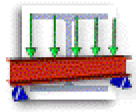
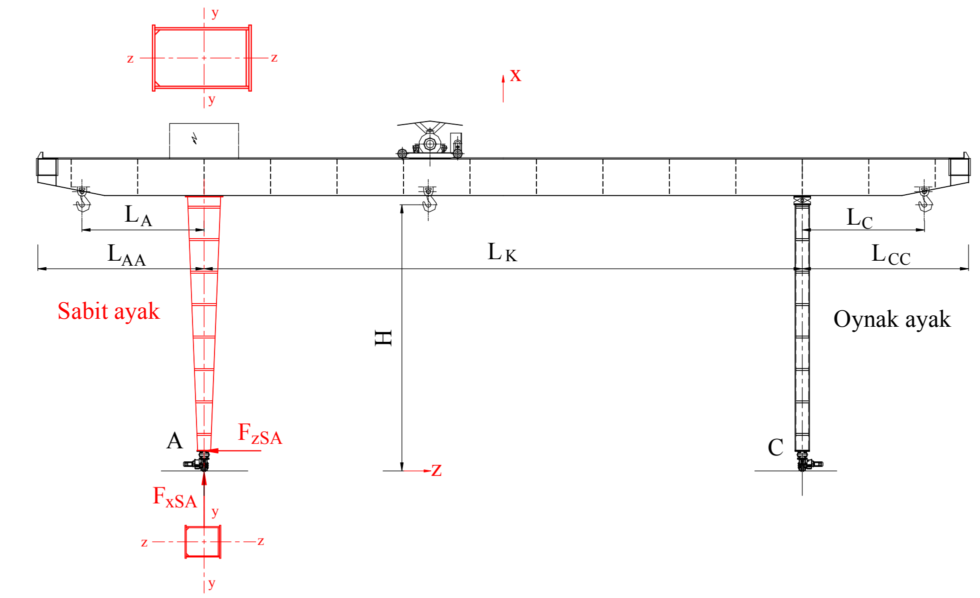
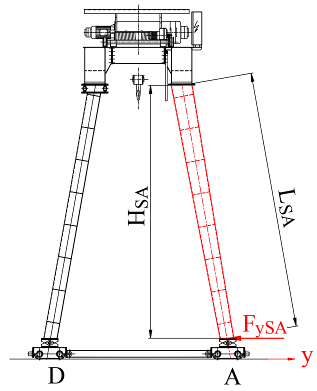


Portal vinç kiriş altı sabit ayak

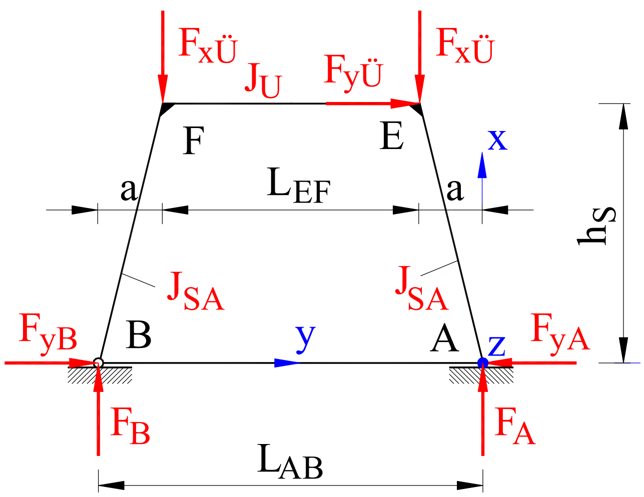
Reference:C:\0\43_01_01_PV_320kN_18m_00_Giris.xmcd
Reference:C:\0\43_01_01_PV_320kN_18m_01_Kiris_ve_UB_Genel.xmcd
Reference:C:\0\43_01_01_PV_320kN_18m_02_0_Ayak_Ondegerleri.xmcd

4 0
Sabit Ayak





xz ekseninde sabit ayak konstrüksiyonu ve hesabı:



$h_S := 7850 \cdot mm$ $\alpha_S := 10 \cdot deg$

$L_{EF} := 2620 \cdot mm$

$a_S := h_S \cdot \tan(\alpha_S)$ $a_S = 1384 \cdot mm$

$L_{AB} := L_{EF} + 2 \cdot a_S$ $L_{AB} = 5388 \cdot mm$

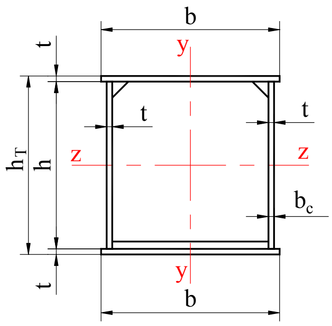
$F_{xAlt} := F_{xÜ} + F_{yÜ} \cdot \frac{h_S}{L_{AB}}$ $F_{xAlt} = 335.343 \cdot kN$

$F_{yAlt} := F_{xÜ} \cdot \frac{a_S}{h_S} + F_{yÜ}$ $F_{yAlt} = 66.11 \cdot kN$

Sabit ayak konstrüksiyonu ve hesabı:

Bilinen değerler:

$F_{SAeks} := F_{xAlt} \cdot \cos(\alpha_S) + F_{yAlt} \cdot \sin(\alpha_S)$ $F_{SAeks} = 341.7 \cdot kN$

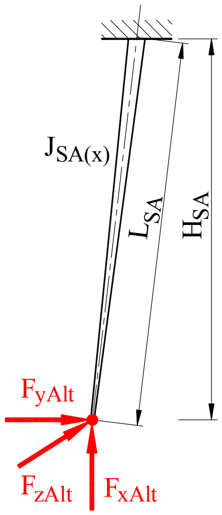


Ekonomik konstrüksiyon için ayak alt kesitinin montaj ölçüleri oynak ayağın aynısı alınır

$b_A := 300 \cdot mm$ $h_A := 300 \cdot mm$ $t := 6 \cdot mm$ $b_ç := 10 \cdot mm$

$y_A := 0.5 \cdot (h_A + t)$ $y_A = 153 \cdot mm$

$J_{zA} := 2 \cdot \frac{b_A \cdot t^3}{12} + 2 \cdot \frac{t \cdot h_A^3}{12} + 2 \cdot t \cdot b_A \cdot y_A^2$ $J_{zA} = 111 \cdot 10^6 \cdot mm^4$



$h_{TA} := h_A + 2 \cdot t$ $\quad h_{TA} = 312 \cdot mm$

$W_{zA} := \frac{2 \cdot J_{zA}}{h_{TA}}$ $\quad W_{zA} = 713.4 \cdot 10^3 \cdot mm^3$

$A_A := 2 \cdot t \cdot (b_A + h_A)$ $\quad A_A = 7200 \cdot mm^2$

Konstrüksiyon resminden $\quad L_{SA} := 7840 \cdot mm$

$z_A := 0.5 \cdot (b_A - t) - b_ç$ $\quad z_A = 137 \cdot mm$

$J_{yA} := 2 \cdot \frac{b_A^3 \cdot t}{12} + 2 \cdot \frac{t^3 \cdot h_A}{12} + 2 \cdot t \cdot h_A \cdot y_A^2$ $\quad J_{yA} = 111.3 \cdot 10^6 \cdot mm^4$

$W_{yA} := \frac{2 \cdot J_{yA}}{b_A}$ $\quad W_{yA} = 741.9 \cdot 10^3 \cdot mm^3$

$J_{yK} := J_y$ $\quad k_{xz} := \frac{L_K^2}{J_{yK}}$ $\quad k_{xz} = 46083 \frac{1}{m^2}$ $\quad k_{xy} := \frac{L_{AR}^2}{J_{uY}}$ $\quad k_{xy} = 1492 \frac{1}{m^2}$

$k_{xz} > k_{xy}$ olduğundan hesaplar xz kesitinde yapılacaktır.

Kesit E: $\quad b_E := 680 \cdot mm$ $\quad h_E := 680 \cdot mm$ $\quad f_{EM} = 213.6 \cdot MPa$

Faktörler:

$k_{8b} := \frac{b_E}{b_A}$ $\quad k_{8b} = 2.26667$ $\quad k_b := \frac{k_{8b} - 1}{L_{SA}}$ $\quad k_b = 0.1616 m^{-1}$

$k_{8h} := \frac{h_E}{h_A}$ $\quad k_{8h} = 2.26667$ $\quad k_h := \frac{k_{8h} - 1}{L_{SA}}$ $\quad k_h = 0.1616 m^{-1}$

$A_E := 2 \cdot t \cdot (b_E + h_E)$ $\quad A_E = 16320 \cdot mm^2$

x e bağlı Eylemsizlik ve karşı koyma momentleri ile alan formülü:

$$J_{yx} = \frac{t}{6} \cdot \left[b_A \cdot (1 + k_b \cdot x) \cdot t^2 + \left[h_A \cdot (1 + k_h \cdot x) \right]^3 + 3 \cdot b_A \cdot (1 + k_b \cdot x) \cdot \left[h_A \cdot (1 + k_h \cdot x) + t \right]^2 \right]$$

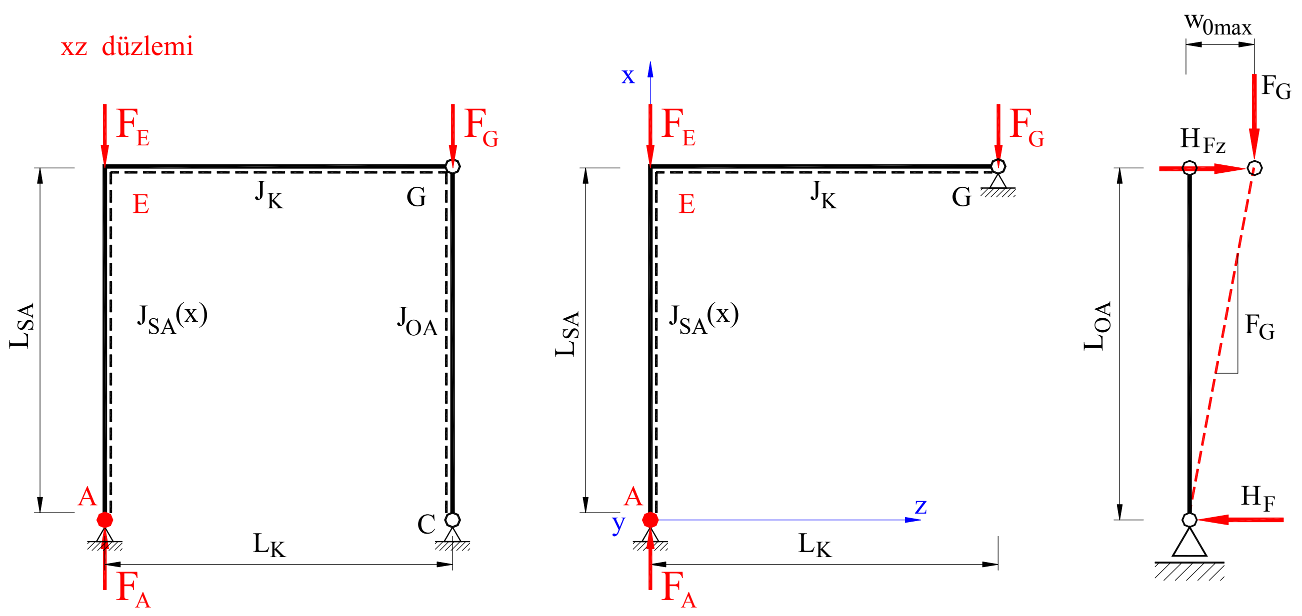
$$W_{yx} = \frac{2 \cdot J_{yx}}{h_A \cdot (1 + k_h \cdot x) + 2 \cdot t}$$

$$J_{zx} = \frac{t}{6} \cdot \left[b_A^3 \cdot (1 + k_b \cdot x)^3 + t^2 \cdot h_A \cdot (1 + k_h \cdot x) + 3 \cdot h_A \cdot (1 + k_h \cdot x) \cdot \left[b_A \cdot (1 + k_b \cdot x) - t - b_ç \right]^2 \right]$$

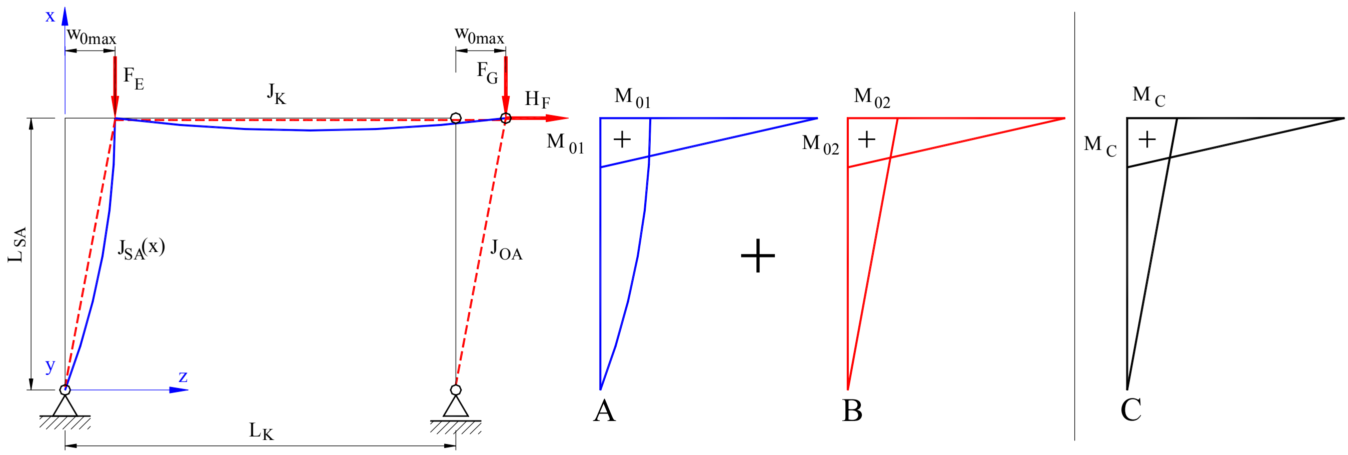
$$W_{zx} = \frac{2 \cdot J_{zx}}{b_A \cdot (1 + k_b \cdot x)}$$

Vianelloya göre çözüm:

$$A_x = 2 \cdot t \cdot \left[b_A \cdot (1 + k_b \cdot x) + h_A \cdot (1 + k_h \cdot x) \right]$$



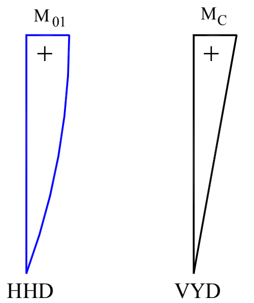
Sabit ayağın hesabı Vianello metodu ile xz düzlemine göre yapılır.



$F_E \cdot w_{0max} = H_F \cdot L_{SA}$ $\qquad H_F = \dfrac{F_E \cdot w_{0max}}{L_{SA}}$

$w_{01} = w_{0max}$ kabul edileceğinden w_{0max} ı hesaplamaya gerek yoktur.

Sabit ayakta F_E etkili 1. sehim



$$w_{11x} = \int_0^{L_{SA}} \frac{M_{01x} \cdot M_{Cx}}{E \cdot J_{ySAx}} dx$$

x e bağlı momentler:

$$M_{Cx} = \frac{x}{L_{SA}} \cdot L_{SA} = x$$

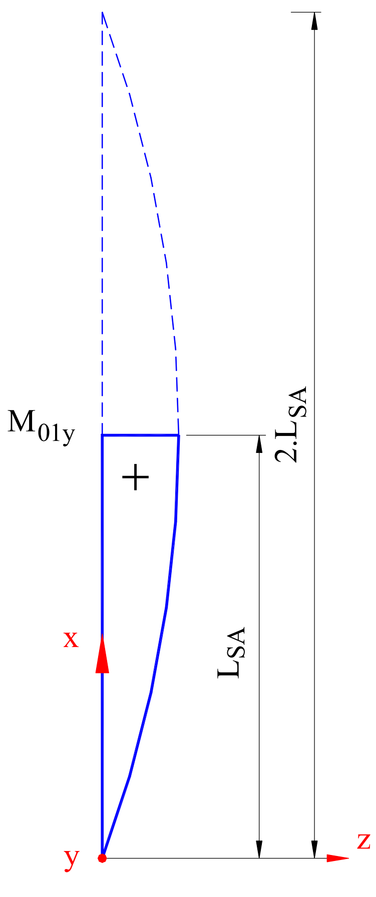
$$M_{01} = F_E \cdot w_{0max}$$

Aşağıda hesaplanan M_{01x} değerini yerleştirelim ve $F_E.w_{0max}$ sabit olduğundan integralin dışına alalım

$$w_{11x} = \int_0^{L_{SA}} \frac{\left(-\frac{F_E \cdot w_{0max}}{L_{SA}^2} \cdot x^2 - \frac{2 \cdot F_E \cdot w_{0max}}{L_{SA}} \cdot x\right) \cdot x}{2 \cdot E \cdot \left[\frac{b_A \cdot (1 + k_b \cdot x) \cdot t^3}{12} + \frac{t \cdot h_A^3 \cdot (1 + k_h \cdot x)^3}{12} + t \cdot b_A \cdot (1 + k_b \cdot x) \cdot [0.5 \cdot [h_A \cdot (1 + k_h \cdot x) + t]]^2\right]} dx$$

$$w_{11x} := \int_0^{L_{SA}} \frac{\frac{x^3}{L_{SA}^2} + \frac{2 \cdot x^2}{L_{SA}}}{2 \cdot E \cdot \left[\frac{b_A \cdot (1 + k_b \cdot x) \cdot t^3}{12} + \frac{t \cdot h_A^3 \cdot (1 + k_h \cdot x)^3}{12} + t \cdot b_A \cdot (1 + k_b \cdot x) \cdot [0.5 \cdot [h_A \cdot (1 + k_h \cdot x) + t]]^2\right]} dx$$

$$w_{11x} = 0.36 \cdot \frac{10^{-6}}{N}$$



M_{01} dağılımı parabol olursa parabolün genel formülü:

$$M_{01x} = a \cdot x^2 + b \cdot x + c$$

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

$M_{0ASx}(x=L_{SA}) = F_E \cdot w_{0max}$ $\qquad c = 0$

$M_{0ASx}(x=2.L_{SA}) = 0$

Eğer $x=2.L_{SA}$ yerleştirirsek:

$$0 = (2 \cdot L_{SA})^2 a + 2 \cdot L_{SA} \cdot b$$

$$0 = 2 \cdot L_{SA} a + b \qquad b = -2 \cdot a \cdot L_{SA}$$

$$x = L_{SA}$$

$$M_{01x} = a \cdot x^2 + b \cdot x + c \qquad F_E \cdot w_{0max} = a \cdot L_{SA}^2 + b \cdot L_{SA} + 0$$

$$F_E \cdot w_{0max} = a \cdot L_{SA}^2 - 2 \cdot a \cdot L_{SA}^2$$

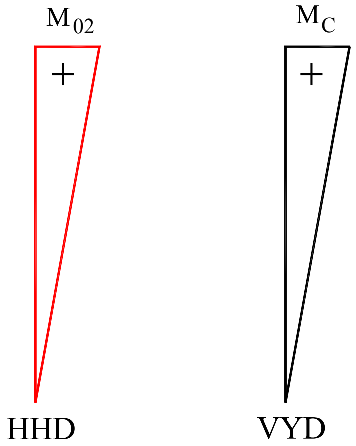
$$F_E \cdot w_{0max} = -a \cdot L_{SA}^2 \qquad a = -\frac{F_E \cdot w_{0max}}{L_{SA}^2}$$

$$b = -2 \cdot a \cdot L_{SA} \qquad b = -\frac{2 \cdot F_E \cdot w_{0max}}{L_{SA}}$$

x e bağlı parabol olarak dağılımlı moment:

$$M_{01x} = -\frac{F_E \cdot w_{0max}}{L_{SA}^2} \cdot x^2 - \frac{2 \cdot F_E \cdot w_{0max}}{L_{SA}} \cdot x$$

Sabit ayağın H_F etkili 2. sehimi



$$w_{12x} = \int_0^{L_Ç} \frac{M_{02x} \cdot M_{Cx}}{E \cdot J_{ySAx}} dx$$

x e bağlı momentler:

$$M_C = \frac{x}{L_{SA}} \cdot L_{SA} = x$$

$$M_{02} = H_F \cdot L_{SA} = F_E \cdot w_{0max}$$

$$M_{02x} = H_F \cdot x = \frac{x}{L_{SA}} \cdot F_E \cdot w_{0max}$$

$$w_{12x} = \int_0^{L_{SA}} \frac{\frac{x}{L_{SA}} \cdot F_E \cdot w_{0max} \cdot x}{E \cdot J_{ySAx}} dx$$

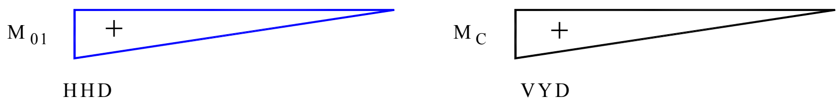
$$w_{12x} = \int_0^{L_{SA}} \frac{\frac{x^2}{L_{SA}}}{2 \cdot E \cdot \left[\frac{b_A \cdot (1 + k_b \cdot x) \cdot t^3}{12} + \frac{t \cdot h_A{}^3 \cdot (1 + k_h \cdot x)^3}{12} + t \cdot b_A \cdot (1 + k_b \cdot x) \cdot \left[0.5 \cdot \left[h_A \cdot (1 + k_h \cdot x) + t\right]\right]^2\right]} dx$$

$F_E \cdot w_{0max} = \text{sabit}$ olduğundan integralin dışına alalım.

$$w_{12x} := \int_0^{L_{SA}} \frac{6 \cdot x^2}{E \cdot \left[b_A \cdot (1 + k_b \cdot x) \cdot t^3 + t \cdot h_A{}^3 \cdot (1 + k_h \cdot x)^3 + 6 \cdot t \cdot b_A \cdot (1 + k_b \cdot x) \cdot \left[h_A \cdot (1 + k_h \cdot x) + t\right]^2\right] \cdot L_{SA}} dx$$

$$w_{12x} = 0.077 \cdot \frac{10^{-6}}{N}$$

EG Kirişinde F_E etkili 3. sehim



$$M_{01} = F_E \cdot w_{0max}$$

$$M_C = L_K$$

$$w_{13} = \int_0^{L_K} \frac{M_{01} \cdot M_C}{E \cdot J_{yK}} dx \qquad E \cdot J_{yK} = \text{sabit}$$

İntegral tablosundan Üçgen + Üçgen

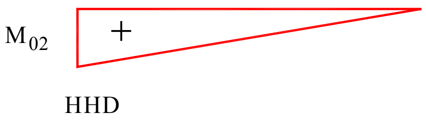
$$w_{13} = \frac{1}{3} \cdot \frac{F_E \cdot w_{0max} \cdot L_K{}^2}{E \cdot J_{yK}}$$

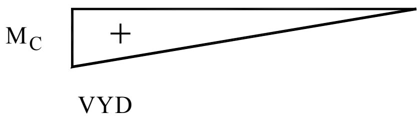
$F_E \cdot w_{0max} = \text{sabit}$ olduğundan integralin dışına alalım.

$$w_{13} := \frac{1}{3} \cdot \frac{L_K{}^2}{E \cdot J_{yK}}$$

$$w_{13} = 0.073 \cdot \frac{10^{-6}}{N}$$

EG Kirişinde H_F etkili 4. sehim





$M_{02} = F_E \cdot w_{0max}$

$M_C = L_K$

$$w_{14} = \int_0^{L_K} \frac{M_{02} \cdot M_C}{E \cdot J_{yK}} dx \qquad E \cdot J_{yK} = \text{sabit}$$

İntegral tablosundan Üçgen + Üçgen $w_{14} = \frac{1}{3} \cdot \frac{F_E \cdot w_{0max} \cdot L_K^2}{E \cdot J_{yK}}$

$F_E \cdot w_{0max}$ = sabit olduğundan integralin dışına alalım. $w_{14} := \frac{1}{3} \cdot \frac{L_K^2}{E \cdot J_{yK}}$ $w_{14} = 0.073 \cdot \frac{10^{-6}}{N}$

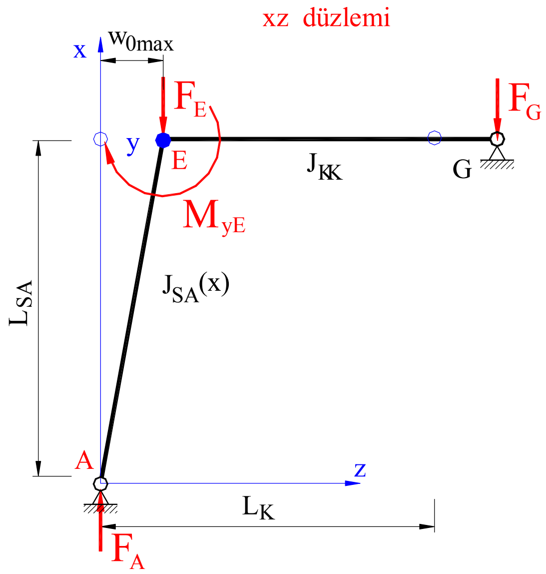
$w_{01} = F_E \cdot w_{0max} \cdot (w_{11x} + w_{12x} + w_{13} + w_{14})$ $F_E = F_{kr}$ $w_{01} = w_{0max}$ kabul edersek

$$F_{kr} := \frac{1}{w_{11x} + w_{12x} + w_{13} + w_{14}} \qquad F_{kr} = 1715 \cdot kN \qquad F_{SAeks} = 342 \cdot kN$$

Sonuç: Çubukta burkulma tehlikesi yoktur.

E Kesitinde mukavemet hesabı:

Eğilme momenti M_{yE}



$xE := L_{SA}$

$$J_{yE} := 2 \cdot \left[\frac{b_A \cdot (1 + k_b \cdot xE) \cdot t^3}{12} + \frac{t \cdot h_A^3 \cdot (1 + k_h \cdot xE)^3}{12} + t \cdot b_A \cdot (1 + k_b \cdot xE) \cdot [0.5 \cdot [h_A \cdot (1 + k_h \cdot xE) + t]]^2 \right] \qquad J_{yE} = 1274 \cdot 10^6 \cdot mm^4$$

$h_{TE} := h_E + 2 \cdot t$ $W_{yE} := \frac{2 \cdot J_{yE}}{h_{TE}}$ $W_{yE} = 3683 \cdot 10^3 \cdot mm^3$

Eylemsizlık radyusu $i_{yE} := \sqrt{\frac{J_{yE}}{A_E}}$ $i_{yE} = 279.5 \cdot mm$

Euler burkulma boyu	$L_{ByE} := \sqrt{\frac{E \cdot J_{yE} \cdot \pi^2}{F_{kr}}}$	$L_{ByE} = 39.249\,m$
Akma narinliği	$\lambda_{Ef} := \pi \cdot \sqrt{\frac{E}{f_y}}$	$\lambda_{Ef} = 93.913$
Temel narinlik	$\lambda_{yE} := \frac{L_{ByE}}{i_{yE}}$	$\lambda_{yE} = 140.451$
Bağıntılı narinlik	$\lambda_{ByE} := \frac{\lambda_{yE}}{\lambda_{Ef}}$	$\lambda_{ByE} = 1.496$
Merkez noktası mesafesi	$k_{elyE} := \frac{W_{yE}}{A_E}$	$k_{elyE} = 225.701 \cdot mm$
Akma kuvveti	$F_{plE} := A_E \cdot f_{EM}$	$F_{plE} = 3486.5 \cdot kN$
Burkulma parametresi	$\alpha_B := 0.34$ Kaynaklı kutular her eksende.	
Max burkulma sehimi	$w_{ymaxE} := k_{elyE} \cdot \alpha_B \cdot (\lambda_{ByE} - 0.2)$	$w_{ymaxE} = 99.418 \cdot mm$
Burkulma yardımcı faktörü	$\varphi_{ByE} := 0.5 \cdot \left[1 + \alpha_B \cdot (\lambda_{ByE} - 0.2) + \lambda_{ByE}^2\right]$	$\varphi_{ByE} = 1.84$
Azaltma faktörü	$\chi_{ByE} := \frac{1}{\varphi_{ByE} + \sqrt{\varphi_{ByE}^2 - \lambda_{ByE}^2}}$	$\chi_{ByE} = 0.344$
Kuvvetin mukavemet emniyeti	$S_{FyE} := \frac{F_{xAlt}}{\chi_{ByE} \cdot F_{plE}}$	$S_{FyE} = 0.280$
Plastikliğin en küçük momenti	$M_{plyE} := W_{yE} \cdot f_{EM}$	$M_{plyE} = 786.9 \cdot kN \cdot m$
	$F_{zAlt1} = 65 \cdot kN$	$M_{0yE} := 0 \cdot kN \cdot m$
	$M_{EyE} := F_{xAlt} \cdot w_{ymaxE} + F_{zAlt1} \cdot w_{ymaxE}$	$M_{EyE} = 39.848 \cdot kN \cdot m$
$-1 \le \psi_y \le 1$	$\psi_{yE} := \frac{M_{0yE}}{M_{EyE}}$	$\psi_{yE} = 0.000$
	$\beta_{MyE} := 1.8 - 0.7 \cdot \psi_{yE}$	$\beta_{MyE} = 1.8$
$\alpha_{pl} \ge 1$	$\alpha_{plyE} := \frac{M_{plyE}}{M_{EyE}}$	$\alpha_{plyE} = 19.748$
$a_y \le 0.8$	$a_{yxE} := \lambda_{ByE} \cdot (2 \cdot \beta_{MyE} - 4) + (\alpha_{plyE} - 1)$	$a_{yxE} = 18.15$
	$a_{yE} := \begin{cases} a_{yxE} & \text{if } a_{yxE} \le 0.8 \\ 0.8 & \text{otherwise} \end{cases}$	$a_{yE} = 0.8$

$k_y \leq 1,5$

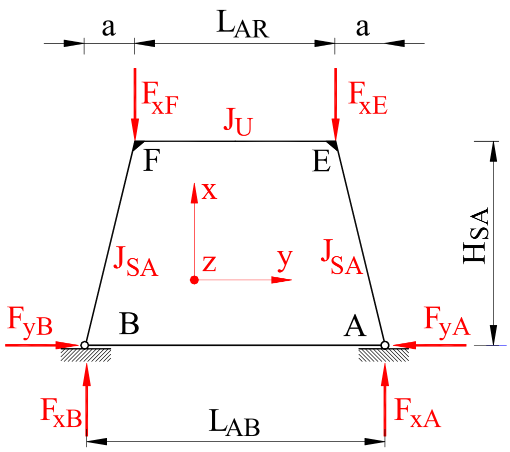
$$k_{yxE} := 1 - \frac{F_{xAlt}}{\chi_{ByE} \cdot F_{plE}} \cdot a_{yE} \qquad k_{yxE} = 0.776$$

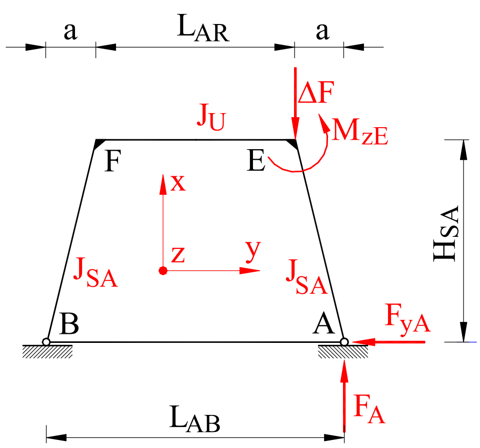
$$k_{yE} := \begin{cases} k_{yxE} & \text{if } k_{yxE} \leq 1.5 \\ 1.5 & \text{otherwise} \end{cases} \qquad k_{yE} = 0.776$$

$$S_{MyE} := \frac{M_{EyE}}{M_{plyE}} \cdot k_{yE} \qquad S_{MyE} = 0.039$$

Eğilme momenti M_{zE}

Eğer F_{xF}=F_{xE} ise z eksenine göre eğılme momenti yoktur. Eğer F_{xE} > F_{xF} ise ΔF kuvvetine göre moment oluşur.





Burada F_{xF}=F_{xE} dir ve eğilme momenti sıfırdır.

$$M_{zE} := F_{yAlt} \cdot h_S$$

$$M_{zEx} := F_{xAlt} \cdot a_S - F_{yAlt} \cdot h_S + F_{yÜ} \cdot h_S \qquad M_{zEx} = 19 \cdot kN \cdot m$$

$$J_{zE} := 2 \cdot \left[\frac{b_A^{\,3} \cdot (1 + k_b \cdot xE)^3 \cdot t}{12} + \frac{t^3 \cdot h_A \cdot (1 + k_h \cdot xE)}{12} + t \cdot h_A \cdot (1 + k_h \cdot xE) \cdot \left[0.5 \cdot \left[b_A \cdot (1 + k_b \cdot xE) - t \right] - b_ç \right]^2 \right]$$

$$J_{zE} = 1187 \cdot 10^6 \cdot mm^4 \qquad W_{zE} := \frac{2 \cdot J_{zE}}{b_E} \qquad W_{zE} = 3491 \cdot 10^3 \cdot mm^3$$

Eylemsizlık radyusu $\quad i_{zE} := \sqrt{\frac{J_{zE}}{A_E}} \quad i_{zE} = 269.7 \cdot mm$

Euler burkulma boyu $\quad L_{BzE} := \sqrt{\frac{E \cdot J_{zE} \cdot \pi^2}{F_{kr}}} \quad L_{BzE} = 37.878\,m$

Narinlik $\quad \lambda_{zE} := \frac{L_{BzE}}{i_{zE}} \quad \lambda_{zE} = 140.451$

Bağıntılı narinlik $\quad \lambda_{BzE} := \frac{\lambda_{zE}}{\lambda_{Ef}} \quad \lambda_{BzE} = 1.496$

Merkez noktası mesafesi $\quad k_{elzE} := \frac{W_{zE}}{A_E} \quad k_{elzE} = 213.92 \cdot mm$

Max burkulma sehimi $w_{zmaxE} := k_{elzE} \cdot \alpha_B \cdot (\lambda_{BzE} - 0.2)$ $w_{zmaxE} = 94 \cdot mm$

Burkulma yardımcı faktörü $\varphi_{BzE} := 0.5 \cdot \left[1 + \alpha_B \cdot (\lambda_{BzE} - 0.2) + \lambda_{BzE}^2\right]$ $\varphi_{BzE} = 1.84$

Azaltma faktörü $\chi_{BzE} := \dfrac{1}{\varphi_{BzE} + \sqrt{\varphi_{BzE}^2 - \lambda_{BzE}^2}}$ $\chi_{BzE} = 0.344$

Kuvvetin mukavemet emniyeti $S_{FzE} := \dfrac{F_{SAeks}}{\chi_{BzE} \cdot F_{plE}}$ $S_{FzE} = 0.285$

Plastikliğin en küçük momenti

$M_{plzE} := W_{zE} \cdot f_{EM}$ $M_{plzE} = 745.8 \cdot kN \cdot m$

$M_{0zE} := F_{yÜ} \cdot h_S$ $M_{0zE} = 73.7 \cdot kN \cdot m$

$-1 \le \psi_z \le 1$ $\psi_{zE} := \dfrac{M_{0zE}}{M_{zEx}}$ $\psi_{zE} = 3.893$

$\beta_{MzE} := 1.8 - 0.7 \cdot \psi_{zE}$ $\beta_{MzE} = -0.925$

$\alpha_{pl} > 1$ $\alpha_{plzE} := \dfrac{M_{plzE}}{M_{zEx}}$ $\alpha_{plzE} = 39.375$

$a_{zEx} := \lambda_{BzE} \cdot (2 \cdot \beta_{MzE} - 4) + (\alpha_{plzE} - 1)$ $a_{zEx} = 29.626$

$a_{zE} := \begin{cases} a_{zEx} & \text{if } a_{zEx} \le 0.8 \\ 0.8 & \text{otherwise} \end{cases}$ $a_{zE} = 0.8$

$k_{zEx} := 1 - \dfrac{F_{xAlt}}{\chi_{BzE} \cdot F_{plE}} \cdot a_{zE}$ $k_{zEx} = 0.776$

$k_{zE} := \begin{cases} k_{zEx} & \text{if } k_{zEx} \le 1.5 \\ 1.5 & \text{otherwise} \end{cases}$ $k_{zE} = 0.776$

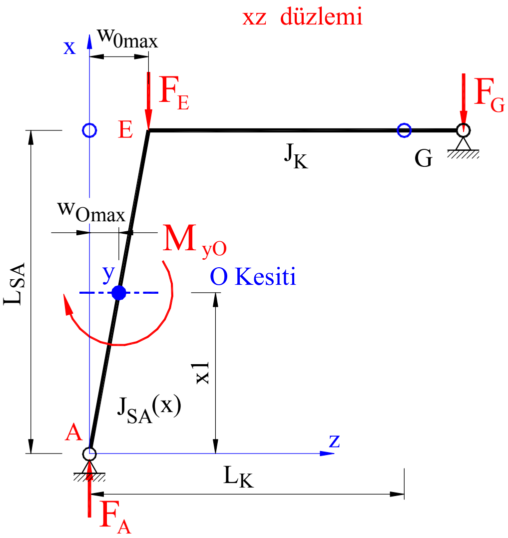
$S_{MzE} := \dfrac{M_{zEx}}{M_{plzE}} \cdot k_{zE}$ $S_{MzE} = 0.020$

$S_{Ey} := \dfrac{F_{SAeks}}{\chi_{ByE} \cdot F_{plE}} + \dfrac{M_{EyE}}{M_{plyE}} \cdot k_{yE} + \dfrac{M_{zEx}}{M_{plzE}} \cdot k_{zE}$ $S_{Ey} = 0.344$

$S_{Ez} := \dfrac{F_{SAeks}}{\chi_{BzE} \cdot F_{plE}} + \dfrac{M_{EyE}}{M_{plyE}} \cdot k_{yE} + \dfrac{M_{zE}}{M_{plzE}} \cdot k_{zE}$ $S_{Ez} = 0.864$

Sonuç: S_{Ey} ve S_{Ez} değerleri 1 den küçük olduğundan E kesitinin hesaplarına göre konstrüksiyon fonksiyonunu yapar.

O Kesitinde mukavemet hesabı:



$x1 := 0.5 \cdot L_{SA}$

$x1 = 3920 \cdot mm$

$z_O := 0.5 \cdot \left[h_A \cdot \left(\left(1 + k_h \cdot x1 \right) \right) + t \right]$

$z_O = 248 \cdot mm$

$$J_{yO} := 2 \cdot \left[\frac{b_A \cdot \left(1 + k_b \cdot x1\right) \cdot t^3}{12} + \frac{t \cdot \left[h_A \cdot \left(1 + k_h \cdot x1\right)\right]^3}{12} + t \cdot b_A \cdot \left(1 + k_b \cdot x1\right) \cdot z_O^{\,2} \right] \qquad J_{yO} = 479 \cdot 10^6 \cdot mm^4$$

$$W_{yO} := \frac{2 \cdot J_{yO}}{h_A \cdot \left(1 + k_h \cdot x1\right) + 2 \cdot t} \qquad W_{yO} = 1910 \cdot 10^3 \cdot mm^3$$

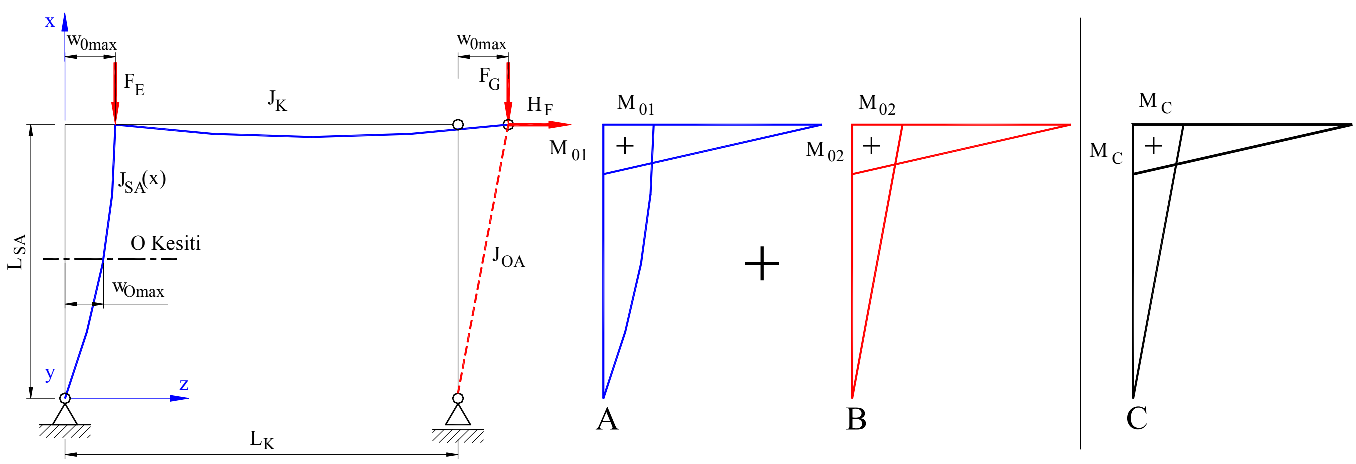
$$A_O := 2 \cdot t \cdot \left[b_A \cdot \left(1 + k_b \cdot x1\right) + h_A \cdot \left(1 + k_h \cdot x1\right) \right] \qquad A_O = 11760 \cdot mm^2$$

$$y_O := 0.5 \cdot \left[b_A \cdot \left(1 + k_b \cdot x1\right) - t \right] - b_ç \qquad y_O = 232 \cdot mm$$

$$J_{zO} := \left[2 \cdot \frac{b_A^{\,3} \cdot \left(1 + k_b \cdot x1\right)^3 \cdot t}{12} + 2 \cdot \frac{t^3 \cdot h_A \cdot \left(1 + k_h \cdot x1\right)}{12} + 2 \cdot t \cdot h_A \cdot \left(1 + k_h \cdot x1\right) \cdot y_O^{\,2} \right] \qquad J_{zO} = 434 \cdot 10^6 \cdot mm^4$$

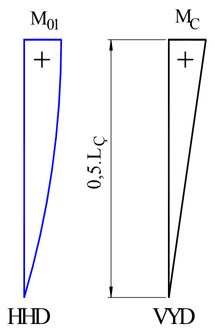
$$W_{zO} := \frac{2 \cdot J_{zO}}{b_A \cdot \left(1 + k_b \cdot x1\right)} \qquad W_{zO} = 1772 \cdot 10^3 \cdot mm^3$$

O Kesitinde moment kontrolü:



$w_{O1} = w_{Omax}$ kabul edileceğinden w_{Omax} ı hesaplamaya gerek yoktur.

O Kesitinde sabit ayağın F_E etkili 1. sehimi



$$w_{O1x} = \int_0^{\frac{L_{SA}}{2}} \frac{M_{01x} \cdot M_{Cx}}{E \cdot J_{yO}} dx$$

x1 e bağlı momentler:

$$M_{Cx} = \frac{2 \cdot x1}{L_{SA}} \cdot \frac{L_{SA}}{2} = x1$$

$$M_{01x} = F_E \cdot w_{Omax} \cdot f(x1)$$

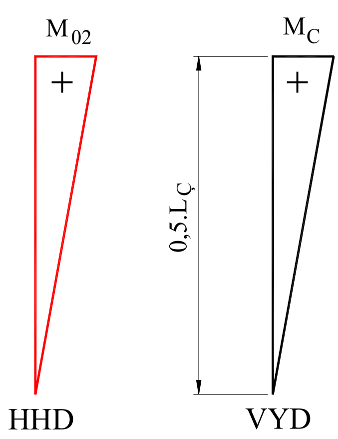
M_{01} dağılımı parabol olursa, parabolün genel formülünde değerleri yerleştirirsek:

$$w_{zO1x} = \int_0^{\frac{L_{SA}}{2}} \frac{\left(-\frac{F_E \cdot w_{Omax}}{L_{SA}^2} \cdot x1^2 - \frac{2 \cdot F_E \cdot w_{Omax}}{L_{SA}} \cdot x1\right) \cdot x1}{2 \cdot E \cdot \left[\frac{b_A \cdot (1 + k_b \cdot x1) \cdot t^3}{12} + \frac{t \cdot h_A^3 \cdot (1 + k_h \cdot x1)^3}{12} + t \cdot b_A \cdot (1 + k_b \cdot x1) \cdot \left[0.5 \cdot \left[h_A \cdot (1 + k_h \cdot x1) + t\right]\right]^2\right]} dx1$$

$$w_{zO1x} := \int_0^{\frac{L_{SA}}{2}} \frac{\frac{x1^3}{L_{SA}^2} + \frac{2 \cdot x1^2}{L_{SA}}}{2 \cdot E \cdot \left[\frac{b_A \cdot (1 + k_b \cdot x1) \cdot t^3}{12} + \frac{t \cdot h_A^3 \cdot (1 + k_h \cdot x1)^3}{12} + t \cdot b_A \cdot (1 + k_b \cdot x1) \cdot \left[0.5 \cdot \left[h_A \cdot (1 + k_h \cdot x1) + t\right]\right]^2\right]} dx1$$

$$w_{zO1x} = 0.085 \cdot \frac{10^{-6}}{N}$$

O Kesitinde sabit ayağın H_F etkili 2. sehim



$$w_{zO2x} = \int_0^{\frac{L_{SA}}{2}} \frac{M_{O2x} \cdot M_{Cx}}{E \cdot J_{yx}} dx$$

x1 e bağlı momentler:

$$M_C = \frac{2 \cdot x1}{L_{SA}} \cdot \frac{L_{SA}}{2} = x1$$

$$M_{02x} = H_F \cdot x1 = \frac{x1}{L_{SA}} \cdot F_E \cdot w_{Omax}$$

$$w_{zO2x} = \int_0^{\frac{L_{SA}}{2}} \frac{\frac{x1}{L_{SA}} \cdot F_E \cdot w_{Omax} \cdot x1}{E \cdot J_{yx}} dx1$$

$$w_{zO2x} = \int_0^{\frac{L_{SA}}{2}} \frac{F_E \cdot w_{Omax} \cdot \frac{x1^2}{L_{SA}}}{2 \cdot E \cdot \left[\frac{b_A \cdot (1 + k_b \cdot x1) \cdot t^3}{12} + \frac{t \cdot h_A{}^3 \cdot (1 + k_h \cdot x1)^3}{12} + t \cdot b_A \cdot (1 + k_b \cdot x1) \cdot \left[0.5 \cdot \left[h_A \cdot (1 + k_h \cdot x1) + t\right]\right]^2\right]} dx$$

$F_E \cdot w_{Omax}$ = sabit olduğundan integralin dışına alalım.

$$w_{zO2x} := \int_0^{\frac{L_{SA}}{2}} \frac{\frac{x1^2}{L_{SA}}}{2 \cdot E \cdot \left[\frac{b_A \cdot (1 + k_b \cdot x1) \cdot t^3}{12} + \frac{t \cdot h_A{}^3 \cdot (1 + k_h \cdot x1)^3}{12} + t \cdot b_A \cdot (1 + k_b \cdot x1) \cdot \left[0.5 \cdot \left[h_A \cdot (1 + k_h \cdot x1) + t\right]\right]^2\right]} dx$$

$$w_{zO2x} = 0.076 \cdot \frac{10^{-6}}{N}$$

$w_{O1} = F_E \cdot w_{Omax} \cdot (w_{zO1x} + w_{zO2x})$ $F_E = F_{kr}$ $w_{O1} = w_{Omax}$ kabul edersek

$$F_{krO} := \frac{1}{w_{zO1x} + w_{zO2x}} \qquad F_{krO} = 6204 \cdot kN \qquad F_{SAeks} = 342 \cdot kN$$

O Kesitinde burkulma tehlikesi yoktur.

O Kesitinde mukavemet hesabı

Eylemsizlık radyusu	$i_{yO} := \sqrt{\frac{J_{yO}}{A_O}}$	$i_{yO} = 201.9 \cdot mm$
Euler burkulma boyu	$L_{ByO} := \sqrt{\frac{E \cdot J_{yO} \cdot \pi^2}{F_{kr}}}$	$L_{ByO} = 24.070 m$
Akma narinliği		
Narinlik	$\lambda_{yO} := \frac{L_{ByO}}{i_{yO}}$	$\lambda_{yO} = 119.225$
Bağıntılı narinlik	$\lambda_{ByO} := \frac{\lambda_{yO}}{\lambda_{Ef}}$	$\lambda_{ByO} = 1.270$
Merkez noktası mesafesi	$k_{elyO} := \frac{W_{yO}}{A_O}$	$k_{elyO} = 162.381 \cdot mm$
Akma kuvveti	$F_{plO} := A_O \cdot f_{EM}$	$F_{plO} = 2512.4 \cdot kN$
Burkulma parametresi	$\alpha_B = 0.34$ Kaynaklı kutular her eksende.	
Max burkulma sehimi	$w_{ymaxO} := k_{elyO} \cdot \alpha_B \cdot (\lambda_{ByO} - 0.2)$	$w_{ymaxO} = 59.048 \cdot mm$

Burkulma yardımcı faktörü	$\varphi_{ByO} := 0.5 \cdot \left[1 + \alpha_B \cdot \left(\lambda_{ByO} - 0.2\right) + \lambda_{ByO}^2\right]$	$\varphi_{ByO} = 1.49$
Azaltma faktörü	$\chi_{ByO} := \dfrac{1}{\varphi_{ByO} + \sqrt{\varphi_{ByO}^2 - \lambda_{ByO}^2}}$	$\chi_{ByO} = 0.442$
Kuvvetin mukavemet emniyeti	$S_{FyO} := \dfrac{F_{xAlt}}{\chi_{ByO} \cdot F_{plO}}$	$S_{FyO} = 0.302$
Eylemsizlık radyusu	$i_{zO} := \sqrt{\dfrac{J_{zO}}{A_O}}$	$i_{zO} = 192.1 \cdot mm$
Euler burkulma boyu	$L_{BzO} := \sqrt{\dfrac{E \cdot J_{zO} \cdot \pi^2}{F_{kr}}}$	$L_{BzO} = 22.908\,m$
Narinlik	$\lambda_{zO} := \dfrac{L_{BzO}}{i_{zO}}$	$\lambda_{zO} = 119.225$
Bağıntılı narinlik	$\lambda_{BzO} := \dfrac{\lambda_{zO}}{\lambda_{Ef}}$	$\lambda_{BzO} = 1.270$
Merkez noktası mesafesi	$k_{elzO} := \dfrac{W_{zO}}{A_O}$	$k_{elzO} = 150.684 \cdot mm$
Max burkulma sehimi	$w_{zmaxO} := k_{elzO} \cdot \alpha_B \cdot \left(\lambda_{BzO} - 0.2\right)$	$w_{zmaxO} = 54.795 \cdot mm$
Burkulma yardımcı faktörü	$\varphi_{BzO} := 0.5 \cdot \left[1 + \alpha_B \cdot \left(\lambda_{BzO} - 0.2\right) + \lambda_{BzO}^2\right]$	$\varphi_{BzO} = 1.49$
Azaltma faktörü	$\chi_{BzO} := \dfrac{1}{\varphi_{BzO} + \sqrt{\varphi_{BzO}^2 - \lambda_{BzO}^2}}$	$\chi_{BzO} = 0.442$
Kuvvetin mukavemet emniyeti	$S_{FzO} := \dfrac{F_{xAlt}}{\chi_{BzO} \cdot F_{plO}}$	$S_{FzO} = 0.302$
Plastikliğin en küçük momenti	$M_{plyO} := W_{yO} \cdot f_{EM}$	$M_{plyO} = 408 \cdot kN \cdot m$
	$M_{yO} := F_{xAlt} \cdot w_{ymaxO}$	$M_{yO} = 19.801 \cdot kN \cdot m$
		$M_{yA} := 0 \cdot kN \cdot m$
$-1 \le \psi_y \le 1$	$\psi_{yO} := \dfrac{M_{yA}}{M_{yO}}$	$\psi_{yO} = 0.000$
	$\beta_{MyO} := 1.8 - 0.7 \cdot \psi_{yO}$	$\beta_{MyO} = 1.8$
$\alpha_{pl} \ge 1$	$\alpha_{plyO} := \dfrac{M_{plyO}}{M_{yO}}$	$\alpha_{plyO} = 20.603$
$a_y \le 0.8$	$a_{yxO} := \lambda_{ByO} \cdot \left(2 \cdot \beta_{MyO} - 4\right) + \left(\alpha_{plyO} - 1\right)$	$a_{yxO} = 19.095$

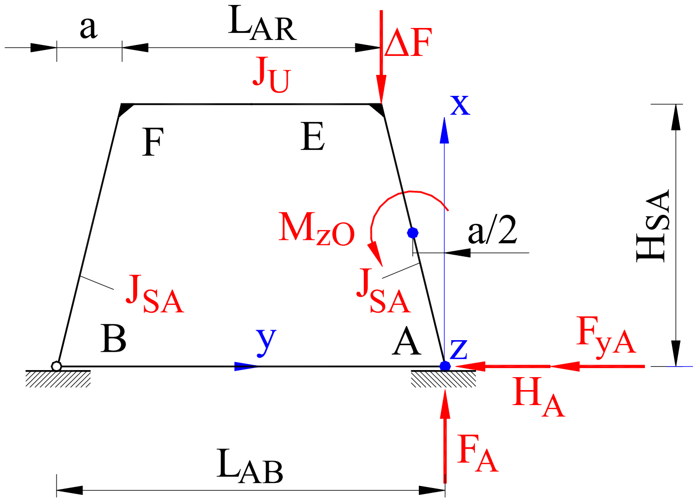
$a_{yO} := \begin{cases} a_{yxO} & \text{if } a_{yxO} \le 0.8 \\ 0.8 & \text{otherwise} \end{cases}$ $a_{yO} = 0.8$

$k_y \le 1,5$ $k_{yxO} := 1 - \frac{F_{xAlt}}{\chi_{ByO} \cdot F_{plO}} \cdot a_{yO}$ $k_{yxO} = 0.758$

$k_{yO} := \begin{cases} k_{yxO} & \text{if } k_{yxO} \le 1.5 \\ 1.5 & \text{otherwise} \end{cases}$ $k_{yO} = 0.758$

$S_{MyO} := \frac{M_{yO}}{M_{plyO}} \cdot k_{yO}$ $S_{MyO} = 0.037$

Eğilme momenti M_{zO}



$M_{zOx} := 0.5 \cdot M_{zEx}$ $M_{zOx} = 9 \cdot kN \cdot m$

$M_{zO} := 0$

Plastikliğin en küçük momenti

$M_{plzO} := W_{zO} \cdot f_{EM}$ $M_{plzO} = 378.6 \cdot kN \cdot m$

$M_{zO1} := 0 \cdot kN \cdot m$

$-1 \le \psi_z \le 1$ $\psi_{zO} := \frac{M_{zO1}}{M_{zOx}}$ $\psi_{zO} = 0.000$

$\beta_{MzO} := 1.8 - 0.7 \cdot \psi_{zO}$ $\beta_{MzO} = 1.8$

$\alpha_{pl} > 1$ $\alpha_{plzO} := \frac{M_{plzO}}{M_{zOx}}$ $\alpha_{plzO} = 39.972$

$a_{zOx} := \lambda_{BzO} \cdot (2 \cdot \beta_{MzO} - 4) + (\alpha_{plzO} - 1)$ $a_{zOx} = 38.464$

$a_{zO} := \begin{cases} a_{zOx} & \text{if } a_{zOx} \le 0.8 \\ 0.8 & \text{otherwise} \end{cases}$ $a_{zO} = 0.8$

$k_{zOx} := 1 - \frac{F_{xAlt}}{\chi_{BzO} \cdot F_{plO}} \cdot a_{zO}$ $k_{zOx} = 0.758$

$k_{zO} := \begin{cases} k_{zOx} & \text{if } k_{zOx} \le 1.5 \\ 1.5 & \text{otherwise} \end{cases}$ $k_{zO} = 0.758$

$$S_{MzO} := \frac{M_{zO}}{M_{plzO}} \cdot k_{zO} \qquad S_{MzO} = 0.000$$

$$S_{yO} := \frac{F_{SAeks}}{\chi_{ByO} \cdot F_{plO}} + \frac{M_{yO}}{M_{plyO}} \cdot k_{yO} + \frac{M_{zO}}{M_{plzO}} \cdot k_{zO} \qquad S_{yO} = 0.345$$

$$S_{zO} := \frac{F_{SAeks}}{\chi_{BzO} \cdot F_{plO}} + \frac{M_{yO}}{M_{plyO}} \cdot k_{yO} + \frac{M_{zO}}{M_{plzO}} \cdot k_{zO} \qquad S_{zO} = 0.345$$

Sonuç: S_{yO} ve S_{zO} değerleri 1 den küçük olduğundan x1 kesitinin hesaplarına göre konstrüksiyon fonksiyonunu yapar.

O kesitinin emniyetli mukavet değerine göre kontrolü:

$$\sigma_{heO} := \frac{F_{SAeks}}{A_O} + \frac{M_{yO}}{W_{yO}} + \frac{M_{zO}}{W_{zO}} \qquad \sigma_{heO} = 39 \cdot MPa \qquad f_{EM} = 214 \cdot MPa$$

$$k_{EMO} := \frac{\sigma_{heO}}{f_{EM}} \qquad k_{EMO} = 0.18$$

E kesitinin emniyetli mukavet değerine göre kontrolü:

$$\sigma_{heE} := \frac{F_{SAeks}}{A_E} + \frac{M_{EyE}}{W_{yE}} + \frac{M_{zE}}{W_{zE}} \qquad \sigma_{heE} = 180 \cdot MPa \qquad f_{EM} = 214 \cdot MPa$$

$$k_{EME} := \frac{\sigma_{heE}}{f_{EM}} \qquad k_{EME} = 0.84$$

Sonuç: Sistemin emniyetli mukavet değerine göre kontrolündede görüldüğü gibi konstrüksiyon fonksiyonunu yapar.

Sabit ayak ağırlığı:

Tolerans ve kaynak katsayısı $k_{tol} := 1.03$

$b_A = 0.3\,m$ $\quad b_E = 0.68\,m$ $\quad b_{SA} := 0.5 \cdot (b_A + b_E)$ $\quad b_{SA} = 0.49\,m$

$A_b := b_{SA} \cdot L_{SA}$ $\quad A_b = 3.842\,m^2$

$h_A = 0.3\,m$ $\quad h_E = 0.68\,m$ $\quad h_{SA} := 0.5 \cdot (h_A + h_E)$ $\quad h_{SA} = 0.49\,m$

$A_h := h_{SA} \cdot L_{SA}$ $\quad A_h = 3.842\,m^2$

$F_b := 2 \cdot b_{SA} \cdot L_{SA} \cdot t \cdot \rho_{St} \cdot g$ $\quad g = 9.807 \frac{m}{s^2}$ $\quad F_b = 3548.8\,N$

$F_h := 2 \cdot h_{SA} \cdot L_{SA} \cdot t \cdot \rho_{St} \cdot g$ $\quad F_h = 3548.8\,N$

Perde adedi: $n_{Pex} := \frac{L_{SA}}{m} - 1$ $\quad n_{Pex} = 6.84$ $\quad n_{Pe} := 7$

$F_{Pe} := \left[b_{SA} - 2 \cdot (b_ç + t)\right] \cdot (h_{SA} - 20 \cdot mm) \cdot t \cdot \rho_{St} \cdot n_{Pe} \cdot g$ $\quad F_{Pe} = 696\,N$

Alt bağlantı kapağı ağırlık kuvveti:

Konstrüksiyondan: $b_{Ba} := 250 \cdot mm$ $h_{Ba} := 400 \cdot mm$ $t_{Ba} := 20 \cdot mm$

$F_{aBa} := b_{Ba} \cdot h_{Ba} \cdot t_{Ba} \cdot \rho_{St} \cdot g$ $F_{aBa} = 154 \cdot N$

Üst bağlantı kapağı ağırlık kuvveti:

Konstrüksiyondan: $b_{Bü} := 1140 \cdot mm$ $h_{Bü} := 800 \cdot mm$ $t_{Bü} := 20 \cdot mm$

$F_{üBa} := b_{Bü} \cdot h_{Bü} \cdot t_{Bü} \cdot \rho_{St} \cdot g$ $F_{üBa} = 1404 \cdot N$

Sabit bir ayağın toplam ağırlık kuvveti:

$F_{SAg} := (F_b + F_h + F_{Pe} + F_{aBa} + F_{üBa}) \cdot k_{tol}$ $F_{SAg} = 9.63 \cdot kN$

$m_{SA} := F_{SAg} \cdot g^{-1}$ $m_{SA} = 982\, kg$

Sabit ayak rüzgar alanı:

y eksenine dik bir ayak alanı: $A_{SAyRüx} := (h_{SA} + 2 \cdot t) \cdot L_{SA}$ $A_{SAyRüx} = 3.936\, m^2$

z eksenine dik bir ayak alanı: $A_{SAzRüx} := b_{SA} \cdot L_{SA}$ $A_{SAzRüx} = 3.84\, m^2$

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