I have contributed to the solution of this workshop problem:

_____ SOLUTION

_____ _____

WORKSHOP 15 – COMPRESSION SPRING $G = 80.8\,GPa$ Table C-1

A helical compression spring is wound from 3.5 mm dia. A228 music wire (set removed) and has an OD of 22 mm. The spring has plain-ground ends.

a) In order to achieve a spring rate of 25 N/mm, specify the total number of coils in the spring

$$C = \frac{OD - d}{d} = \frac{22 - 3.5}{3.5} = 5.29$$

$$N_a\Big|_{est} = \frac{d\,G\,(1000)}{8C^3k} = \frac{3.5(80.8)(1000}{8(5.29)^3 25} = \boxed{9.57}$$

b) Round to the nearest 1/4 turn

$$\boxed{N_a = 9.5} \qquad N_t = N_a + 1 = \boxed{10.5}$$

c) Calculate the actual spring rate

$$k_{actual} = \frac{d\,G\,(1000)}{8C^3 N_a} = \boxed{25.2\ N/mm}$$

d) If a force of 500 N is applied, what is the deflection in the spring?

$$y = \frac{F}{k_{actual}} = \frac{500}{25.2} = \boxed{19.8mm}$$

e) What is the shear stress? Use $K_s = 1 + \frac{.5}{C} = 1.09$

$$\tau = \frac{8K_s FC}{\pi d^2} = \frac{8(1.09)(500)5.29}{\pi (3.5)^2} = \boxed{601\ MPa}$$

f) What is the factor of safety against yielding (use $S_{ys} = 0.65\,S_{ut}$)?

Table 10-13
$A = 2153.5\,MPa$
$b = -.1625$

$$S_{ut} = \frac{A}{d^m} = \frac{2153.5}{(3.5)^{-.1625}} = 1844\ MPa$$

$$S_{ys} = .65\,S_{ut} = 1142\ MPa$$

$$N = \frac{S_{ys}}{\tau} = \frac{1142}{601} = \boxed{1.9}$$