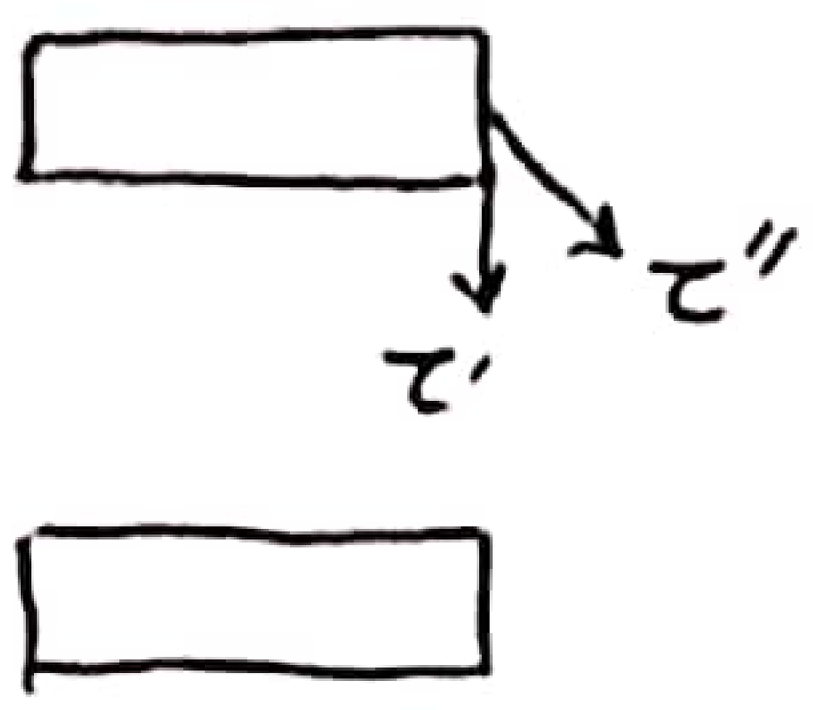
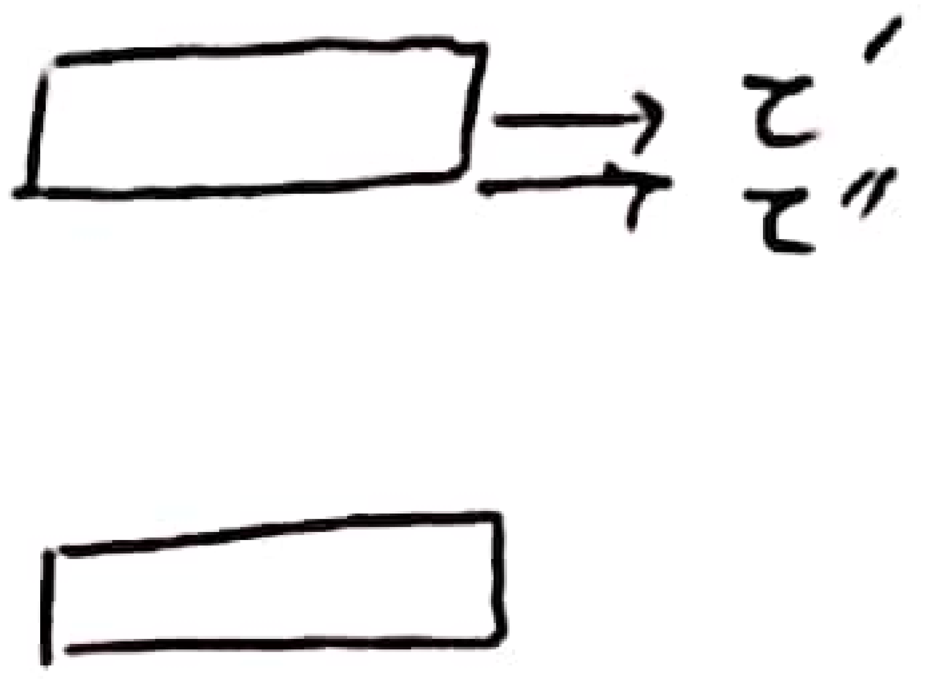
تکلیف سری ۱ طراحی اجزاء ۱

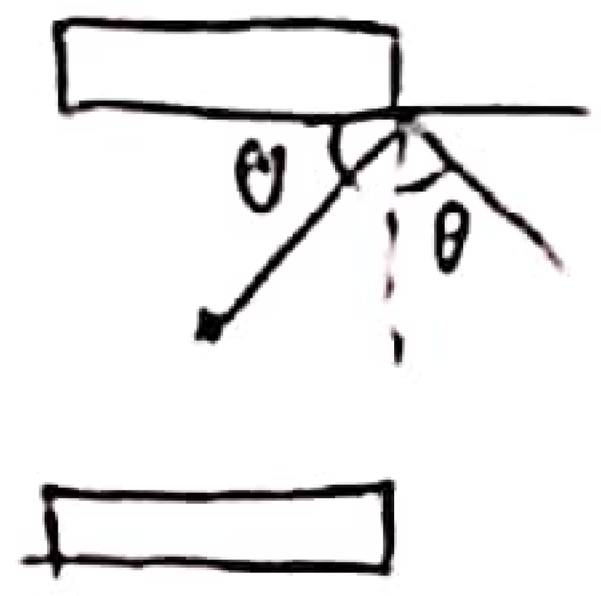
سوال ۱)

ناشی از نیروی برشی



ناشی از ممان خمشی





$\tan\theta = \frac{d/2}{b/2} = \frac{1}{0.5} \rightarrow \theta = 64°$

① $\begin{cases} \tau_1' = \dfrac{V}{A} \\ \tau_1'' = \dfrac{Mr}{J} \end{cases}$ $\begin{cases} M = V \times 5 \\ J = 0.707hJ_u \end{cases}$

② $\begin{cases} \tau_2' = \dfrac{1.414F}{hL} \\ \tau_2'' = \dfrac{Mc}{I} \end{cases}$ $\begin{cases} M = V \times 5 \\ I = 0.707hI_u \end{cases}$

* $c = d/2 = 2/2 = 1$ in
* $r = \sqrt{(b/2)^2 + (d/2)^2} = \sqrt{(0.5)^2 + 1^2} = 1.1$ in
* $M = 0.5 \times 10^3 \times 5 = 25oo$ lb.in
* $F = P = 10 \times 10^3$ lb
* $l = b = 1$ in

Table 9-1:

بخش ①

$| \; | \rightarrow A = 1.414hd, \quad J_u = \frac{d(3b^2+d^2)}{6}$

$\square \rightarrow A = 1.414(b+d)h, \quad J_u = \frac{(b+d)^3}{6}$

⇓

$= \rightarrow A = 1.414h[(b+d)-d], \quad J_u = \frac{(b+d)^3}{6} - \frac{d(3b^2+d^2)}{6}$

$\rightarrow A = 1.414hb, \quad J_u = \frac{1}{6}\left[(b+d)^3 - d(3b^2+d^2)\right]$

Table 9-2:

بخش ②

$= \rightarrow A = 1.414hb, \quad I_u = \frac{bd^2}{2}$

برآیند نیروها (تنش‌ها)

$\tau_x = \tau_2' + \tau_2'' + \tau_1'' \sin\theta$

$\tau_y = \tau_1' + \tau_1'' \cos\theta$

$\rightarrow \tau = \sqrt{\tau_x^2 + \tau_y^2}$

Table 9-3:

E60XX $S_{ut} = 62$ kpsi $\rightarrow \tau_{all} = 0.3 \times 62 = 18.6$ kpsi

E120XX $S_{ut} = 120$ kpsi $\rightarrow \tau_{all} = 120 \times 0.3 = 36$ kpsi

↑ از صورت مسئله

(2)

$$\tau_n = \frac{1.414 \times 10 \times 10^3}{h \times 1} + \frac{2500 \times 1}{0.707h \times \frac{1 \times 2^2}{2}} + \frac{2500 \times 1.1 \times \sin 64}{0.707h \times \frac{1}{6}[(1+2)^3 - 2(3 \times 1^2 + 2^2)]}$$

$$\rightarrow \quad \tau_n = \frac{1}{h}\left[14.14 \times 10^3 + 1.77 \times 10^3 + 1.61 \times 10^3\right] = \frac{17.52 \times 10^3}{h}$$

$$\tau_y = \frac{0.5 \times 10^3}{1.414h \times 1} + \frac{2500 \times 1.1 \times \cos 64}{0.707h \times \frac{1}{6}[(1+2)^3 - 2(3 \times 1^2 + 2^2)]}$$

$$\rightarrow \quad \tau_y = \frac{1}{h}\left[0.35 \times 10^3 + 0.77 \times 10^3\right] = \frac{1.12 \times 10^3}{h}$$

$$\tau = \sqrt{\tau_n^2 + \tau_y^2} = \tau_{all}$$

$$\tau = \frac{1}{h}\sqrt{(17.52 \times 10^3)^2 + (1.12 \times 10^3)^2} = \frac{17.56 \times 10^3}{h}$$

E60XX $\longrightarrow$ $h = \frac{17.56 \times 10^3}{18.6 \times 10^3} = 0.94$ in

E120XX $\longrightarrow$ $h = \frac{17.56 \times 10^3}{36 \times 10^3} = 0.49$ in

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Table 9-6 :

E60XX $\longrightarrow$ $h = 1$ in $\longrightarrow (F/length)_{all} = 12.73$ klb/in

E120XX $\longrightarrow$ $h = 0.5$ in $\longrightarrow (F/length)_{all} = 12.73$ klb/in

length $= 2b = 2 \times 1 = 2$ in

E60XX $\longrightarrow$ $F_{all} = 12.73 \times 2 = 25.46$ klb

E120XX $\longrightarrow$ $F_{all} = 12.73 \times 2 = 25.46$ klb

$\tau = \frac{17.56 \times 10^3}{h}$

E60XX $\longrightarrow$ $\tau = \frac{17.56 \times 10^3}{1} = 17.56$ kpsi

E120XX $\longrightarrow$ $\tau = \frac{17.56 \times 10^3}{0.5} = 35.12$ kpsi

$F_{all} = \tau_{all} \times A = \tau_{all} \times 1.414hb$ * τ_{all} based on Table 9-6

E60XX $\longrightarrow$ $\tau_{all} = \frac{25.46}{1.414 \times 1 \times 1} = 18.01$ kpsi

E120XX $\longrightarrow$ $\tau_{all} = \frac{25.46}{1.414 \times 0.5 \times 1} = 36.01$ kpsi

پس در مقایسه با τ_{all} محاسبه شده از صورت مسئله، الکترود E120XX مناسب میباشد!

③

Table 6-2 ⟶ As-forged (wing for weld) : $a = 39.9$ kpsi, $b = -0.995$

$$k_a = a S_{ut}^{b}$$

$$E60XX \;\&\; k_a = 39.9 \times (62)^{-0.995} = 0.657$$

$$E120XX \div k_a = 39.9 \times (120)^{-0.995} = 0.341$$

$k_b = 1$ for shear

$k_c = 0.59$ for torsion

$k_d = k_e = k_f = 1$

$$S'_e = 0.5\, S_{ut} = \begin{cases} \longrightarrow E60XX : S'_e = 62 \times 0.5 = 31 \text{ kpsi} \\ \longrightarrow E120XX : S'_e = 120 \times 0.5 = 60 \text{ kpsi} \end{cases}$$

$E60XX \longrightarrow S_e = 0.657 \times 1 \times 0.59 \times 1 \times 1 \times 1 \times 31 = 12.02$ kpsi

$E120XX \longrightarrow S_e = 0.341 \times 1 \times 0.59 \times 1 \times 1 \times 1 \times 60 = 12.07$ kpsi

$K_f = K_{fs} = 1$ (صورت مسئله)

$P_{max} = 10$ klb $\qquad V_{max} = 0.5$ klb

$P_{min} = 0 \qquad V_{min} = 0$

$$P_a = \frac{P_{max} - P_{min}}{2} = \frac{10-0}{2} = 5 \text{ klb} \qquad V_a = 0.25 \text{ klb}$$

$$P_m = \frac{P_{max} + P_{min}}{2} = \frac{10+0}{2} = 5 \text{ klb} \qquad V_m = 0.25 \text{ klb}$$

در حالت خستگی، نیروی وارده نصف نیروی حالت استاتیکی است.

$$\Rightarrow \tau_a = \frac{\tau}{2} \;,\; \tau_m = \frac{\tau}{2}$$

$$\text{Goodman} \longrightarrow \frac{\tau_a}{S_{se}} + \frac{\tau_m}{S_{ut}} = 1 \text{ or } \frac{1}{n}$$

$$\tau_a = \frac{17.56 \times 10^3}{2h}$$

④

E60XX

$$\frac{\dfrac{17.56\times10^{3}}{2h}}{12.02\times10^{3}}+\frac{\dfrac{17.56\times10^{3}}{2h}}{62\times10^{3}}=1 \rightarrow h = 88.7 \text{ in } !$$

E120XX

$$\frac{\dfrac{17.56\times10^{3}}{2h}}{12.07\times10^{3}}+\frac{\dfrac{17.56\times10^{3}}{2h}}{120\times10^{3}}=1 \rightarrow h = 96.3 \text{ in } !$$

چنین ضخامت هایی برای جوشی که براساس جدول 9-6 مجبور نیستید و لذا هیچکدام از الکترودها برای این پیکربندی مناسب نیستند!

جواب سؤال ۳

با توجه به شکل squared and ground (Figure 10.2)

Table 10-1 $\rightarrow$ $N_e = 2$

$N_t = N_a + 2$

$L_0 = pN_a + 2d$

$L_s = dN_t$

$$S_{ut} = \frac{A}{d^m}$$

Table 10-4 $\rightarrow$ A227 HD $\rightarrow$ $m = 0.190$, $A = 140 \text{ kpsi}\cdot\text{in}^m$

$$\rightarrow S_{ut} = \frac{140}{(0.25)^{0.190}} = 182.2 \text{ kpsi}$$

$S_{sy} = 0.56\, S_{ut} = 0.56\times182.2 = 102.0$ kpsi

$S_{su} = 0.67\, S_{ut} = 0.67\times182.2 = 122.1$ kpsi

Table 10-5 $\rightarrow$ $d > 0.125$, A227 HD $\rightarrow$ $E = 28.5$ Mpsi

$G = 11.4$ Mpsi

$D = 4 - 0.25 = 3.75$ in

$$C = \frac{D}{d} = \frac{3.75}{0.25} = 15 \rightarrow 4 \leq C \leq 12$$

این شرط طراحی برقرار نباشد!

(5)

سختی $k = \frac{F}{y} \longrightarrow k = \frac{F_{max}}{y_{max}} = \frac{15}{2} = 7.5$

$$k = \frac{d^4 G}{8 D^3 N_a} \Rightarrow N_a = \frac{d^4 G}{8 k D^3} = \frac{(0.25)^4 \times 11.4 \times 10^6}{8 \times 7.5 \times (3.75)^3} = 14.1$$

$3 \leq N_a \leq 15$ — این شرط طراحی برقرار است!

$$N_t = N_a + 2 = 16.1$$

$L_s = d N_t = 0.25 \times 16.1 = 4.025 \text{ in} > 2 \text{ in}$ — × مناسب نیست!

$L_0 = L_s + y_{max} = 4.025 + 2 = 6.025 \text{ in} > 4 \text{ in}$ — × مناسب نیست!

$$K_B = \frac{4C+2}{4C-3} = \frac{4 \times 15 + 2}{4 \times 15 - 3} = 1.1$$

$$\tau_s = K_B \frac{8 F_{max} D}{\pi d^3} = 1.1 \times \frac{8 \times 15 \times 3.75}{\pi (0.25)^3} = 10084.1 \text{ psi}$$

$$n_s = \frac{S_{sy}}{\tau_s} = \frac{102.0 \times 10^3}{10084.1} = 10.1$$

↑ استاتیکی

↓ خستگی

$$F_a = \frac{F_{max} - F_{min}}{2} = \frac{15 - 10}{2} = 2.5 \text{ lb}$$

$$F_m = \frac{F_{max} + F_{min}}{2} = \frac{15 + 10}{2} = 12.5 \text{ lb}$$

$$\tau_a = K_B \frac{8 F_a D}{\pi d^3} = 1.1 \times \frac{8 \times 2.5 \times 3.75}{\pi (0.25)^3} = 1680.7 \text{ psi}$$

$$\tau_m = K_B \frac{8 F_m D}{\pi d^3} = 1.1 \times \frac{8 \times 12.5 \times 3.75}{\pi (0.25)^3} = 8403.4 \text{ psi}$$

Peen $\longrightarrow$ $S_{sa} = 57.5$ kpsi , $S_{sm} = 77.5$ kpsi

$$S_{se} = \frac{S_{sa}}{1 - \frac{S_{sm}}{S_{su}}} = \frac{57.5}{1 - \frac{77.5}{122.1}} = 157.4 \text{ kpsi}$$

$$n_f = \frac{S_{sa}}{\tau_a} = \frac{57.5 \times 10^3}{1680.7} = 34.2 \;!$$

(6)

$$L_0 < \frac{\pi D}{\alpha}\left[\frac{2(E-G)}{2G+E}\right]^{1/2}$$

Table 10-2 $\longrightarrow \alpha = 1 \longrightarrow (L_0)_{cr} = \frac{\pi \times 3.75}{1}\left[\frac{2(28.5-11.4)}{2\times 11.4+28.5}\right]^{1/2} = 9.6$ in

$L_0 = 6.025 \overset{!}{<} (L_0)_{cr} = 9.6 \longrightarrow$ فنر کشش پذیر است. ✓

Table A-5 : $\gamma = 0.282$

$$W = \frac{\pi^2 d^2 D N_a \gamma}{4} = \frac{\pi^2 \times (0.25)^2 \times 3.75 \times 14.1 \times 0.282}{4} = 2.3 \text{ lb}$$

$$f_n = 0.5\sqrt{\frac{386k}{W}} = 0.5\sqrt{\frac{386\times 7.5}{2.3}} = 17.7 \text{ Hz}$$

بیشتر از فرکانس بارگذاری (۱۰ هرتز) است و لذا پدیده رزونانس رخ نمی‌دهد.