



Quiz - 1

Name:

key

Student #:

A helical compression spring is made of #18 music wire and has 3.5 mm pitch. The total number of turns is 15 and the ends are squared and ground.

a) Find the free length and solid length of the spring.

Table A-28, MW #18 ~ $d = 0.041 \text{ in} = 1.04 \text{ mm}$

$L_0 = 47.58 \text{ mm}$

Table 10-1, $N_a = 15 - 2 = 13 \text{ turns}$, $L_s = d N_t = 1.04 * 15 = 15.62 \text{ mm}$

$L_s = 15.62 \text{ mm}$

$L_0 = P N_a + 2d = 3.5 * 13 + 2 * 1.04 = 47.58 \text{ mm}$

b) If the spring rate is $k = 1 \text{ N/mm}$, find the mean coil diameter.

$k = \frac{d^4 G}{8 D^3 N_a} \sim \text{Table 10-5} \sim G = 81.7 \text{ GPa}$

$\Rightarrow D = \sqrt[3]{\frac{(1.04)^4 (81700)}{8 (1) (13)}} = 9.72 \text{ mm}$

$D = 9.72 \text{ mm}$

c) Find the force required to compress the spring to its solid length.

$y_{\max} = L_0 - L_s = 47.58 - 15.62 = 31.96 \text{ mm}$

$F = k y = 1 * 31.96 = 31.96 \text{ N}$

$F_s = 31.96 \text{ N}$

d) Find the maximum shear stress in the spring when it is compressed to its solid length.

$C = D/d = 9.72/1.04 = 9.35$, $K_B = \frac{4C+2}{4C-3} = 1.145$

$\tau_{\max} = K_B \frac{8 F D}{\pi d^3} = 1.145 \frac{8 (31.96) (9.72)}{\pi (1.04)^3} = 805.2 \text{ MPa}$

$\tau_{\max} = 805.2 \text{ MPa}$

e) Find the factor of safety for the spring when it is compressed to its solid length.

Table 10-4 ~ $A = 2211 \text{ MPa}$ & $m = 0.145 \Rightarrow S_{ut} = 2211 / (1.04)^{0.145} = 2198 \text{ MPa}$

Table 10-6 ~ $S_{ys} = 0.45 S_{ut} = 0.45 * 2198 = 989.2 \text{ MPa}$

$n_s = S_{ys} / \tau_{\max} = 989.2 / 805.2 = 1.23$

$n_s = 1.23$

f) Is buckling possible?

$(L_0)_{cr} = 5.26 D = 51.2 \text{ mm}$

$47.58 < 51.2 \Rightarrow \text{No buckling}$

No