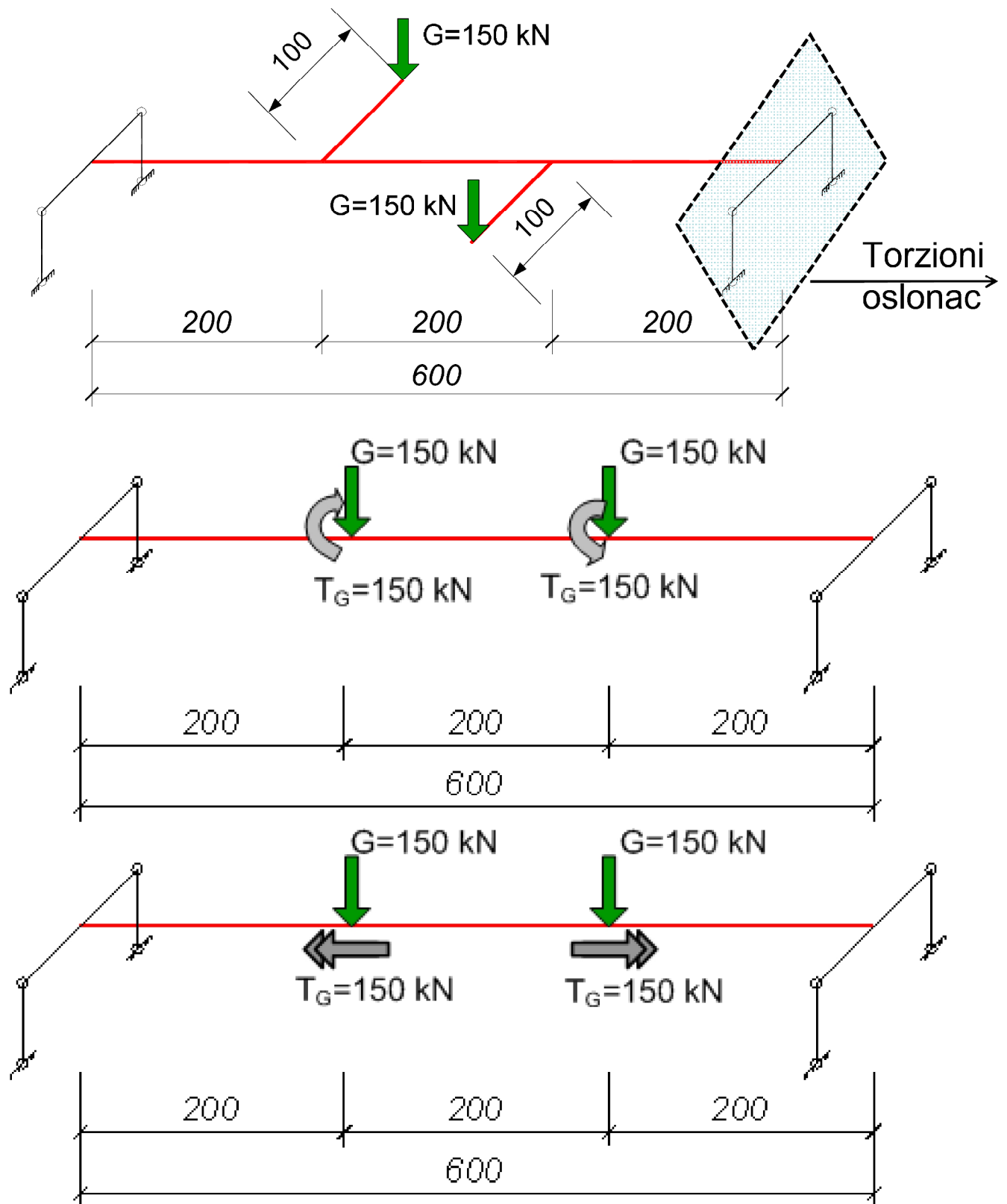
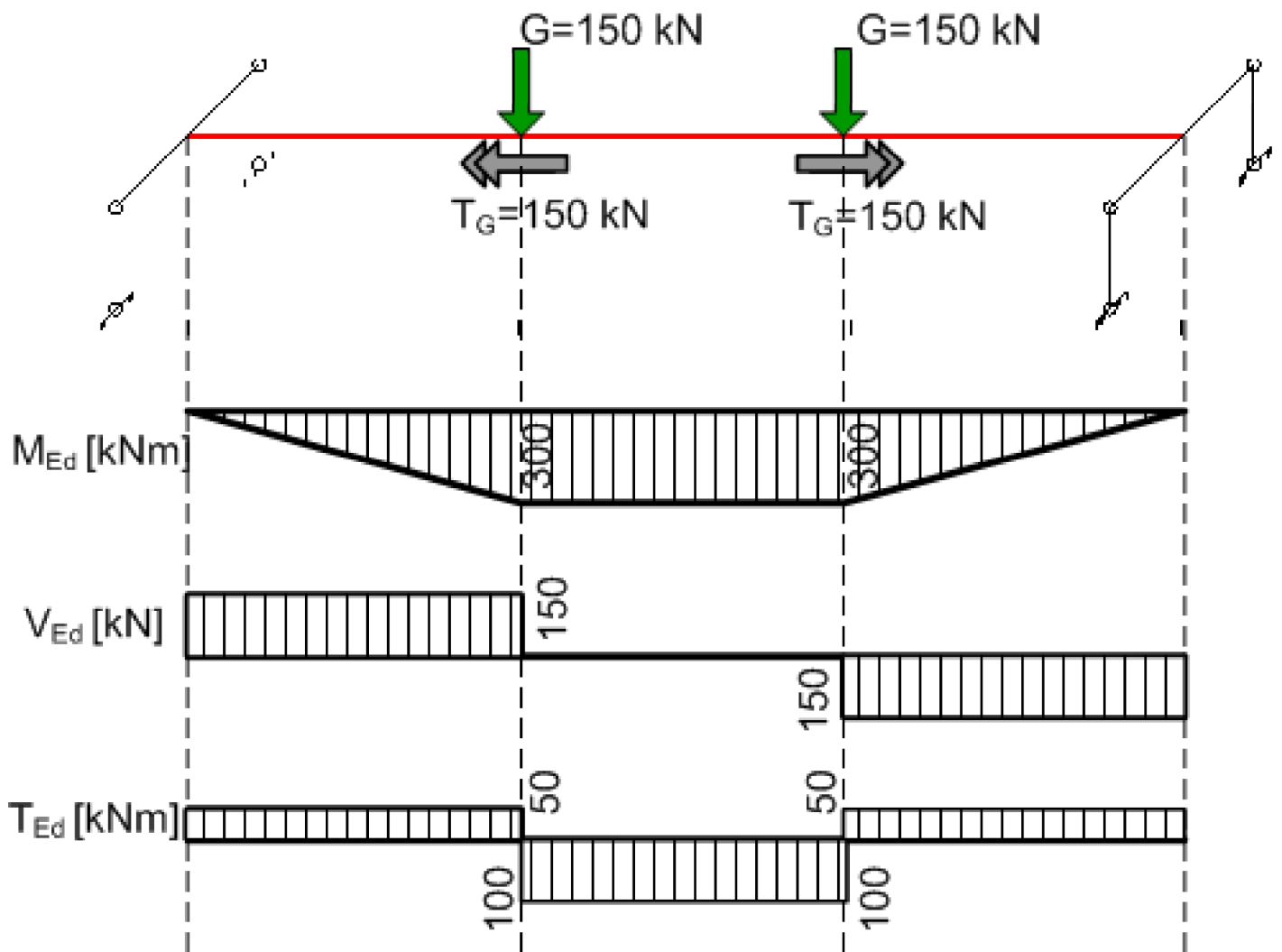


- Za nosač POS 1 prikazan na skici nacrtati dijagrame presečnih sila usled prikazanih sila $G = 150 \text{ kN}$, a zatim izvršiti osiguranje od glavnih napona zatezanja na pojedinim delovima nosača.
- Nosač nije potrebno dimenzionisati prema momentima savijanja.
- Karakteristike preseka: $b = 45 \text{ cm}$, $h = 60 \text{ cm}$
- Karakteristike materijala: **C 30/37**, **B500**





- Analiziraju se krajnje trećine nosača

- Proračunske vrednosti uticaja:

$$V_{Ed} = \gamma_G \cdot V_g = 1.35 \cdot 150 = 202.5\text{ kN}$$

$$T_{Ed} = \gamma_G \cdot T_g = 1.35 \cdot 50 = 67.5\text{ kNm}$$

- Karakteristike ekvivalentnog tankozidnog preseka:

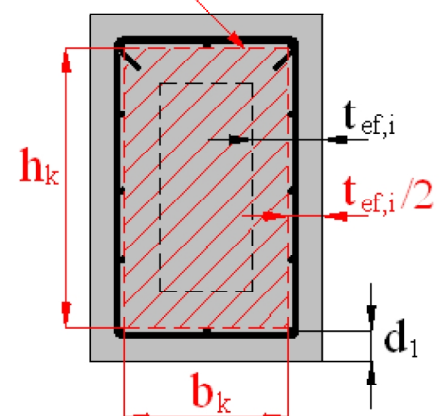
$$t_{ef} = \max \left\{ \begin{array}{l} \frac{A}{u} = \frac{b \cdot h}{2 \cdot (b + h)} = \frac{45 \cdot 60}{2 \cdot (45 + 60)} = \underline{\underline{12.86\text{ cm}}} \\ 2 \cdot d_1 = 2 \cdot 5 = 10.0\text{ cm} \end{array} \right.$$

$$b_k = b - 2 \cdot t_{ef} / 2 = 50 - 2 \cdot 12.86 / 2 = 32.14\text{ cm}$$

$$h_k = h - 2 \cdot t_{ef} / 2 = 60 - 2 \cdot 12.86 / 2 = 47.14\text{ cm}$$

$$A_k = b_k \cdot h_k = 32.14 \cdot 47.14 = 1515.08\text{ cm}^2$$

$$u_k = 2 \cdot (b_k + h_k) = 2 \cdot (32.14 + 47.14) = 158.56\text{ cm}$$



1. Određivanje nosivosti AB preseka na smicanje bez poprečne armature:

- Pretpostavlja se da je presek armiran minimalnim procentom podužne armature za savijanje*: $d = h - d_1 = 60 - 5 = 55 \text{ cm}$

$$A_{s,\min} = \max \begin{cases} 0.0013 \cdot b \cdot d = 0.0013 \cdot 45 \cdot 55 = 3.22 \text{ cm}^2 \\ 0.26 \cdot \frac{f_{ctm}}{f_{yd}} \cdot b \cdot d = 0.26 \cdot \frac{2.9}{500} \cdot 45 \cdot 55 = 3.73 \text{ cm}^2 \end{cases}$$

$$\Rightarrow \text{usvojeno: } \underline{2\text{Ø}16 (4.02 \text{ cm}^2)} \Rightarrow \rho_1 = 4.02 / (45 \cdot 55) = 0.0016$$

$$C_{Rd,c} = 0.12, \quad k = 1 + \sqrt{\frac{200}{55 \cdot 10}} = 1.603$$

$$V_{c,Rd} = \max \begin{cases} (0.12 \cdot 1.603 \cdot \sqrt[3]{100 \cdot 0.0016 \cdot 30}) \cdot 45 \cdot 55 \cdot 10^{-1} = 80.31 \text{ kN} \\ (0.035 \cdot 1.603^{3/2} \cdot 30^{1/2}) \cdot 45 \cdot 55 \cdot 10^{-1} = \underline{\underline{96.30 \text{ kN}}} \end{cases}$$

2. Određivanje nosivosti AB preseka na torziju bez učešća armature:

$$T_{c,Rd} = f_{ctd} \cdot 2 \cdot A_k \cdot t_{ef} = 0.133 \cdot 2 \cdot 1515.08 \cdot 12.86 \cdot 10^{-2} = 51.83 \text{ kNm}$$

3. Kontrola nosivosti preseka na interakciju smicanja i torzije:

$$\frac{T_{Ed}}{T_{c,Rd}} + \frac{V_{Ed}}{V_{c,Rd}} = \frac{67.5}{51.83} + \frac{202.5}{96.3} = 3.402 > 1.0 \rightarrow \text{potrebno je računski odrediti površinu poprečne i podužne armature !}$$

4. Maksimalna sila smicanja koju presek može da prihvati:

$$V_{Rd,\max} = \frac{\alpha_{cw} \cdot b_w \cdot z \cdot v_1 \cdot f_{cd}}{ctg\theta + tg\theta} = \frac{1.0 \cdot 45 \cdot 0.9 \cdot 55 \cdot 0.528 \cdot 1.7}{ctg45 + tg45} = 999.7 \text{ kN}$$

$$\alpha_{cw} = 1.0, \quad v = 0.6 \cdot (1 - 30/250) = 0.528$$

$$z = 0.9 \cdot d = 49.5 \text{ cm}, \quad \theta = 45^\circ, \quad \alpha = 90^\circ$$

5. Maksimalni moment torzije koji presek može da prihvati:

$$T_{Rd,\max} = 2 \cdot A_k \cdot \alpha_{cw} \cdot v \cdot f_{cd} \cdot t_{ef,i} \cdot \sin\theta \cdot \cos\theta$$

$$T_{Rd,\max} = 2 \cdot 1515.31 \cdot 1.0 \cdot 0.528 \cdot 1.7 \cdot 12.86 \cdot \sin 45^\circ \cdot \cos 45^\circ \cdot 10^{-2} = 174.91 \text{ kNm}$$

6. Kontrola maksimalne nosivosti preseka na interakciju smicanja i torzije:

$$\frac{T_{Ed}}{T_{Rd,max}} + \frac{V_{Ed}}{V_{Rd,max}} = \frac{67.5}{174.91} + \frac{202.5}{999.70} = 0.588 < 1.0$$

7. Određivanje potrebne površine poprečne armature - uzengija:

- Potrebne uzengije za prihvatanje sile smicanja:

$$V_{Rd,s} = \frac{A_{sw,V}}{s_V} \cdot z \cdot f_{ywd} \cdot ctg\theta = V_{Ed} = \frac{m \cdot a_{sw,V}}{s_V} \cdot z \cdot f_{ywd} \cdot ctg\theta$$

$$\frac{4 \cdot a_{sw,V}^{(1)}}{s_V} = \frac{202.5}{49.5 \cdot 43.5 \cdot ctg45^\circ} = 0.0941$$

$$\frac{a_{sw,V}^{(1)}}{s_V} = \frac{0.0941}{4} = 0.0235$$



$$a_{sw,V}^{(1)} = 0.0941 / 4 \cdot s_V = 0.0235 \cdot s_V$$

- Potrebne uzengije za prihvatanje momenata torzije:

$$\frac{a_{sw}}{s_T} = \frac{T_{Ed}}{2 \cdot A_k \cdot f_{ywd} \cdot ctg\theta}$$

$$\frac{a_{sw,T}^{(1)}}{s_T} = \frac{67.5 \cdot 10^2}{2 \cdot 1515.31 \cdot 43.5} \cdot tg45^\circ = 0.0512$$



$$a_{sw,T}^{(1)} = 0.0512 \cdot s_T$$

8. Kontrola minimalne poprečne armature : $\rho_{w,min} = 0.08\sqrt{30} / 500 = 0.000876$

- Za silu smicanja:

$$\left(\frac{a_{sw,V}^{(1)}}{s_V} \right)_{min} = \frac{1}{m_V} \cdot \rho_{w,min} \cdot b \cdot \sin \alpha = \frac{1}{4} \cdot 0.000876 \cdot 45 \cdot \sin 90^\circ = 0.0099 < 0.0235 = \frac{a_{sw,V}^{(1)}}{s_V}$$

- Za moment torzije:

$$\left(\frac{a_{sw,T}^{(1)}}{s_{w,T}} \right)_{min} = \frac{1}{m_T} \cdot \rho_{w,min} \cdot b \cdot \sin \alpha = \frac{1}{1} \cdot 0.000876 \cdot 45 \cdot \sin 90^\circ = 0.0394 < 0.0512 = \frac{a_{sw,T}^{(1)}}{s_T}$$

9. Usvajanje poprečne armature

- Spoljašnje uzengije:

$$a_{sw}^{(1)} = a_{sw,V}^{(1)} + a_{sw,T}^{(1)} = 0.0235 \cdot s_V + 0.0512 \cdot s_T = 0.0747 \cdot s, \quad (s_V = s_T)$$

$$U\emptyset 10 \Rightarrow s = \frac{0.785}{0.0747} = 10.51 \text{ cm}$$

- Unutrašnje uzengije:

$$a_{sw,V}^{(1)} = 0.0235 \cdot s_V$$

$$U\emptyset 8 \Rightarrow s = \frac{0.503}{0.0235} = 21.40 \text{ cm} \quad \Rightarrow \text{usvojeno: } \underline{U\emptyset 8 / 20 \text{ cm}}$$

10. Podužna armatura za prihvatanje torzije:

$$A_{sl} = \frac{67.5 \cdot 10^2}{2 \cdot 1515.31 \cdot 43.478} \cdot 158.56 \cdot \text{ctg}45^\circ = 8.12 \text{ cm}^2$$

11. Dodatna zategnuta armatura na krajnjem osloncu:

$$\Delta A_s = \frac{202.5}{2 \cdot 43.478} \cdot (\text{ctg}45^\circ - \text{ctg}90^\circ) = 2.33 \text{ cm}^2$$