



PISNI IZPIT IZ PREDMETA JEKLENE KONSTRUKCIJE

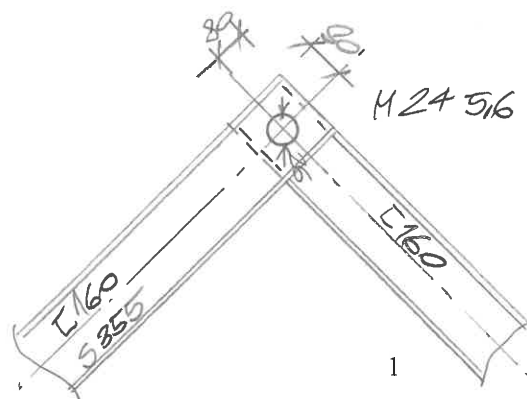
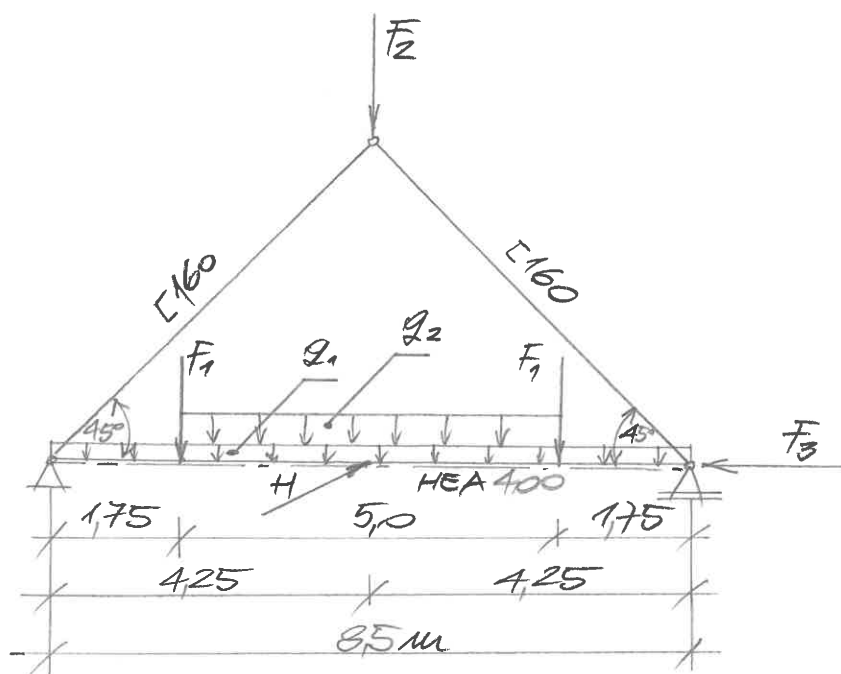
G-UN1, GING, VS

Kandidat:

Naloga

Strešna konstrukcija razpona $L=8,5$ m iz valjanega prereza HEA 400 in materiala S 355 je obremenjena s točkovnima silama $F_1=7,5$ kN (stalna obtežba), zvezno obtežbo $q_1=5$ kN/m (stalna obtežba), zvezno obtežbo $q_2=10$ kN/m (koristna obtežba), z navpično silo $F_2=30$ kN (sneg), z bočno vodoravno silo $H=2,5$ kN (veter) in silo $F_3=100$ kN (veter). Lastno težo konstrukcije zanemari. V kombinaciji obtežb upoštevaj koristno obtežbo kot dominantni spremenljivi vpliv.

- Po mejnem stanju nosilnosti dimenzioniraj nosilec, ki je bočno podprt samo na obeh svojih podporah. Nariši diagrame notranjih statičnih količin. 50%
- Po mejnem stanju uporabnosti preveri skupno vertikalno deformacijo w_{tot} v sredini nosilca. 20%
- Preveri nosilnost jeklenega špirovca iz [160 in slemenski vijak M 24 kakovosti 5.6. 30%



RAZUNSKA OBTEZBA:

$$F_{1ed} = 1,35 \cdot 7,5 = 10,125 \text{ kN}$$

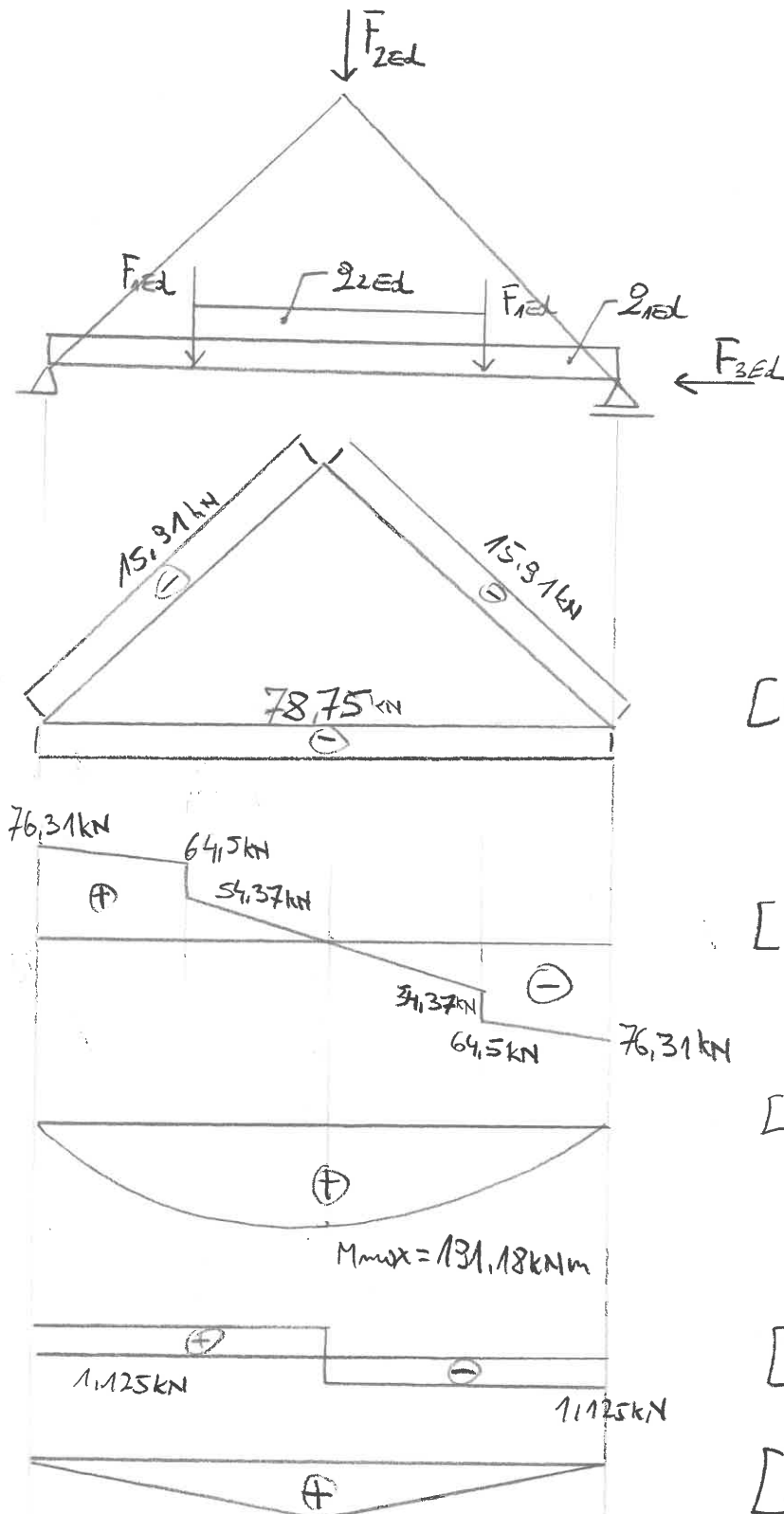
$$q_{1ed} = 1,35 \cdot 5 = 6,75 \text{ kN/m}$$

$$q_{2ed} = 1,5 \cdot 10 = 15 \text{ kN/m}$$

$$F_{2ed} = 1,5 \cdot 0,5 \cdot 30 \text{ kN} = 22,5 \text{ kN}$$

$$F_{3ed} = 1,5 \cdot 0,6 \cdot 100 = 90 \text{ kN}$$

$$H_{ed} = 1,5 \cdot 0,6 \cdot 2,5 = 2,25 \text{ kN}$$



$[N_{ed}]$

$[V_{z,ed}]$

$[M_{y,ed}]$

$[V_{x,ed}]$

$[M_{z,ed}]$

$$M_{z,ed} = \frac{2,25 \cdot 8,5}{4} = 4,78 \text{ kNm}$$

- KLASIFIKACIJA PREREZA HEA 400 : S_{355} ; $\epsilon = 0,81$

° STOJNA :

$$\alpha = \frac{78,75}{2 \cdot 1,1 \cdot 35,5} = 1,008$$

$$\alpha = \frac{1}{29,8} \left(\frac{29,8}{2} + 1,008 \right) = 0,534$$

$$\frac{29,8}{1,1} = 27,09 \leq \frac{396 \cdot 0,81}{(13 \cdot 0,534 - 1)} = 53,98 \checkmark$$

A.R.P.

° PASNIKA :

$$c = \frac{b}{2} - \frac{t_w}{2} - r = 117,5 \text{ mm}$$

$$\frac{117,5}{19} = 6,18 \leq 9 \cdot 0,81 = 7,29 \checkmark \text{ A.R.P.}$$

HEA 400 SPADA V A.R.P.!

° ODORNOST PREREZA :

$$\frac{78,75}{158 \cdot 35,5} + \frac{13118}{2562 \cdot 35,5} + \frac{478}{873 \cdot 35,5} \leq 1,0$$

1,0 1,0 1,0

$$0,014 + 0,21 + 0,0154 = 0,24 \leq 1,0 \checkmark$$

° SRIZNA ODORNOST PREREZA :

- N Z-Z SMERI :

$$V_{z,Ed} \leq \frac{[A - 2 \cdot b \cdot t_f + (t_w + 2r) \cdot t_f] \cdot f_y}{\sqrt{3} \cdot \gamma_{M0}} = \frac{57,35 \cdot 35,5}{\sqrt{3} \cdot 1,0}$$

$$76,31 \text{ kN} \leq 1175,4 \text{ kN} \checkmark \quad V_{z,Ed} \leq 0,5 \cdot V_{p,Ed} \checkmark$$

N Y-Y SMERI :

$$V_{y,Ed} \leq \frac{[A - (h - 2 \cdot t_f) \cdot t_w] \cdot f_y}{\sqrt{3} \cdot \gamma_{M0}} = \frac{120,28 \cdot 35,5}{\sqrt{3} \cdot 1,0}$$

$$\underline{1,125 \text{ kN} \leq 2465,25 \text{ kN}} \quad \checkmark$$

$$\underline{V_{y,Ed} \leq 0,5 \cdot V_{y,Rd}} \quad \checkmark$$

• ODBRANOST ELEMENTA : UKLON + ZVRNITELJ + UPDGB !

• Izračun χ_y :

$$\lambda_y = \frac{850}{16,8} = 50,59$$

$$\bar{\lambda}_y = \frac{50,59}{93,9 \cdot 0,81} = 0,66$$

UKLONSKA
KRIVULJA $\left. \begin{array}{l} \frac{h}{b} \geq 1,2 \\ L_f \leq 400 \text{ mm} \end{array} \right\} a)$

$$\underline{\chi_y = 0,872}$$

• Izračun χ_z :

$$\lambda_z = \frac{850}{7,34} = 115,8$$

$$\bar{\lambda}_z = \frac{115,8}{93,9 \cdot 0,81} = 1,52$$

UKLONSKA
KRIVULJA b)

$$\underline{\chi_z = 0,335}$$

• Izračun χ_{LT} :

$$C_1 = 1,13$$

$$I_w = 2942000 \text{ cm}^6$$

$$G = 8077 \text{ kN/cm}^2$$

$$C_2 = 0,46$$

$$I_z = 8560 \text{ cm}^4$$

$$E = 21000 \text{ kN/cm}^2$$

$$z_g = 19,5$$

$$I_t = 189 \text{ cm}^4$$

$$L = 850 \text{ cm}$$

$$M_{CR} = C_1 \cdot \frac{\pi^2 \cdot E \cdot I_z}{L^2} \left[\sqrt{\frac{I_w}{I_z} + \frac{G \cdot I_t \cdot L^2}{\pi^2 \cdot E \cdot I_z} + (C_2 z_g)^2} - (C_2 z_g) \right]$$

$$M_{CR} = 64845 \text{ kNcm}$$

$$\bar{\lambda}_{LT} = \sqrt{\frac{2562 \cdot 35,5}{64845}} = 1,18$$

UKLONSKA
KRIVULJA $\frac{h}{b} \leq 2$ b)

$$\phi_{LT} = 0,5 \left[1 + 0,34(1,18 - 0,4) + 0,75 \cdot 1,18^2 \right] = 1,15$$

$$\underline{\chi_{LT}} = \frac{1}{1,15 + \sqrt{1,15^2 - 0,75 \cdot 1,18^2}} = \underline{\underline{0,60}}$$

• faktorji c_{my} ; c_{mz} ; c_{mLT}

$$c_{my} = 0,95$$

$$c_{mz} = 0,9$$

$$c_{mLT} = 0,95$$

• faktorji k_{yy} ; k_{yz} ; k_{zy} ; k_{zz}

$$\underline{k_{yy} = 0,957}$$

$$0,95 \left(1 + (0,66 - 0,2) \cdot \frac{78,75}{0,872 \cdot \frac{5644,5}{1,0}} \right)$$

$$\leq 0,95 \left(1 + 0,8 \cdot \frac{78,75}{0,872 \cdot \frac{5644,5}{1,0}} \right)$$

$$0,957 \leq 0,962$$

$$\underline{k_{yz} = 0,6 - k_{zz} = 0,571}$$

$$\underline{k_{zz} = 0,952}$$

$$0,9 \left(1 + (2 \cdot 1,52 - 0,6) \cdot \frac{78,75}{0,335 \cdot \frac{5644,5}{1,0}} \right)$$

$$\leq 0,9 \left(1 + 1,4 \cdot \frac{78,75}{0,375 \cdot \frac{5644,5}{1,0}} \right)$$

$$0,991 \leq 0,952$$

$$\underline{k_{zy} = 0,994}$$

$$\left[1 - \frac{0,1 \cdot 1,52}{0,95 - 0,25} \cdot \frac{78,75}{0,335 \cdot \frac{5644,5}{1,0}} \right]$$

$$\geq \left[1 - \frac{0,1}{(0,95 - 0,25)} \cdot \frac{78,75}{0,335 \cdot \frac{5644,5}{1,0}} \right]$$

$$0,991 \geq 0,994$$

$$\frac{78,75}{0,872 \cdot 158 \cdot 35,5} + 0,957 \cdot \frac{19118}{0,60 \cdot 2562 \cdot 35,5} + 0,571 \cdot \frac{478}{873 \cdot 35,5} \leq 1,0$$

$$0,016 + 0,335 + 0,0088 = 0,36 \leq 1,0 \quad \checkmark$$

$$\frac{78,75}{0,335 \cdot 158 \cdot 35,5} + 0,994 \cdot \frac{19118}{0,6 \cdot 2562 \cdot 35,5} + 0,952 \cdot \frac{478}{873 \cdot 35,5} \leq 1,0$$

$$0,0416 + 0,348 + 0,014 = 0,404 \leq 1,0 \quad \checkmark$$

PO MSN USTREZA!

DEFORMACIJA NOSILCA:

$$F_1 = 7,5 \text{ kN}$$

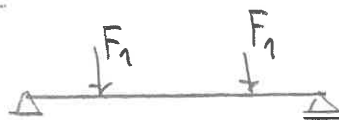
$$q_1 = 5 \text{ kN/m}$$

$$q_2 = 10 \text{ kN/m}$$

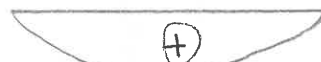
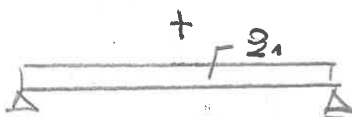
$$E = 21000 \text{ kN/m}^2$$

$$I_y = 45070 \text{ cm}^4$$

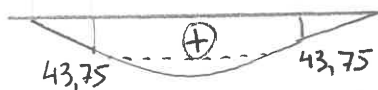
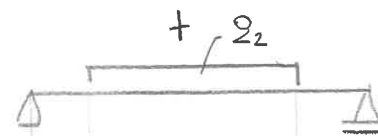
$$L = 850 \text{ cm}$$



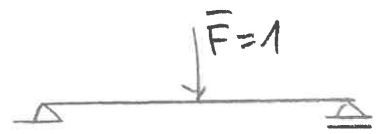
$$M_0 = F_1 \cdot 1,75 = 13,125 \text{ kNm}$$



$$M_0 = \frac{q_1 \cdot L^2}{8} = 45,15 \text{ kNm}$$



$$M_0 = 75,0 \text{ kNm}$$



$$M = \frac{\bar{F} \cdot L}{4} = 2,125 \text{ m}$$

$$\int = \int \frac{M_0 \cdot \bar{M}}{EI} dx =$$

$$= \frac{1016,13}{210 \cdot 10^6 \cdot 4,507 \cdot 10^{-4}} = 0,0107 \text{ m} = 1,07 \text{ cm} \leq \frac{L}{200} \quad \checkmark$$

$$451,684 + 564,45$$

- KONTROLA NOSILNOSTI [✓] ŠPIROVCA [160 S355

- UKLON OKOLI Z-Z OSI

$$\lambda_z = \frac{601 \text{ cm}}{1,89} = 317,99$$

$$\bar{\lambda}_z = \frac{317,99}{93,9 \cdot 0,81} = 4,18$$

UKLONSKA
KRIVULJA $\hookrightarrow$ $\chi_z = 0,051$

$$15,91 \text{ kN} \leq 0,051 \cdot \frac{24 \text{ cm}^2 \cdot 355 \frac{\text{kN}}{\text{cm}^2}}{1,0} = 43,64 \text{ kN} \checkmark$$

- STRIŽNA NOSILNOST VIJAKA M24; 5.6

$$F_{v,rd} = \frac{0,6 \cdot 50 \cdot 3,53}{1,25} = 84,72 \text{ kN}$$

$$15,91 \text{ kN} \leq 84,72 \text{ kN} \checkmark$$

- BOČNA NOSILNOST VIJAKA M24 5.6

$$F_{b,rd} = \frac{2,5 \cdot 0,98 \cdot 51 \cdot 2,4 \cdot 0,75}{1,25} = 179,93 \text{ kN} \geq 15,91 \text{ kN} \checkmark$$

$$a = \min \left\{ \frac{80}{3 \cdot 26} = 1,025 ; \frac{50}{51} = 0,98 ; 1 \right\}$$

$$l = a = 7,5 \text{ mm}$$

- PODJEKTNJA NOSILNOST NETO PRESEKA [160, $d_o = 26 \text{ mm}$

$$A_{\text{NET}} = 24 \text{ cm}^2 - d_o \cdot l = 22,05 \text{ cm}^2$$

$$15,91 \text{ kN} \leq \frac{0,9 \cdot 22,05 \cdot 51}{1,25} = 809,67 \text{ kN} \checkmark$$

