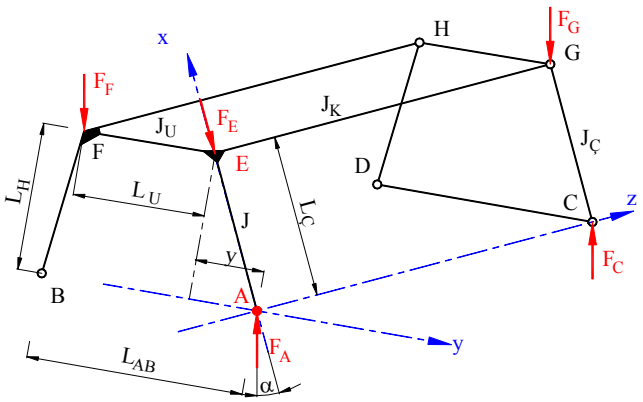
İki düzlemdeki çerçevelerin kesiti devamlı değişen ortak çubuğu

Sistem ve bilinen değerler:



Malzeme := "S235"

$f_y := 235 \cdot MPa$

$\gamma_M := 1.1$

Emniyetli akma mukavemeti

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

$f_{EM} = 214 \cdot MPa$

Elastiklik modülü

$E := 210000 \cdot MPa$

Kiriş

$L_K := 18 \cdot m$

$J_{yK} := 7447 \cdot 10^6 \cdot mm^4$

Uç bağlantı

$L_U := 2 \cdot m$

$J_{yU} := 703 \cdot 10^6 \cdot mm^4$

Kabul: Eğrinin şekli parabol

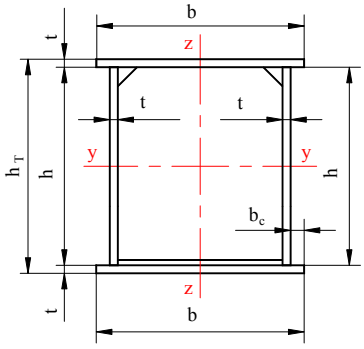
$L_H := 8 \cdot m$

$\alpha := 10 \cdot deg$

$F_A := 400 \cdot kN$

$F_G := 0.4 \cdot F_A$

$F_F := 0.9 \cdot F_A$



1. Kısım

$b_1 := 420 \cdot mm$

$h_1 := 380 \cdot mm$

$t := 10 \cdot mm$

$b_Ç := 10 \cdot mm$

$h_{T1} := h_1 + 2 \cdot t$

$h_{T1} = 400 \cdot mm$

$z_1 := 0.5 \cdot (h_1 + t)$

$z_1 = 195 \cdot mm$

$J_{y1} := 2 \cdot \frac{b_1 \cdot t^3}{12} + 2 \cdot \frac{t \cdot h_1^3}{12} + 2 \cdot t \cdot b_1 \cdot z_1^2$

$J_{y1} = 411 \cdot 10^6 \cdot mm^4$

$W_{y1} := \frac{2 \cdot J_{y1}}{h_{T1}}$

$W_{y1} = 2055 \cdot 10^3 \cdot mm^3$

$A_1 := 2 \cdot t \cdot (b_1 + h_1)$

$A_1 = 16000 \cdot mm^2$

$L_Ç := L_H \cdot \cos(\alpha)^{-1}$

$L_Ç = 8.123\,m$

$y_1 := 0.5 \cdot (b_1 + t) - b_Ç$

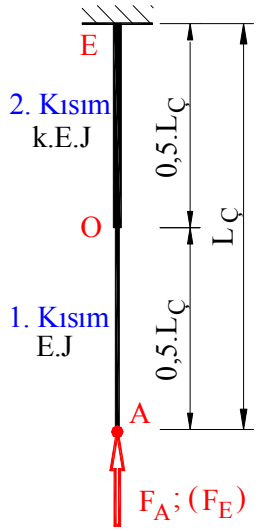
$y_1 = 205 \cdot mm$

$J_{z1} := 2 \cdot \frac{b_1^3 \cdot t}{12} + 2 \cdot \frac{t^3 \cdot h_1}{12} + 2 \cdot t \cdot h_1 \cdot y_1^2$

$J_{z1} = 443 \cdot 10^6 \cdot mm^4$

$W_{z1} := \frac{2 \cdot J_{z1}}{b_1}$

$W_{z1} = 2109 \cdot 10^3 \cdot mm^3$



$k_{xz} := \frac{L_K^2}{J_{yK}}$

$k_{xz} = 43507 \frac{1}{m^2}$

$k_{xy} := \frac{L_U^2}{J_{yU}}$

$k_{xy} = 5690 \frac{1}{m^2}$

$k_{xz} > k_{xy}$ olduğundan burkulma hesabı xz kesitinde yapılacaktır.

$F_E := F_A \cdot \cos(\alpha)^{-1}$ $F_E = 406.2 \cdot kN$

2. Kısım

$k := 1.5$

$b_2 := k \cdot b_1$ $b_2 = 630 \cdot mm$ $h_2 := k \cdot h_1$ $h_2 = 570 \cdot mm$

$h_{T2} := h_2 + 2 \cdot t$ $h_{T2} = 590 \cdot mr$ $z_2 := 0.5 \cdot (h_2 + t)$ $z_2 = 290 \cdot mm$

$$J_{y2} := 2 \cdot \frac{b_2 \cdot t^3}{12} + 2 \cdot \frac{t \cdot h_2^3}{12} + 2 \cdot t \cdot b_2 \cdot z_2^2 \qquad J_{y2} = 1368 \cdot 10^6 \cdot mm^4$$

$$W_{y2} := \frac{2 \cdot J_{y2}}{h_{T2}} \qquad W_{y2} = 4639 \cdot 10^3 \cdot mm^3$$

$EJ_{y2} := E \cdot J_{y2}$ $EJ_{y2} = 287 \cdot MN \cdot m^2$

$y_2 := 0.5 \cdot (b_2 + t) - b_ç$ $y_2 = 310 \cdot mm$

$$J_{z2} := 2 \cdot \frac{b_2^3 \cdot t}{12} + 2 \cdot \frac{t^3 \cdot h_2}{12} + 2 \cdot t \cdot h_2 \cdot y_2^2 \qquad J_{z2} = 1512 \cdot 10^6 \cdot mm^4$$

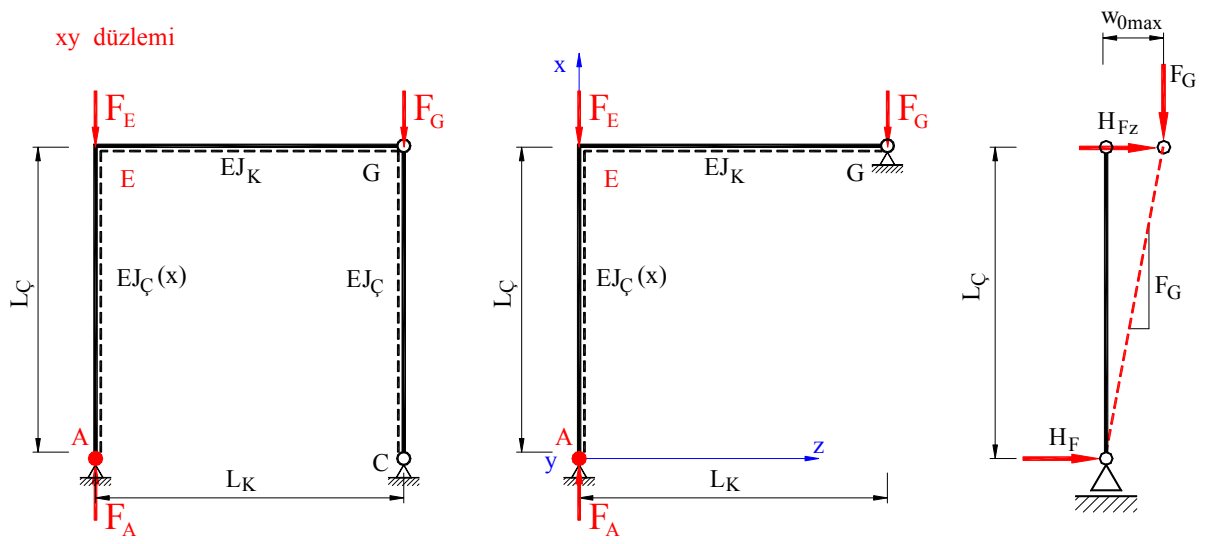
$$W_{z2} := \frac{2 \cdot J_{z2}}{b_2} \qquad W_{z2} = 4801 \cdot 10^3 \cdot mm^3$$

$EJ_{z2} := E \cdot J_{z2}$ $EJ_{z2} = 318 \cdot MN \cdot m^2$

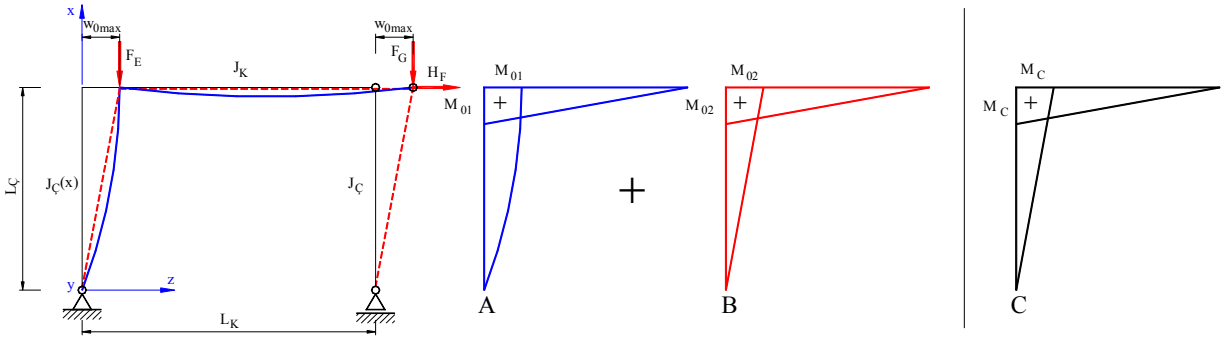
$k_{Jz} := \frac{J_{z2}}{J_{z1}}$ $k_{Jz} = 3.414$

$A_2 := 2 \cdot t \cdot (b_2 + h_2)$ $A_2 = 24000 \cdot mm^2$

Vianelloya göre çözüm:

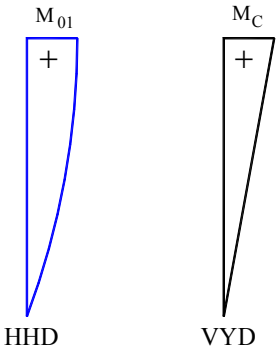


AE çubuğunun hesabı Vianello metodu ile xz düzlemine göre yapılır.



$$F_E \cdot w_{0max} = H_F \cdot L_Ç \qquad H_F = \frac{F_E \cdot w_{0max}}{L_Ç}$$

AE çubuğunda F_E etkili 1. sehim



$$M_{01y} = F_E \cdot w_{0zmax} \qquad M_{1y} = L_Ç$$

$$w_{01z1} = \int_0^{\frac{L_Ç}{2}} M_{01y} \cdot M_{1y} \cdot \frac{1}{EJ_{y1}}\, dx \qquad w_{01z2} = \int_0^{\frac{L_Ç}{2}} M_{01y} \cdot M_y \cdot \frac{1}{k \cdot EJ_{y1}}\, dx$$

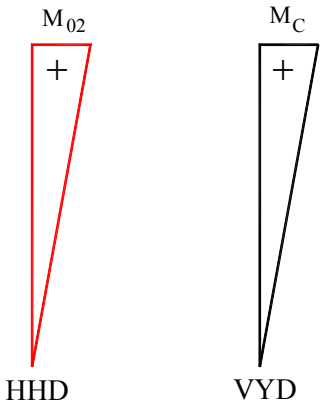
$$w_{01z} = w_{01z1} + w_{01z2} = \frac{5}{12} \cdot F_E \cdot w_{0zmax} \cdot L_Ç \cdot \frac{L_Ç}{2 \cdot E \cdot J_{y1}} + \frac{5}{12} \cdot F_E \cdot w_{0zmax} \cdot L_Ç \cdot \frac{L_Ç}{2 \cdot k \cdot E \cdot J_{y1}}$$

$F_E \cdot w_{0zmax}$ = sabit dışarı alalım

$$w_{01z} := \frac{5 \cdot L_Ç^{\,2}}{24 \cdot E \cdot J_{y1}} \cdot \left(1 + \frac{1}{k}\right)$$

$$w_{01z} = 0.266 \cdot \frac{10^{-6}}{N}$$

AE çubuğunda H_F etkili 2. sehim



$$M_{02y} = F_E \cdot w_{0zmax} \qquad M_{1y} = L_Ç$$

$$w_{02z1} = \int_0^{\frac{L_Ç}{2}} M_{02y} \cdot M_{1y} \cdot \frac{1}{E \cdot J_{y1}}\, dx \qquad w_{02z2} = \int_0^{\frac{L_Ç}{2}} M_{02y} \cdot M_{1y} \cdot \frac{1}{k \cdot E \cdot J_{y1}}\, dx$$

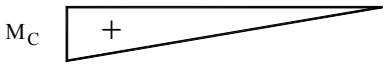
$$w_{02z} = w_{02z1} + w_{02z2} = \frac{1}{3}\cdot F_E\cdot w_{0zmax}\cdot L_Ç\cdot\frac{L_Ç}{2}\cdot\frac{1}{E\cdot J_{y1}} + \frac{1}{3}\cdot F_E\cdot w_{0zmax}\cdot L_Ç\cdot\frac{L_Ç}{2}\cdot\frac{1}{k\cdot E\cdot J_{y1}}$$

$$w_{02z} = \frac{1}{3}\cdot F_E\cdot w_{0zmax}\cdot L_Ç\cdot\frac{L_Ç}{2\cdot E\cdot J_{y1}}\cdot\left(1+\frac{1}{k}\right)$$

$F_E\cdot w_{0ymax}$ = sabit dışarı alalım $\quad w_{02z} := \frac{L_Ç^2}{6\cdot E\cdot J_{y1}}\cdot\left(1+\frac{1}{k}\right)$ $\quad w_{02z} = 0.212\cdot\frac{10^{-6}}{N}$

EG Kirişinde F_E etkili 3. sehim

HHD



VYD

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

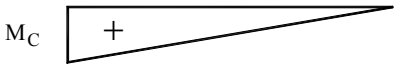
$M_C = L_K$

$$w_{13z} = \int_0^{L_K}\frac{M_{01}\cdot M_C}{E\cdot J_{yK}}\,dx$$ $\quad E\cdot J_{Ky}$ = sabit $\quad$ İntegral tablosundan $\quad$ Üçgen + Üçgen $\quad w_{13z} = \frac{1}{3}\cdot\frac{F_E\cdot w_{0zmax}\cdot L_K^2}{E\cdot J_{yK}}$

$F_E\cdot w_{0zmax}$ = sabit olduğundan integralin dışına alalım. $\quad w_{13z} := \frac{1}{3}\cdot\frac{L_K^2}{E\cdot J_{yK}}$ $\quad w_{13z} = 0.069\cdot\frac{10^{-6}}{N}$

EG Kirişinde H_F etkili 4. sehim

HHD



VYD

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

$M_C = L_K$

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

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

$F_E\cdot w_{0max}$ = sabit olduğundan integralin dışına alalım. $\quad w_{14z} := \frac{1}{3}\cdot\frac{L_K^2}{E\cdot J_{yK}}$ $\quad w_{14z} = 0.069\cdot\frac{10^{-6}}{N}$

$w_{01} = F_E\cdot w_{0max}\cdot\left(w_{01z} + w_{02z} + w_{13z} + w_{14z}\right)$ $\quad F_E = F_{kr}$ $\quad w_{01} = w_{0max}$ $\quad$ kabul edersek

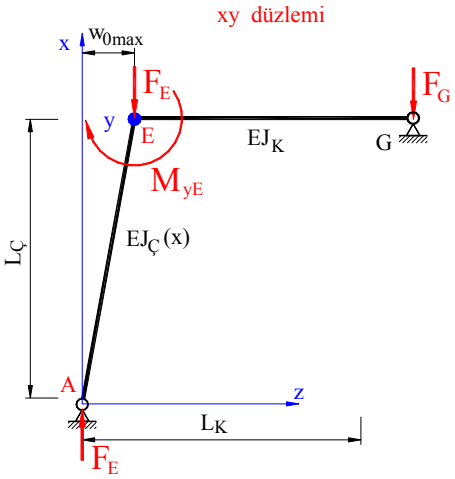
$$F_{kr} := \frac{1}{w_{01z} + w_{02z} + w_{13z} + w_{14z}}$$

$F_{kr} = 1623\cdot kN$ $\quad F_A = 400\cdot kN$

Sonuç: Çubukta burkulma tehlikesi yoktur.

E Kesitinde mukavemet hesabı:

Eğilme momenti M_{yE}



$x := 8 \cdot m$

Eylemsizlık radyusu $i_{y2} := \sqrt{\frac{J_{y2}}{A_2}}$ $i_{y2} = 238.8 \cdot mm$

Euler burkulma boyu $L_{By2} := \sqrt{\frac{E \cdot J_{y2} \cdot \pi^2}{F_{kr}}}$ $L_{By2} = 41.800\,m$

Akma narinliği $\lambda_E := \pi \cdot \sqrt{\frac{E}{f_y}}$ $\lambda_E = 93.913$

Narinlik $\lambda_{y2} := \frac{L_{By2}}{i_{y2}}$ $\lambda_{y2} = 175.055$

Bağıntılı narinlik $\lambda_{By2} := \frac{\lambda_{y2}}{\lambda_E}$ $\lambda_{By2} = 1.864$

Merkez noktası mesafesi $k_{ely2} := \frac{W_{y2}}{A_2}$ $k_{ely2} = 193.28 \cdot mm$

Akma kuvveti $F_{pl2} := A_2 \cdot f_{EM}$ $F_{pl2} = 5127.3 \cdot kN$

Burkulma parametresi $\alpha_B := 0.34$ Kaynaklı kutular her eksende.

Max burkulma sehimi $w_{zmax2} := k_{ely2} \cdot \alpha_B \cdot (\lambda_{By2} - 0.2)$ $w_{zmax2} = 109.35 \cdot mm$

Burkulma yardımcı faktörü $\varphi_{By2} := 0.5 \cdot \left[1 + \alpha_B \cdot (\lambda_{By2} - 0.2) + \lambda_{By2}^2\right]$ $\varphi_{By2} = 2.52$

Azaltma faktörü $\chi_{By2} := \frac{1}{\varphi_{By2} + \sqrt{\varphi_{By2}^2 - \lambda_{By2}^2}}$ $\chi_{By2} = 0.237$

Kuvvetin mukavemet emniyeti $S_{Fy2} := \frac{F_E}{\chi_{By2} \cdot F_{pl2}}$ $S_{Fy2} = 0.334$

Plastikliğin
en küçük momenti

$M_{ply2} := W_{y2} \cdot f_{EM}$ $\quad M_{ply2} = 991 \cdot kN \cdot m$

$M_{0y2} := 0 \cdot kN \cdot m$

$M_{y2} := F_E \cdot w_{zmax2}$ $\quad M_{y2} = 44.415 \cdot kN \cdot m$

$-1 \le \psi_y \le 1$

$\psi_{y2} := \dfrac{M_{0y2}}{M_{y2}}$ $\quad \psi_{y2} = 0.000$

$\beta_{My2} := 1.8 - 0.7 \cdot \psi_{y2}$ $\quad \beta_{My2} = 1.8$

$\alpha_{pl} \ge 1$

$\alpha_{ply2} := \dfrac{M_{ply2}}{M_{y2}}$ $\quad \alpha_{ply2} = 22.312$

$a_y \le 0.8$

$a_{y2x} := \lambda_{By2} \cdot \left(2 \cdot \beta_{My2} - 4\right) + \left(\alpha_{ply2} - 1\right)$ $\quad a_{y2x} = 20.567$

$a_{y2} := \begin{cases} a_{y2x} & \text{if } a_{y2x} \le 0.8 \\ 0.8 & \text{otherwise} \end{cases}$ $\quad a_{y2} = 0.8$

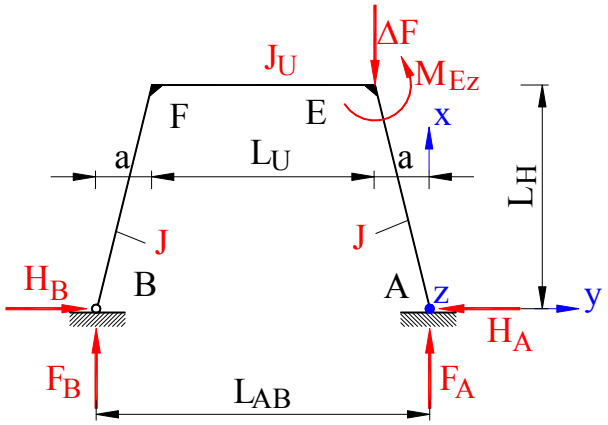
$k_y \le 1{,}5$

$k_{y2x} := 1 - \dfrac{F_E}{\chi_{By2} \cdot F_{pl2}} \cdot a_{y2}$ $\quad k_{y2x} = 0.733$

$k_{y2} := \begin{cases} k_{y2x} & \text{if } k_{y2x} \le 1.5 \\ 1.5 & \text{otherwise} \end{cases}$ $\quad k_{y2} = 0.733$

$S_{My2} := \dfrac{M_{y2}}{M_{ply2}} \cdot k_{y2}$ $\quad S_{My2} = 0.033$

Eğilme momenti M_z



$\Delta F := F_A - F_F$ $\quad \Delta F = 40 \cdot kN$

$a := L_H \cdot \sin(\alpha)$ $\quad a = 1.389\,m$

$L_{AB} := L_U + 2 \cdot a$ $\quad L_{AB} = 4.778\,m$

$M_{z2A} := F_A \cdot a - 0.5 \cdot \Delta F \cdot a \cdot \dfrac{L_U}{L_{AB}}$

$M_{z2A} = 544.045 \cdot kN \cdot m$

Eylemsizlık radyusu

$i_{z2} := \sqrt{\dfrac{J_{z2}}{A_2}}$ $\quad i_{z2} = 251 \cdot mm$

Euler burkulma boyu

$L_{Bz2} := \sqrt{\dfrac{E \cdot J_{z2} \cdot \pi^2}{F_{kr}}}$ $\quad L_{Bz2} = 43.944\,m$

Narinlik

$$\lambda_{z2} := \frac{L_{Bz2}}{i_{z2}} \qquad \lambda_{z2} = 175.055$$

Bağıntılı narinlik

$$\lambda_{Bz2} := \frac{\lambda_{z2}}{\lambda_E} \qquad \lambda_{Bz2} = 1.864$$

Merkez noktası mesafesi

$$k_{elz2} := \frac{W_{z2}}{A_2} \qquad k_{elz2} = 200.05\cdot mm$$

Max burkulma sehimi

$$w_{ymax2} := k_{elz2}\cdot\alpha_B\cdot\left(\lambda_{Bz2} - 0.2\right) \qquad w_{ymax2} = 113.181\cdot mm$$

Burkulma yardımcı faktörü

$$\varphi_{Bz2} := 0.5\cdot\left[1 + \alpha_B\cdot\left(\lambda_{Bz2} - 0.2\right) + \lambda_{Bz2}^{\,2}\right] \qquad \varphi_{Bz2} = 2.52$$

Azaltma faktörü

$$\chi_{Bz2} := \frac{1}{\varphi_{Bz2} + \sqrt{\varphi_{Bz2}^{\,2} - \lambda_{Bz2}^{\,2}}} \qquad \chi_{Bz2} = 0.237$$

Kuvvetin mukavemet emniyeti

$$S_{Fz2} := \frac{F_E}{\chi_{Bz2}\cdot F_{pl2}} \qquad S_{Fz2} = 0.334$$

Plastikliğin
en küçük momenti

$$M_{plz2} := W_{z2}\cdot f_{EM} \qquad M_{plz2} = 1025.7\cdot kN\cdot m$$

$$M_{z2B} := F_E\cdot w_{ymax2} \qquad M_{z2B} = 46\cdot kN\cdot m$$

$$M_{z2} := M_{z2A} + M_{z2B} \qquad M_{z2} = 590\cdot kN\cdot m$$

$$M_{0z2} := 0\cdot kN\cdot m$$

$-1 \le \psi_z \le 1$

$$\psi_{z2} := \frac{M_{0z2}}{M_{z2}} \qquad \psi_{z2} = 0.000$$

$$\beta_{Mz2} := 1.8 - 0.7\cdot\psi_{z2} \qquad \beta_{Mz2} = 1.8$$

$\alpha_{pl} > 1$

$$\alpha_{plz2} := \frac{M_{plz2}}{M_{z2}} \qquad \alpha_{plz2} = 1.738$$

$$a_{z2x} := \lambda_{Bz2}\cdot\left(2\cdot\beta_{Mz2} - 4\right) + \left(\alpha_{plz2} - 1\right) \qquad a_{z2x} = -0.007$$

$$a_{z2} := \begin{cases} a_{z2x} & \text{if } a_{z2x} \le 0.8 \\ 0.8 & \text{otherwise} \end{cases} \qquad a_{z2} = -0.007$$

$$k_{z2x} := 1 - \frac{F_A}{\chi_{Bz2}\cdot F_{pl2}}\cdot a_{z2} \qquad k_{z2x} = 1.002$$

$$k_{z2} := \begin{cases} k_{z2x} & \text{if } k_{z2x} \le 1.5 \\ 1.5 & \text{otherwise} \end{cases} \qquad k_{z2} = 1.002$$

$$S_{Mz2} := \frac{M_{z2}}{M_{plz2}}\cdot k_{z2} \qquad S_{Mz2} = 0.577$$

$$S_{y2} := \frac{F_E}{\chi_{By2} \cdot F_{pl2}} + \frac{M_{y2}}{M_{ply2}} \cdot k_{y2} + \frac{M_{z2}}{M_{plz2}} \cdot k_{z2}$$

$S_{y2} = 0.943$

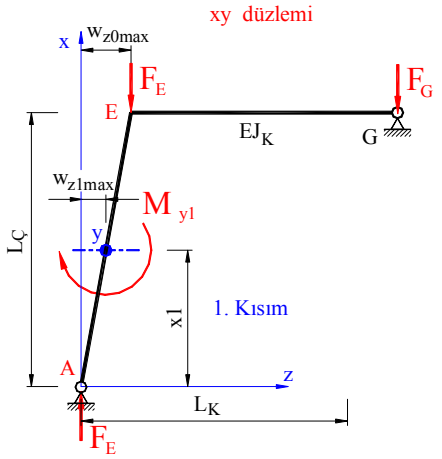
$$S_{z2} := \frac{F_E}{\chi_{Bz2} \cdot F_{pl2}} + \frac{M_{y2}}{M_{ply2}} \cdot k_{y2} + \frac{M_{z2}}{M_{plz2}} \cdot k_{z2}$$

$S_{y2} = 0.943$

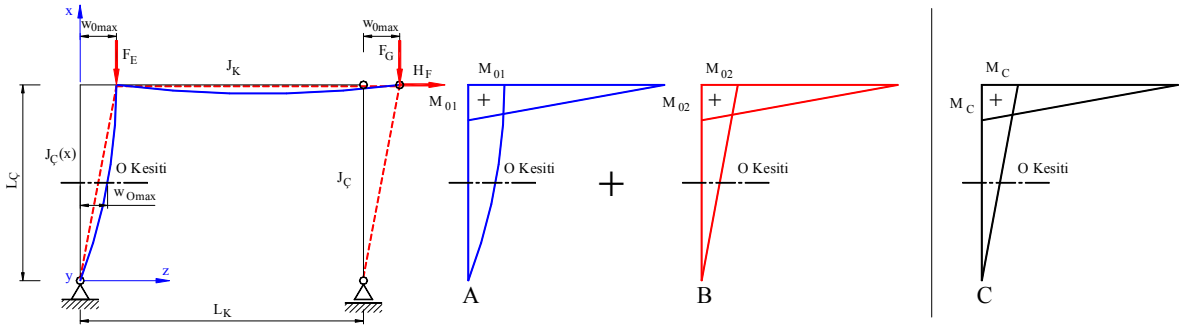
Sonuç: S_{y2} ve S_{z2} değerleri 1 den küçük olduğundan 2. kısımın hesaplarına göre konstrüksiyon fonksiyonunu yapar.

O Kesitinde mukavemet hesabı:

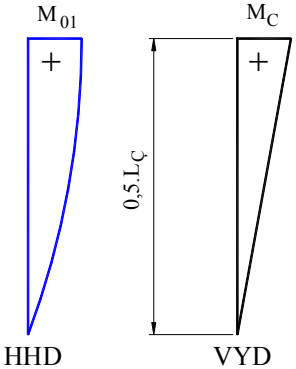
$x1 = 0.5 \cdot L_Ç$ $\quad$ $x1 := 4 \cdot m$



O Kesitinde moment kontrolü:



O Kesitinde AE çubuğunda F_E etkili 1. sehim



$$M_{1y} = F_E \cdot w_{1zmax}$$

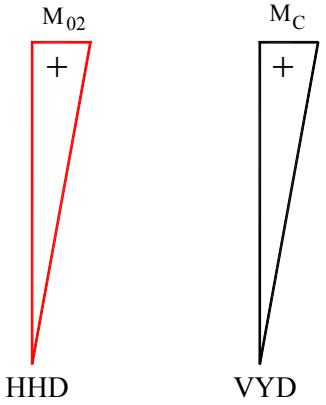
$$M_{Cy} = \frac{L_Ç}{2}$$

$$w_{1z} = \int_0^{\frac{L_Ç}{2}} M_{1y} \cdot M_{Cy} \cdot \frac{1}{EJ_{y1}} \, dx$$

$$w_{1z} = \frac{5}{12} \cdot F_E \cdot w_{1zmax} \cdot \frac{L_Ç}{2} \cdot \frac{L_Ç}{2 \cdot E \cdot J_{y1}}$$

$F_E \cdot w_{1zmax}$ = sabit dışarı alalım $\quad w_{1z} := \dfrac{5 \cdot L_Ç^{2}}{48 \cdot E \cdot J_{y1}}$ $\quad w_{1z} = 0.080 \cdot \dfrac{10^{-6}}{N}$

O Kesitinde AE çubuğunda H_F etkili 2. sehim



$M_{2y} = F_E \cdot w_{1zmax}$ $\quad M_{Cy} = \dfrac{L_Ç}{2}$

$w_{2z} = \displaystyle\int_0^{\frac{L_Ç}{2}} M_{02y} \cdot M_{1y} \cdot \frac{1}{E \cdot J_{y1}}\, dx$ $\quad w_{2z} = \dfrac{1}{3} \cdot F_E \cdot w_{1zmax} \cdot \dfrac{L_Ç}{2} \cdot \dfrac{L_Ç}{2} \cdot \dfrac{1}{E \cdot J_{y1}}$

$F_E \cdot w_{1zmax}$ = sabit dışarı alalım $\quad w_{2z} := \dfrac{L_Ç^{2}}{12 \cdot E \cdot J_{y1}}$ $\quad w_{2z} = 0.064 \cdot \dfrac{10^{-6}}{N}$

$w_{1z} = F_E \cdot w_{1zmax} \cdot (w_{1z} + w_{2z})$ $\quad F_E = F_{kr}$ $\quad w_{1z} = w_{1zmax}$ kabul edersek

$F_{kr1} := \dfrac{1}{w_{1z} + w_{2z}}$ $\quad F_{kr1} = 6974 \cdot kN$ $\quad F_A = 400 \cdot kN$

O Kesitinde burkulma tehlikesi yoktur.

O Kesitinde mukavemet hesabı

Eylemsizlık radyusu $\quad i_{y1} := \sqrt{\dfrac{J_{y1}}{A_1}}$ $\quad i_{y1} = 160.3 \cdot mm$

Euler burkulma boyu $\quad L_{By1} := \sqrt{\dfrac{E \cdot J_{y1} \cdot \pi^{2}}{F_{kr1}}}$ $\quad L_{By1} = 11.051\,m$

Akma narinliği $\quad \lambda_E = 93.913$

Narinlik $\quad \lambda_{y1} := \dfrac{L_{By1}}{i_{y1}}$ $\quad \lambda_{y1} = 68.955$

Bağıntılı narinlik $\quad \lambda_{By1} := \dfrac{\lambda_{y1}}{\lambda_E}$ $\quad \lambda_{By1} = 0.734$

Merkez noktası mesafesi $\quad k_{ely1} := \dfrac{W_{y1}}{A_1}$ $\quad k_{ely1} = 128.417 \cdot mm$

Akma kuvveti $\quad F_{pl1} := A_1 \cdot f_{EM}$ $\quad F_{pl1} = 3418.2 \cdot kN$

Burkulma parametresi $\quad \alpha_B = 0.34$ Kaynaklı kutular her eksende.

Max burkulma sehimi $\quad w_{ymax1} := k_{ely1} \cdot \alpha_B \cdot (\lambda_{By1} - 0.2)$ $\quad w_{ymax1} = 23.326 \cdot mm$

Burkulma yardımcı faktörü $\varphi_{By1} := 0.5\cdot\left[1+\alpha_B\cdot\left(\lambda_{By1}-0.2\right)+\lambda_{By1}^{2}\right]$ $\varphi_{By1} = 0.86$

Azaltma faktörü $\chi_{By1} := \frac{1}{\varphi_{By1}+\sqrt{\varphi_{By1}^{2}-\lambda_{By1}^{2}}}$ $\chi_{By1} = 0.764$

Kuvvetin mukavemet emniyeti $S_{Fy1} := \frac{F_E}{\chi_{By1}\cdot F_{pl1}}$ $S_{Fy1} = 0.156$

Eylemsizlık radyusu $i_{z1} := \sqrt{\frac{J_{z1}}{A_1}}$ $i_{z1} = 166.4\cdot mm$

Euler burkulma boyu $L_{Bz1} := \sqrt{\frac{E\cdot J_{z1}\cdot\pi^{2}}{F_{kr1}}}$ $L_{Bz1} = 11.473\,m$

Narinlik $\lambda_{z1} := \frac{L_{Bz1}}{i_{z1}}$ $\lambda_{z1} = 68.955$

Bağıntılı narinlik $\lambda_{Bz1} := \frac{\lambda_{z1}}{\lambda_E}$ $\lambda_{Bz1} = 0.734$

Merkez noktası mesafesi $k_{elz1} := \frac{W_{z1}}{A_1}$ $k_{elz1} = 131.825\cdot mm$

Max burkulma sehimi $w_{zmax1} := k_{elz1}\cdot\alpha_B\cdot\left(\lambda_{Bz1}-0.2\right)$ $w_{zmax1} = 23.945\cdot mm$

Burkulma yardımcı faktörü $\varphi_{Bz1} := 0.5\cdot\left[1+\alpha_B\cdot\left(\lambda_{Bz1}-0.2\right)+\lambda_{Bz1}^{2}\right]$ $\varphi_{Bz1} = 0.86$

Azaltma faktörü $\chi_{Bz1} := \frac{1}{\varphi_{Bz1}+\sqrt{\varphi_{Bz1}^{2}-\lambda_{Bz1}^{2}}}$ $\chi_{Bz1} = 0.764$

Kuvvetin mukavemet emniyeti $S_{Fz1} := \frac{F_E}{\chi_{Bz1}\cdot F_{pl1}}$ $S_{Fz1} = 0.156$

Plastikliğin en küçük momenti $M_{ply1} := W_{y1}\cdot f_{EM}$ $M_{ply1} = 439\cdot kN\cdot m$

$M_{y1} := F_E\cdot w_{zmax1}$ $M_{y1} = 9.726\cdot kN\cdot m$

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

$-1 \le \psi_y \le 1$ $\psi_{y1} := \frac{M_{yA}}{M_{y1}}$ $\psi_{y1} = 0.000$

$\beta_{My1} := 1.8-0.7\cdot\psi_{y1}$ $\beta_{My1} = 1.8$

$\alpha_{pl} \ge 1$ $\alpha_{ply1} := \frac{M_{ply1}}{M_{y1}}$ $\alpha_{ply1} = 45.133$

$a_y \le 0.8$ $a_{y1x} := \lambda_{By1}\cdot\left(2\cdot\beta_{My1}-4\right)+\left(\alpha_{ply1}-1\right)$ $a_{y1x} = 43.839$

$$a_{y1} := \begin{cases} a_{y1x} & \text{if } a_{y1x} \le 0.8 \\ 0.8 & \text{otherwise} \end{cases} \qquad a_{y1} = 0.8$$

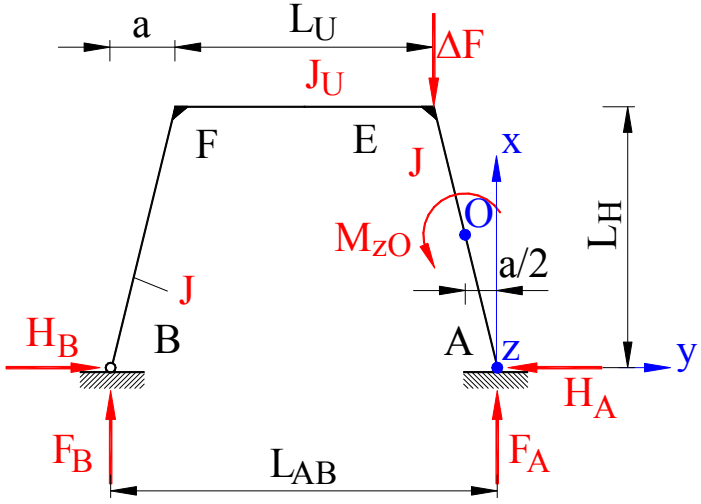
$k_y \le 1,5$

$$k_{y1x} := 1 - \frac{F_E}{\chi_{By1} \cdot F_{pl1}} \cdot a_{y1} \qquad k_{y1x} = 0.876$$

$$k_{y1} := \begin{cases} k_{y1x} & \text{if } k_{y1x} \le 1.5 \\ 1.5 & \text{otherwise} \end{cases} \qquad k_{y1} = 0.876$$

$$S_{My1} := \frac{M_{y1}}{M_{ply1}} \cdot k_{y1} \qquad S_{My1} = 0.019$$

Eğilme momenti M_{zO}



$\Delta F = 40 \cdot kN$

$a = 1.389\,m$

$L_{AB} = 4.778\,m$

$$M_{z1A} := 0.5 \cdot F_A \cdot a - 0.25 \cdot \Delta F \cdot a \cdot \frac{L_U}{L_{AB}}$$

$M_{z1A} = 272.023 \cdot kN \cdot m$

Plastikliğin
en küçük momenti

$$M_{plz1} := W_{z1} \cdot f_{EM} \qquad M_{plz1} = 450.6 \cdot kN \cdot m$$

$M_{z11} := 0 \cdot kN \cdot m$

$$M_{z1B} := F_A \cdot w_{ymax1} \qquad M_{z1B} = 9 \cdot kN \cdot m$$

$$M_{z1} := M_{z1A} + M_{z1B} \qquad M_{z1} = 281 \cdot kN \cdot m$$

$-1 \le \psi_z \le 1$

$$\psi_{z1} := \frac{M_{z11}}{M_{z1}} \qquad \psi_{z1} = 0.000$$

$$\beta_{Mz1} := 1.8 - 0.7 \cdot \psi_{z1} \qquad \beta_{Mz1} = 1.8$$

$\alpha_{pl} > 1$

$$\alpha_{plz1} := \frac{M_{plz1}}{M_{z1}} \qquad \alpha_{plz1} = 1.602$$

$$a_{z1x} := \lambda_{Bz1} \cdot \left(2 \cdot \beta_{Mz1} - 4\right) + \left(\alpha_{plz1} - 1\right) \qquad a_{z1x} = 0.308$$

$$a_{z1} := \begin{cases} a_{z1x} & \text{if } a_{z1x} \le 0.8 \\ 0.8 & \text{otherwise} \end{cases} \qquad a_{z1} = 0.308$$

$$k_{z1x} := 1 - \frac{F_A}{\chi_{Bz1} \cdot F_{pl1}} \cdot a_{z1} \qquad k_{z1x} = 0.953$$

$$k_{z1} := \begin{cases} k_{z1x} & \text{if } k_{z1x} \le 1.5 \\ 1.5 & \text{otherwise} \end{cases} \qquad k_{z1} = 0.953$$

$$S_{Mz1} := \frac{M_{z1}}{M_{plz1}} \cdot k_{z1} \qquad S_{Mz1} = 0.595$$

$$S_{y1} := \frac{F_E}{\chi_{By1} \cdot F_{pl1}} + \frac{M_{y1}}{M_{ply1}} \cdot k_{y1} + \frac{M_{z1}}{M_{plz1}} \cdot k_{z1} \qquad S_{y1} = 0.770$$

$$S_{z1} := \frac{F_E}{\chi_{Bz1} \cdot F_{pl1}} + \frac{M_{y1}}{M_{ply1}} \cdot k_{y1} + \frac{M_{z1}}{M_{plz1}} \cdot k_{z1} \qquad S_{z1} = 0.770$$

Sonuç: S_{y1} ve S_{z1} değerleri 1 den küçük olduğundan x1 kesitinin hesaplarına göre konstrüksiyon fonksiyonunu yapar.

O kesitinin emniyetli mukavet değerine göre kontrolü:

$$\sigma_{he1} := \frac{F_E}{A_1} + \frac{M_{y1}}{W_{y1}} + \frac{M_{z1}}{W_{z1}} \qquad \sigma_{he1} = 164 \cdot MPa$$

$$f_{EM} = 214 \cdot MPa$$

$$k_{EM1} := \frac{\sigma_{he1}}{f_{EM}} \qquad k_{EM1} = 0.77$$

E kesitinin emniyetli mukavet değerine göre kontrolü:

$$\sigma_{he2} := \frac{F_E}{A_2} + \frac{M_{y2}}{W_{y2}} + \frac{M_{z2}}{W_{z2}} \qquad \sigma_{he2} = 149 \cdot MPa$$

$$f_{EM} = 214 \cdot MPa$$

$$k_{EM2} := \frac{\sigma_{he2}}{f_{EM}} \qquad k_{EM2} = 0.70$$

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

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