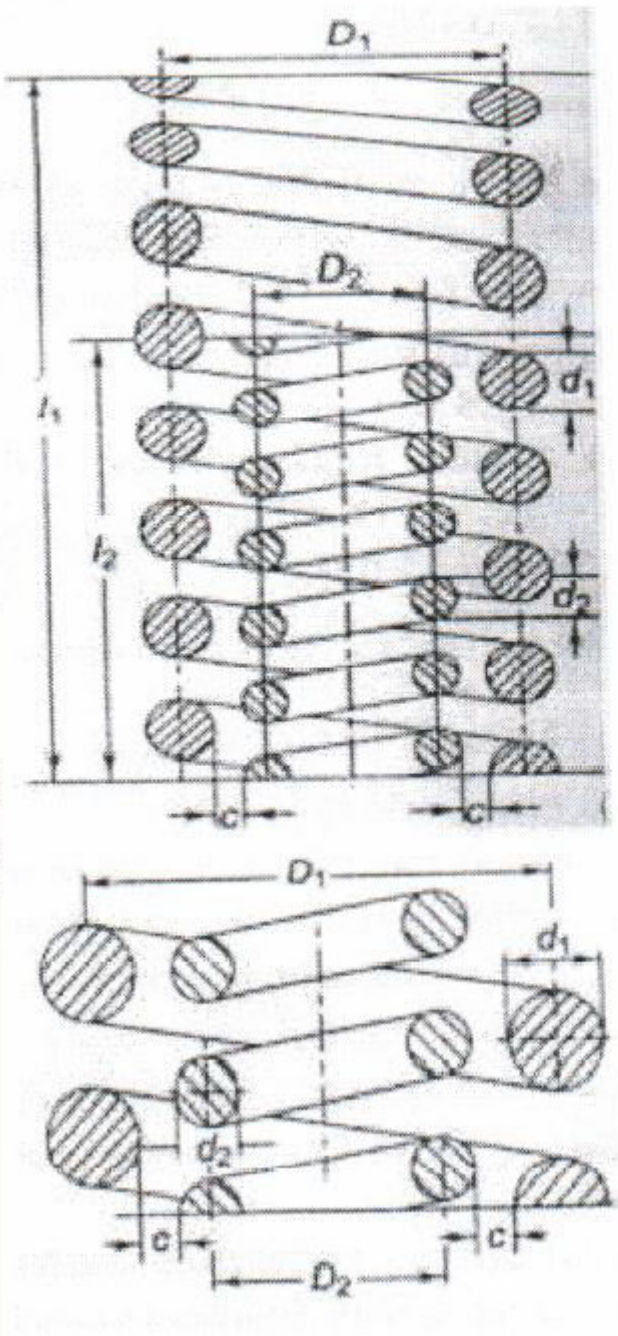

Fig Reference Spring Diagram

Load P = 6 kN; Corresponding spring deflection δ = 50 mm; Maximum permissible shear stress τ = 800 MPa; Spring index C = 6; Shear modulus of spring material G = 82 GPa

Assumptions:

a) The springs are made of same material.

b) Maximum induced shear stresses are equal in the springs.

c) Both thc springs have equal free length i.e. $l_1 = l_2$

d) In principle, deflections are also equal in both springs.

e) Helix angle = $10^0 \pm 2^0$.

Design Steps:

Step I: *Estimate the axial load on each spring*

- P = P_i (on inner spring) + P_o (on outer spring)
- Obtain another relationship between P_i and P_o by using the assumed conditions.
- Induced shear stresses in closely coiled helical spring is given by

$$\tau = K_w\left(\frac{8PD}{\pi d^3}\right),$$ where K_W – Wahl's stress factor; P – axial load; D – mean coil diameter; d – wire diameter.

- Axial deflection of the closely coiled helical spring is given by

$$\delta = \frac{8PD^3N_a}{Gd^4},$$ where N_a – number of active coils

Step II: Find out spring wires' and mean coil's diameters

- Use the above given formulas to obtain inner wire diameter d_i and outer wire diameter d_o, inner coil diameter D_i, and outer coil diameter D_o.
- Spring index C = D/d ; Obtain the relationship between d_i and d_o; consider the diametral clearance (2c) between the coils is equal to the difference between the wire diameters.

Step III: Obtain the solid length and free length of the springs

- Solid length = d. N_t, where N_t – total number of coils.
- Total number of coils may be obtained from the following chart: (Use any one type)

Type of Spring ends	Number of active coils N_a
Plain and ground ends	$N_t - 1$
Square and ground ends	$N_t - 2$

- Assuming the spring is fully compressed: Free length = Solid length + δ
- Axial pitch = **Free length**$/(N_t - 1)$

Step IV: Draw the free length configuration of the springs.

Ex. Demonstrate the following welded joints with schematic sketches and corresponding symbols:

a) Spot Weld
b) Double-U Butt Joint
c) Double-V Butt Joint
d) Double-Bevel Butt Joint
e) Fillet Weld
f) Edge Weld