İçindekiler

D. XZ Aksı

D.6. XZ1 - 6000 MM ELEMAN TASARıMı

D.6.6. KOLON HEA 300

Çubuk Özellikler :

Name: 12

Kesit: HEA 300

Len: 6 m

Buckling Lengths

L_x: $k_x \cdot L = 3$ m

L_y: $k_y \cdot L = 3$ m

HEA 300 Özellikler :

$b = 0.3$ m $t_f = 0.014$ m

$h = 0.29$ m $t_w = 0.0085$ m

$A = 0.012085$ m^2

$I_x = 0.000194606$ m^4

$I_y = 6.33284E\text{-}05$ m^4

$S_x = 0.00134211$ m^3

$S_y = 0.00042219$ m^3

$Z_x = 0.00148294$ m^3

$Z_y = 0.000654051$ m^3

$i_x = 0.126898$ m

$i_y = 0.0723896$ m

$C_w = 1.20603E\text{-}06$ m^3

$J_c = 8.51731E\text{-}07$ m^3

Malzeme Özellikler: S235

F_y :Yield stress = 235000 kN/m²

F_u :Ultimate stres = 360000 kN/m²

E :Elasticity modulus = 2.000E+8 kN/m²

G : Shear modulus = 7.692E+7 kN/m²

Cross Section Check According to TDY-2018

Tablo 9.3 – Enkesit Kosullari

$$C_a = \frac{P_u}{\Phi_c \cdot (F_y \cdot A)} \Rightarrow \Phi_c = 0.90 \Rightarrow \frac{32.4}{0.90 \cdot (235000 \cdot 0.0121)} = 0.0127$$

$C_a = 0.0127 \leq 0.125$

Sinir Degerler $\lambda_{md} = 3.76\sqrt{\frac{E}{F_y}} \cdot (1 - 2.75 \cdot C_a)$

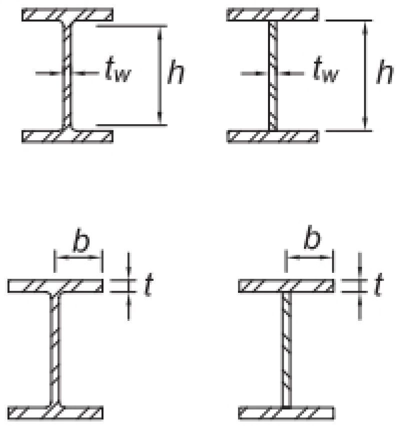
$$\lambda_{md} = 3.76\sqrt{\frac{2.000E+8}{235000}} \cdot (1 - 2.75 \cdot 0.0127) = 105.86$$

$h/tw = 0.208/0.0085 = 24.5 \Longrightarrow 24.5 \leq 105.86$ *Yeterli* ✔ *o.k.*

Tablo 9.3 – Enkesit Kosullari

Sinir Degerler $\lambda_{md} = 0.38\sqrt{\frac{E}{F_y}} = 0.38\sqrt{\frac{2.000E+8}{235000}} = 11.1$

$b/f = 0.15/0.014 = 10.7 \Longrightarrow 10.7 \leq 11.1$ *Yeterli* ✔ *o.k.*



Steel Member Design According to CYTHYE 2016: YDKT

CUBUK UZERINDEKI YAYILI YUKLER

Yükleme Türü	Koordinat Sistemi	Yayılı yük	Birim
OZ	Global-z	-0.931	kN/m
RUZGAR-L	Global-x	1.444	kN/m
RUZGAR-R	Global-x	-1.463	kN/m
RUZGAR-F	Global-x	3.078	kN/m
RUZGAR-B	Global-x	2.423	kN/m
KAPLAMA	Global-z	-0.570	kN/m
ASIK	Global-z	-0.637	kN/m

Sınıflandırma

Başlık Narinliği

Slender Limit $\lambda_r = 0.56\sqrt{\frac{E}{F_y}} = 0.56\sqrt{\frac{2.000E+8}{235000}} = 16.3$

$b/f = 0.15/0.014 = 10.7 \Longrightarrow 10.7 < 16.3$ Narin olmayan

Gövde Narinliği

Slender Limit $\lambda_r = 1.49\sqrt{\frac{E}{F_y}} = 1.49\sqrt{\frac{2.000E+8}{235000}} = 43.5$

$h/tw = 0.208/0.0085 = 24.5 \Longrightarrow 24.5 < 43.5$ Narin olmayan

Başlık Narinliği

Compact Limit $\lambda_p = 0.38\sqrt{\frac{E}{F_y}} = 0.38\sqrt{\frac{2.000E+8}{235000}} = 11.1$

Non compact Limit $\lambda_r = 1\sqrt{\frac{E}{F_y}} = 1\sqrt{\frac{2.000E+8}{235000}} = 29.2$

$b/f = 0.15/0.014 = 10.7 \Longrightarrow$ Kompakt

Gövde Narinliği

Compact Limit $\lambda_p = 3.76\sqrt{\frac{E}{F_y}} = 3.76\sqrt{\frac{2.000E+8}{235000}} = 109.69$

Non compact Limit $\lambda_r = 5.7\sqrt{\frac{E}{F_y}} = 5.7\sqrt{\frac{2.000E+8}{235000}} = 166.29$

$h/tw = 0.208/0.0085 = 24.5 \Longrightarrow$ Kompakt

Check against flexure and axial force

Yük Birleşimleri

ComboType = *ULS*

Combo Name = 1.2xOLU+1.2xASIK+1.2xKAPLAMA+1.6xKAR1

İstasyon

Loc :	6	*m*
N :	-69.9	*kN*
M33 :	-171.43	*kN.m*
V22 :	0.0	*kN*
M22 :	0.0	*kN.m*
V33 :	-51.9	*kN*
T :	0.0	*kN*

Narin olmayan enkesitli elemanlarin eksenel basinc kuvveti altindaki nominal basinc dayaniminin hesaplanmasi,

$$\left(\frac{L_c}{r}\right)_{major} = \frac{k_x \cdot L_{major}}{i_x} = \frac{k_x \cdot L_{major}}{\sqrt{\frac{I_{xx}}{A_g}}} = \frac{0.5 \cdot 3}{\sqrt{\frac{0.000195}{0.0121}}} = 23.6$$

$$\left(\frac{L_c}{r}\right)_{minor} = \frac{k_y \cdot L_{minor}}{i_y} = \frac{k_y \cdot L_{minor}}{\sqrt{\frac{I_{yy}}{A_g}}} = \frac{0.5 \cdot 3}{\sqrt{\frac{6.33E\text{-}05}{0.0121}}} = 41.4$$

$$\frac{L_c}{r} = \max\left\{\left(\frac{L_c}{r}\right)_{major}, \left(\frac{L_c}{r}\right)_{minor}\right\} = 41.4$$

Elastik burkulma gerilmesi,

$$F_e = \frac{\pi^2 E}{\left(\frac{L_c}{r}\right)^2} = \frac{\pi^2 \cdot 200E{+}6}{(41.4)^2} = 1149315.55 \ kN/m^2 \qquad (8.4)$$

Kritik burkulma gerilmesi F_{craxis}

$$\frac{L_c}{r} \leq 4.71\sqrt{\frac{E}{F_y}} \qquad 41.4 \leq 4.71\sqrt{\frac{200E{+}6}{235000}} \qquad 41.4 \leq 137.4 \Rightarrow$$

$$F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right] \cdot F_y = \left[0.658^{\frac{235000}{1149315.55}}\right] \cdot 235000 = 215725.06 \ kN \qquad (8.2)$$

$$P_n = F_{cr} \cdot A_g = 215725.06 \cdot 0.0121 = 2607.04 \ kN \qquad (8.1)$$

$$\left(\frac{KL}{r}\right)_{major} = \frac{k_x L_x}{i_x} = \frac{k_x L_x}{\sqrt{\frac{I_{xx}}{A_g}}} = \frac{0.5 \cdot 3}{\sqrt{\frac{0.000195}{0.0121}}} = 23.6$$

$$\left(\frac{KL}{r}\right)_{minor}=\frac{k_y L_y}{i_y}=\frac{k_y L_y}{\sqrt{\frac{I_{yy}}{A_g}}}=\frac{0.5\cdot 3}{\sqrt{\frac{6.33\text{E-}05}{0.0121}}}=41.4$$

$$F_{e\_x}=\frac{\pi^2 E}{\left(\frac{L_c}{r}\right)^2_{major}}=\frac{\pi^2\cdot 200\text{E+}6}{(Lcr)^2}=3531803.94\ kN \qquad (8.4)$$

$$F_{e\_y}=\frac{\pi^2 E}{\left(\frac{L_c}{r}\right)^2_{minor}}=\frac{\pi^2\cdot 200\text{E+}6}{(Lcr)^2}=1149315.55\ kN \qquad (8.4)$$

$$F_{eaxis}=\left(\frac{\pi^2\cdot E\cdot C_w}{(K_z\cdot L)^2}+G\cdot I_t\right)\frac{1}{(I_{xx}+I_{yy})} \qquad (8.5)$$

$$F_e=\left(\frac{\pi^2\cdot 200\text{E+}6\cdot 1.21\text{E-}06}{(1\cdot 3)^2}+7.692\text{E+}7\cdot 8.52\text{E-}07\right)\frac{1}{(6.33\text{E-}05+0.000195)}=1279507.77\ kN$$

Kritik burkulma gerilmesi F_{craxis}

$$\frac{L_c}{r}\le 4.71\sqrt{\frac{E}{F_y}} \qquad 41.4\le 4.71\sqrt{\frac{200\text{E+}6}{235000}} \qquad 41.4\le 137.4\Rightarrow$$

$$F_{cr}=\left[0.658^{\frac{F_y}{F_e}}\right]\cdot F_y=\left[0.658^{\frac{235000}{1279507.77}}\right]\cdot 235000=217611.8\ kN \qquad (8.2)$$

$$P_n=F_{cr}\cdot A_g=217611.8\cdot 0.0121=2629.84\ kN \qquad (8.1)$$

Selection of Compressive Design Strength

$$P_n=\min\{P_1,P_2,P_3,P_4\}$$
$$P_n=\min\{2607.04,2629.84,0.0,0.0\}=2607.04$$
$$P=\Phi_c\cdot P_n=0.9\cdot 2607.04=2346.33$$

C_b *yanal burkulmali burulma duzeltme katsayisi*, (9.1)

$$C_b=\frac{12.5M_{max}}{2.5M_{max}+3M_A+4M_B+3M_C} \qquad (9.1)$$

$$C_b=\frac{12.5\cdot 171.43}{2.5\cdot 171.43+3\cdot 61.94+4\cdot 15.85+3\cdot 93.64}=2.24$$

Kuvvetli eksenleri etrafında eğilme etkisindeki kompakt U-enkesitli ve çift simetri eksenli kompakt I-enkesitli elemanlar

$M_n = M_p = F_y Z_x \qquad (9.2)$

$M_n = M_p = 235000 \cdot 0.00148 = 348.5 \quad kNm$

Lateral torsional buckling resistance of doubly symmetric compact I-Shaped members and channels bent about their major axis, as per F2.2

$r_{ts}^2 = \dfrac{\sqrt{I_y C_w}}{S_x} \qquad (9.8a)$

$r_{ts}^2 = \dfrac{\sqrt{6.33\text{E-05x}1.206027\text{E-006}}}{0.00134} = 0.00651 \Longrightarrow r_{ts} = 0.0807$

$L_p = 1.76 r_y \sqrt{\dfrac{E}{F_y}} \qquad (9.6a)$

$L_p = 1.76 \cdot 0.0724 \cdot \sqrt{\dfrac{200\text{E+6}}{235000}} = 3.72 \quad m$

$L_r = 1.95 r_{ts} \dfrac{E}{0.7F_y} \sqrt{\dfrac{Jc}{S_x h_o} + \sqrt{\left(\dfrac{Jc}{S_x h_o}\right)^2 + 6.76\left(\dfrac{0.7F_y}{E}\right)^2}} \qquad (9.6b)$

$L_r = 1.95 \cdot 0.0807 \dfrac{200\text{E+6}}{0.7 \cdot 235000} \sqrt{\dfrac{8.52\text{E-07}}{0.00134 \cdot 0.276} + \sqrt{\left(\dfrac{8.52\text{E-07}}{0.00134 \cdot 0.276}\right)^2 + 6.76\left(\dfrac{0.7 \cdot 235000}{200\text{E+6}}\right)^2}}$

$L_r = 14.1 \quad m$

$M_{n\text{-}major} = \min\{M_{F2\text{-}1}, M_{F2\text{-}1}\}$

$M_{n\text{-}major} = \min\{348.5, 348.5\}$

$M_{n\text{-}major} = 348.5 \quad kN\text{-}m$

Zayıf eksenleri etrafında eğilme etkisindeki I-enkesitli ve U-enkesitli elemanlar

Akma Sinir Durumu

$M_n = M_p = F_y Z_y \leq 1.6 F_y S_y \qquad (9.39)$

$M_n = M_p = 235000 \cdot 0.000654 \leq 1.6 \cdot 235000 \cdot 0.000422 = 153.7 \quad kN\text{-}m$

Nominal flexural strength

$M_{desing,cx+} = \Phi_b \cdot M_{n,x+} = 0.9 \cdot 348.5 = 313.65 \quad kN\text{-}m$

$M_{desing,cy+} = \Phi_b \cdot M_{n,y+} = 0.9 \cdot 153.7 = 138.33 \quad kN\text{-}m$

Egilme momenti ve eksenel kuvvet etkisindeki cift ve tek simetri eksenli elemanlar

$$\frac{P_r}{P_c}<0.2 \Rightarrow \frac{69.9}{2346.33}<0.2 \text{ oldugunda}$$

$$\frac{P_r}{2P_c}+\left(\frac{M_{rx}}{M_{cx}}+\frac{M_{ry}}{M_{cy}}\right)\leq 1.0 \qquad (11.1b)$$

$$\frac{69.9}{2\cdot 2346.33}+\left(\frac{-171.43}{313.65}+\frac{0.0}{138.33}\right)\leq 1.0$$

$0.561 \leq 1.0$ *Yeterli* ✔ *o.k.*

Check against shear

Yük Birleşimleri

ComboType = *ULS*

Combo Name = 1.2xOLU+1.2xASIK+1.2xKAPLAMA+1.6xKAR1

İstasyon

Loc :	0.0	*m*
N :	-78.6	*kN*
M33 :	139.73	*kN.m*
V22 :	0.0	*kN*
M22 :	0.0	*kN.m*
V33 :	-51.9	*kN*
T :	0.0	*kN*

G − SHEAR STRENGHT in y direction

$E = 200E{+}6\ kN/m^2$

$F_y = 235000\ kN/m^2$

$A_v = 0.00456\ m^2$

Section Type = *HSection*

$h = h\_2c = 0.208\ m$

$t_w = 0.0085\ m$

C_v *faktoru hesabi*

$$h/t_w \leq 2.24\cdot\sqrt{E/F_y} \rightarrow C_w = 1$$

$$24.5 \leq 2.24\cdot\sqrt{200E{+}6/235000} \rightarrow C_w = 1 \qquad (10.1a)$$

$$V_n = 0.6\cdot F_y\cdot A_w\cdot C_{vPB} \qquad (10.1)$$

$$V_n = 0.6\cdot 235000\cdot 0.00456\cdot 1 = 642.96\ kN$$

$$ratio_{shear\ y} = V_y \Big/ \Phi_n V_{n-y}$$

$$ratio_{shear\ y} = 51.9 / (1 \cdot 642.96) = 0.0807 < 1.0$$ ✔ o.k.

Deplasman Kontrolü

Combo : SLS − OLU+ASIK+KAPLAMA+KAR1+0.5xRUZGAR-R

$$\delta_{limit} = \frac{l}{Limit} = \frac{6}{300} = 0.02\ m$$

$$\delta/\delta_{limit} = 0.011/0.02 = 0.55 \leq 1 \rightarrow Yeterli$$ ✔ o.k.

Combo : Live − RUZGAR-L

$$\delta_{limit} = \frac{l}{Limit} = \frac{6}{360} = 0.017\ m$$

$$\delta/\delta_{limit} = 0.00898/0.017 = 0.54 \leq 1 \rightarrow Yeterli$$ ✔ o.k.