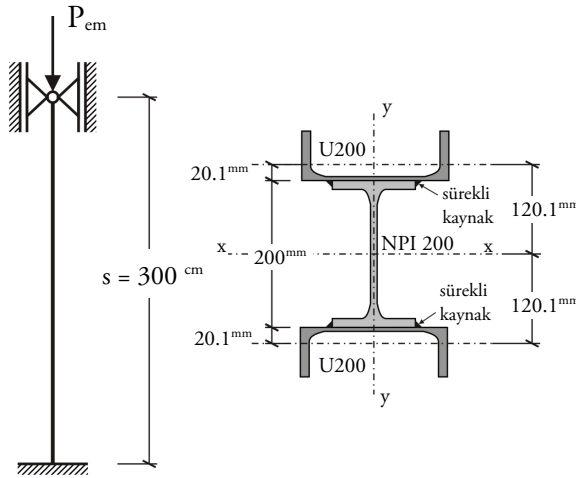


Çelik Yapılar Yarıyıl Sonu Sınavı Sayısal Soruların Cevapları

4.)



Şekilde ölçüleri ve yükleme durumu verilen basınç çubuğunun güvenle taşıyabileceği basınç kuvvetini (P_{em}) hesaplayınız. (YH1, Ç37)

$$\sigma_{em} = 1.44 \text{ t/cm}^2$$

$$\text{Burkulma boyu } s_k = 0.8 s$$

$$s_{kx} = s_{ky} = 0.8 \cdot s = 0.8 \cdot 300 = 240 \text{ cm}$$

$$U 200 \Rightarrow I_x = 1910 \text{ cm}^4; I_y = 148 \text{ cm}^4; F = 32.2 \text{ cm}^2; e = 2.01 \text{ cm}$$

$$NPI 200 \Rightarrow I_x = 2140 \text{ cm}^4; I_y = 117 \text{ cm}^4; F = 33.5 \text{ cm}^2$$

$$I_{xx} = 2140 + 2 \cdot [148 + 32.2 \cdot 12.01^2] = 11725.06 \text{ cm}^4$$

$$I_{yy} = 117 + 2 \cdot 1910 = 3937 \text{ cm}^4$$

$$\Sigma F = 33.5 + 2 \cdot 32.2 = 97.9 \text{ cm}^2$$

$$i_{xx} = \sqrt{\frac{I_{xx}}{\Sigma F}} = \sqrt{\frac{11725.06}{97.9}} = 10.94 \text{ cm}; i_{yy} = \sqrt{\frac{I_{yy}}{\Sigma F}} = \sqrt{\frac{3937}{97.9}} = 6.34 \text{ cm}$$

$$\lambda_x = \frac{s_{kx}}{i_{xx}} = \frac{240}{10.94} \cong 22; \lambda_y = \frac{s_{ky}}{i_{yy}} = \frac{240}{6.34} \cong 38$$

$$\lambda_x = 22 \Rightarrow \text{tablodan } \omega = 1.04$$

$$\lambda_y = 38 \Rightarrow \text{tablodan } \omega = 1.13$$

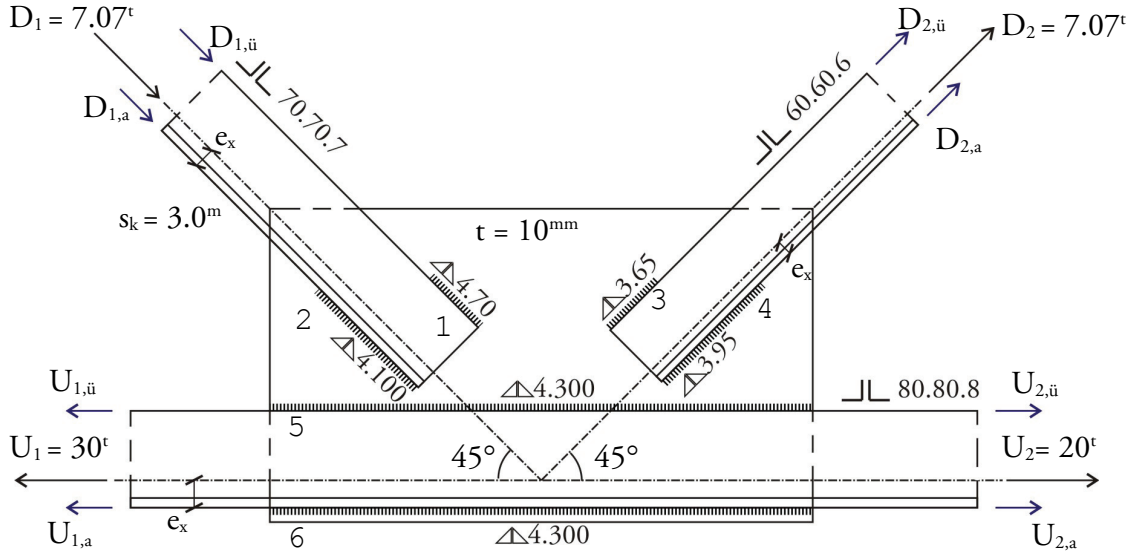
$$\sigma = \omega \cdot \frac{P}{\Sigma F} \leq \sigma_{em} \Rightarrow P \leq \frac{\sigma_{em} \cdot \Sigma F}{\omega}$$

Büyük olan ω 'ya göre hesap yapmak yeterli olur.

$$P_{em} = \frac{1.44 \cdot 97.9}{1.13} = 124.76 \text{ t}$$

Basınç çubuğunun emniyetle taşıyabileceği kuvvet $P_{em} = 124.76 \text{ t}$ 'dur.

5.)



Şekilde verilen kafes kiriş düğüm noktasında gerekli tüm kontrolleri yapınız.

(YH1, Ç37)

$$\sigma_{em} = 1.44 \text{ t/cm}^2$$

$$\text{Köşe kaynakta } \tau_{kem} = 1.1 \text{ t/cm}^2$$

D_2 ve U_2 'nin hesaplanması:

$$\Sigma Y = 0 \quad D_1 \cdot \sin 45 = D_2 \cdot \sin 45 \Rightarrow D_1 = D_2 = 7.07 \text{ t}$$

$$\Sigma X = 0 \quad U_2 = U_1 - D_1 \cdot \cos 45 - D_2 \cdot \cos 45 = 30 - 5 - 5 = 20 \text{ t}$$

Basınç diyagonalinde kontroller:

$$\text{L70.70.7: } F = 9.40 \text{ cm}^2 ; i_x = i_y = 2.12 \text{ cm} ; e_x = e_y = 1.97 \text{ cm}$$

$$i_{xx} = \sqrt{\frac{2 \cdot I_x}{2 \cdot F}} = i_x$$

$$\lambda_x = \lambda_y = \frac{s_k}{i_{xx}} = \frac{300}{2.12} \cong 142$$

$$\lambda_x = \lambda_y = 142 \Rightarrow \text{tablodan } \omega = 3.41$$

$$\sigma = \omega \cdot \frac{P}{\Sigma F} = 3.41 \cdot \frac{7.07}{2 \cdot 9.40} = 1.28 < \sigma_{em} = 1.44 \text{ t/cm}^2 \quad \checkmark$$

Kaynaklarda kontrol:

$$D_{1,a} = (7^{cm} - 1.97^{cm}) \cdot \frac{7.07^t}{7^{cm}} = 5.08 \text{ t} ; D_{1,\bar{u}} = 1.97^{cm} \cdot \frac{7.07^t}{7^{cm}} = 1.99 \text{ t}$$

1 nolu kaynakta kontrol:

$$a = 4 \text{ mm}$$

$$3 \text{ mm} \leq a \leq 0.7 t_{min} \Rightarrow 3 \text{ mm} \leq 4 \text{ mm} \leq 0.7 \cdot 7 = 4.9 \text{ mm}$$

$$l_1 = 70 - 2 \cdot 4 = 62 \text{ mm} \quad \checkmark$$

$$15a \leq l_k \leq 100a \Rightarrow 15 \cdot 4 = 60 \text{ mm} \leq l_1 = 62 \text{ mm} \leq 100 \cdot 4 = 400 \text{ mm}$$

$$\tau_k = \frac{P}{\Sigma al} = \frac{1.99}{2 \cdot 0.4 \cdot 6.2} = 0.40 < 1.1 \text{ t/cm}^2$$

2 nolu kaynakta kontrol:

$$a = 4 \text{ mm}$$

$$3 \text{ mm} \leq a \leq 0.7 t_{\min} \Rightarrow 3 \text{ mm} \leq 4 \text{ mm} \leq 0.7 \cdot 7 = 4.9 \text{ mm}$$

$$l_2 = 100 - 2 \cdot 4 = 92 \text{ mm}$$

$$15a \leq l_k \leq 100a \Rightarrow 15 \cdot 4 = 60 \text{ mm} \leq l_2 = 92 \text{ mm} \leq 100 \cdot 4 = 400 \text{ mm}$$

$$\tau_k = \frac{P}{\Sigma a l} = \frac{5.08}{2 \cdot 0.4 \cdot 9.2} = 0.69 < 1.1 \text{ t / cm}^2$$

Çekme diyagonalinde kontroller:

$$\mathbf{L60.60.6:} \quad F = 6.91 \text{ cm}^2 ; e_x = e_y = 1.69 \text{ cm}$$

$$\sigma = \frac{P}{\Sigma F} = \frac{7.07}{2 \cdot 6.91} = 0.51 < \sigma_{em} = 1.44 \text{ t / cm}^2 \quad \checkmark$$

Kaynaklarda kontrol:

$$D_{2,a} = (6^{cm} - 1.69^{cm}) \cdot \frac{7.07^t}{6^{cm}} = 5.08 \text{ t} ; D_{2,\ddot{u}} = 1.69^{cm} \cdot \frac{7.07^t}{6^{cm}} = 1.99 \text{ t}$$

3 nolu kaynakta kontrol:

$$a = 3 \text{ mm}$$

$$3 \text{ mm} \leq a \leq 0.7 t_{\min} \Rightarrow 3 \text{ mm} \leq 3 \text{ mm} \leq 0.7 \cdot 6 = 4.2 \text{ mm}$$

$$l_3 = 65 - 2 \cdot 3 = 59 \text{ mm}$$

$$15a \leq l_k \leq 100a \Rightarrow 15 \cdot 3 = 45 \text{ mm} \leq l_3 = 59 \text{ mm} \leq 100 \cdot 3 = 300 \text{ mm}$$

$$\tau_k = \frac{P}{\Sigma a l} = \frac{1.99}{2 \cdot 0.3 \cdot 5.9} = 0.56 \text{ t / cm}^2 < 1.1 \text{ t / cm}^2$$

4 nolu kaynakta kontrol:

$$a = 3 \text{ mm}$$

$$3 \text{ mm} \leq a \leq 0.7 t_{\min} \Rightarrow 3 \text{ mm} \leq 3 \text{ mm} \leq 0.7 \cdot 7 = 4.9 \text{ mm}$$

$$l_4 = 95 - 2 \cdot 3 = 89 \text{ mm}$$

$$15a \leq l_k \leq 100a \Rightarrow 15 \cdot 3 = 45 \text{ mm} \leq l_4 = 89 \text{ mm} \leq 100 \cdot 3 = 300 \text{ mm}$$

$$\tau_k = \frac{P}{\Sigma a l} = \frac{5.08}{2 \cdot 0.3 \cdot 8.9} = 0.95 \text{ t / cm}^2 < 1.1 \text{ t / cm}^2$$

Alt başlık çubuğunda kontroller:

$$\mathbf{L80.80.8:} \quad F = 12.3 \text{ cm}^2 ; e_x = e_y = 2.26 \text{ cm}$$

$$P = \begin{pmatrix} U_1 \\ U_2 \end{pmatrix}_{\max} = 30 \text{ t} \quad \checkmark$$

$$\sigma = \frac{P}{\Sigma F} = \frac{30}{2 \cdot 12.3} = 1.22 < \sigma_{em} = 1.44 \text{ t / cm}^2$$

Kaynaklarda kontrol:

$$U = 1.5 \cdot (30 - 20) = 15 \text{ t}$$

$$U_a = (8^{cm} - 2.26^{cm}) \cdot \frac{15^t}{8^{cm}} = 10.76 \text{ t} ; U_{\ddot{u}} = 2.26^{cm} \cdot \frac{15^t}{8^{cm}} = 4.24 \text{ t}$$

5 nolu kaynakta kontrol:

$$a = 4 \text{ mm}$$

$$3 \text{ mm} \leq a \leq 0.7 t_{\min} \Rightarrow 3 \text{ mm} \leq 4 \text{ mm} \leq 0.7 \cdot 8 = 5.6 \text{ mm}$$

$$l_5 = 300 - 2 \cdot 4 = 292 \text{ mm} \quad \checkmark$$

$$15a \leq l_k \leq 100a \Rightarrow 15 \cdot 4 = 69 \text{ mm} \leq l_5 = 292 \text{ mm} \leq 100 \cdot 4 = 400 \text{ mm}$$

$$\tau_k = \frac{P}{\Sigma a l} = \frac{4.24}{2 \cdot 0.4 \cdot 29.2} = 0.18 \text{ t / cm}^2 < 1.1 \text{ t / cm}^2$$

6 nolu kaynakta kontrol:

$$a = 4 \text{ mm}$$

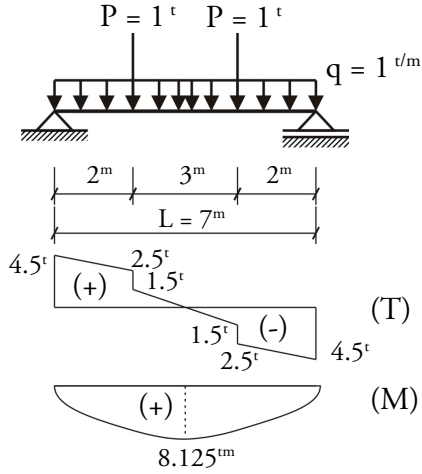
$$3 \text{ mm} \leq a \leq 0.7 t_{\min} \Rightarrow 3 \text{ mm} \leq 4 \text{ mm} \leq 0.7 \cdot 8 = 5.6 \text{ mm}$$

$$l_6 = 300 - 2 \cdot 4 = 292 \text{ mm} \quad \checkmark$$

$$15a \leq l_k \leq 100a \Rightarrow 15 \cdot 4 = 69 \text{ mm} \leq l_6 = 292 \text{ mm} \leq 100 \cdot 4 = 400 \text{ mm}$$

$$\tau_k = \frac{P}{\Sigma a l} = \frac{10.76}{2 \cdot 0.4 \cdot 29.2} = 0.46 \text{ t / cm}^2 < 1.1 \text{ t / cm}^2$$

6.)



Şekilde yükleme durumu verilen kirişi bir NPI profili kullanarak boyutlandırınız.

(YH1, Ç37)

$$\tau_{em} = 0.831\text{ t/cm}^2 \quad \sigma_{em} = 1.44\text{ t/cm}^2$$

$$E = 2.1 \times 10^6\text{ kg/cm}^2 ; f_{lim} = L/300$$

$$f_{max} = \frac{5}{384} \cdot \frac{qL^4}{EI_x} + \frac{3-4\alpha^2}{24EI_x} \cdot \alpha PL^3 ; \alpha = \frac{2}{7}$$

Seçilen profil NPI 360

Gerilme kontrolü:

$$NPI\ 360 \Rightarrow I_x = 19610\text{ cm}^4 ; W_x = 1090\text{ cm}^3 ; t_g = 1.3\text{ cm} ; S_x = 638\text{ cm}^3 ; h_1 = 29\text{ cm}$$

$$\sigma = \frac{M_{max}}{W_x} = \frac{812.5}{1090} = 0.75 < 1.44\text{ t/cm}^2 \quad \checkmark$$

Maksimum kayma gerilmesi I kesitin gövdesinin ortasında etmektedir.

$$\tau_{max} = \frac{T_{max} \cdot S_x}{I_x \cdot t_g} = \frac{4.5 \cdot 638}{19610 \cdot 1.3} = 0.112 < 0.831\text{ t/cm}^2 \quad \checkmark$$

ya da

$$\tau_{max} \cong \frac{T_{max}}{h_1 \cdot t_g} = \frac{4.5}{29 \cdot 1.3} = 0.119 < 0.831\text{ t/cm}^2 \quad \checkmark$$

$$f_{max} = \frac{5}{384} \cdot \frac{qL^4}{EI_x} + \frac{3-4\alpha^2}{24EI_x} \cdot \alpha PL^3$$

$$= \frac{5}{384} \cdot \frac{0.01 \cdot 700^4}{2.1 \cdot 10^3 \cdot 19610} + \frac{3-4\left(\frac{2}{7}\right)^2}{24 \cdot 2.1 \cdot 10^3 \cdot 19610} \cdot \frac{2}{7} \cdot 1 \cdot 700^3 = 1.024\text{ cm} < \frac{700}{300} = 2.33\text{ cm} \quad \checkmark$$