

1. naloga

Dimenzionirajte stebel v prerezu B-B na osno-upogibno obremenitev (2T).

$l_1 = 3 \text{ m}$

$l_2 = 3 \text{ m}$

$l_3 = 3 \text{ m}$

$h_1 = 2 \text{ m}$

$h_2 = 2 \text{ m}$

$\alpha = 15^\circ$

stalna obtežba

$g = 20 \text{ kN/m}$

spremenljiva obtežba

(lahko deluje samo na delu nosilca

$q = 15 \text{ kN/m}$

Horizontalni elementi:

T - prerez

$b_T = 40 \text{ cm}$

$h_T = 60 \text{ cm}$

$b_{T,0} = 20 \text{ cm}$

$d_{T,0} = 11 \text{ cm}$

$a_T = 5 \text{ cm}$

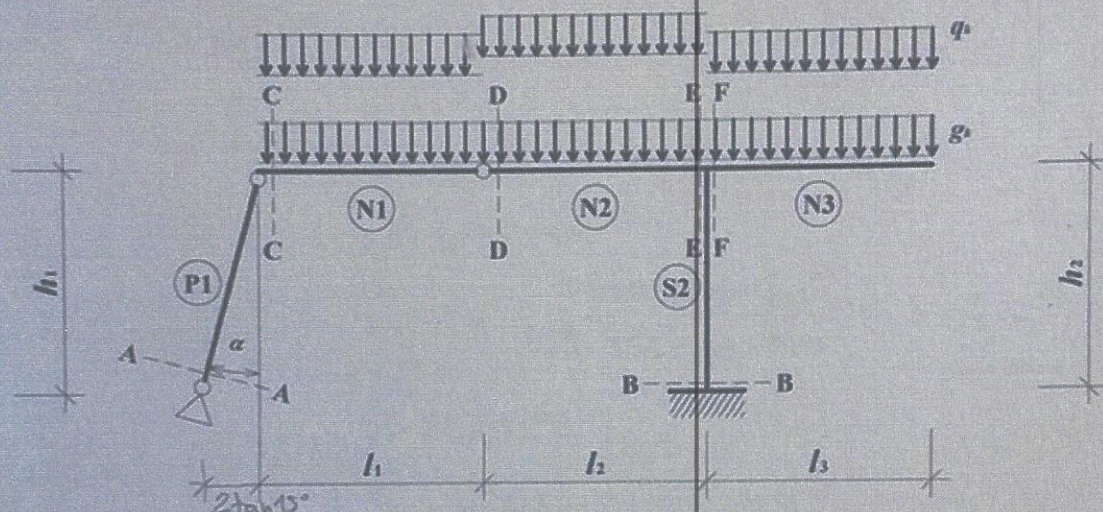
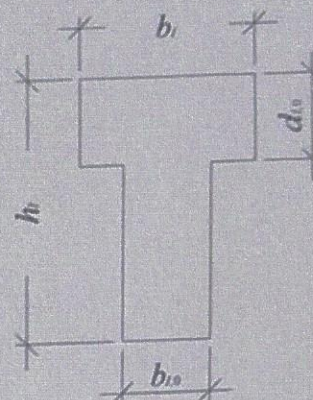
Vertikalni, poševni element:

kvadratni prerez

$b_{II} = 40 \text{ cm}$

$h_{II} = 40 \text{ cm}$

$a_{II} = 5 \text{ cm}$



Za podano podano konstrukcijo določite po standardu SIST EN 1992-1-1

a) potrebni prerez, razmak in profil ϕ stremen za prevzem prečnih sil v desnem delu konstrukcije (elementi N2, N3 in S2). Določite tudi dodatno vzdolžno armaturo in jo vpišite v prerez (samo shematsko zgoraj ali spodaj). Širina podpore je 40 cm. Vertikalna stremena naj bodo edina strižna armatura. Določite tudi osno-upogibno armaturo v prerezu E-E. (5T)

$$\rho_{w,min} = \frac{(0,08\sqrt{f_{ck}})}{f_{yk}}$$

f_{ck}, f_{yk} v MPa

jeklo S500

b) tako novo največjo možno razdaljo l_3 , da bo v prerezu F-F zadostovala vertikalna strižna stremenska armatura $\phi 10/18 \text{ cm}$ ($n=2$). Redukcijo prečnih sil zaradi širine podpore ni potrebno upoštevati. Natezne armature je v tem delu nosilca 20 cm^2 . (2T)

2. naloga (1T)

Določite višino prečnega prereza h tako, da bo pri podani obremenitvi še zadoščala enojna armatura. Določite tudi potrebni prerez armature (prereza armaturnih palic ni potrebno izbirati). Upoštevajte pogoj, da bo armatura v mejnem stanju nosilnosti plastificirana – upoštevajte mejne deformacije ($\epsilon_s/\epsilon_c = 5/2, 9\%$).

$b = 65 \text{ cm}$

$h = ?$

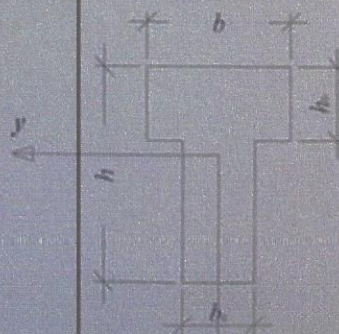
$b_0 = 26 \text{ cm}$

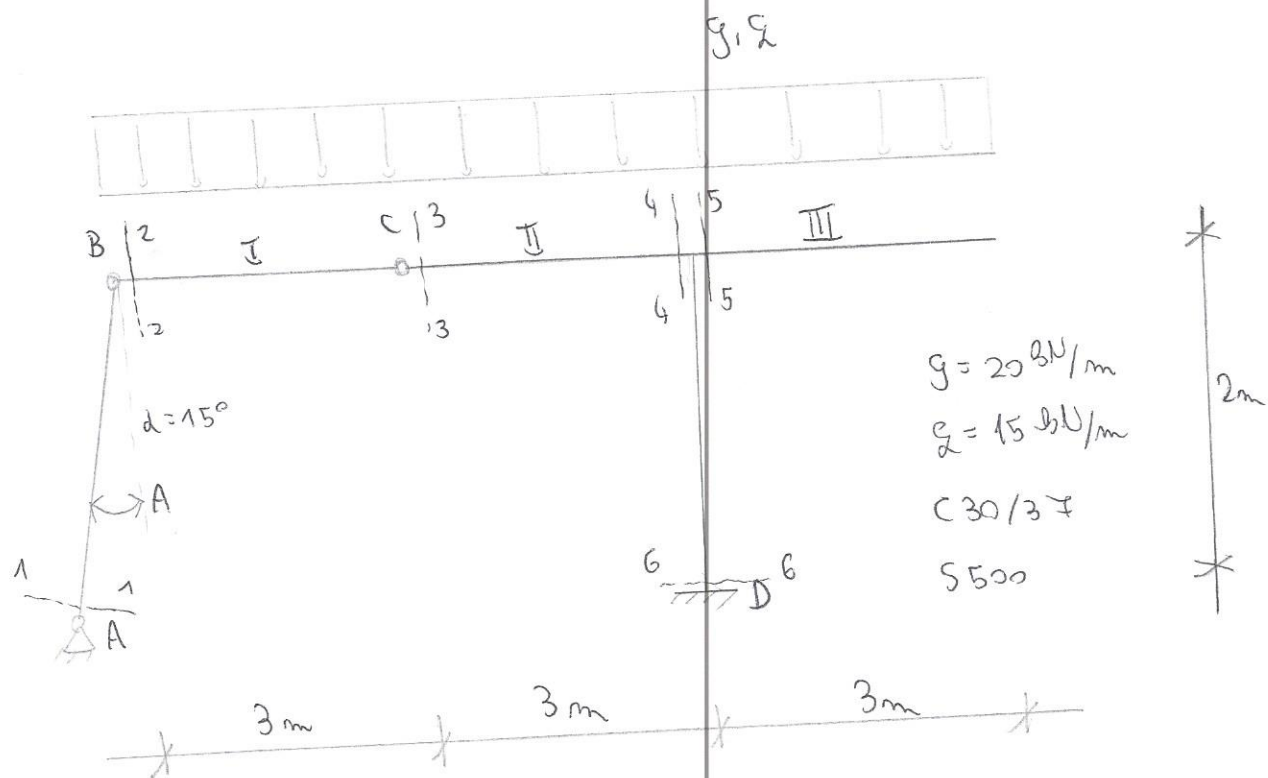
$d_0 = h_0 = 10 \text{ cm}$

$a = 10 \text{ cm}$

$M_{ed} = -1460 \text{ kNm}$

beton: C60/75; jeklo: S500





VPLIVI ZARADI STALNE OBTEŽBE:

① $\sum M_B^A = 0$

$$A_x \cdot 2\text{m} + A_z \cdot 2\text{m} \cdot \tan \alpha = 0$$

$$A_x = -A_z \tan \alpha$$

$$\boxed{A_x = +804 \text{ kN}}$$

② $\sum M_C^A = 0$

$$g \cdot \frac{(3\text{m})^2}{2} + A_x \cdot 2\text{m} + A_z \cdot (3\text{m} + 2\text{m} \cdot \tan \alpha) = 0$$

$$g \cdot \frac{9\text{m}^2}{2} + A_z (2 \tan \alpha + 3\text{m} + 2\text{m} \tan \alpha) = 0$$

$$A_z \cdot 3\text{m} = -g \cdot \frac{9\text{m}^2}{2} \Rightarrow \boxed{A_z = -300 \text{ kN}}$$

③ $\sum X = 0$

$$A_x + B_x = 0$$

$$B_x = -A_x$$

$$\boxed{B_x = -804 \text{ kN}}$$

④ $\sum Z = 0$

$$g \cdot 9\text{m} + A_z + B_z = 0$$

$$\Rightarrow B_z = -g \cdot 9\text{m} - A_z$$

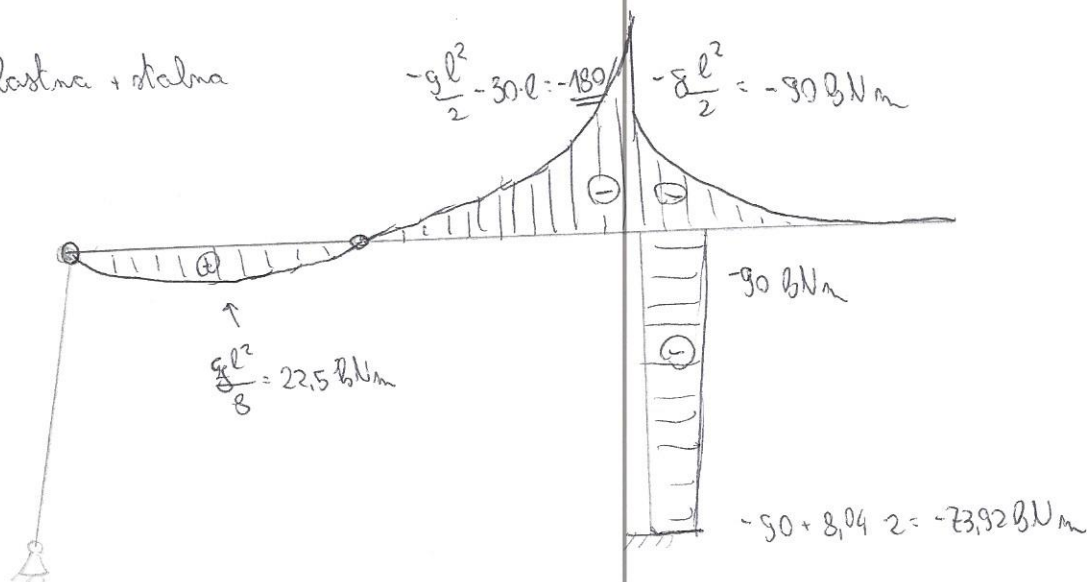
$$\boxed{B_z = -150 \text{ kN}}$$

⑤ $\sum M_D = 0$

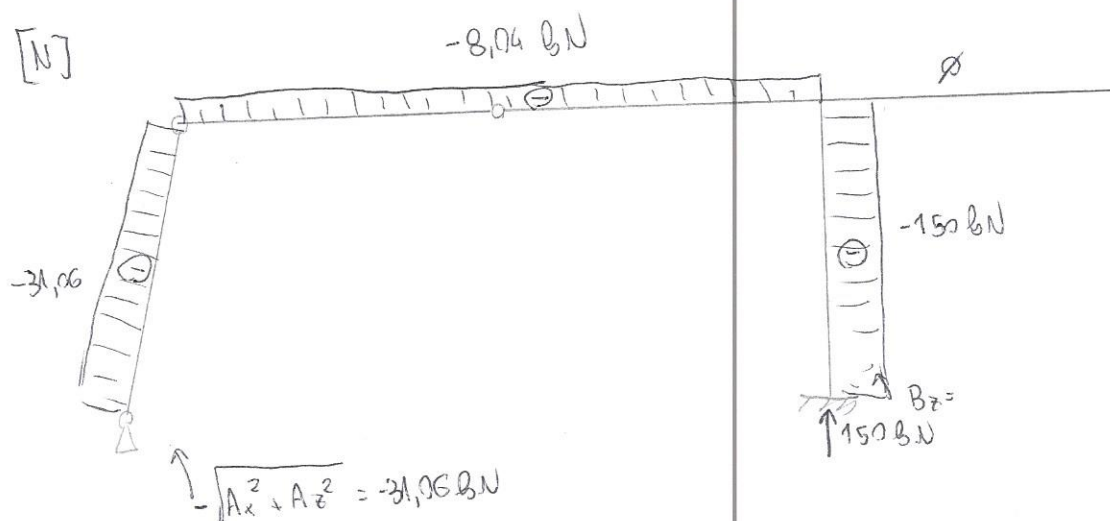
$$M_D + A_z \cdot (6\text{m} + 2 \tan \alpha) + g \cdot 3\text{m} \cdot 4.5\text{m} = 0$$

M + N - kostura + stalna

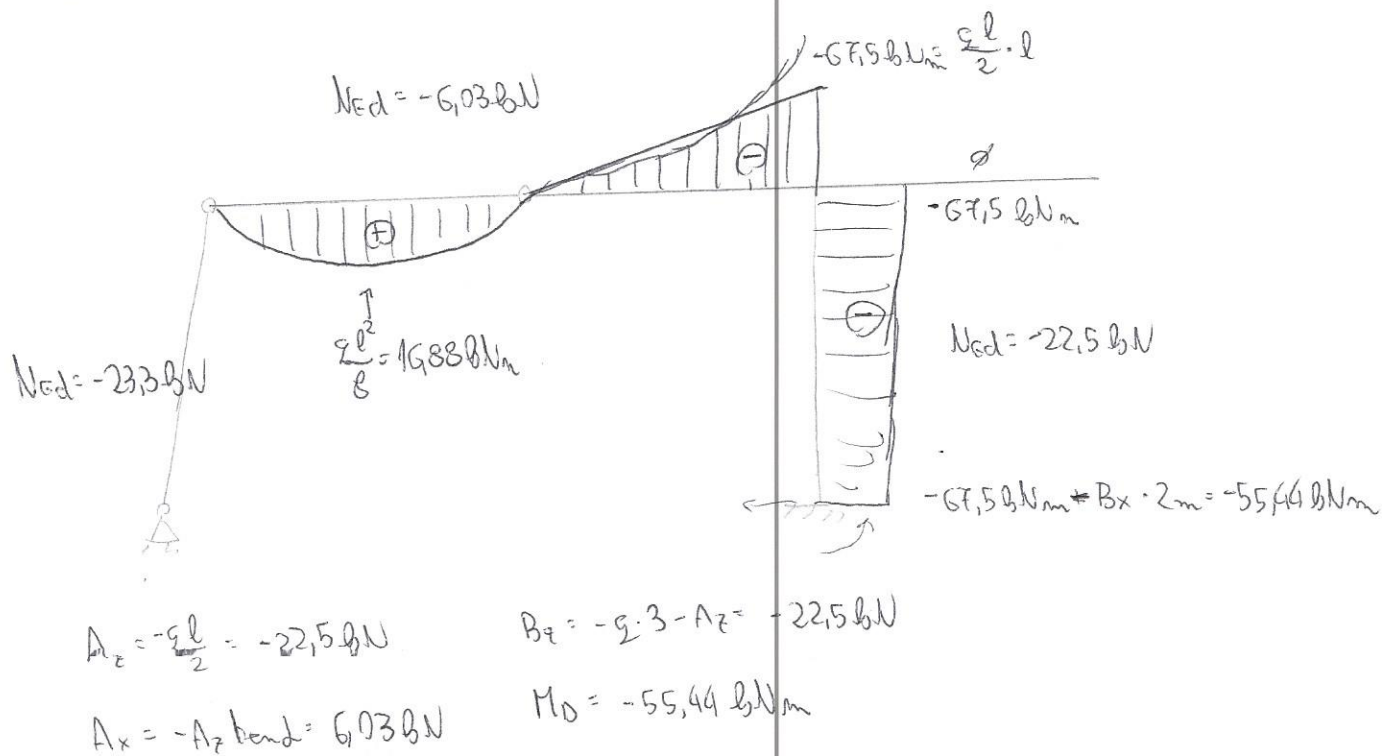
[M]



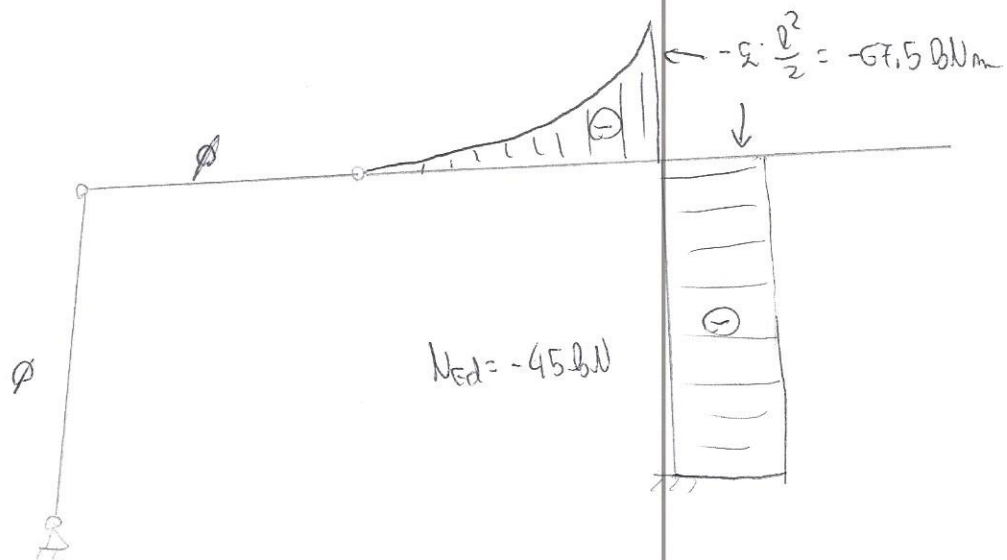
[N]



KORISTNA V POLJU I.



KORISTNA V POLJU II



KORISTNA V POLJU III



1-1:

$$N_{min} = 1,35(-31,06 \text{ kN}) + 1,5(-23,3 \text{ kN}) = -76,88 \text{ kN}$$

2-2:

$$M_{max} = 0$$

$$N_{min} = -8,04 \cdot 1,35 - 6,03 \cdot 1,5 = -19,9 \text{ kN}$$

3-3:

- 11 snalno kot 2-2

4-4:

$$M_{min} = -180 \text{ kNm} \cdot 1,35 - 67,5 \text{ kNm} \cdot 1,5 \cdot 2 = -445,5 \text{ kNm}$$

$$n_{ed} N_{ed} = -8,04 \text{ kN} \cdot 1,35 - 6,03 \text{ kN} \cdot 1,5 = -19,9 \text{ kN}$$

5-5:

$$M_{min} = -90 \text{ kNm} \cdot 1,35 - 67,5 \text{ kNm} \cdot 1,5 = -222,75 \text{ kNm}$$

$$n_{ed} N_{ed} = 0$$

6-6:

$$M_{min} = -73,92 \text{ kNm} \cdot 1,35 - 55,44 \text{ kNm} \cdot 1,5 - 67,5 \text{ kNm} \cdot 1,5 = -284,2 \text{ kNm}$$

$$n_{ed} N_{ed} = -150 \text{ kN} \cdot 1,35 - 22,5 \text{ kN} \cdot 1,5 - 45 \text{ kN} \cdot 1,5 = -303,75 \text{ kN}$$

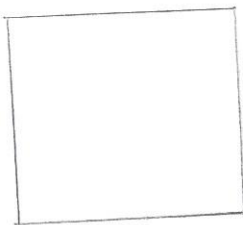
$$N_{min} = -150 \cdot 1,35 - 22,5 \cdot 1,5 - 45 \cdot 1,5 \cdot 2 = -371,3 \text{ kN}$$

$$n_{ed} M_{ed} = -73,92 \cdot 1,35 - 55,44 \cdot 1,5 - 67,5 \cdot 1,5 + 67,5 \cdot 1,5 = -182,95 \text{ kNm}$$

• DIMENZIONIRANJE ARMATURE V PREREZU 6-6:

$$a = a' = 5 \text{ cm}$$

$$z_s = 15 \text{ cm}$$



40 cm

40 cm

$$1. M_{eds} = 284,2 \text{ kNm} + 0,15 \cdot 303,75 = 329,16 \text{ kNm}$$

$$2. M_{eds} = 182,95 \text{ kNm} + 371,3 \cdot 0,15 = 238,65 \text{ kNm}$$

$$b_{d1} = \frac{M_{eds}}{b d^2 \rho_{rd}} = 0,3365 \leftarrow \text{potrebna dvojna armatura}$$

$$\xi = \frac{a'}{d} = \frac{5}{35} = 0,143 \approx 0,15$$

gledam $b_d = 0,34$

$$\Rightarrow b_s = 1,201$$

$$b_s' = 0,221$$

$$A_s = b_s \frac{M_{eds}}{d \cdot p_{yd}} + \frac{M_{ed}}{p_{yd}} = 1,201 \frac{329768 \text{ Nm}}{35 \text{ cm} \cdot 43,48 \frac{\text{N}}{\text{cm}^2}} - \frac{284,2 \text{ N}}{43,48 \frac{\text{N}}{\text{cm}^2}}$$

$$A_s = 19,5 \text{ cm}^2$$

$$A'_s = b'_s \frac{M_{eds}}{d \cdot p_{yd}} = 4,8 \text{ cm}^2$$

2. PREGLEDUJOČA OSNA SILA IN PRIPADAJOČI MOMENT

$$b_d = \frac{M_{eds}}{b d^2 p_{ed}} = 0,244 \quad \leftarrow \text{zadostuje enojna armatura}$$

$$\xi_s / -\xi_1 = 6 / 3,50 / 20 \quad b_s = 1,181$$

Ta obtežba ni merodajna

• DIMENZIONIRANJE V 4-4:

$$M_{ed} = -445,5 \text{ kNm}$$

$$N_{ed} = -19,9 \text{ kN}$$

izberem si $a = 5 \text{ cm}$

POIŠČEM TEŽIŠČE:

$$A = 1420 \text{ cm}^2$$

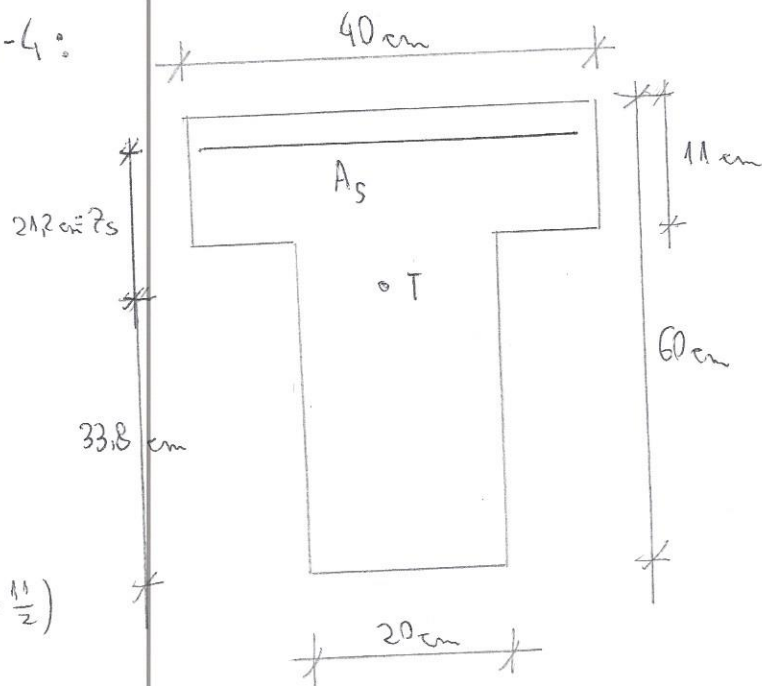
$$S_y = 49 \text{ cm} \cdot 20 \left(\frac{49 \text{ cm}}{2} \right) + 11 \text{ cm} \cdot 10 \cdot \left(49 + \frac{11}{2} \right)$$

$$S_y = 47990 \text{ cm}^3$$

$$z_T = 33,8 \text{ cm}$$

$$z_s = 60 \text{ cm} - z_T - 5 \text{ cm} = 21,2 \text{ cm}$$

$$d = 55 \text{ cm}$$



$$\Rightarrow M_{eds} = M_{ed} - N_{ed} \cdot z_s = 445,5 \text{ kNm} + 19,9 \text{ kN} \cdot 0,212 \text{ m}$$

$$M_{eds} = 449,72 \text{ kNm}$$

$$b_{ed} = \frac{M_{eds}}{b d^2 f_{yd}} = \frac{4972 \text{ Nm}}{20 \text{ cm} \cdot (55 \text{ cm})^2 \cdot 2 \text{ N/cm}^2} = 0,372$$

⇒ potrebna dvojná armatúra!

$$\xi = \frac{\alpha'}{d} = \frac{5}{55} = 0,1$$

$$x = 0,411 \cdot 55 \text{ cm} = 22,61 \text{ cm} \leq 49 \text{ cm} \checkmark$$

$$b_s = 1,181$$

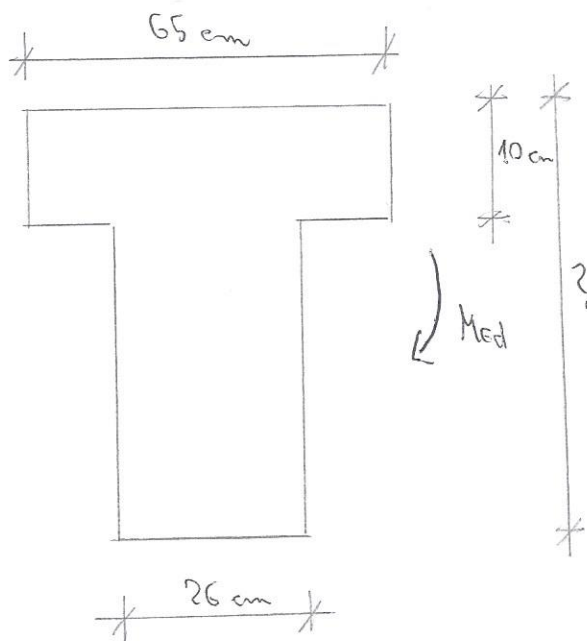
$$b'_s = 0,303$$

$$A_s = b_s \frac{M_{eds}}{b d f_{yd}} + \frac{M_{ed}}{f_{yd}}$$

$$A_s = 21,75 \text{ cm}^2$$

$$A'_s = \frac{M_{eds}}{d f_{yd}} b'_s = 5,7 \text{ cm}^2$$

2. NALOGA



$$\alpha = 10 \text{ cm}$$

$$(\epsilon_s / \epsilon_c = 5 / 2,9 \text{ ‰})$$

C 60/75

S 500

$$M_{ed} = -1460 \text{ Nm}$$

- armatúra se plastifikovala

$$\Rightarrow f_{yd} = 43,48 \text{ N/cm}^2$$

$$b_{ed} = 0,220$$

$$b_x = 0,367$$

$$b_s = 1,161$$

$$\Rightarrow b_{ed} = \frac{M_{eds}}{b d^2 f_{yd}}$$

$$\Rightarrow d = \sqrt{\frac{M_{eds}}{b f_{yd} \cdot b_{ed}}} = 79,9 \text{ cm} \Rightarrow \boxed{h = 90 \text{ cm}}$$

26 cm 80 cm

$$x = d \cdot b_x = 29,4 \text{ cm} \leq 80 \text{ cm} \checkmark$$

$$A_s = 48,73 \text{ cm}^2$$