Zadatak 8.1 Nosivosti centrično pritisnutog elementa višedelnog poprečnog preseka

Izvršiti kontrolu nosivosti centrično pritisnutog elementa višedelnog poprečnog preseka sastavljenog od dva vrućevaljana profila IPE 300. Element je **rešetkastog tipa**, dužine L = 15 m, sa zglobnim uslovima oslanjanja oko obe ose. Vezni elementi u vidu dijagonala i vertikala su od vrućevaljanih profila L50/50/5 i postavljeni su na rastojanju a = 600 mm. Osovinsko rastojanje između samostalnih elemenata je h$_0$ = 700 mm. Element je izložen dejstvu normalne sile N$_{Ed}$ = 1200 kN. Osnovni materijal je čelik S355.

Kvalitet materijala $f_y := 355\ \boldsymbol{MPa}$ $\varepsilon := \sqrt{\dfrac{235\ \boldsymbol{MPa}}{f_y}} = 0.81$ $E := 210\ \boldsymbol{GPa}$

                                                                     $G := 81\ \boldsymbol{GPa}$

Koeficijenti sigurnosti za nosivost $\gamma_{M0} := 1$ $\gamma_{M1} := 1$

Geometrijske karakteristike poprečnog preseka IPE 300
$A_1 := 5380\ \boldsymbol{mm}^2$ $I_{1y} := 8360\ \boldsymbol{cm}^4$ $I_{1z} := 604\ \boldsymbol{cm}^4$

Geometrijske karakteristike poprečnog preseka L 50/50/5
$A_d := 4.80\ \boldsymbol{cm}^2$ $I_{du} := 17.42\ \boldsymbol{cm}^4$ $I_{dv} := 4.51\ \boldsymbol{cm}^4$
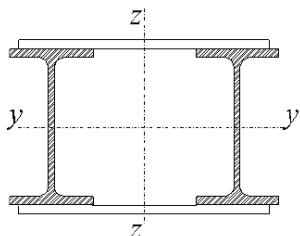
Geometrijske karakteristike pojasa (jedan IPE 300)
$A_{ch} = 53.8\ \boldsymbol{cm}^2$ $I_{chy} = 8360\ \boldsymbol{cm}^4$ $I_{chz} := 604\ \boldsymbol{cm}^4$
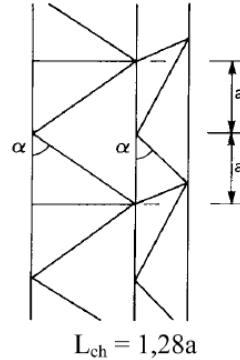
Geometrijske karakteristike višedelnog preseka (dva IPE 300)
$A = 107.6\ \boldsymbol{cm}^2$ $I_y = 16720\ \boldsymbol{cm}^4$

Poprečni presek   Oblik ispune   Uslovi oslanjanja

$L_{ch} = 1{,}28a$

dužina dijagonale $d := \sqrt{a^2 + h_0{}^2} = 921.95\ \boldsymbol{mm}$

Klasa poprečnog preseka
$b_f := 150\ \boldsymbol{mm}$ $h := 300\ \boldsymbol{mm}$ $t_w := 7.1\ \boldsymbol{mm}$ $t_f := 10.7\ \boldsymbol{mm}$ $r := 15\ \boldsymbol{mm}$

nožica:

        $c := \dfrac{b_f - t_w}{2} - r = 56.45\ \boldsymbol{mm}$ $\dfrac{c}{t_f} = 5.28$ $<$ $\lambda_{K1} := 9\ \varepsilon = 7.32$ **K1**

.

rebro:

$$c := h - 2\ t_f - 2\ r = 248.6\ mm \qquad \frac{c}{t_w} = 35.01 \quad < \quad \lambda_{K1} := 33\ \varepsilon = 26.85 \qquad \textbf{K1}$$

Poprečni presek je klase 1!

Izvijanje oko materijalne ose (y-osa na skici)

$$N_{Rk} := A \cdot f_y = 3820\ kN$$

$$N_{cr} := \pi^2\ \frac{E \cdot I_y}{L^2} = 1540\ kN$$

$$\lambda := \sqrt{\frac{N_{Rk}}{N_{cr}}} = 1.57$$

kriva izvijanja: **a** $\alpha = 0.21$

$$\Phi := 0.5\ \left(1 + \alpha \cdot (\lambda - 0.2) + \lambda^2\right) = 1.88$$

$$\chi := min\left(\frac{1}{\Phi + \sqrt{\Phi^2 - \lambda^2}}, 1\right) = 0.343$$

$$N_{bRd} := \chi \cdot \frac{N_{Rk}}{\gamma_{M1}} = 1308\ kN$$

$$\frac{N_{Ed}}{N_{bRd}} = 0.92 \quad < 1$$

Izvijanje oko nematerijalne ose (z-osa na skici)

$$N_{Rk} := A \cdot f_y = 3820\ kN \qquad \text{(presek je klase 1)}$$

$$I_{eff} := 0.5\ h_0^2 \cdot A_{ch} = 131810\ cm^4$$

$$N_{cr} := \pi^2\ \frac{E \cdot I_{eff}}{L^2} = 12142\ kN$$

broj paralelnih ravni ispune $n := 2$

krutost na smicanje $S_v := \dfrac{n \cdot E \cdot A_d \cdot a \cdot h_0^2}{d^3} = 75633\ kN$

$$N_{crV} := \frac{1}{\dfrac{1}{N_{cr}} + \dfrac{1}{S_v}} = 10462\ kN$$

ekvivalentna relativna vitkost $\lambda_{eq} := \sqrt{\dfrac{N_{Rk}}{N_{crV}}} = 0.6$

kriva izvijanja: **b** $\alpha = 0.34$

$$\Phi := 0.5\ \left(1 + \alpha \cdot (\lambda_{eq} - 0.2) + \lambda_{eq}^2\right) = 0.75$$

$$\chi := min\left(\frac{1}{\Phi + \sqrt{\Phi^2 - \lambda_{eq}^2}}, 1\right) = 0.835$$

$$N_{bRd} := \chi \cdot \frac{N_{Rk}}{\gamma_{M1}} = 3189 \ kN$$

$$\frac{N_{Ed}}{N_{bRd}} = 0.38 \quad < 1$$

Kontrola nosivosti samostalnog elementa u sredini štapa

početna geometrijska imperfekcija $\quad \delta_0 := \frac{L}{500} = 30 \ mm$

$$M_{Ed} := \frac{N_{Ed} \cdot \delta_0}{1 - \frac{N_{Ed}}{N_{crV}}} = 40.66 \ kN \cdot m$$

$$N_{chEd} := \frac{N_{Ed}}{2} + \frac{M_{Ed} \cdot h_0}{2 \ I_{eff}} \cdot A_{ch} = 658.09 \ kN$$

$$N_{Rk} := A_1 \cdot f_y = 1910 \ kN$$

$$L_{ch} := 1.28 \ a = 768 \ mm$$

$$N_{cr} := \pi^2 \ \frac{E \cdot I_{1z}}{L_{ch}^2} = 21224 \ kN$$

$$\lambda := \sqrt{\frac{N_{Rk}}{N_{cr}}} = 0.3$$
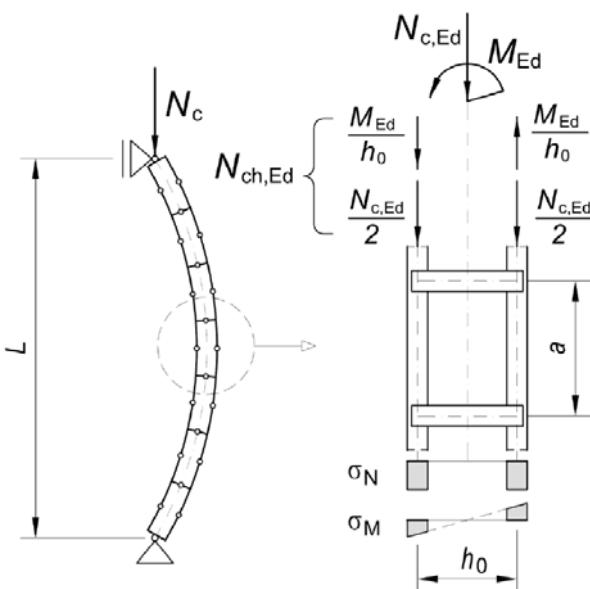
kriva izvijanja: **b** $\qquad \alpha = 0.34$

$$\Phi := 0.5 \left(1 + \alpha \cdot (\lambda - 0.2) + \lambda^2\right) = 0.56$$

$$\chi := min\left(\frac{1}{\Phi + \sqrt{\Phi^2 - \lambda^2}}, 1\right) = 0.964$$

$$N_{bRd} := \chi \cdot \frac{N_{Rk}}{\gamma_{M1}} = 1841 \ kN$$

$$\frac{N_{chEd}}{N_{bRd}} = 0.36 \quad < 1$$

Kontrola nosivosti veznih elemenata - dijagonale

$$V_{Ed} := \frac{\pi}{L} \cdot M_{Ed} = 8.52 \ kN$$

$$N_{dEd} := \frac{V_{Ed}}{n} \cdot \frac{d}{h_0} = 5.61 \ kN$$

$$N_{Rk} := A_d \cdot f_y = 170.4 \ \textbf{kN}$$

$$N_{cru} := \pi^2 \ \frac{E \cdot I_{du}}{d^2} = 424.76 \ \textbf{kN} \qquad\qquad N_{crv} := \pi^2 \ \frac{E \cdot I_{dv}}{d^2} = 109.97 \ \textbf{kN}$$

$$i_u := 1.90 \ \textbf{cm} \qquad i_v := 0.97 \ \textbf{cm} \qquad u_0 := 1.4 \cdot \sqrt{2} \ \textbf{cm} = 1.98 \ \textbf{cm} \qquad v_0 := 0 \ \textbf{cm}$$

$$i_0 := \sqrt{i_u^2 + i_v^2 + u_0^2 + v_0^2} = 2.91 \ \textbf{cm}$$

$$I_t := 0.39 \ \textbf{cm}^4 \qquad I_w := 0 \ \textbf{cm}^6$$

$$N_{crT} := \frac{1}{i_0^2} \cdot \left(G \cdot I_t + \pi^2 \cdot \frac{E \cdot I_w}{d^2} \right) = 372.92 \ \textbf{kN}$$

$$\beta := 1 - \frac{u_0^2}{i_0^2} = 0.54$$

$$N_{crTF} := \frac{N_{cru}}{2 \ \beta} \cdot \left(1 + \frac{N_{crT}}{N_{cru}} - \sqrt{\left(1 + \frac{N_{crT}}{N_{cru}} \right)^2 - 4 \ \beta \cdot \frac{N_{crT}}{N_{cru}}} \right) = 236.13 \ \textbf{kN}$$

$$N_{cr} := min \ (N_{cru}, N_{crv}, N_{crT}, N_{crTF}) = 109.97 \ \textbf{kN}$$

$$\lambda := \sqrt{\frac{N_{Rk}}{N_{cr}}} = 1.24$$

kriva izvijanja: **b** $\qquad\qquad \alpha = 0.34$

$$\Phi := 0.5 \ \left(1 + \alpha \cdot (\lambda - 0.2) + \lambda^2 \right) = 1.45$$

$$\chi := min \left(\frac{1}{\Phi + \sqrt{\Phi^2 - \lambda^2}}, 1 \right) = 0.454$$

$$N_{bRd} := \chi \cdot \frac{N_{Rk}}{\gamma_{M1}} = 77 \ \textbf{kN}$$

$$\frac{N_{dEd}}{N_{bRd}} = 0.07 \quad < 1$$

Zadatak 8.2 Nosivosti centrično pritisnutog elementa višedelnog poprečnog preseka

Izvršiti kontrolu nosivosti centrično pritisnutog elementa višedelnog poprečnog preseka sastavljenog od dva vrućevaljana profila UPN 300. Element je **ramovskog tipa**, dužine L = 12 m, sa zglobnim uslovima oslanjanja oko obe ose. Vezni elementi su od ravnog lima dimenzija 120x12 mm i postavljeni su na rastojanju a = 500 mm. Osovinsko rastojanje između samostalnih elemenata je h0 = 400 mm. Element je izložen dejstvu normalne sile NEd = 1400 kN. Osnovni materijal je čelik S275.

Kvalitet materijala $\quad f_y := 275 \ MPa \quad\quad \varepsilon := \sqrt{\dfrac{235 \ MPa}{f_y}} = 0.92 \quad\quad E := 210 \ GPa$

Koeficijenti sigurnosti za nosivost $\quad \gamma_{M0} := 1 \quad \gamma_{M1} := 1$

Geometrijske karakteristike poprečnog preseka UPN 300
$A_1 := 58.8 \ cm^2 \quad\quad I_{1y} := 8030 \ cm^4 \quad\quad I_{1z} := 495 \ cm^4$

Geometrijske karakteristike lima $\quad b := 120 \ mm \quad\quad t := 12 \ mm$
$A_b := b \cdot t = 14.4 \ cm^2 \quad I_b := \dfrac{1}{12} \ b^3 \cdot t = 172.8 \ cm^4$
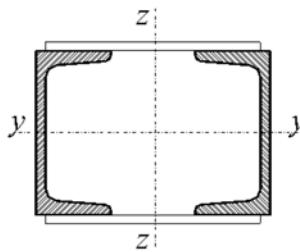
Geometrijske karakteristike pojasa (jedan UPN 300)
$A_{ch} = 58.8 \ cm^2 \quad\quad I_{chy} = 8030 \ cm^4 \quad\quad I_{chz} = 495 \ cm^4$

Geometrijske karakteristike višedelnog preseka (dva UPN 300)
$A = 117.6 \ cm^2$

Poprečni presek   Uslovi oslanjanja

Klasa poprečnog preseka
$b_f := 100 \ mm \quad\quad h := 300 \ mm \quad\quad t_w := 10 \ mm \quad\quad t_f := 16 \ mm \quad\quad r := 16 \ mm$

nožica:

$\quad\quad c := b_f - t_w - r = 74 \ mm \quad\quad\quad \dfrac{c}{t_f} = 4.63 \quad\quad < \quad \lambda_{K1} := 9 \ \varepsilon = 8.32 \quad\quad$ **K1**

rebro:

$\quad\quad c := h - 2 \ t_f - 2 \ r = 236 \ mm \quad\quad \dfrac{c}{t_w} = 23.6 \quad\quad < \quad \lambda_{K1} := 33 \ \varepsilon = 30.51 \quad\quad$ **K1**

   Poprečni presek je klase 1!

<u>Izvijanje oko materijalne ose (y-osa na skici)</u>

$$N_{Rk} := A \cdot f_y = 3234 \ \textbf{kN}$$

$$N_{cr} := \pi^2 \ \frac{E \cdot I_y}{L^2} = 2407 \ \textbf{kN}$$

$$\lambda := \sqrt{\frac{N_{Rk}}{N_{cr}}} = 1.16$$

kriva izvijanja: **c** $\alpha = 0.49$

$$\Phi := 0.5 \ \left(1 + \alpha \cdot (\lambda - 0.2) + \lambda^2 \right) = 1.41$$

$$\chi := min \left(\frac{1}{\Phi + \sqrt{\Phi^2 - \lambda^2}}, 1 \right) = 0.454$$

$$N_{bRd} := \chi \cdot \frac{N_{Rk}}{\gamma_{M1}} = 1467 \ \textbf{kN}$$

$$\frac{N_{Ed}}{N_{bRd}} = 0.95 \quad < 1$$

<u>Izvijanje oko nematerijalne ose (z-osa na skici)</u>

$$N_{Rk} := A \cdot f_y = 3234 \ \textbf{kN}$$

$$I_0 := 0.5 \ h_0^2 \cdot A_{ch} + 2 \ I_{chz} = 48030 \ \textbf{cm}^4$$

$$i_0 := \sqrt{\frac{I_0}{2 \ A_{ch}}} = 20.21 \ \textbf{cm} \qquad \lambda := \frac{L}{i_0} = 59.38 \quad < 75 \qquad \mu := 1$$

$$I_{eff} := 0.5 \ h_0^2 \cdot A_{ch} + 2 \ \mu \cdot I_{chz} = 48030 \ \textbf{cm}^4$$

$$N_{cr} := \pi^2 \ \frac{E \cdot I_{eff}}{L^2} = 6913 \ \textbf{kN}$$

broj paralelnih ravni ispune $n := 2$

krutost na smicanje $S_v := min \left(\dfrac{24 \cdot E \cdot I_{chz}}{a^2 \cdot \left(1 + \dfrac{2 \ I_{chz}}{n \cdot I_b} \cdot \dfrac{h_0}{a} \right)}, 2 \ \pi^2 \cdot \dfrac{E \cdot I_{chz}}{a^2} \right) = 30317 \ \textbf{kN}$

$$N_{crV} := \frac{1}{\dfrac{1}{N_{cr}} + \dfrac{1}{S_v}} = 5629 \ \textbf{kN}$$

ekvivalentna relativna vitkost $\lambda_{eq} := \sqrt{\dfrac{N_{Rk}}{N_{crV}}} = 0.76$

kriva izvijanja: **c** $\alpha = 0.49$

$$\Phi := 0.5 \ \left(1 + \alpha \cdot \left(\lambda_{eq} - 0.2 \right) + \lambda_{eq}^2 \right) = 0.92$$

$$\chi := min\left(\frac{1}{\Phi + \sqrt{\Phi^2 - \lambda_{eq}{}^2}}, 1\right) = 0.689$$

$$N_{bRd} := \chi \cdot \frac{N_{Rk}}{\gamma_{M1}} = 2227 \ kN$$

$$\frac{N_{Ed}}{N_{bRd}} = 0.63 \quad < 1$$

Kontrola nosivosti samostalnog elementa u sredini štapa

početna geometrijska imperfekcija $\quad \delta_0 := \frac{L}{500} = 24 \ mm$

$$M_{Ed} := \frac{N_{Ed} \cdot \delta_0}{1 - \frac{N_{Ed}}{N_{crV}}} = 44.72 \ kN \cdot m$$

$$N_{chEd} := \frac{N_{Ed}}{2} + \frac{M_{Ed} \cdot h_0}{2 \ I_{eff}} \cdot A_{ch} = 809.5 \ kN$$

$$N_{Rk} := A_1 \cdot f_y = 1617 \ kN$$

$$L_{ch} := a = 500 \ mm$$

$$N_{cr} := \pi^2 \ \frac{E \cdot I_{1z}}{L_{ch}{}^2} = 41038 \ kN$$

$$\lambda := \sqrt{\frac{N_{Rk}}{N_{cr}}} = 0.2$$
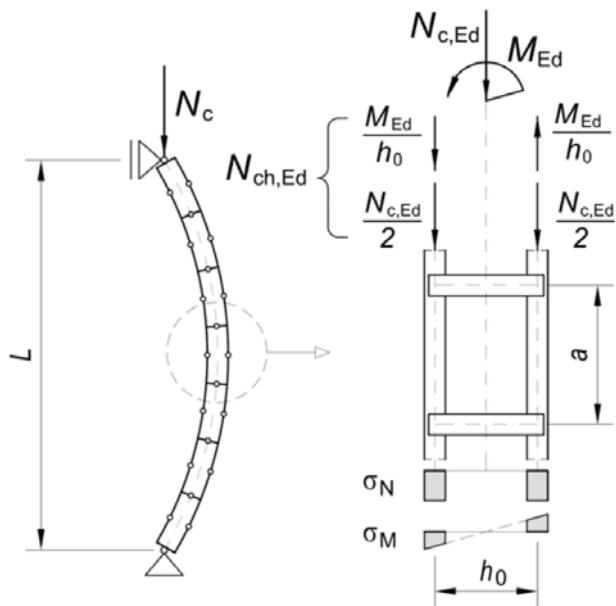
kriva izvijanja: **c** $\quad \alpha = 0.49$

$$\Phi := 0.5 \left(1 + \alpha \cdot (\lambda - 0.2) + \lambda^2\right) = 0.52$$

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

$$N_{bRd} := \chi \cdot \frac{N_{Rk}}{\gamma_{M1}} = 1617 \ kN$$

$$\frac{N_{chEd}}{N_{bRd}} = 0.5 \quad < 1$$

Kontrola nosivosti samostalnog elementa u krajnjem polju

$$V_{Ed} := \frac{\pi}{L} \cdot M_{Ed} = 11.71 \ kN$$

$$M_{chEd} := V_{Ed} \cdot \frac{a}{4} = 1.46 \ kN \cdot m$$

$$V_{chEd} := \frac{V_{Ed}}{2} = 5.85 \ kN$$

$$N_{chEd} := \frac{N_{Ed}}{2} = 700 \ kN$$

Kontrola nosivosti poprečnog preseka na smicanje

$$A_{vy} := 2 \ b_f \cdot t_f = 32 \ cm^2$$

$$V_{plyRd} := \frac{A_{vy} \cdot f_y}{\sqrt{3} \cdot \gamma_{M0}} = 508.07 \ kN$$

$$\frac{V_{chEd}}{V_{plyRd}} = 0.01 \ < 1$$

$$\frac{V_{Ed}}{V_{plyRd}} < 0.5 \qquad$$ Ne treba sprovoditi kontrolu
interakcije savijanja i smicanja!

Kontrola nosivosti poprečnog preseka na savijanje

$$W_{plz} := 130 \ cm^3$$

$$M_{cRd} := \frac{W_{plz} \cdot f_y}{\gamma_{M0}} = 35.75 \ kN \cdot m$$

$$\frac{M_{chEd}}{M_{cRd}} = 0.04 \ < 1$$

Kontrola nosivosti poprečnog preseka na pritisak

$$N_{plRd} := \frac{A_1 \cdot f_y}{\gamma_{M0}} = 1617 \ kN$$

$$\frac{N_{chEd}}{N_{plRd}} = 0.43 \ < 1$$

Kontrola nosivosti poprečnog preseka na interakciju savijanja i pritiska
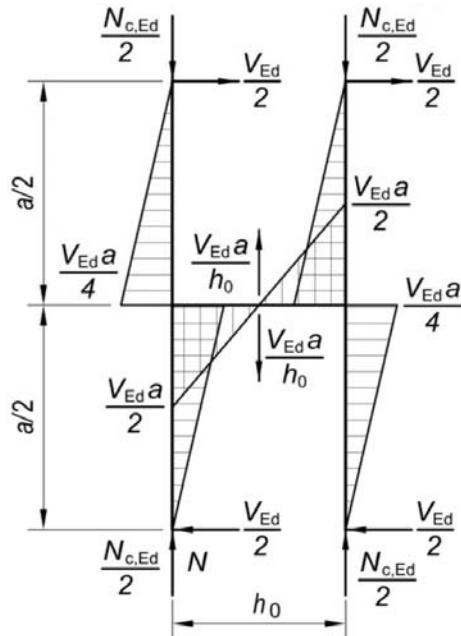
$$A_N := \frac{N_{chEd}}{\dfrac{f_y}{\gamma_{M0}}} = 25.45 \ cm^2 \qquad y_s := 2.89 \ cm$$

$$\frac{A_N}{2} = 12.73 \ cm^2 \ < \ (h - 2 \ t_f) \cdot t_w = 26.8 \ cm^2 \qquad$$ površina rebra je dovoljna za
prijem aksijalne sile pritiska

$$M_{NRd} := \frac{b_f}{2} \cdot t_f \cdot b_f \ \frac{f_y}{\gamma_{M0}} = 22 \ kN \cdot m$$

redukovani moment je sračunat konzervativno, računajući
da samo nožice primaju normalne napone usled savijanja

$$\frac{M_{chEd}}{M_{NRd}} = 0.07 \ < 1$$

Kontrola bočno-torzionog savijanja se ne sprovodi obzirom da je element opterećen na savijanje oko slabije ose inercije.

Kontrola nosivosti ekscentrično pritisnutog elementa

Koeficijenti interakcije k_{yz} i k_{zz} se određuju prema pilogu A, obzirom da je presek monosimetričan.

$$W_{ely} := 535 \ cm^3 \qquad W_{ply} := 632 \ cm^3 \qquad W_{elz} := 67.8 \ cm^3 \qquad W_{plz} := 130 \ cm^3$$

$$N_{Rk} := A_1 \cdot f_y = 1617 \ kN \qquad\qquad L_{ch} := a = 500 \ mm$$

$$N_{cry} := \pi^2 \ \frac{E \cdot I_{1y}}{L_{ch}^2} = 665725 \ kN \qquad\qquad \lambda_y := \sqrt{\frac{N_{Rk}}{N_{cry}}} = 0.05$$

kriva izvijanja: **c** $\qquad\qquad \alpha = 0.49 \qquad \Phi_y := 0.5 \ (1 + \alpha \cdot (\lambda_y - 0.2) + \lambda_y^2) = 0.46$

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

$$N_{crz} := \pi^2 \ \frac{E \cdot I_{1z}}{L_{ch}^2} = 41038 \ kN \qquad\qquad \lambda_z := \sqrt{\frac{N_{Rk}}{N_{crz}}} = 0.2$$

kriva izvijanja: **c** $\qquad\qquad \alpha = 0.49 \qquad \Phi_z := 0.5 \ (1 + \alpha \cdot (\lambda_z - 0.2) + \lambda_z^2) = 0.52$

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

$$\lambda_{max} := \max (\lambda_y, \lambda_z) = 0.2$$

$$\psi_i := 0 \qquad C_{mz0} := 0.79 + 0.21 \ \psi_i + 0.36 \cdot (\psi_i - 0.33) \cdot \frac{N_{chEd}}{N_{crz}} = 0.79$$

$$C_{mz} := C_{mz0} = 0.79$$

$$\mu_y := \frac{1 - \dfrac{N_{Ed}}{N_{cry}}}{1 - \chi_y \cdot \dfrac{N_{Ed}}{N_{cry}}} = 1 \qquad\qquad\qquad \mu_z := \frac{1 - \dfrac{N_{chEd}}{N_{crz}}}{1 - \chi_z \cdot \dfrac{N_{chEd}}{N_{crz}}} = 1$$

$$w_y := min\left(\frac{W_{ply}}{W_{ely}}, 1.5\right) = 1.18 \qquad\qquad w_z := min\left(\frac{W_{plz}}{W_{elz}}, 1.5\right) = 1.5$$

$$n_{pl} := \frac{N_{chEd}}{A_1 \cdot f_y} = 0.43$$

$$M_{yRk} := W_{ply} \cdot f_y = 173.8 \ kN \cdot m \qquad\qquad M_{zRk} := W_{plz} \cdot f_y = 35.75 \ kN \cdot m$$

$$c_{LT} := 0 \qquad\qquad e_{LT} := 0$$

$$C_{yz} := \max\left(1 + (w_z - 1) \cdot \left(\left(2 - \frac{14}{w_z^5} \cdot C_{mz}^2 \cdot \lambda_{max}^2\right) \cdot n_{pl} - c_{LT}\right), 0.6 \cdot \sqrt{\frac{w_z}{w_y}} \cdot \frac{W_{elz}}{W_{plz}}\right) = 1.423$$

$$C_{zz} := \max\left(1 + (w_z - 1) \cdot \left(2 - \frac{1.6}{w_z} \cdot C_{mz}{}^2 \cdot \lambda_{max} - \frac{1.6}{w_z} \cdot C_{mz}{}^2 \cdot \lambda_{max}{}^2 - e_{LT}\right) \cdot n_{pl}, \frac{W_{elz}}{W_{plz}}\right) = 1.399$$

$$k_{yz} := C_{mz} \cdot \frac{\mu_y}{1 - \dfrac{N_{Ed}}{N_{crz}}} \cdot \frac{1}{C_{yz}} \cdot 0.6 \cdot \sqrt{\frac{w_z}{w_y}} = 0.388$$

$$k_{zz} := C_{mz} \cdot \frac{\mu_z}{1 - \dfrac{N_{Ed}}{N_{crz}}} \cdot \frac{1}{C_{zz}} = 0.583$$

$$\frac{N_{chEd}}{\chi_y \dfrac{N_{Rk}}{\gamma_{M1}}} + k_{yz} \cdot \frac{M_{chEd}}{\dfrac{M_{zRk}}{\gamma_{M1}}} = 0.45 < 1$$

$$\frac{N_{chEd}}{\chi_z \dfrac{N_{Rk}}{\gamma_{M1}}} + k_{zz} \cdot \frac{M_{chEd}}{\dfrac{M_{zRk}}{\gamma_{M1}}} = 0.46 < 1$$

<u>Kontrola nosivosti prečki</u>

$$V_{bEd} := \frac{V_{Ed} \cdot a}{h_0} = 14.64 \; \boldsymbol{kN}$$

$$M_{bEd} := \frac{V_{Ed} \cdot a}{2} = 2.93 \; \boldsymbol{kN \cdot m}$$

Kontrola nosivosti poprečnog preseka na smicanje

$$\tau_{bEd} := \frac{3}{2} \cdot \frac{V_{bEd}}{A_b} = 15.25 \; \boldsymbol{MPa}$$

$$\frac{\tau_{bEd}}{\dfrac{f_y}{\sqrt{3} \cdot \gamma_{M0}}} = 0.1 \qquad < 1$$

Kontrola nosivosti poprečnog preseka na savijanje

$$\sigma_{bEd} := \frac{M_{bEd}}{\dfrac{I_b}{0.5 \; b}} = 101.63 \; \boldsymbol{MPa}$$

$$\frac{\sigma_{bEd}}{\dfrac{f_y}{\gamma_{M0}}} = 0.37 \quad < 1$$