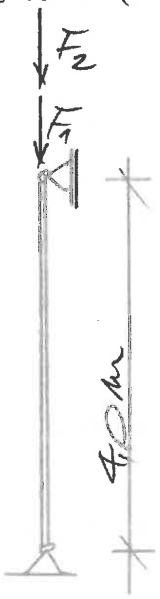
UNIVERZA V MARIBORU
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JEKLENE ARHITEKTONSKE KONSTRUKCIJE

Kandidat:

1. Naloga

4 m visok jekleni steber prereza IPE 200 iz materiala S 275 je obremenjen s silo F_1=100 kN (stalna obtežba) in silo F_2=75 kN (koristna obtežba). Lastno težo nosilca zanemari. Ali steber prenese dano obtežbo?

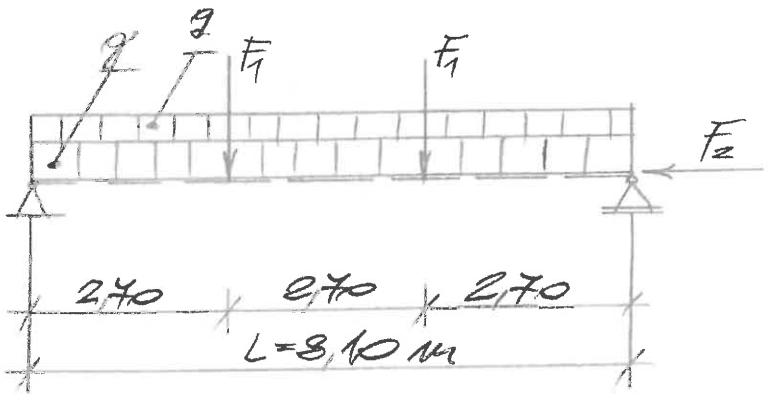


30%

2. Naloga

Strešni nosilec dolžine L=8,10 m iz valjanega prereza HEA 650 in materiala S 355 je obremenjen z zvezno obtežbo g=30 kN/m (stalna obtežba), q=25 kN/m (koristna obtežba), z navpičnima silama F_1=75 kN (stalna obtežba) in vodoravno silo F_2=150 kN (veter). Lastno težo nosilca zanemari. V kombinaciji obtežb upoštevaj koristno obtežbo kot dominantni spremenljivi vpliv.

- Z elastično odpornostjo dimenzioniraj nosilec, ki je bočno podprt samo na obeh svojih podporah. Nariši diagrame notranjih statičnih količin. 60%
- Po mejnem stanju uporabnosti preveri vertikalno deformacijo na sredini razpona nosilca za zvezno stalno obtežbo g. 10%



JEKLENE ARHITEKTONSKE KONSTRUKCIJE

1. NALOGA

$$N_{Ed} = \gamma_g \cdot F_1 + \gamma_g \cdot F_2 = 1{,}35 \cdot 100 + 1{,}50 \cdot 75 = 247{,}50\ kN$$

IPE200: $A = 28{,}5\ cm^2$ $i_z = 2{,}24\ cm$

S275 : $f_y = 27{,}5\ kN/cm^2$ $\varepsilon = 0{,}92$

$$\lambda_z = \frac{l_{wz}}{i_z} = \frac{400}{2{,}24} = 178{,}57$$

$$\bar{\lambda}_z = \frac{\lambda_z}{93{,}9 \cdot \varepsilon} = \frac{178{,}57}{93{,}9 \cdot 0{,}92} = 2{,}06$$

$h/b > 1{,}2$, z-z → uklon. krivulja b

$$\Big\} \chi_z = \chi_{min} = 0{,}1987$$

$$N_{b,Rd} = \chi_z \frac{A \cdot f_y}{\gamma_{M1}} = 0{,}1987 \frac{28{,}5 \cdot 27{,}5}{1{,}0} = 155{,}73\ kN$$

$N_{Ed} = 247{,}50\ kN > N_{b,Rd} = 155{,}73\ kN$

STEBER NE PRENESE DANE OBTEŽBE!

2. NALOGA

$$g_{ed} = \gamma_g \cdot g = 1{,}35 \cdot 30 = 40{,}50\ kN/m^1$$

$$q_{Ed} = \gamma_q \cdot q = 1{,}50 \cdot 25 = 37{,}50\ kN/m^1$$

$$F_{1ed} = \gamma_g \cdot F_1 = 1{,}35 \cdot 75 = 101{,}25\ kN$$

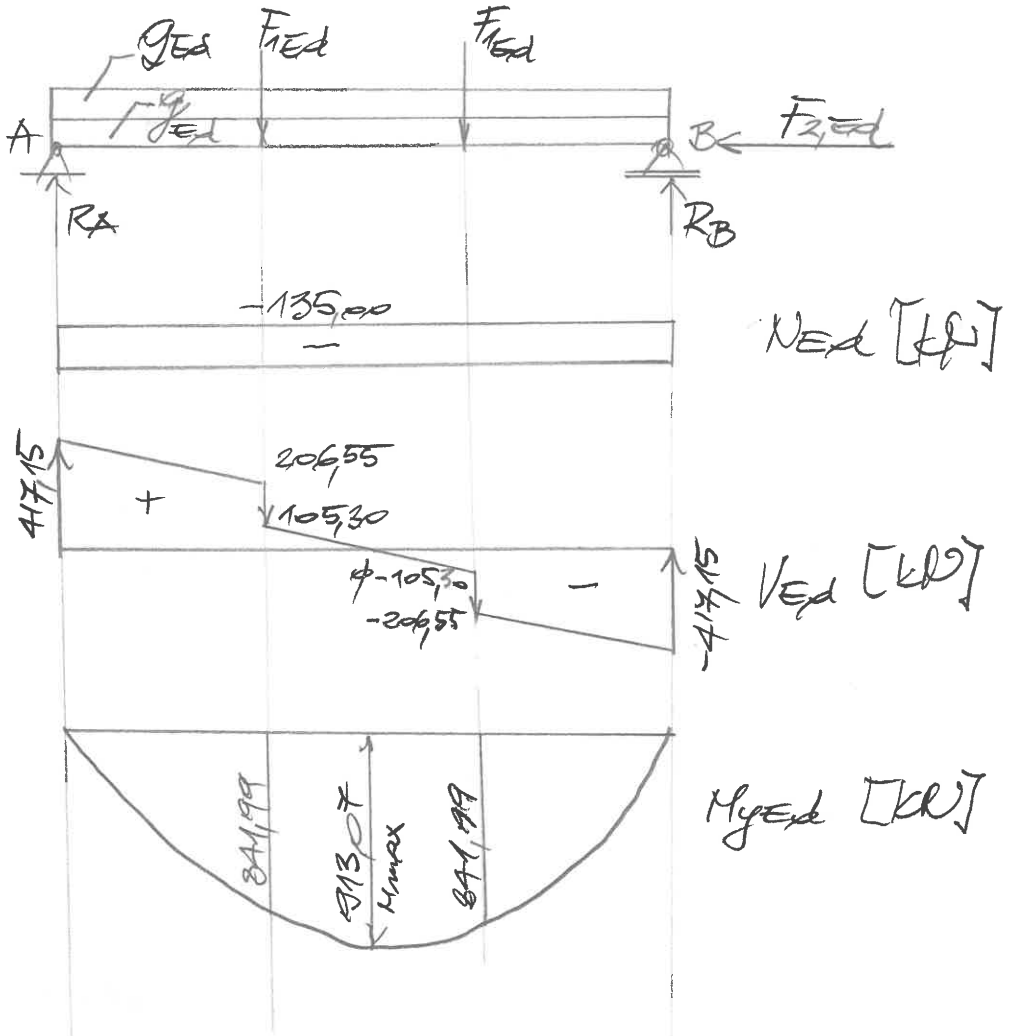
$$F_{2Ed} = \gamma_q \cdot \psi_1 \cdot F_2 = 1{,}50 \cdot 0{,}6 \cdot 150 = 135{,}0\ kN$$

$$V_{z\,max} = R_A = (40{,}50 + 37{,}5) \cdot \frac{8{,}10}{2} + 101{,}25 = 417{,}15\ kN$$

$$M_{max} = R_A \cdot L/2 - (g_{ed} + q_{ed}) \frac{L^2}{2 \cdot 4} - F_{1ed} \cdot \frac{L}{6}$$

$$M_{max} = 417{,}15 \cdot \frac{8{,}10}{2} - (40{,}5 + 37{,}5) \cdot \frac{8{,}10^2}{8} - 101{,}25 \cdot \frac{8{,}10}{6} = 913{,}07\ kNm$$

$N_{Ed} = -135{,}00\ kN$



przekrój:

$$\frac{N_{Ed}}{\frac{A \cdot f_y}{\gamma_{M0}}} + \frac{M_{yEd}}{\frac{W_y \cdot f_y}{\gamma_{M0}}} < 1{,}0$$

$$\frac{135{,}0}{\frac{242 \cdot 35{,}5}{1{,}0}} + \frac{913{,}07 \times 100}{5470 \cdot 35{,}5} \overset{?}{<} 1{,}0$$

$0{,}015 + 0{,}470 = 0{,}485 < 1{,}0$ O.K.

HEA 650 S355

$A = 242\ cm^2$

$W_y = 5470\ cm^3$

$i_y = 26{,}9\ cm$ $i_z = 6{,}97$

$I_y = 175200\ cm^4$

$I_z = 11720\ cm^4$

$I_t = 450\ cm^4$

$I_w = 11027000\ cm^6$

$f_y = 35{,}5\ kN/cm^2$

$\varepsilon = 0{,}81$

ścinanie:

$$V_{pl,Rd} \simeq \frac{h_w \cdot t_w \cdot f_y}{\sqrt{3} \cdot \gamma_{M0}} \simeq \frac{64{,}0 \cdot 1{,}35 \cdot 35{,}5}{\sqrt{3} \cdot 1{,}0} = 1770{,}85\ kN > V_{max} = 417{,}15\ kN$$

O.K.

odporność mostka!

$R_z = \chi_{min}$:

$$\lambda_z = \frac{l_{wz}}{i_z} = \frac{810}{6,97} = 116,21$$

$$\bar{\lambda}_z = \frac{\lambda_z}{93,9\varepsilon} = \frac{116,21}{93,9 \cdot 0,61} = 1,53$$

$h/b = 71,2$ z-z : ukł. kon. krzyw. b

$\Big\}$ $\chi_z = 0,3314$ (miarodajna krzywa)

zlamiter!

$C_1 = 1,132$ $C_2 = 0,459$ $z_g = h/2 = 64/2 = 32\,cm$, $k = k_w = 1,0$

$J_z = 11720\,cm^4$ $J_t = 450\,cm^4$ $J_w = 11027000\,cm^6$

$L = 810\,cm$ $q = 8,076\,kN/cm^2$ $E = 21000\,kN/cm^2$

$$M_{cr} = C_1 \frac{\pi^2 E J_z}{L^2} \left\{ \sqrt{\frac{J_w}{J_z} + \frac{L^2 \cdot G \cdot J_t}{\pi^2 \cdot E \cdot J_z} + (C_2 \cdot z_g)^2} - (C_2 z_g) \right\}$$

$M_{cr} = 132239\,kNcm$

$$\bar{\lambda}_{LT} = \sqrt{\frac{W_y \cdot f_y}{M_{cr}}} = \sqrt{\frac{5470 \cdot 35,5}{132239}} = 1,21$$

Standardowy profil: $h/b > 2$ → krzyw. c

$\Big\}$ $\chi_{LT} = 0,49$

$$\Phi_{LT} = 0,5\left[1 + 0,49(1,21 - 0,4) + 0,75 \cdot 1,21^2\right] = 1,25$$

$$\chi_{LT} = \frac{1}{1,25 + \sqrt{1,25^2 - 0,75 \cdot 1,21^2}} = 0,52$$

miarodajna suwaka (z uwzględnieniem skali z osi)

$$\frac{N_{Ed}}{\chi_z \frac{A \cdot f_y}{\gamma_{M1}}} + \frac{M_{yEd}}{\chi_{LT} \frac{W_y \cdot f_y}{\gamma_{M1}}} \leq 1,0$$

$$\frac{135,0}{0,33 \frac{242 \cdot 35,5}{1,0}} + \frac{913,07 \times 100}{0,52 \cdot \frac{5470 \cdot 35,5}{1,0}} \overset{?}{\leq} 1,0$$

$0,952 < 1,0$ ✓ OK.

po MSN mostek ustrzega!

MSU - deformacije

$g = 30\ kN/m^1 = 0{,}30\ kN/cm^1$

$L = 810\ cm$

$E = 21000\ kN/cm^2$

$J_y = 175200\ cm^4$

$$w = \frac{5 g L^4}{384 \cdot E \cdot J_y} = 0{,}46\ cm < L/200 = 810/200 = 4{,}05\ cm$$

OK,

ustreza!