

$$m=0.163, A=186 \text{ kpsi}$$

$$S_{ut} = \frac{186}{0.105^{0.163}} = 269 \text{ kpsi}$$

$$S_{sy} = 0.75 \times 0.577 \times 269 = 116.4 \text{ kpsi}$$

$$D = 1.225 - 1.05 = 1.12 \text{ in}$$

$$C = D/d = 1.12/0.105 = 10.67$$

$$k_s = \frac{2(10.67)+1}{2(10.67)} = 1.05$$

$$N_a = \text{تعداد حلقه‌های مؤثر} = 12 - 1 = 11$$

$$L_s = \text{طول مرده فنر} = 0.105 \times 12 = 1.26 \text{ in}$$

(ب)

$$F_s = \frac{\pi d^3 S_{sy}}{8k_s D} = \frac{\pi(0.105)^3 (116.4 \times 10^3)}{8(1.05)(1.12)} = 45 \text{ lb}$$

(پ)

$$k = \frac{Gd^4}{8ND^3} = \frac{(11.5 \times 10^6)(0.105)^4}{8(11)(1.12)^3} = 11.31 \text{ lb/in}$$

(الف)

$$L_0 = \frac{F_s}{k} + L_s = \frac{45}{11.31} + 1.26 = 5.24 \text{ in}$$

ت) با فرض اینکه دو سر فنر ثابت، ساده و سنگ خورده باشد داریم:

$$\alpha = 0.5 \Rightarrow L_f = \frac{2.63D}{\alpha} = \frac{2.63(1.12)}{0.5} \Rightarrow L_f = 5.89 \text{ in}$$

بنابراین فنر دچار کمانش نخواهد شد.

$$m = 0.201, \quad A = 1510 \text{ MPa}$$

$$S_{ut} = \frac{1510}{2^{0.201}} = 1314 \text{ MPa}$$

$$S_{sy} = 0.75 \times 0.577 \times 1314 = 565 \text{ MPa}$$

$$D = 20 \rightarrow C = 20/2 = 2$$

$$k_s = \frac{21}{20} = 1.05$$

$$N_a = 8.5 - 1 = 7.5$$

$$L_s = 2 \times 8.5 = 17 \text{ mm}$$

(پ)

$$F_s = \frac{\pi d^3 S_{sy}}{8k_s D} = \frac{\pi(0.002)^3 (565 \times 10^6)}{8(1.05)(0.02)} = 84.5 \text{ N}$$

(ت)

$$k = \frac{Gd^4}{8ND^3} = \frac{(79.3 \times 10^9)(0.002)^4}{8(7.5)(0.02)^3} = 2640 \text{ N/m}$$

(الف)

$$y = \frac{F_s}{k} = \frac{84.5 \times 10^3}{2640} = 33 \text{ mm} \Rightarrow L_0 = y + L_s = 33 + 17 = 50 \text{ mm}$$

(ب)

$$P = \frac{L_0}{N_t} = \frac{50}{8.5} = 5.88 \text{ mm}$$

(ث)

$$L_f = \frac{2.63D}{\alpha} = \frac{2.63 \times 20}{0.5} = 105.2 \text{ mm} \rightarrow \text{بنابراین فنر دچار کماتش نمی شود.}$$

$$N_t = L_s / d = 14.35 / 1.4 = 10.25$$

$$D = 12.19 - 1.4 = 10.79 \text{ mm} \rightarrow C = 10.79 / 1.4 = 7.707$$

$$N_a = 10.25 - 2 = 8.25 \text{ حلقة}$$

$$k_s = \frac{2(7.707) + 1}{2(7.707)} = 1.065$$

$$m = 0.163, A = 2060 \text{ MPa}$$

$$S_{ut} = \frac{2060}{1.4^{0.163}} = 1950 \text{ MPa}$$

$$S_{sy} = 0.75 \times 0.577 \times 1950 = 839 \text{ MPa}$$

$$\tau_{max} = 0.9(839) = 755 \text{ MPa}$$

(ب)

$$F = \frac{\pi d^3 \tau_{max}}{8k_s D} = \frac{\pi(0.0014)^3 (755 \times 10^6)}{8(1.065)(10.79 \times 10^{-3})} = 70.8 \text{ N}$$

$$k = \frac{Gd^4}{8ND^3} = \frac{(79.3 \times 10^9)(0.0014)^4}{8(8.25)(10.79 \times 10^{-3})^3} = 3674 \text{ N/m}$$

(الف)

$$y_s = \frac{F}{k} = \frac{70.8 \times 10^3}{3674} = 19.27 \text{ mm} \Rightarrow L_0 = y_s + L_s = 19.27 + 14.35 = 33.62 \text{ mm}$$

(الف)

$$m = 0.201, A = 1570 \text{ MPa}$$

$$S_{ut} = \frac{1570}{2^{0.201}} = 1365.8 \text{ MPa} \rightarrow S_{yt} = 0.75 \times S_{ut} = 1024 \text{ MPa}$$

$$S_{sy} = 0.75 \times 0.577 \times 1365.8 = 591 \text{ Mpa}$$

(ب)

$$C = D / d = 12 / 2 = 6$$

$$k_s = \frac{2(6)+1}{2(6)} = 1.083$$

$$\tau = 1.083 \frac{8 \times 30 \times 12}{\pi 2^3} = 124 \text{ MPa}$$

(پ)

$$k = \frac{Gd^4}{8ND^3} = 765 \text{ N/m}$$

(ت)

$$F = \frac{\pi d^3 S_{sy}}{8k_s D} = 143 \text{ N}$$

(ث)

$$r_m = 3 \text{ mm} \rightarrow r_i = 3 - 1 = 2 \text{ mm} \rightarrow k = 3/2 = 1.5$$

$$F_{\max} = \frac{\pi \times 2^3 \times 591}{8 \times 1.5 \times 12} = 103 \text{ N}$$

(ج)

$$\sigma = S_{yt} = \frac{Mc}{I} + \frac{F}{A} = k \left( \frac{32Fr_m}{\pi d^3} \right) + \frac{4F}{\pi d^2}$$

$$r_i = 6 - (d/2) = 5 \text{ mm} \rightarrow k = r_m/r_i = 6/5 = 1.2$$

$$1024 = 1.2 \left( \frac{32F_{\max}(6)}{\pi 2^3} \right) + \frac{4F_{\max}}{\pi 2^2} \Rightarrow F_{\max} = 108 \text{ N}$$

(ج) به پیش‌باری که بر روی فنر به مقدار  $F=30 \text{ N}$  وجود دارد، قبل از فشردن آن باید غلبه شود. پس:

$$y = \frac{F}{k} = \frac{103 - 30}{765} \times 10^3 = 95.4 \text{ mm}$$

$$L = \text{فاصله بین دو سر فنر} = 95.4 + 264 = 329.4 \text{ mm}$$

(الف)

$$m = 0.163, A = 186 \text{ kpsi}$$

$$D = 0.654 - 0.055 = 0.599 \text{ in}$$

$$S_{ut} = \frac{186}{0.055^{0.163}} = 298 \text{ kpsi}$$

$$S_{sy} = 0.75 \times 0.577 \times 298 = 128.14 \text{ kpsi}$$

$$C = D/d = 0.599/0.055 = 10.89$$

$$k_i = \frac{4(10.89)^2 - 10.89 - 1}{4(10.89)(9.89)} = 1.0735$$

$$F_r = \frac{\pi d^3 \delta}{32k_i} = \frac{\pi(0.055)^3 (128)(10^3)}{32(1.0735)} = 1.95 \text{ lb.in}$$

(ب)

$$k' = \frac{(0.055)^4 (30)(10^6)}{10.8(0.599)(6)} = 7.07 \text{ lb.in/rev}$$

$$n = Fr/k' = 1.95 / 7.07 = 0.275 \text{ rev}$$

$$D_i = D_o - 2d = 0.654 - 2(0.055) = 0.544 \text{ in}$$

$$N' = 6 + 0.275 = 6.275$$

$$D'_i = \frac{N}{N'} D_i = \frac{6}{6.275} (0.544) = 0.52 \text{ in}$$

(پ)

$$\theta = 0.275(360^\circ) = 99^\circ$$