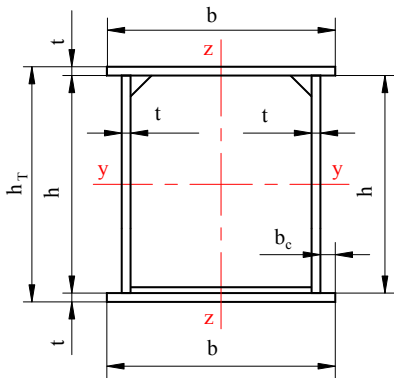
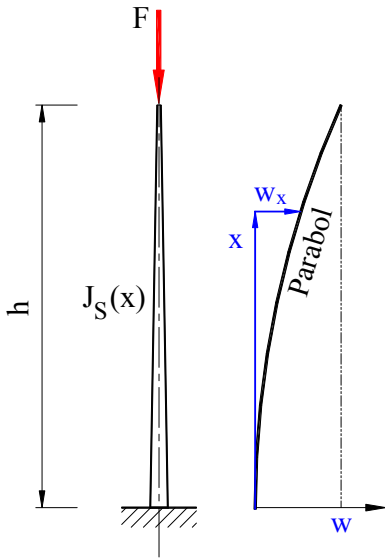


Zorlama: Yalnız aksenal kuvvet

Bilinen değerler:



Resim 2

Kesit II, alt 4 m:

Faktörler

$$x := 4 \cdot \text{m}$$

$$\text{Malzeme} := \text{"S235"}$$

$$f_y := 235 \cdot \text{MPa}$$

$$E := 210000 \cdot \text{MPa}$$

$$\gamma_M := 1.1$$

$$h_S := 4 \cdot \text{m}$$

Emniyetli akma mukavemeti

$$f_{EM} := \frac{f_y}{\gamma_M}$$

$$f_{EM} = 213.6 \cdot \text{MPa}$$

Resim 1

$$F_x := 700 \cdot \text{kN}$$

Kabul: Eğrinin şekli parabol

$$H_y := 60 \cdot \text{kN}$$

$$H_z := 40 \cdot \text{kN}$$

Kesit 0, üst 0 m:

$$b_0 := 320 \cdot \text{mm}$$

$$h_0 := 320 \cdot \text{mm}$$

$$t := 10 \cdot \text{mm}$$

$$b_c := 10 \cdot \text{mm}$$

$$h_{T0} := h_0 + 2 \cdot t$$

$$h_{T0} = 340 \cdot \text{mm}$$

$$z_0 := 0.5 \cdot (h_0 + t)$$

$$z_0 = 165 \cdot \text{mm}$$

$$J_{y0} := 2 \cdot \frac{b_0 \cdot t^3}{12} + 2 \cdot \frac{t \cdot h_0^3}{12} + 2 \cdot t \cdot b_0 \cdot z_0^2$$

$$J_{y0} = 228.9 \cdot 10^6 \cdot \text{mm}^4$$

$$y_0 := 0.5 \cdot (b_0 + t) - b_c$$

$$y_0 = 155 \cdot \text{mm}$$

$$J_{z0} := 2 \cdot \frac{b_0^3 \cdot t}{12} + 2 \cdot \frac{t^3 \cdot h_0}{12} + 2 \cdot t \cdot h_0 \cdot y_0^2$$

$$J_{z0} = 208.4 \cdot 10^6 \cdot \text{mm}^4$$

z eksenli değerleri daha zayıf olduğundan hesaplar z eksenine göre yapılır.

$$W_{z0} := \frac{2 \cdot J_{z0}}{b_0}$$

$$W_{z0} = 1302.7 \cdot 10^3 \cdot \text{mm}^3$$

$$EJ_{z0} := E \cdot J_{z0}$$

$$EJ_{z0} = 43.8 \cdot \text{MN} \cdot \text{m}^2$$

$$A_0 := 2 \cdot t \cdot (b_0 + h_0)$$

$$A_0 = 12800 \cdot \text{mm}^2$$

$$k_{II} := 1.5$$

$$b_2 := k_{II} \cdot b_0$$

$$b_2 = 480 \cdot \text{mm}$$

$$h_2 := k_{II} \cdot h_0$$

$$h_2 = 480 \cdot \text{mm}$$

$$k_{IIb} := \frac{b_2}{b_0}$$

$$k_{IIb} = 1.500$$

$$k_b := \frac{k_{IIb} - 1}{h_S}$$

$$k_b = 0.125 \cdot \text{m}^{-1}$$

$$k_{bx} = 1 + k_b \cdot x$$

$$k_{IIh} := \frac{h_2}{h_0}$$

$$k_{IIh} = 1.500$$

$$k_h := \frac{k_{IIh} - 1}{h_S}$$

$$k_h = 0.125 \cdot \text{m}^{-1}$$

$$k_{hx} = 1 + k_h \cdot x$$

$$J_{z2} := 2 \cdot \frac{b_2^3 \cdot t}{12} + 2 \cdot \frac{t^3 \cdot h_2}{12} + 2 \cdot t \cdot h_2 \cdot [0.5 \cdot (b_2 + t) - b_c]^2$$

$$J_{z2} = 714.6 \cdot 10^6 \cdot \text{mm}^4$$

$$W_{z2} := \frac{2 \cdot J_{z2}}{b_2}$$

$$W_{z2} = 2977.3 \cdot 10^3 \cdot \text{mm}^3$$

$$A_2 := 2 \cdot t \cdot (b_2 + h_2)$$

$$A_2 = 19200 \cdot \text{mm}^2$$

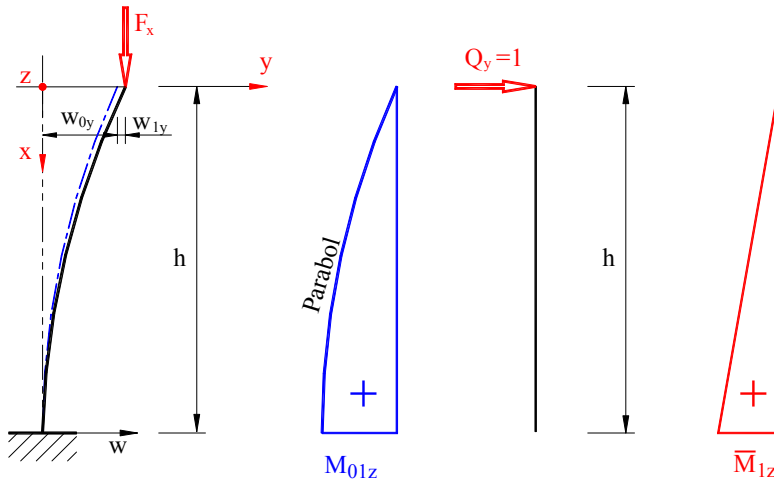
$$EJ_{z2} := E \cdot J_{z2}$$

$$EJ_{z2} = 150.1 \cdot \text{MN} \cdot \text{m}^2$$

x e bağı eylemsizlik ve karşı koyma momenti

$$y_x = 0.5 \cdot [b \cdot (1 + k_b \cdot x) - t] - b_c$$

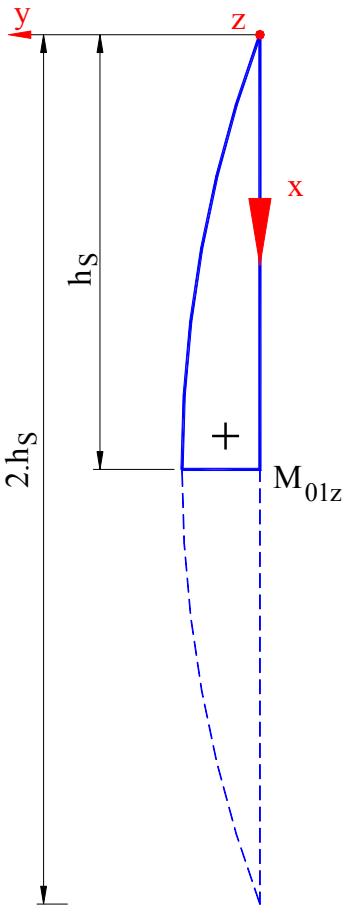
$$J_{zx} = 2 \cdot \left[\frac{b^3 \cdot (1 + k_b \cdot x)^3 \cdot t}{12} + \frac{t^3 \cdot h \cdot (1 + k_b \cdot x)}{12} + t \cdot h \cdot (1 + k_h \cdot x) \cdot [0.5 \cdot [b \cdot (1 + k_b \cdot x) - t] - b_c]^2 \right]$$

Vianelloya göre çözüm:**Resim 5**

$$M_{0z} = F_x \cdot w_{0y}$$

$$M_1 := h_s$$

$$w_{1yx} = \int_0^{h_s} M_{01zx} \cdot M_{1zx} \cdot \frac{1}{E \cdot J_{zx}} dx$$

**Resim 6**

Genelde parabol denklemi

$$M_{0zx} = a \cdot x^2 + b \cdot x + c$$

$$M_{0zx}(x=0) = 0$$

$$M_{0zx}(x=h_s) = F_x \cdot w_{0max}$$

$$M_{0zx}(x=2 \cdot h_s) = 0$$

Eğer $x=2 \cdot h_s$ yerleştirilirse:

$$0 = (2 \cdot L_s)^2 a + 2 \cdot L_s \cdot b$$

$$0 = 2 \cdot L_s a + b$$

b yi yerleştiririm

$$M_{0zx} = a \cdot x^2 + b \cdot x + c$$

$$F_x \cdot w_0 = a \cdot h_s^2 - 2 \cdot a \cdot h_s^2$$

$$F_x \cdot w_0 = -a \cdot h_s^2$$

$$b = -2 \cdot a \cdot h_s$$

x e bağı moment dağılımı

$$c = 0$$

$$b = -2 \cdot a \cdot L_s$$

$$x = h_s^2$$

$$F_x \cdot w_0 = a \cdot h_s^2 + b \cdot h_s + 0$$

$$a = -\frac{F_x \cdot w_0}{h_s^2}$$

$$b = -\frac{2 \cdot F_x \cdot w_0}{h_s}$$

$$M_{0zx} = -\frac{F_x \cdot w_{0y}}{h_s^2} \cdot x^2 - \frac{2 \cdot F_x \cdot w_{0y}}{h_s} \cdot x$$

$$M_{0zx} = F_x \cdot w_{0y} \cdot \left(\frac{x^2}{h_s^2} + \frac{2 \cdot x}{h_s} \right)$$

$$w_{1yx} = \int_0^{h_s} \frac{F_x \cdot w_{0y} \cdot \left(\frac{x^2}{h_s^2} + \frac{2 \cdot x}{h_s} \right) \cdot x}{2 \cdot E \cdot \left[\frac{b_0^3 \cdot (1 + k_b \cdot x)^3 \cdot t}{12} + \frac{t^3 \cdot h_0 \cdot (1 + k_b \cdot x)}{12} + t \cdot h_0 \cdot (1 + k_h \cdot x) \cdot [0.5 \cdot [b_0 \cdot (1 + k_b \cdot x) - t] - b_c]^2 \right]} dx$$

$$w_{1yx} := \int_0^{h_s} \frac{\frac{x^3}{h_s^2} + \frac{2 \cdot x^2}{h_s}}{2 \cdot E \cdot \left[\frac{b_0^3 \cdot (1 + k_b \cdot x)^3 \cdot t}{12} + \frac{t^3 \cdot h_0 \cdot (1 + k_b \cdot x)}{12} + t \cdot h_0 \cdot (1 + k_h \cdot x) \cdot [0.5 \cdot [b_0 \cdot (1 + k_b \cdot x) - t] - b_c]^2 \right]} dx$$

$F_x \cdot w_{0y} = \text{sabit}$ İntegralin dışına alalım ve integralin değeri:

$$w_{1yx} = 139 \cdot \frac{10^{-9}}{N}$$

Kritik burkulma kuvveti

Eğer $F_x = F_{kr}$; $w_{y\max} = w_{0yx}$ ve $w_{z\max} = w_{0zx}$ ise:

$$w_{y\max} = F_x \cdot w_{0yx} \cdot w_{1yx} \quad 1 = F_{kr} \cdot w_{1yx} \quad F_{kr} := \frac{1}{w_{1yx}} \quad F_{kr} = 7196.2 \cdot \text{kN}$$

$$F_{kr} = 7196 \cdot \text{kN}$$

$$F_x = 700 \cdot \text{kN}$$

Sonuç: Çubukta burkulma tehlikesi yoktur.

Kesit II de mukavemet hesabı:

Eylemsizlik radyusu $i_{z2} := \sqrt{\frac{J_{z2}}{A_2}} \quad i_{z2} = 192.9 \cdot \text{mm}$

Euler burkulma boyu $L_{Bz2} := \sqrt{\frac{E J_{z2} \cdot \pi^2}{F_{kr}}} \quad L_{Bz2} = 14.346 \text{ m}$

Akma narinliği $\lambda_E := \pi \cdot \sqrt{\frac{E}{f_y}} \quad \lambda_E = 93.9$

Narinlik $\lambda_{z2} := \frac{L_{Bz2}}{i_{z2}} \quad \lambda_{z2} = 74.4$

Bağıntılı narinlik	$\lambda_{Bz2} := \frac{\lambda_{z2}}{\lambda_E}$	$\lambda_{Bz2} = 0.792$
Merkez noktası mesafesi	$k_{elz2} := \frac{W_{z2}}{A_2}$	$k_{elz2} = 155.1 \cdot \text{mm}$
Akma kuvveti	$F_{pl2} := A_2 \cdot f_{EM}$	$F_{pl2} = 4101.8 \cdot \text{kN}$
Burkulma parametresi	$\alpha_B := 0.34$ Kaynaklı kutular her ekseninde.	
Max burkulma sehimi	$w_{zmax2} := k_{elz2} \cdot \alpha_B \cdot (\lambda_{Bz2} - 0.2)$	$w_{zmax2} = 31.2 \cdot \text{mm}$
Burkulma yardımcı faktörü	$\varphi_{Bz2} := 0.5 \cdot \left[1 + \alpha_B \cdot (\lambda_{Bz2} - 0.2) + \lambda_{Bz2}^2 \right]$	$\varphi_{Bz2} = 0.91$
Azaltma faktörü	$\chi_{Bz2} := \frac{1}{\varphi_{Bz2} + \sqrt{\varphi_{Bz2}^2 - \lambda_{Bz2}^2}}$	$\chi_{Bz2} = 0.729$
Kuvvetin mukavemet emniyeti	$S_{Fz2} := \frac{F_x}{\chi_{Bz2} \cdot F_{pl2}}$	$S_{Fz2} = 0.234$

Burkulma sehimi momenti:

	$M_{pl2} := W_{z2} \cdot f_{EM}$	$M_{pl2} = 636.1 \cdot \text{kN} \cdot \text{m}$
	$M_{b2} := F_x \cdot w_{zmax2}$	$M_{b2} = 21.8 \cdot \text{kN} \cdot \text{m}$
$\Delta M < 1$	$\Delta M := \frac{M_{b0}}{M_{b2}}$	$\Delta M = 0.000$
	$\beta_m := 0.66 + 0.44 \cdot \Delta M$	$\beta_m = 0.66$
Momentin mukavemet emniyeti	$S_{Mz} := \frac{\beta_m \cdot M_{b2}}{M_{pl2}}$	$S_{Mz} = 0.023$
		$\Delta n := 0.1$
	$S_{he} := S_{Fz2} + S_{Mz} + \Delta n$	$S_{he} = 0.357$

Sonuç: S_{he} değeri 1 den küçük olduğundan konstrüksiyon fonksiyonunu yapar.

SON
