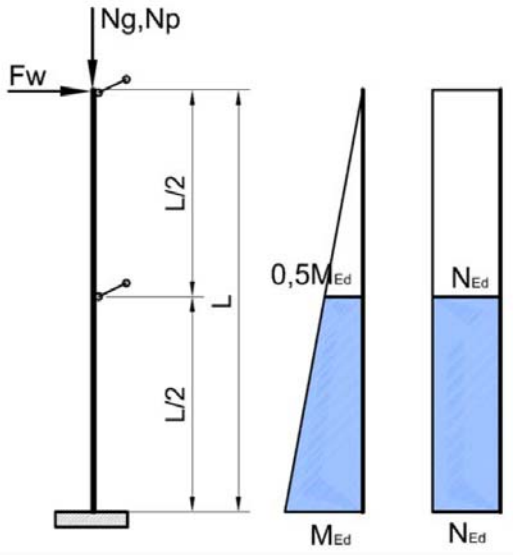
Zadatak 7 Ekscentrično pritisnut element

Dimenzionisati stub opterećen poprečnim i aksijalnim silama prema skici.
Dužina elementa je $L := 8\ m$
Karakteristične vrednosti opterećenja su:

$F_w := 3.5\ kN$ $N_g := 45\ kN$ $N_p := 80\ kN$

Maksimalno dopušteno pomeranje vrha stuba je L/150.
Osnovni materijal je S235.



Koeficijenti sigurnosti

$\gamma_{M0} := 1$ $\gamma_{M1} := 1$ $\gamma_G := 1.35$ $\gamma_Q := 1.5$

Koeficijenti za reprezentativne vrednosti

$\psi_{0w} := 0.6$ $\psi_{0p} := 0.7$

Proračunske vrednosti uticaja

kombinacija 1

$N_{Ed1} := \gamma_G \cdot N_g + \gamma_Q \cdot N_p = 180.75\ kN$
$M_{Ed1} := \psi_{0w} \cdot \gamma_Q \cdot F_w \cdot L = 25.2\ kN \cdot m$
$V_{Ed1} := \psi_{0w} \cdot \gamma_Q \cdot F_w = 3.15\ kN$

kombinacija 2

$N_{Ed2} := \gamma_G \cdot N_g + \psi_{0p} \cdot \gamma_Q \cdot N_p = 144.75\ kN$
$M_{Ed2} := \gamma_Q \cdot F_w \cdot L = 42\ kN \cdot m$
$V_{Ed2} := \gamma_Q \cdot F_w = 5.25\ kN$

$N_{Ed} := \max\left(N_{Ed1}, N_{Ed2}\right) = 180.75\ kN$
$M_{Ed} := \max\left(M_{Ed1}, M_{Ed2}\right) = 42\ kN \cdot m$
$V_{Ed} := \max\left(V_{Ed1}, V_{Ed2}\right) = 5.25\ kN$

Kvalitet materijala S235

$f_y := 235\ MPa$ $\varepsilon := \sqrt{\frac{235\ MPa}{f_y}} = 1$ $\eta := 1$ $E := 210\ GPa$ $G := 81\ GPa$

Pretpostavlja se poprečni presek IPE 300.

Geometrijske karakteristike poprečnog preseka

$h = 300\ mm$ $b_f = 150\ mm$ $t_w = 7.1\ mm$ $t_f = 10.7\ mm$ $r = 15\ mm$

$A = 53.8\ cm^2$ $A_{vz} = 25.68\ cm^2$ $I_w = 125900\ cm^6$
$I_y = 8356\ cm^4$ $I_z = 603.8\ cm^4$ $I_t = 20.12\ cm^4$
$W_{ply} = 628.4\ cm^3$ $W_{plz} = 125.2\ cm^3$

$W_{ely} := \frac{I_y}{\frac{h}{2}} = 557.07\ cm^3$ $W_{elz} := \frac{I_z}{\frac{b_f}{2}} = 80.51\ cm^3$

Klasa poprečnog preseka

nožica:

$$c := \frac{b_f - t_w}{2} - r = 56.45\ mm \qquad \frac{c}{t_f} = 5.28 \qquad < \qquad \lambda_{K1} := 9\ \varepsilon = 9 \qquad \textbf{K1}$$

rebro: $c := h - 2\ t_f - 2\ r = 248.6\ mm$

$$h_N := \frac{N_{Ed}}{\frac{t_w \cdot f_y}{\gamma_{M0}}} = 108.33\ mm \quad < \quad h_w := h - 2\ t_f = 278.6\ mm$$

deo rebra je pritisnut, p.n.o. je u rebru

$$d_c := \frac{c}{2} + \frac{h_N}{2} = 178.47\ mm \qquad \alpha := \frac{d_c}{c} = 0.718 \quad \begin{matrix} < 1 \\ > 0.5 \end{matrix}$$

$$\frac{c}{t_w} = 35.01 < \lambda_{K1} := \frac{396\ \varepsilon}{13\ \alpha - 1} = 47.52 \qquad \textbf{K1}$$

Poprečni presek je klase 1!

Kontrola graničnog stanja nosivosti

Kontrola nosivosti poprečnog preseka na pritisak

$$N_{plRd} := \frac{A \cdot f_y}{\gamma_{M0}} = 1264.3\ kN$$

$$\frac{N_{Ed}}{N_{plRd}} = 0.14 \quad < 1$$

Kontrola nosivosti poprečnog preseka na savijanje

$$M_{cRd} := \frac{W_{ply} \cdot f_y}{\gamma_{M0}} = 147.67\ kN \cdot m$$

$$\frac{M_{Ed}}{M_{cRd}} = 0.28 \quad < 1$$

Kontrola nosivosti poprečnog preseka na smicanje

$h_w := h - 2\ t_f = 278.6\ mm$

$$\frac{h_w}{t_w} = 39.24 \quad < 72\ \frac{\varepsilon}{\eta} = 72$$

Vitkost rebra zadovoljava uslov za primenu plastične nosivosti preseka na smicanje i ne treba proveravati izbočavanje smicanjem!

$$V_{plzRd} := \frac{A_{vz} \cdot f_y}{\sqrt{3} \cdot \gamma_{M0}} = 348.42\ kN$$

$$\frac{V_{Ed}}{V_{plzRd}} = 0.02 \quad < 1$$

$$\frac{V_{Ed}}{V_{plzRd}} < 0.5$$

Ne treba sprovoditi kontrolu interakcije savijanja i smicanja!

Kontrola nosivosti poprečnog preseka na interakciju savijanja i aksijalnog naprezanja

$$\frac{N_{Ed}}{N_{plRd}} = 0.14 \quad < 0.25$$

$A_w := h_w \cdot t_w = 19.78\ cm^2$

$$\frac{N_{Ed}}{\frac{A_w \cdot f_y}{\gamma_{M0}}} = 0.39 \quad < 0.50$$

Ne treba sprovoditi kontrolu interakcije savijanja i aksijalnog naprezanja!

Kontrola nosivosti elementa na fleksiono izvijanje

$N_{Rk} := A \cdot f_y = 1264.3\ kN$

izvijanje oko y ose $L_y := 2\ L = 16\ m$

$$N_{cr} := \pi^2 \frac{E \cdot I_y}{L_y^2} = 676.52\ kN$$

$$\lambda := \sqrt{\frac{N_{Rk}}{N_{cr}}} = 1.37$$

$$Izvijanje := \text{if } \lambda \le 0.2 \vee \frac{N_{Ed}}{N_{cr}} \le 0.04 \text{ “zanemaruje se” else “treba proveriti”} = \text{“treba proveriti”}$$

kriva izvijanja je "a" $\alpha = 0.21$

$$\Phi := 0.5\ \left(1 + \alpha \cdot (\lambda - 0.2) + \lambda^2\right) = 1.56$$

$$\chi_y := min\left(\frac{1}{\Phi + \sqrt{\Phi^2 - \lambda^2}}, 1\right) = 0.43$$

izvijanje oko z ose $L_z := 0.5\ L = 4\ m$

$$N_{cr} := \pi^2 \frac{E \cdot I_z}{L_z^2} = 782.15\ kN$$

$$\lambda := \sqrt{\frac{N_{Rk}}{N_{cr}}} = 1.27$$

$$Izvijanje := \text{if } \lambda \le 0.2 \vee \frac{N_{Ed}}{N_{cr}} \le 0.04 \text{ "zanemaruje se" else "treba proveriti"} = \text{"treba proveriti"}$$

kriva izvijanja je "b" $\alpha = 0.34$

$$\Phi := 0.5\left(1 + \alpha \cdot (\lambda - 0.2) + \lambda^2\right) = 1.49$$

$$\chi_z := min\left(\frac{1}{\Phi + \sqrt{\Phi^2 - \lambda^2}}, 1\right) = 0.44$$

$$\chi := min\left(\chi_y, \chi_z\right) = 0.43$$

$$N_{bRd} := \chi \frac{A \cdot f_y}{\gamma_{M1}} = 549 \ kN$$

$$\frac{N_{Ed}}{N_{bRd}} = 0.33 \quad < 1$$

Kontrola nosivosti elementa na bočno-torziono izvijanje

$$L_{cr} := 0.5 \ L = 4 \ m$$

M ( ) $\beta_m M$	M · $\beta_m M$	$1.75 + 1.05\beta_m + 0.3\beta_m^2$ 2.5	$-1 \le \beta_m \le 0.6$ $0.6 \le \beta_m \le 1$

$$C_1 := 1.75 + 1.05 \cdot (-0.5) + 0.3 \cdot (-0.5)^2 = 1.3 \qquad C_2 := 0 \qquad C_3 := 0$$

$$k_z := 1 \qquad k_w := 1 \qquad z_j := 0 \ mm \qquad z_g := 0 \ mm$$

$$M_{Rk} := W_{ply} \cdot f_y = 147.67 \ kN \cdot m$$

$$M_{cr} := C_1 \cdot \frac{\pi^2 \cdot E \cdot I_z}{(k_z \cdot L_{cr})^2} \cdot \left(\sqrt{\left(\frac{k_z}{k_w}\right)^2 \cdot \frac{I_w}{I_z} + \frac{(k_z \cdot L_{cr})^2 \cdot G \cdot I_t}{\pi^2 \cdot E \cdot I_z} + (C_2 \cdot z_g - C_3 \cdot z_j)^2} - (C_2 \cdot z_g - C_3 \cdot z_j)\right)$$

$$M_{cr} = 207.61 \ kN \cdot m$$

$$\lambda_{LT} := \sqrt{\frac{M_{Rk}}{M_{cr}}} = 0.84 \qquad BTI := \text{if } \lambda_{LT} \le 0.4 \vee \frac{M_{Ed}}{M_{cr}} \le 0.16 \text{ "zanemaruje se" else "treba proveriti"} = \text{"treba proveriti"}$$

Metoda za vrućevaljane pofile i ekvivalentne zavarene preseke

kriva izvijanja je "b" $\alpha_{LT} = 0.34$

$$\Phi_{LT} := 0.5\ \left(1+\alpha_{LT}\cdot\left(\lambda_{LT}-0.4\right)+0.75\ {\lambda_{LT}}^{2}\right)=0.84$$

$$\chi_{LT} := min\left(\frac{1}{\Phi_{LT}+\sqrt{{\Phi_{LT}}^{2}-0.75\ {\lambda_{LT}}^{2}}},1,\frac{1}{{\lambda_{LT}}^{2}}\right)=0.79$$

$$k_c := \frac{1}{1.33-0.33\cdot 0.5}=0.86$$

$$f := min\left(1-0.5\ \left(1-k_c\right)\cdot\left(1-2\ \left(\lambda_{LT}-0.8\right)^{2}\right),1\right)=0.93$$

$$\chi_{LTmod} := min\left(\frac{\chi_{LT}}{f},1\right)=0.85$$

$$M_{bRd} := \chi_{LTmod}\ \frac{M_{Rk}}{\gamma_{M1}}=126\ \ kN\cdot m$$

$$\frac{M_{Ed}}{M_{bRd}}=0.33\quad <1$$

Kontrola nosivosti ekscentrično pritisnutog elementa - aneks B

Dijagram momenata	Opseg važenja	C_{my} i C_{mz} i C_{mLT}	
		jednakopodeljeno opterećenje	koncentrisano opterećenje
M ψM	$-1 \le \psi \le 1$	$0{,}6 + 0{,}4\psi \ge 0{,}4$	

posmatra se dijagram My na segmentu između tačaka pridržavanja u pravcu ose z

$$C_{my} := 0.6+0.4\cdot 0=0.6$$

posmatra se dijagram Mz na segmentu između tačaka pridržavanja u pravcu ose y

$$C_{mz} := 0$$

posmatra se dijagram My na segmentu između tačaka pridržavanja u pravcu ose y

$$C_{mLT} := 0.6+0.4\cdot 0.5=0.8$$

Kombinacija 1

$$N_{Ed} := N_{Ed1}\qquad M_{Ed} := M_{Ed1}$$

$$k_{yy} := min\left(C_{my}\cdot\left(1+\left(\lambda_y-0.2\right)\cdot\frac{N_{Ed}}{\chi_y\cdot\frac{N_{Rk}}{\gamma_{M1}}}\right),C_{my}\cdot\left(1+0.8\cdot\frac{N_{Ed}}{\chi_y\cdot\frac{N_{Rk}}{\gamma_{M1}}}\right)\right)=0.758$$

$$k_{zy} := \max\left(1-\frac{0.1\ \lambda_z}{C_{mLT}-0.25}\cdot\frac{N_{Ed}}{\chi_z\cdot\frac{N_{Rk}}{\gamma_{M1}}},1-\frac{0.1}{C_{mLT}-0.25}\cdot\frac{N_{Ed}}{\chi_z\cdot\frac{N_{Rk}}{\gamma_{M1}}}\right)=0.941$$

$$\frac{N_{Ed}}{\chi_y\cdot\frac{N_{Rk}}{\gamma_{M1}}}+k_{yy}\cdot\frac{M_{Ed}}{\chi_{LT}\cdot\frac{M_{Rk}}{\gamma_{M1}}}=0.49\quad <1$$

$$\frac{N_{Ed}}{\chi_z\cdot\frac{N_{Rk}}{\gamma_{M1}}}+k_{zy}\cdot\frac{M_{Ed}}{\chi_{LT}\cdot\frac{M_{Rk}}{\gamma_{M1}}}=0.53\quad <1$$

Kombinacija 2

$N_{Ed} := N_{Ed2}$ $M_{Ed} := M_{Ed2}$

$$k_{yy} := min\left(C_{my}\cdot\left(1+(\lambda_y-0.2)\cdot\frac{N_{Ed}}{\chi_y\cdot\frac{N_{Rk}}{\gamma_{M1}}}\right), C_{my}\cdot\left(1+0.8\cdot\frac{N_{Ed}}{\chi_y\cdot\frac{N_{Rk}}{\gamma_{M1}}}\right)\right) = 0.727$$

$$k_{zy} := \max\left(1-\frac{0.1\ \lambda_z}{C_{mLT}-0.25}\cdot\frac{N_{Ed}}{\chi_z\cdot\frac{N_{Rk}}{\gamma_{M1}}}, 1-\frac{0.1}{C_{mLT}-0.25}\cdot\frac{N_{Ed}}{\chi_z\cdot\frac{N_{Rk}}{\gamma_{M1}}}\right) = 0.953$$

$$\frac{N_{Ed}}{\chi_y\cdot\frac{N_{Rk}}{\gamma_{M1}}}+k_{yy}\cdot\frac{M_{Ed}}{\chi_{LT}\cdot\frac{M_{Rk}}{\gamma_{M1}}} = 0.52 \qquad < 1$$

$$\frac{N_{Ed}}{\chi_z\cdot\frac{N_{Rk}}{\gamma_{M1}}}+k_{zy}\cdot\frac{M_{Ed}}{\chi_{LT}\cdot\frac{M_{Rk}}{\gamma_{M1}}} = 0.6 \qquad < 1$$

Kontrola nosivosti ekscentrično pritisnutog elementa - aneks A

$\lambda_{max} := \max(\lambda_y, \lambda_z) = 1.37$

određivanje λ_0

$$M_{cr0} := \frac{\pi^2\cdot E\cdot I_z}{L_{cr}^{\ 2}}\cdot\left(\sqrt{\frac{I_w}{I_z}+\frac{L_{cr}^{\ 2}\cdot G\cdot I_t}{\pi^2\cdot E\cdot I_z}}\right) = 159.7\ \boldsymbol{kN\cdot m}$$

$$\lambda_0 := \sqrt{\frac{M_{Rk}}{M_{cr0}}} = 0.96$$

kritična sila torzionog izvijanja

$L_T := 0.5\ L = 4\ \boldsymbol{m}$

$i_y := \sqrt{\frac{I_y}{A}} = 12.46\ \boldsymbol{cm}$ $i_z := \sqrt{\frac{I_z}{A}} = 3.35\ \boldsymbol{cm}$ $y_0 := 0\ \boldsymbol{cm}$ $z_0 := 0\ \boldsymbol{cm}$

$$i_0 := \sqrt{i_y^{\ 2}+i_z^{\ 2}+y_0^{\ 2}+z_0^{\ 2}} = 12.91\ \boldsymbol{cm}$$

$$N_{crT} := \frac{1}{i_0^{\ 2}}\left(G\cdot I_t+\pi^2\cdot\frac{E\cdot I_w}{L_T^{\ 2}}\right) = 1957.87\ \boldsymbol{kN}$$

Kombinacija 1

$N_{Ed} := N_{Ed1}$ $M_{Ed} := M_{Ed1}$ $M_{yEd} := M_{Ed}$ $M_{zEd} := 0\ \boldsymbol{kN\cdot m}$

koeficijent uniformnog momenta

Dijagram momenata	$C_{mi,0}$
M_1 ψM_1 $-1 \le \psi \le 1$	$C_{mi,0} = 0{,}79 + 0{,}21\,\psi_i + 0{,}36\,(\psi_i - 0{,}33)\,\frac{N_{Ed}}{N_{cr,i}}$

$$\psi_i := 0 \qquad C_{my0} := 0.79 + 0.21\ \psi_i + 0.36 \cdot \langle \psi_i - 0.33 \rangle \cdot \frac{N_{Ed}}{N_{cry}} = 0.76 \qquad C_{mz0} := 0$$

$$\varepsilon_y := \frac{M_{Ed}}{N_{Ed}} \cdot \frac{A}{W_{ely}} = 1.35 \qquad a_{LT} := \max\left(1 - \frac{I_t}{I_y}, 0\right) = 1$$

$$0.2 \cdot \sqrt{C_1} \cdot \sqrt[4]{\left(1 - \frac{N_{Ed}}{N_{crz}}\right) \cdot \left(1 - \frac{N_{Ed}}{N_{crT}}\right)} = 0.21 \ < \ \lambda_0 = 0.96$$

$$C_{my} := \text{if } 0.2 \cdot \sqrt{C_1} \cdot \sqrt[4]{\left(1 - \frac{N_{Ed}}{N_{crz}}\right) \cdot \left(1 - \frac{N_{Ed}}{N_{crT}}\right)} > \lambda_0 \ = 0.89$$
$$\quad \| \ C_{my0}$$
$$\quad \text{else}$$
$$\quad \| \ C_{my0} + \langle 1 - C_{my0} \rangle \cdot \frac{\sqrt{\varepsilon_y} \cdot a_{LT}}{1 + \sqrt{\varepsilon_y} \cdot a_{LT}}$$

$$C_{mz} := C_{mz0} = 0$$

$$C_{mLT} := \text{if } 0.2 \cdot \sqrt{C_1} \cdot \sqrt[4]{\left(1 - \frac{N_{Ed}}{N_{crz}}\right) \cdot \left(1 - \frac{N_{Ed}}{N_{crT}}\right)} > \lambda_0 \ = 1$$
$$\quad \| \ 1$$
$$\quad \text{else}$$
$$\quad \| \ \max\left(C_{my}{}^2 \cdot \frac{a_{LT}}{\sqrt{\left(1 - \frac{N_{Ed}}{N_{crz}}\right) \cdot \left(1 - \frac{N_{Ed}}{N_{crT}}\right)}}, 1\right)$$

$$\mu_y := \frac{1 - \frac{N_{Ed}}{N_{cry}}}{1 - \chi_y \cdot \frac{N_{Ed}}{N_{cry}}} = 0.829 \qquad w_y := min\left(\frac{W_{ply}}{W_{ely}}, 1.5\right) = 1.128$$

$$\mu_z := \frac{1 - \frac{N_{Ed}}{N_{crz}}}{1 - \chi_z \cdot \frac{N_{Ed}}{N_{crz}}} = 0.856 \qquad w_z := min\left(\frac{W_{plz}}{W_{elz}}, 1.5\right) = 1.5$$

$$n_{pl} := \frac{N_{Ed}}{N_{plRd}} = 0.14$$

$$M_{plyRd} := \frac{W_{ply} \cdot f_y}{\gamma_{M0}} = 147.67 \ \boldsymbol{kN \cdot m} \qquad M_{plzRd} := \frac{W_{plz} \cdot f_y}{\gamma_{M0}} = 29.42 \ \boldsymbol{kN \cdot m}$$

$$b_{LT} := 0.5 \ a_{LT} \cdot \lambda_0^{\ 2} \cdot \frac{M_{yEd}}{\chi_{LT} \cdot M_{plyRd}} \cdot \frac{M_{zEd}}{M_{plzRd}} = 0$$

$$d_{LT} := 2 \ a_{LT} \cdot \frac{\lambda_0}{0.1 + \lambda_z^{\ 4}} \cdot \frac{M_{yEd}}{C_{my} \cdot \chi_{LT} \cdot M_{plyRd}} \cdot \frac{M_{zEd}}{M_{plzRd}} = 0$$

$$C_{yy} := \max\left(1 + \langle w_y - 1 \rangle \cdot \left(\left(2 - \frac{1.6}{w_y} \cdot C_{my}^{\ 2} \cdot \lambda_{max} - \frac{1.6}{w_y} \cdot C_{my}^{\ 2} \cdot \lambda_{max}^{\ 2}\right) \cdot n_{pl} - b_{LT}\right), \frac{W_{ely}}{W_{ply}}\right) = 0.97$$

$$C_{zy} := \max\left(1 + \langle w_y - 1 \rangle \cdot \left(\left(2 - \frac{14}{w_y^{\ 5}} \cdot C_{my}^{\ 2} \cdot \lambda_{max}^{\ 2}\right) \cdot n_{pl} - d_{LT}\right), 0.6 \cdot \sqrt{\frac{w_y}{w_z}} \cdot \frac{W_{ely}}{W_{ply}}\right) = 0.83$$

$$k_{yy} := C_{my} \cdot C_{mLT} \cdot \frac{\mu_y}{1 - \frac{N_{Ed}}{N_{cry}}} \cdot \frac{1}{C_{yy}} = 1.035$$

$$k_{zy} := C_{my} \cdot C_{mLT} \cdot \frac{\mu_z}{1 - \frac{N_{Ed}}{N_{cry}}} \cdot \frac{1}{C_{zy}} \cdot 0.6 \cdot \sqrt{\frac{w_y}{w_z}} = 0.65$$

$$\frac{N_{Ed}}{\chi_y \cdot \frac{N_{Rk}}{\gamma_{M1}}} + k_{yy} \cdot \frac{M_{Ed}}{\chi_{LT} \cdot \frac{M_{Rk}}{\gamma_{M1}}} = 0.55 \qquad < 1$$

$$\frac{N_{Ed}}{\chi_z \cdot \frac{N_{Rk}}{\gamma_{M1}}} + k_{zy} \cdot \frac{M_{Ed}}{\chi_{LT} \cdot \frac{M_{Rk}}{\gamma_{M1}}} = 0.46 \qquad < 1$$

Kombinacija 2

$N_{Ed} := N_{Ed2}$ $M_{Ed} := M_{Ed2}$ $M_{yEd} := M_{Ed}$ $M_{zEd} := 0 \ \boldsymbol{kN \cdot m}$

koeficijent uniformnog momenta

$$\psi_i := 0 \qquad C_{my0} := 0.79 + 0.21 \ \psi_i + 0.36 \cdot \langle \psi_i - 0.33 \rangle \cdot \frac{N_{Ed}}{N_{cry}} = 0.76 \qquad C_{mz0} := 0$$

$$\varepsilon_y := \frac{M_{Ed}}{N_{Ed}} \cdot \frac{A}{W_{ely}} = 2.8 \qquad a_{LT} := \max\left(1 - \frac{I_t}{I_y}, 0\right) = 1$$

$$0.2 \cdot \sqrt{C_1} \cdot \sqrt[4]{\left(1 - \frac{N_{Ed}}{N_{crz}}\right) \cdot \left(1 - \frac{N_{Ed}}{N_{crT}}\right)} = 0.21 \ < \ \lambda_0 = 0.96$$

$$C_{my} := \text{if } 0.2 \cdot \sqrt{C_1} \cdot \sqrt[4]{\left(1-\frac{N_{Ed}}{N_{crz}}\right)\cdot\left(1-\frac{N_{Ed}}{N_{crT}}\right)} > \lambda_0 \;\; C_{my0} \;\; \text{else} \;\; C_{my0} + (1-C_{my0}) \cdot \frac{\sqrt{\varepsilon_y}\cdot a_{LT}}{1+\sqrt{\varepsilon_y}\cdot a_{LT}} = 0.91 \qquad C_{mz} := C_{mz0} = 0$$

$$C_{mLT} := \text{if } 0.2 \cdot \sqrt{C_1} \cdot \sqrt[4]{\left(1-\frac{N_{Ed}}{N_{crz}}\right)\cdot\left(1-\frac{N_{Ed}}{N_{crT}}\right)} > \lambda_0 \;\; 1 \;\; \text{else} \;\; \max\left(C_{my}{}^2 \cdot \frac{a_{LT}}{\sqrt{\left(1-\frac{N_{Ed}}{N_{crz}}\right)\cdot\left(1-\frac{N_{Ed}}{N_{crT}}\right)}}, 1\right) = 1$$

$$\mu_y := \frac{1-\frac{N_{Ed}}{N_{cry}}}{1-\chi_y\cdot\frac{N_{Ed}}{N_{cry}}} = 0.87 \qquad w_y := min\left(\frac{W_{ply}}{W_{ely}}, 1.5\right) = 1.13$$

$$\mu_z := \frac{1-\frac{N_{Ed}}{N_{crz}}}{1-\chi_z\cdot\frac{N_{Ed}}{N_{crz}}} = 0.89 \qquad w_z := min\left(\frac{W_{plz}}{W_{elz}}, 1.5\right) = 1.5$$

$$n_{pl} := \frac{N_{Ed}}{N_{plRd}} = 0.11$$

$$M_{plyRd} := \frac{W_{ply}\cdot f_y}{\gamma_{M0}} = 147.67 \; kN\cdot m \qquad M_{plzRd} := \frac{W_{plz}\cdot f_y}{\gamma_{M0}} = 29.42 \; kN\cdot m$$

$$b_{LT} := 0.5 \; a_{LT}\cdot\lambda_0{}^2 \cdot \frac{M_{yEd}}{\chi_{LT}\cdot M_{plyRd}} \cdot \frac{M_{zEd}}{M_{plzRd}} = 0$$

$$d_{LT} := 2 \; a_{LT}\cdot\frac{\lambda_0}{0.1+\lambda_z{}^4}\cdot\frac{M_{yEd}}{C_{my}\cdot\chi_{LT}\cdot M_{plyRd}}\cdot\frac{M_{zEd}}{M_{plzRd}} = 0$$

$$C_{yy} := \max\left(1+\langle w_y-1\rangle\cdot\left(\left(2-\frac{1.6}{w_y}\cdot C_{my}{}^2\cdot\lambda_{max}-\frac{1.6}{w_y}\cdot C_{my}{}^2\cdot\lambda_{max}{}^2\right)\cdot n_{pl}-b_{LT}\right), \frac{W_{ely}}{W_{ply}}\right) = 0.973$$

$$C_{zy} := \max\left(1+\langle w_y-1\rangle\cdot\left(\left(2-\frac{14}{w_y{}^5}\cdot C_{my}{}^2\cdot\lambda_{max}{}^2\right)\cdot n_{pl}-d_{LT}\right), 0.6\cdot\sqrt{\frac{w_y}{w_z}}\cdot\frac{W_{ely}}{W_{ply}}\right) = 0.855$$

$$k_{yy} := C_{my} \cdot C_{mLT} \cdot \frac{\mu_y}{1 - \frac{N_{Ed}}{N_{cry}}} \cdot \frac{1}{C_{yy}} = 1.033$$

$$k_{zy} := C_{my} \cdot C_{mLT} \cdot \frac{\mu_z}{1 - \frac{N_{Ed}}{N_{cry}}} \cdot \frac{1}{C_{zy}} \cdot 0.6 \cdot \sqrt{\frac{w_y}{w_z}} = 0.627$$

$$\frac{N_{Ed}}{\chi_y \cdot \frac{N_{Rk}}{\gamma_{M1}}} + k_{yy} \cdot \frac{M_{Ed}}{\chi_{LT} \cdot \frac{M_{Rk}}{\gamma_{M1}}} = 0.63 \qquad < 1$$

$$\frac{N_{Ed}}{\chi_z \cdot \frac{N_{Rk}}{\gamma_{M1}}} + k_{zy} \cdot \frac{M_{Ed}}{\chi_{LT} \cdot \frac{M_{Rk}}{\gamma_{M1}}} = 0.48 \qquad < 1$$

Kontrola graničnog stanja upotrebljivosti

Kontrola deformacija - pomeranje vrha stuba

$$w := \frac{F_w \, L^3}{3 \, E \cdot I_y} = 34.04 \ mm \qquad < \qquad w_{dop} := \frac{L}{150} = 53.33 \ mm$$