GLASGOW CALEDONIAN UNIVERSITY

School of Engineering & Built Environment

ENGINEERING DESIGN & ANALYSIS 2 (M2H721926)

Tutorial – Design of Springs

Note: Unless otherwise stated, take the Modulus of Rigidity for spring material to be 80 GN/m^2 and the Wahl Factor to be (4C-1/4C-4)+(0.615/C).

Q.1 Determine the required number of coils and permissible deflection in a helical spring made of 1.6mm diameter steel wire, assuming a spring index of 6 and an allowable stress of 345 MN/m^2 in shear. The spring rate is to be 1800 N/m.

(Ans: n=42; $\delta = 25.7mm$ **)**

Q.2 Design a close-coiled helical spring of plain ground ends with a spring rate of 20 N/mm using a wire diameter of 7.5 mm such that when subjected to a maximum load of 250 N, the shearing stress should not exceed 80MN/m^2. Take the Wahl factor as C+0.2/C-l.

(Ans: D=42.1mm; n=21.2; $\delta = 12.5mm$**;** $\mathbf{L_s}$**=159mm)**

Q.3 When a coil spring with a spring rate of 18 kN/m is compressed 30 mm, the coils are closed. The allowable shear stress is 345 MN/m^2, the spring index is 8 and the ends are squared and ground, with G= 83 GN/m^2. Calculate the required wire diameter, the spring mean diameter, the number of coils and the closed length of the spring.

(Ans: d=6.14 mm; D=49.12mm; n=7.09; $\mathbf{L_s}$**=57.3 mm)**

Q.4 Design a coil spring to have a mean diameter of 125 mm and a spring rate of 72 kN/m. The total axial load is 8 kN, the allowable shear stress is 275 MN/m^2 and the spring is to have squared and ground ends.

(Ans: d=22.7mm; n=20.9; δ **= 111.1mm;** $\mathbf{L_s}$**=474.4mm)**

Q.5 A close-coiled helical spring having a wire diameter of 6.5 mm, requires to have a spring rate of 18 kN/m and to carry a maximum static load of 175 N. The maximum shear stress is limited to 85 MN/m^2 for the spring material.

Determine the mean coil diameter and the number of coils in each of the following cases:

i) ignoring the modification factor; **(52.4 mm; 7 coils)**

ii) using a modification factor of the form: $k = \dfrac{C + 0.2}{C - 1}$ **(43 mm; 13 coils)**

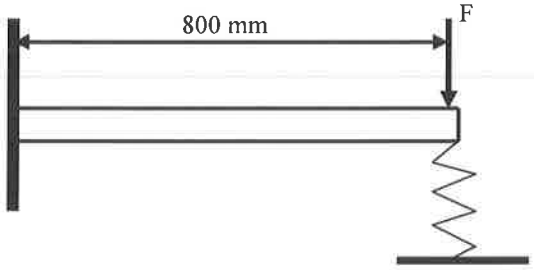
Q.6 Design a square-ended close-coiled helical compression spring which is to fit over a 25 mm rod and exert a force of 100 N when it is 85 mm in length. The spring wire is available in diameters of 3.25 mm, and 3.50 mm, 4.00 mm and 4.50 mm, with the wire material having a working shear stress limit of 180 MN/m^2 and a modulus of rigidity of 81 GN/m^2. Take the Wahl factor as C+0.2/C-1.

Q.7 The free end of a steel 800 mm long cantilever spring beam is directly in contact with a helical compression spring as shown in the figure. The width of the beam cross-section is 600 mm and its thickness is 12 mm. The spring has 10 active coils of 12.5 mm wire diameter and has an outside diameter of 100 mm. Taking E = 200 GN/m^2 and G = 83 GN/m^2, determine:

i) the force, if applied gradually to the end of the cantilever, required to cause a deflection of 40 mm;

ii) the bending stress in the beam at a section 400 mm from the fixed end;

iii) the energy absorbed by the spring.



Note: The max. deflection at the free end of a cantilever is found from:

$$y = \frac{FL^3}{3EI}$$

(Ans: F=5562N; σ=112.5N/mm^2; E$_s$=30.2J)