

Rade Tomović 202107

**GODIŠNJI ZADATAK - LIST 1**

1. Za gredu pravougaonog preseka, širine 35 cm i visine 80 cm, sračunata je potrebna površina armature u donjoj, zategnutoj zoni, od  $35.28 \text{ cm}^2$ . Potrebno je usvojiti broj i raspored šipki tako da budu zadovoljene odredbe Pravilnika o zaštitnim slojevima i čistom rastojanju između profila. Potrebno je gredu armirati na sledeće načine:

- u prva dva slučaja koristiti pojedinačne profile (dva primera sa različitim prečnicima usvojene armature),
- ako je širina grede 25 cm, rasporediti usvojenu armaturu u presek.

U svim primerima usvojiti uzengije  $U\emptyset 8/25$ . Sračunati ukupnu potrebnu dužinu uzengije  $L_u$ . Sve usvojene preseke nacrtati u razmeri 1:10.

2. Odrediti potrebnu površinu armature i oblikovati poprečni presek pravougaonog oblika centrično zategnutog elementa. Usvojeni poprečni presek nacrtati u razmeri 1:5.

$$Z_G = 360 \text{ kN} \quad Z_P = 395 \text{ kN}$$

3. Dimenzionisati centrično pritisnuti stub (ne uvodeći u proračun izvijanje), ukoliko je poprečni presek:

- pravougaoni, zadate širine  $b = 35 \text{ cm}$ ,
- kružnog oblika,

Usvojene poprečne preseke nacrtati u razmeri 1:10.

$$N_G = 2280 \text{ kN} \quad N_P = 585 \text{ kN}$$

4. Dimenzionisati centrično pritisnut stub opterećen silama iz prethodnog zadatka, ukoliko je poprečni presek pravougaonog oblika zadatah dimenzija:

$$b = 35 \text{ cm} \quad d = 60 \text{ cm}$$

Usvojeni poprečni presek nacrtati u razmeri 1:10.

Dimenzionisanja u zadacima 2 do 4 sprovesti po **teoriji granične nosivosti**.

Za sve zadatke: **MB 35** , **RA 400/500** , **umereno agresivna sredina**

u Beogradu, 08/10/2010.

Predmetni nastavnik:

asistent:

overa:

25.10.10

V.prof. dr Snežana Marinković, dipl.grad.inž.

rok završetka zadatka: **25.10.2010.**

# Godišnji zadatak - List 1

## Zadatak 1:

$$b = 35 \text{ cm}$$

MB 35

UØ8/25

$$d = 80 \text{ cm}$$

$$R = 1:10$$

$$A_{a1} = 35,28 \text{ cm}^2$$

RA 400/500

umereno agresivna sredina  $a_0 = 2,5 \text{ cm}$

a) Usvajeno u donjoj zoni 8 RØ25

$$A_{a1, \text{usv}} = 39,28 \text{ cm}^2$$

$$a' = a_0 + \phi_u + \frac{\phi}{2} = 4,55 \text{ cm}$$

$$L_u = 2a_u + 2b_u + 16 - 5\phi_u$$

$$L_u = 30,2 + 75,2 + 16 - 5 \cdot 0,8$$

$$a'' = a' + e_v + \phi = 10,05$$

$$L_u = 222 \text{ cm}$$

$$a_1 = \frac{4 \cdot 4,55 + 4 \cdot 10,05}{8} = 7,3 \text{ cm}$$

b) Usvajeno 10 RØ22

$$L_u = 222 \text{ cm}$$

$$A_{a1, \text{usv}} = 38 \text{ cm}^2$$

$$a' = 2,5 + 0,8 + 1,1 = 4,4 \text{ cm}$$

$$a'' = a' + 3 \text{ cm} + 22 \text{ cm} = 9,6 \text{ cm}$$

$$a_1 = \frac{4(4,4) + 9,6}{8} = 7 \text{ cm}$$

c) Usvajeno 8 RØ25

$$A_{a1, \text{usv}} = 39,28 \text{ cm}^2$$

$$a' = 4,55$$

$$a'' = 10,05$$

$$a''' = 15,55$$

$$a_1 = \frac{3(4,55 + 10,05) + 2 \cdot 15,55}{8}$$

$$a_1 = 9,76 \text{ cm}$$

$$L_u = 2 \cdot 20 + 2 \cdot 75 + 16 - 5 \cdot 0,8$$

$$L_u = 202 \text{ cm}$$

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### Zadatak 2:

$$Z_g = 360 \text{ kN}$$

$$Z_p = 395 \text{ kN}$$

$$Z_u = 1,6 \cdot Z_g + 1,8 \cdot S_p \quad \alpha \quad \varepsilon_a \geq 3\%$$

$$Z_u = 1,6 \cdot 360 + 1,8 \cdot 395 = 1287 \text{ kN}$$

$$MB35 \rightarrow f_B = 23 \text{ MPa}$$

$$\sigma_v = 400 \text{ MPa} \quad \varepsilon_a = 10\%$$

$$A_a = \frac{Z_u}{\sigma_v} = \frac{1287}{40} = 32,175 \text{ cm}^2 \Rightarrow 12 R \emptyset 19$$

$$A_{a, \text{stv}} = 34,08 \text{ cm}^2$$

$$b \geq 2a_0 + 2\emptyset_u + 4\emptyset + 3e_H \geq 29,2 \text{ cm} \quad \text{Usvajamo } b = 30 \text{ cm}$$

$$d \geq 2a_0 + 2\emptyset_u + 3\emptyset + 2e_v \geq 18,3 \text{ cm} \quad \text{Usvajamo } d = 20 \text{ cm}$$

### Zadatak 3:

$$b = 35 \text{ cm}$$

$$N_g = 2280 \text{ kN}$$

$$N_p = 585 \text{ kN}$$

$$N_u = 1,9 \cdot N_g + 2,1 \cdot 585 = 5560,5 \text{ kN}$$

$$N_u = A_b \cdot f_B + A_a \cdot \sigma_v$$

$$\mu = 0,6\% = \frac{A_a}{A_b}$$

$$f_B = 23 \text{ MPa} = 2,3 \frac{\text{kN}}{\text{cm}^2}$$

$$N_u = A_b \cdot f_B + A_b \cdot \frac{A_a}{A_b} \cdot \sigma_v$$

$$\sigma_v = 400 \text{ MPa} = 40 \frac{\text{kN}}{\text{cm}^2}$$

$$N_u = A_b \cdot f_B \left( 1 + \mu \cdot \frac{\sigma_v}{f_B} \right)$$

$$A_b = \frac{N_u}{f_B \left( 1 + \mu \frac{\sigma_v}{f_B} \right)} = \frac{5560,5}{2,3 \left( 1 + 0,6 \cdot 10^{-2} \cdot \frac{400}{2,3} \right)} = 2189,17 \text{ cm}^2$$

$$d = \frac{A_b}{b} = 62,55, \quad \text{Usvajamo } d = 65 \text{ cm}$$

$$b/d = 35/65 \text{ cm}$$

$$A_{a, \text{potr}} = 0,6 \cdot A_{b, \text{potr}} = 0,6 \cdot 2189,17 \cdot 10^{-2}$$

$$A_{a, \text{potr}} = 13,13 \text{ cm}^2 \Rightarrow \text{Usvajamo } 8R \emptyset 16$$

Za kug:

$$D \geq \sqrt{\frac{4}{\pi} A_b} = 52,79 \text{ cm}$$

$$D = 55 \text{ cm} \Rightarrow \text{Usvajamo } 6R \emptyset 19$$

### Zadatak 4

$$b = 35 \text{ cm} \quad d = 60 \text{ cm}$$

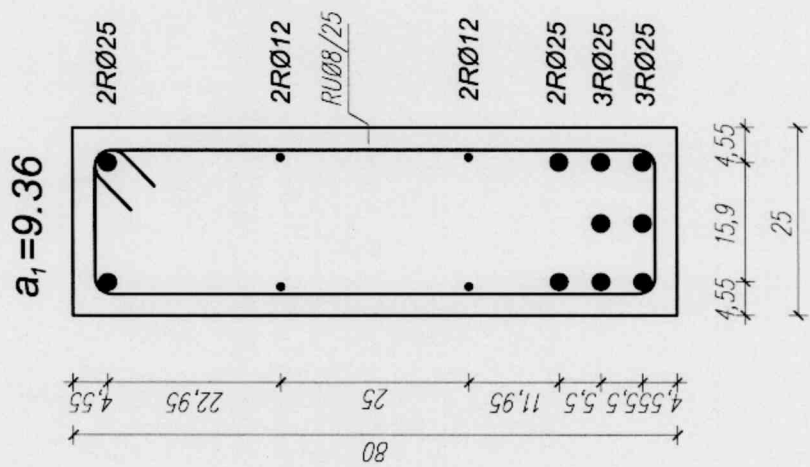
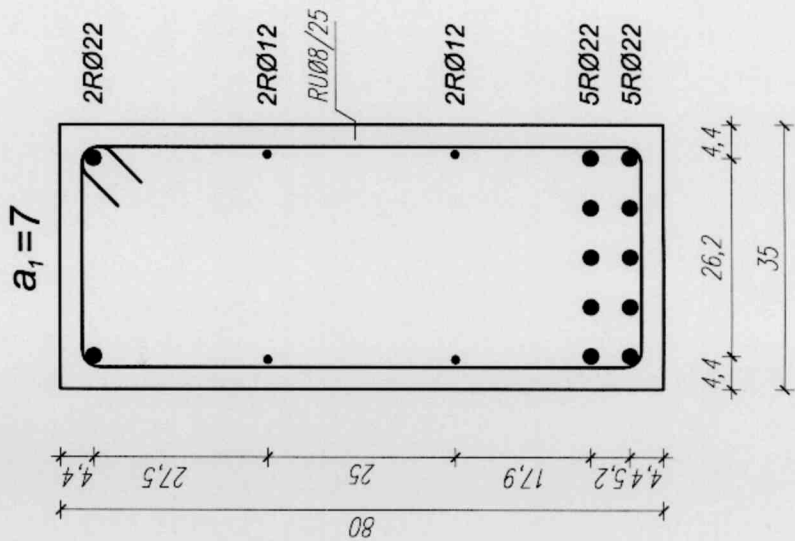
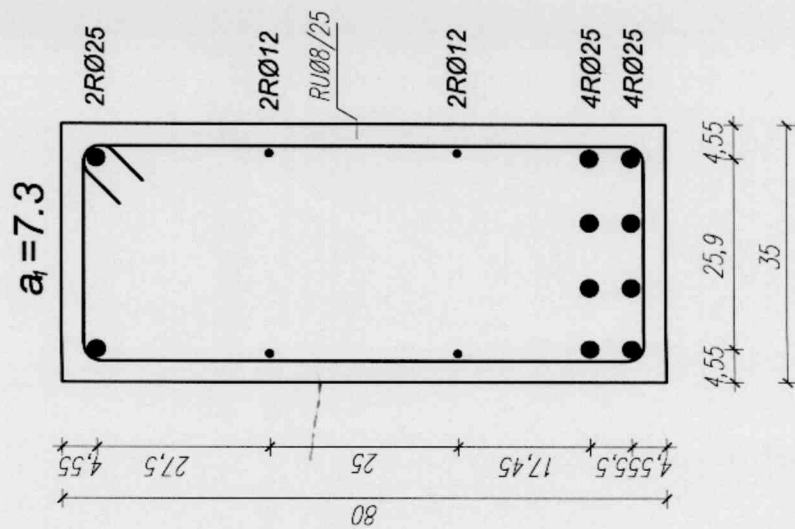
$$N_u = 5560,5 \text{ kN}$$

$$A_a = \frac{N_u - A_b \cdot f_{b3}}{f_{bv}} = \frac{5560 - 2100 \cdot 2,3}{40} = 18,25 \text{ cm}^2$$

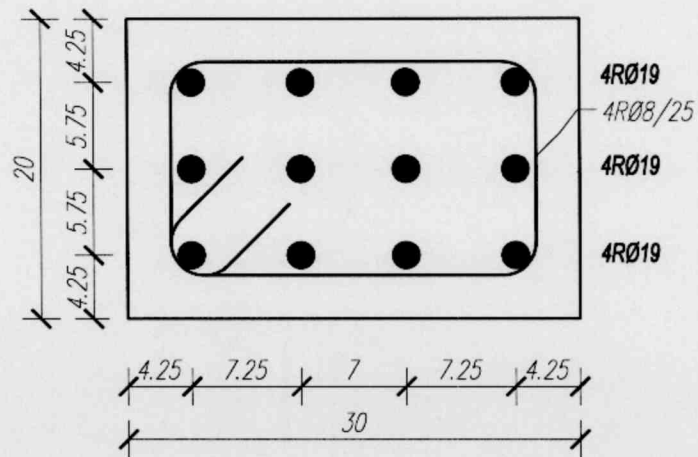
Usvajamo  $8R \emptyset 19$

$$A_{a, \text{stv}} = 22,72 \text{ cm}^2$$

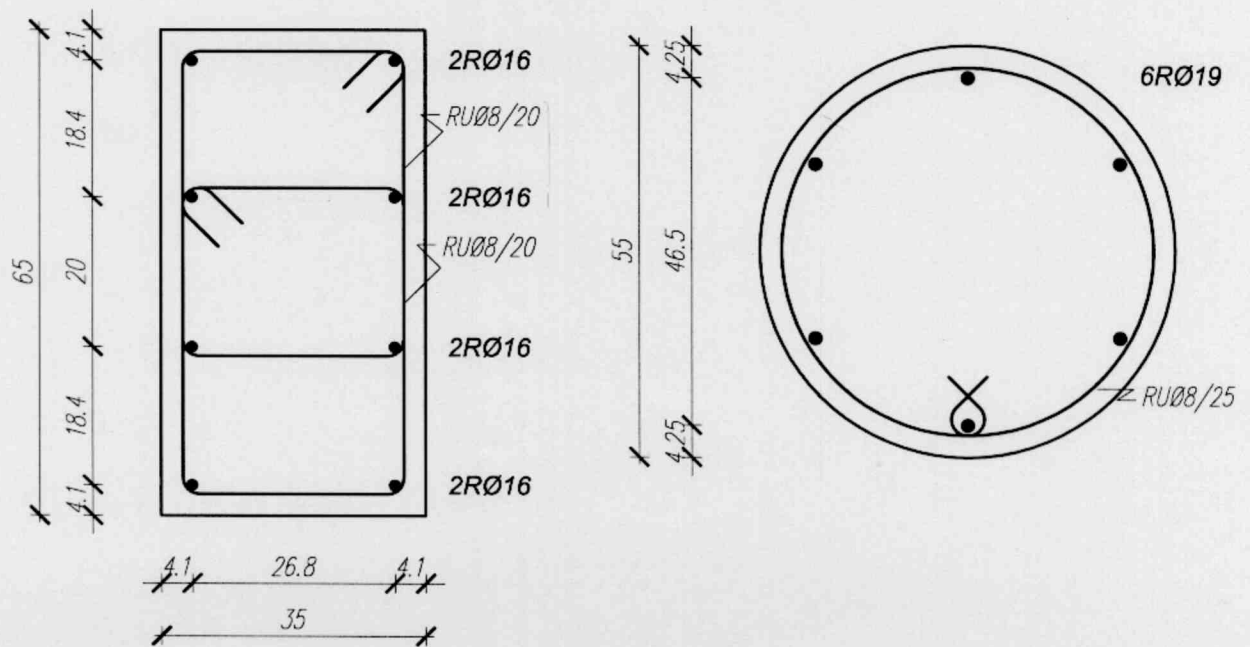
Godišnji zadatak— List 1  
Zadatak 1  
Razmera  $R=1:10$



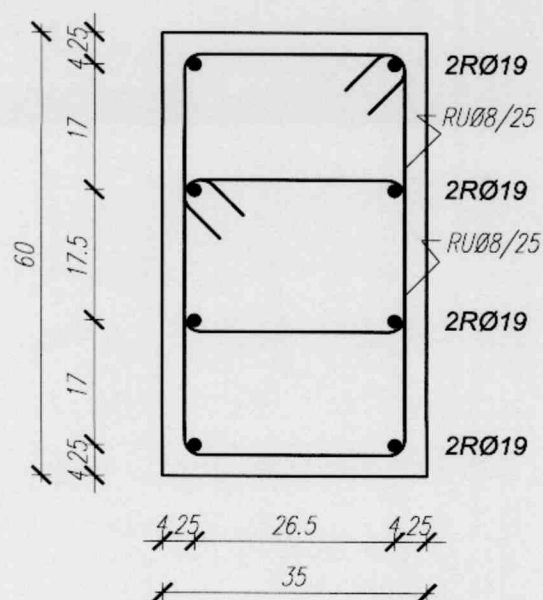
Godišnji zadatak-List 1  
Zadatak 2  
Razmera R 1:5



Godišnji zadatak – List 1  
Zadatak 3  
Razmera R 1:10



Zadatak 4  
Razmera R 1:10





## GODIŠNJI ZADATAK – LIST 2

1. Odrediti visinu i potrebnu površinu armature za presek pravougaonog oblika, opterećen momentima savijanja  $M_g$  i  $M_p$  usled stalnog, odnosno povremenog opterećenja.

$$b = 35 \text{ cm}$$

$$M_g = 111.8 \text{ kNm}$$

$$M_p = 65 \text{ kNm}$$

2. Odrediti potrebnu površinu armature za presek pravougaonog oblika poznatih dimenzija, opterećen momentima savijanja  $M_g$  i  $M_p$ . Odrediti potrebnu površinu armature za slučajeve da je isti presek, pored zadatih momenata savijanja, opterećen i silom zatezanja.

$$b = 30 \text{ cm}$$

$$M_g = 250.4 \text{ kNm}$$

$$Z_g = -188.1 \text{ kN}$$

$$d = 70 \text{ cm}$$

$$M_p = 197 \text{ kNm}$$

$$Z_p = -148.1 \text{ kN}$$

3. Odrediti potrebnu površinu armature za pravougaoni presek poznatih dimenzija, opterećen zadatim momentima savijanja i silama pritiska.

$$b = 30 \text{ cm}$$

$$M_g = 400.6 \text{ kNm}$$

$$N_g = 571.9 \text{ kN}$$

$$d = 70 \text{ cm}$$

$$M_p = 315.4 \text{ kNm}$$

$$N_p = 450.3 \text{ kN}$$

4. Odrediti potrebnu površinu armature za T presek poznatih dimenzija, opterećen graničnim momentom savijanja  $M_u$ .

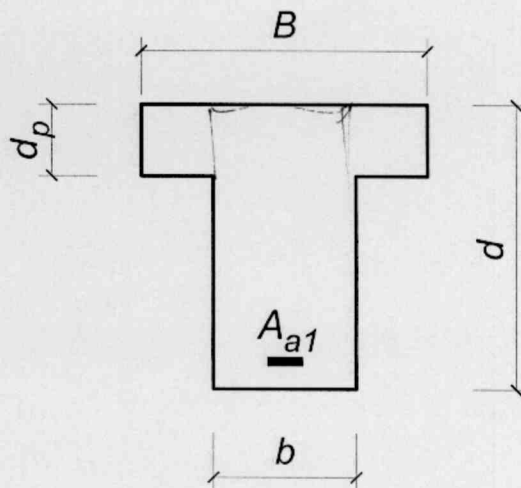
$$b = 30 \text{ cm}$$

$$B = 155 \text{ cm}$$

$$d = 70 \text{ cm}$$

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

$$M_u = 755.24 \text{ kNm}$$



za sve zadatke: **MB 50 RA 400/500**  
Sve proračunate poprečne preseke nacrtati u razmeri 1:10.

u Beogradu, 26/10/2010.

asistent: Koković

overa:

rok završetka zadatka: **8.11.2010.**

Predmetni nastavnik:

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34.21 ... 40.36 # 39.49 // 20.84 # 31.02

2a 2b 3 Hf



## Godišnji zadatak - List 2

### Zadatak 1:

$$b = 35 \text{ cm}$$

$$R_A \quad 400/500 \Rightarrow \gamma_v = 40 \text{ kN/cm}^2$$

$$M_{B50} \Rightarrow f_{v3} = 3,0 \text{ kN/cm}^2$$

$$M_g = 111,8 \text{ kNm}$$

$$M_p = 65 \text{ kNm}$$

$$M_u = 1,6 M_g + 1,8 M_p = 295,88 \text{ kNm}$$

$$\text{usvajamo: } \varepsilon_{a1} = 10\% \quad \varepsilon_b = 3,5\%$$

$$\text{iz tablica: } k = 2,311 \quad \bar{\mu}_{1m} = 20,988\%$$

$$h = k \cdot \sqrt{\frac{M_u}{b \cdot f_{v3}}} = 2,311 \cdot \sqrt{\frac{295,88 \cdot 10^2}{35 \cdot 3}} = 38,8 \text{ cm}$$

$$A_a = \bar{\mu}_{1m} \cdot \frac{b \cdot h}{100} \cdot \frac{f_{v3}}{\gamma_v} = 20,988 \cdot \frac{35 \cdot 38,8}{100} \cdot \frac{3}{40} = \underline{21,58 \text{ cm}^2}$$

$$\text{Usvajamo } 8R\emptyset 19 \quad A_{a, \text{stv}} = 22,72 \text{ cm}^2$$

$$a' = 2,5 + 0,8 + \frac{1,9}{2} = 4,25$$

$$a'' = 4,25 + 3 + 1,9 = 9,15$$

$$a_1 = \frac{4 \cdot a' + 3 \cdot a''}{8} = 6,7 \text{ cm}$$

$$d = h + a_1 = 45,5 \text{ cm} \Rightarrow \text{usvajamo}$$

$$d = 50 \text{ cm} \quad 45 \text{ cm}$$

### Zadatak 2:

$$b = 30 \text{ cm} \quad d = 70 \text{ cm}$$

$$M_g = 250,4 \text{ kNm}$$

$$M_p = 197,0 \text{ kNm}$$

$$Z_g = -188,1 \text{ kN}$$

$$Z_p = -148,1 \text{ kN}$$

$$M_u = 1,6 M_g + 1,8 M_p = 755,24 \text{ kNm}$$

$$Z_u = 1,6 \cdot 188,1 + 1,8 \cdot 148,1 = 567,54 \text{ kNm}$$

$$a) \text{ pretp. } a_1 = 9 \text{ cm}$$

$$h = 70 - 9 = 61 \text{ cm}$$

$$k = \frac{h}{\sqrt{\frac{M_u}{b \cdot f_B}}} = \frac{61}{\sqrt{\frac{755,24 \cdot 10^2}{30 \cdot 3}}} = 2,106$$

iz tablice interpolacijom:  $\mu_m = 26,024 \%$

$$A_a = 26,024 \cdot \frac{30 \cdot 61}{100} \cdot \frac{3}{40} = 35,72 \text{ cm}^2$$

Usvajamo se  $A_{a,stv} = 36,96$  (8RØ28)

$$a_1 = 7,6 \text{ cm} \quad d - a_1 = 70 - 7,6 = 62,4 > 61$$

b) pretp.  $a_1 = 9 \text{ cm} \Rightarrow h = d - a_1 = 61 \text{ cm}$

$$M_{zu} = M_u - z_u \left( \frac{d}{2} - a_1 \right)$$

$$M_{zu} = 755,24 - 567,54 \left( \frac{0,7}{2} - 0,09 \right) = 607,68 \text{ kNm}$$

$$k = \frac{h}{\sqrt{\frac{M_{zu}}{b \cdot f_B}}} = \frac{61}{\sqrt{\frac{607,68 \cdot 10^2}{30 \cdot 3}}} = 2,348$$

$$\Rightarrow \mu_m = 20,249 \%$$

$$A_a = 20,249 \cdot \frac{30 \cdot 61}{100} \cdot \frac{3}{40} + \frac{567,54}{40}$$

$$A_a = 42,21 \text{ cm}^2$$

Usvajamo  $A_{a,stv} = 8RØ28$  (49,28 cm<sup>2</sup>)

$$a_1 = 9,775 \text{ cm} \quad d - a_1 = 60,225 \approx 61 \text{ cm}$$

Zadatak 3:

$$b = 30 \text{ cm} \quad d = 70 \text{ cm}$$

$$M_g = 400,6 \text{ kNm} \quad M_p = 315,4 \text{ kNm}$$

$$N_g = 571,9 \text{ kNm} \quad N_p = 450,3 \text{ kNm}$$

$$M_u = 1,6 \cdot 400,6 + 1,8 \cdot 315,4 = 1208,68 \text{ kNm}$$

$$N_u = 1,6 \cdot 571,9 + 1,8 \cdot 450,3 = 1725,58 \text{ kN}$$

pretp.  $a_1 = 9 \text{ cm} \Rightarrow h = 61 \text{ cm}$

$$M_{au} = 1208,68 + 1725,58 \left( \frac{0,7}{2} - 0,09 \right)$$

$$M_{au} = 1657,33 \text{ kNm}$$

$$k = \frac{61}{\sqrt{\frac{1657,33 \cdot 10^2}{30 \cdot 3}}} = 1,421 \Rightarrow \varepsilon_a < 3\% \text{ (iz tablice)}$$

Usvaj. se  $\varepsilon_{a1} = 3\%$ .

$$k^* = 1,719 \quad \bar{\mu}_{1M}^* = 43,590\%$$

$$M_{abu} = \left( \frac{h}{k^*} \right)^2 \cdot b \cdot f_b = \left( \frac{61}{1,719} \right)^2 \cdot 30 \cdot 3 \cdot 10^{-2} = 1133,31 \text{ kNm}$$

$$\Delta M_{au} = M_{au} - M_{abu} = 1657,33 - 1133,31 = 524,02 \text{ kNm}$$

pretpostavka  $a_2 = 7 \text{ cm} \Rightarrow A_{a2} = \frac{\Delta M_{au}}{(h - a_2) \cdot \sigma_v} = 24,26 \text{ cm}^2$

$$A_{a1} = \bar{\mu}_{1M}^* \cdot \frac{b \cdot h}{100} \cdot \frac{f_b}{\sigma_v} - \frac{N_u}{\sigma_v} + A_2 = 40,95 \text{ cm}^2$$

pošto je  $A_{a1} > A_{a2} \Rightarrow$  svaki presek se posebno armira

$A_{a1}$  usvajamo 8RØ28 (44,18 cm<sup>2</sup>)

$A_{a2}$  usvajamo 5RØ28 (24,55 cm<sup>2</sup>)

$$a_1 = 9,775$$

$$d - a_1 = 60,225 \approx 61$$

Zadatak 4:

$$b = 30 \text{ cm}$$

$$B = 155 \text{ cm}$$

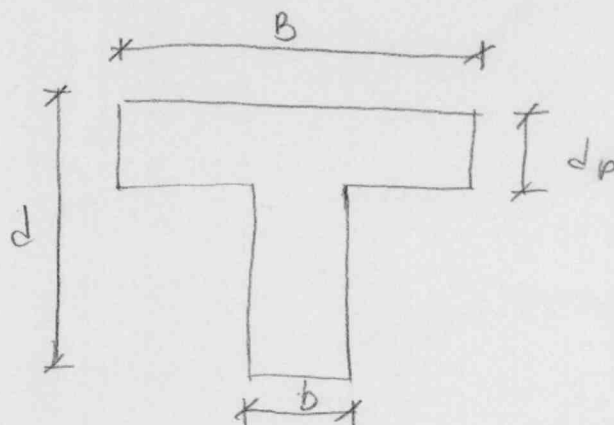
$$d = 70 \text{ cm}$$

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

$$M_u = 755,24 \text{ kNm}$$

$$B/b = 155/30 = 5,17 > 5$$

zanemaruje se nosivost rebara



$$z_{bp} = \frac{M_u}{B \cdot d_p \cdot \left(h - \frac{d_p}{2}\right)} = \frac{755,24 \cdot 10^2}{155 \cdot 15 \left(63 - \frac{15}{2}\right)} = 0,59 \text{ kN/cm}^2$$

$z_{bp} < f_b \Rightarrow$  neutralna linija se nalazi u ploči  
pa se presek dimenzioniše kao pravougaoni

$$\epsilon_{bp} = 2 \cdot \left(1 - \sqrt{1 - \frac{z_{bp}}{f_b}}\right) = 0,207\%$$

$$x_o = \frac{\epsilon_{bp}}{\epsilon_{bp} + \epsilon_a} \left(h - \frac{d_p}{2}\right)$$

$$x_o = \frac{0,207}{0,207 + 10} \left(63 - \frac{15}{2}\right) = 1,13 \text{ cm} < \frac{d_p}{2} = 7,5 \text{ cm}$$

$$k = \frac{h}{\sqrt{\frac{M_u}{B \cdot f_b}}} = \frac{63}{\sqrt{\frac{755,24 \cdot 10^2}{155 \cdot 3}}} = 4,943$$

iz tablice  $\mu_{im} = 4,238$   $\epsilon_b = 1,07\%$   $\epsilon_a = 10\%$

$$x = \mu \cdot h = 0,096 \cdot 63 = 6,08 \text{ cm} < d_p = 15 \text{ cm}$$

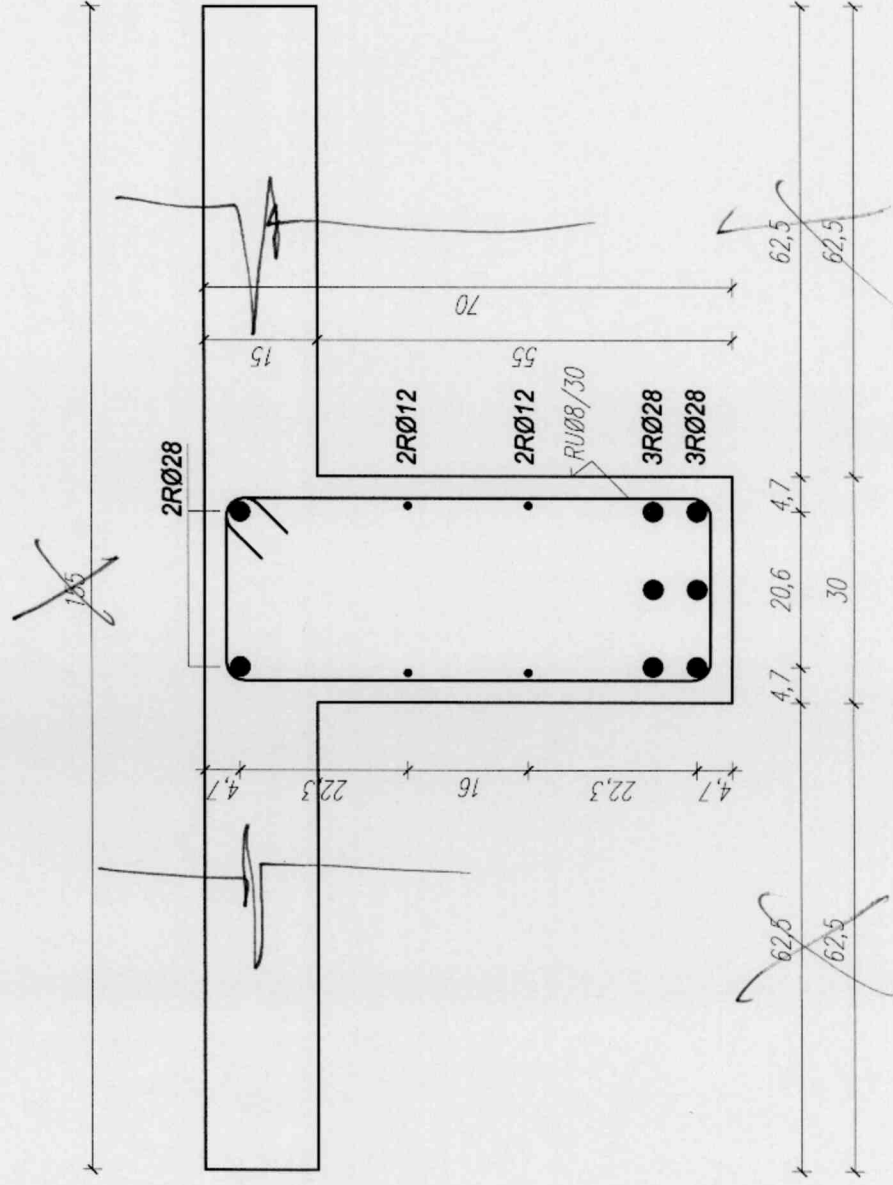
$$A_a = 4,238 \cdot \frac{155 \cdot 63}{100} \cdot \frac{3}{40} = 31,04 \text{ cm}^2$$

Uvek se 6R  $\varnothing 28$  (36,95 cm<sup>2</sup>)

$$a_1 = 6,63 \text{ cm} \quad 2 - a_1 = 63,37 \text{ cm} > h = 63 \text{ cm}$$



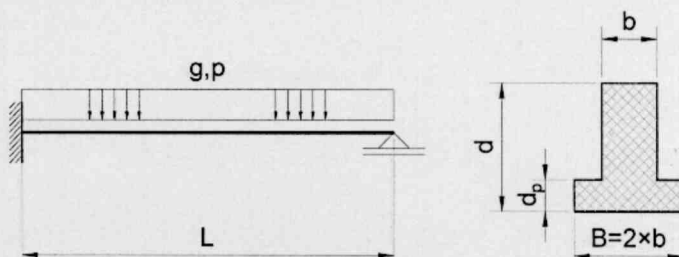
Godišnji zadatak – List 2  
 Zadatak 4  
 Razmera  $R = 1:10$



### GODIŠNJI ZADATAK – LIST 3

1. Za nosač čiji su statički sistem i opterećenje prikazani na skici desno, potrebno je dimenzionisati karakteristične preseke prema  $M$  i  $T$ . U stalno opterećenje  $g = 60 \text{ kN/m}$  je uračunata i sopstvena težina nosača. Opterećenje  $p = 19 \text{ kN/m}$  je povremeno opterećenje. Poprečni presek nosača je konstantan i prikazan je na skici, a izvodi se od betona **MB 30**. Nosač armirati rebrastom armaturom RA 400/500. Nacrtati u razmeri 1:10 sve usvojene poprečne preseke sa svim neophodnim kotama i oznakama.

$$\begin{aligned} L &= 5.6 \text{ m} \\ b &= 30 \text{ cm} \\ d &= 60 \text{ cm} \\ d_p &= 14 \text{ cm} \end{aligned}$$



2. Odrediti potrebnu površinu armature za kružni poprečni presek prečnika  $D$ , opterećen graničnim momentom savijanja  $M_u$  i graničnom normalnom silom pritiska  $N_u$ . Usvojeni poprečni presek nacrtati u razmeri 1:10.

$$M_u = 97 \text{ kNm} \quad N_u = 62 \text{ kN} \quad D = 35 \text{ cm} \quad \text{MB 30} \quad \text{RA 400/500}$$

3. Za stub pravougaonog poprečnog preseka date su tri kombinacije uticaja usled stalnog i povremenog opterećenja. Odrediti potrebnu površinu armature prema merodavnim uticajima, a zatim usvojeni poprečni presek nacrtati u razmeri 1:10. Uticaj izvijanja zanemariti.

a.	$N_g = 1277.2 \text{ kN}$	$M_p = \pm 751.1 \text{ kNm}$	$b = 40 \text{ cm}$
b.	$N_g = 3196.6 \text{ kN}$	$M_p = \pm 546 \text{ kNm}$	$d = 80 \text{ cm}$
c.	$N_g = 4440.6 \text{ kN}$	$M_p = \pm 217.3 \text{ kNm}$	MB 40
			RA 400/500

u Beogradu, 11/11/2010.

asistent: Koković

overa: 15.11.10

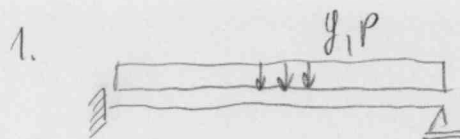
Predmetni nastavnik:

V.prof. dr Snežana Marinković, dipl.građ.inž., s.r.

rok završetka zadatka: **22.11.2010.**

19.62 ... (36.38) 29.1 24.63 22.57 ... 1.849





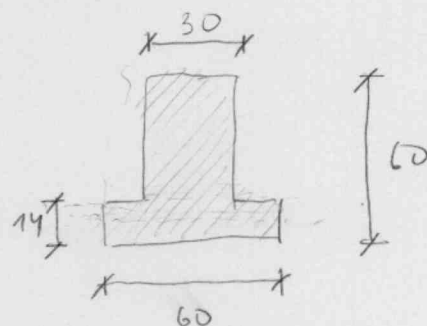
$$g = 60 \text{ kN/m}$$

$$p = 19 \text{ kN/m}$$

$$MB30 \rightarrow f_b = 2.05 \text{ kN/cm}^2$$

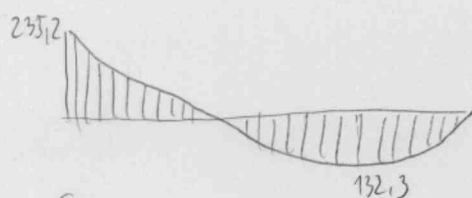
$$RA400/500 \rightarrow b_v = 40 \text{ kN/cm}^2$$

$$\text{Usvajamo } \eta_g = 1.6 \quad \eta_p = 1.8$$

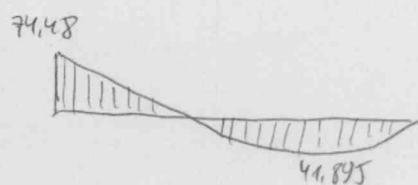


$$L = 5.6$$

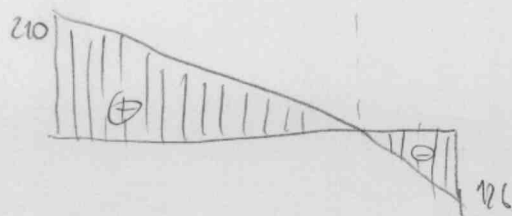
(M<sub>g</sub>)



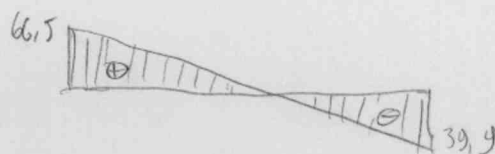
(M<sub>p</sub>)



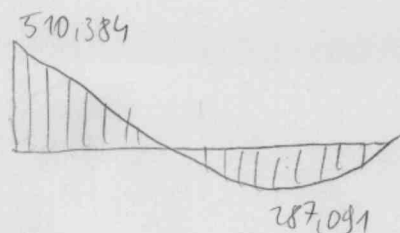
(T<sub>g</sub>)



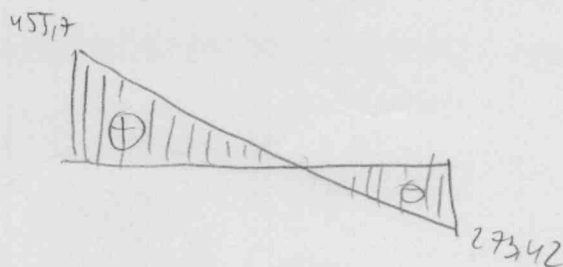
(T<sub>p</sub>)



(M<sub>u</sub>)



(T<sub>u</sub>)



Usvajanje armature prema M<sub>u</sub>

$$M_{u1} = 510.384 \text{ kNm} \quad (B=26=60 \text{ cm})$$

Proveravamo gde je neutralna linija

$$a_1 = 7 \text{ cm} \quad h = d - a_1 = 53 \text{ cm}$$

$$k = \frac{53}{\sqrt{\frac{510.384 \cdot 100}{60 \cdot 2.05}}} = 2.602$$

interpolacijom vrednosti iz tabele

$$\bar{\mu} = 16,138 \quad s = 0,2138$$

$$x = s \cdot h = 11,33 < d_p = 14 \Rightarrow \text{radimo kao pravougoni preseki}$$

$$A_{a1} = \mu \frac{bh}{100} \cdot \frac{f_b}{\gamma_v} = 26,3 \text{ cm}^2$$

$$\text{Usvajamo } 6R\emptyset 25 (29,46 \text{ cm}^2)$$

$$\text{Za polje } M_{u2} = 287,091 \text{ kNm}$$

$$a_2 = 6 \text{ cm} \quad h = 54 \Rightarrow k = \frac{54}{\sqrt{\frac{287,091 \cdot 100}{30 \cdot 2,05}}} \Rightarrow \bar{\mu} = 17,632$$

$$A_{a1} = \mu \frac{bh}{100} \cdot \frac{f_b}{\gamma_v} = 14,64 \text{ cm}^2 \Rightarrow \text{Usvajamo } 3R\emptyset 25 (14,73 \text{ cm}^2)$$

$$a_1 = 7,5 \quad d - a_1 = 52,5 \approx 53 \text{ (imamo sigurnost zbog većeg } A_{a1})$$

$$a_2 = 4,75 \quad d - a_2 = 55,25 \approx 54$$

Proračun uzdužnog za T sile

$$T_1 = 455,7 \text{ kN} \quad T_2 = 273,42 \text{ kN}$$

$$T_{n1} = \frac{455,7}{0,9 \cdot 53 \cdot 30} = 0,318 \text{ kN/cm}^2 = 3,18 \text{ MPa}$$

$$T_{n2} = \frac{273,42}{0,9 \cdot 54 \cdot 30} = 0,187 \text{ kN/cm}^2 = 1,87 \text{ MPa}$$

$$T_r (\text{MB30}) = 1,1 \text{ MPa}$$

$$1,1 < 3,18 < 3,3$$

$$1,1 < 1,87 < 3,3$$

Tražimo gde je  $T = 0$  (M u polju je max.)

$$455,7 : x = 273,42 : (5,6 - x)$$

$$x = 3,5 \text{ m} \Rightarrow x' = 2,1 \text{ m}$$

Dužina osiguranja

$$\lambda_1 \Rightarrow 3,13 : 3,5 = 1,1 : a \Rightarrow a = 1,21 \text{ m}$$

$$\lambda_1 = x - a = 3,5 - 1,21 = 2,29 \text{ m} \quad \text{Usvajamo} \quad \lambda_1 = 2,3 \text{ m}$$

$$\lambda_2 \quad 1,87 : 2,1 = 1,1 : b \Rightarrow b = 1,23 \text{ m}$$

$$\lambda_2 = x' - b = 0,87 \text{ m} \quad \text{Usvajamo} \quad \lambda_2 = 0,9 \text{ m}$$

Redukovani naponi

$$\sigma_{ru1} = \frac{3}{2} (3,18 - 1,1) = 3,12 \text{ MPa}$$

$$\sigma_{ru2} = \frac{3}{2} (1,87 - 1,1) = 1,155 \text{ MPa}$$

Usvajanje uzdužice

Za levu stranu nosiča  $m=4$   $\theta=45^\circ$   $\alpha=90^\circ$   $\emptyset 10$

$$e_{u1} = \frac{m \cdot a^{(n)} \cdot \sigma_v}{b \cdot \sigma_{ru}} = \frac{4 \cdot 0,1785}{30 \cdot 0,312} \cdot 40 = 13,42 \text{ cm}$$

$$e_{u1} = \frac{m \cdot a^{(n)}}{\mu_{min} \cdot b} = \frac{4 \cdot 0,1785}{0,2 \cdot 10^2 \cdot 30} = 52,33 \text{ cm}$$

$$\left. \begin{array}{l} e_{u1} = 13,42 \text{ cm} \\ e_{u1} = 52,33 \text{ cm} \end{array} \right\} \begin{array}{l} e_{u1} = 12,5 \text{ cm} \\ \text{UR } \emptyset 10 / 12,5 \end{array}$$

Za desnu stranu  $m=2$   $\theta=45^\circ$   $\alpha=90^\circ$   $\emptyset 10$

$$e_{u2} = \frac{2 \cdot 0,1785}{30 \cdot 0,1155} \cdot 40 = 18,12$$

$$e_{u2} = \frac{2 \cdot 0,1785}{0,2 \cdot 10^2 \cdot 30} = 26,17$$

$$\left. \begin{array}{l} e_{u2} = 18,12 \\ e_{u2} = 26,17 \end{array} \right\} \begin{array}{l} e_{u2} = 17,5 \\ \text{UR } \emptyset 10 / 17,5 \end{array}$$

Za polje usvajamo UR  $\emptyset 10 / 25$

Dodatna integrita armatura preko slobodnog oslonca

$$\Delta A = \frac{T_u}{\sigma_{sv}} = \frac{271,42}{80} = 3,42 \text{ cm}^2$$

$$\frac{1}{3} A_{a1} = \frac{1}{3} 14,64 = 4,88 \text{ cm}^2$$

$$\left. \begin{array}{l} \Delta A = 3,42 \\ \frac{1}{3} A_{a1} = 4,88 \end{array} \right\} \begin{array}{l} \Delta A = 4,88 \\ 2R \emptyset 25 (7,60 \text{ cm}^2) \end{array}$$

2.  $M_u = 97 \text{ kNm}$

$M_u = 62 \text{ kNm}$

$D = 35 \text{ cm}$

MB30  $\rightarrow f_b = 2,05 \text{ kN/cm}^2$

RA 400/500  $\rightarrow z_v = 40 \text{ kN/cm}^2$

Uvažamo  $a = 4 \text{ cm} \rightarrow$  gledamo diagram interakcije

za odnos  $\frac{R}{R} = 0,100$

$$\left. \begin{aligned} n_u &= \frac{N_u}{\pi d^2 \cdot f_b} = 0,03 \\ m_u &= \frac{M_u}{R \pi d^2 f_b} = 0,14 \end{aligned} \right\} \bar{M} = 0,348$$

$A_d = \mu \cdot \pi \cdot d^2 \cdot \frac{f_b}{z_v} = 19,62 \text{ cm}^2$

Uvažamo GRØ 22 ( $22,8 \text{ cm}^2$ )

3. a)  $N_g = 1277,2 \text{ kN}$   $M_p = \pm 751,1 \text{ kNm}$

b)  $N_g = 3196,6 \text{ kN}$   $M_p = \pm 546 \text{ kNm}$

c)  $N_g = 4440,6 \text{ kN}$   $M_p = \pm 217,5 \text{ kNm}$

$b = 40 \text{ cm}$   $d = 80 \text{ cm}$  MB 40  $\rightarrow f_b = 2,35$   $z_v = 40 \text{ kN/cm}^2$

d)  $\varepsilon_{s1} > 3\%$   $\eta_g = 1,6$   $\eta_p = 1,8$

$N_u = 1,6 \cdot 1277,2 = 2043,32 \text{ kN}$

$M_u = 1,8 \cdot 751,1 = 1351,98 \text{ kNm}$

$n_u = \frac{N_u}{b \cdot d \cdot f_b} = 0,25$

$m_u = \frac{M_u \cdot 100}{b \cdot d^2 \cdot f_b} = 0,207$

Na dijagramu ( $d=8\text{ cm}$   $\frac{a}{d}=0,100$ ) očitava se  $\mu=0,282$

Usvajamo  $\eta_g=1$

$$\left. \begin{array}{l} Nu=1277,2 \Rightarrow n_u=0,136 \\ m_u=0,207 \end{array} \right\} \Rightarrow \mu=0,361 \%$$

b) pretpostavimo pritiska  $\eta_g=1,9$   $\eta_p=2,1$

$$Nu=1,9 \cdot 3196,6 = 6073,54$$

$$Mu=2,1 \cdot 546,1 = 1146,6$$

$$\left. \begin{array}{l} n_u=0,744 \\ m_u=0,176 \end{array} \right\} \Rightarrow \mu=0,26\% \quad E_a=0,5\%$$

Interpolacija da nađemo  $\eta_g$  i  $\eta_p$

$$\left. \begin{array}{l} \eta_g = 1,9 - \frac{1,9-1,6}{3-0} \cdot 0,5 = 1,85 \\ \eta_p = 2,1 - \frac{2,1-1,8}{3-0} \cdot 0,5 = 2,05 \end{array} \right\} \Rightarrow \left. \begin{array}{l} Nu=5913,71 \\ Mu=1119,51 \end{array} \right\} \Rightarrow \left. \begin{array}{l} n_u=0,725 \\ m_u=0,171 \end{array} \right\} \Rightarrow \mu=0,255\%$$

$$\left. \begin{array}{l} c) Nu=1,9 \cdot 4440,6 = 8437,14 \\ Mu=2,1 \cdot 217,3 = 456,73 \end{array} \right\} \Rightarrow \left. \begin{array}{l} n_u=1,034 \\ m_u=0,07 \end{array} \right\} \Rightarrow \mu=0,18\%$$

Usvajamo  $\mu_{max}=0,361\%$

$$A_a = \bar{\mu} \cdot b \cdot d \cdot \frac{f_b}{\gamma_v} = 73,644$$

$$A_{a1} = A_{a2} = \frac{A_a}{2} = 36,82 \text{ cm}^2$$

Usvajamo  $\pm 8R\phi 25$

115.

Di jagram za  
dimenzionisanje  $M_{xu}$  i  $N_u$

OF - IMK

$$\sigma_v = 40.0 \text{ KN/cm}^2$$

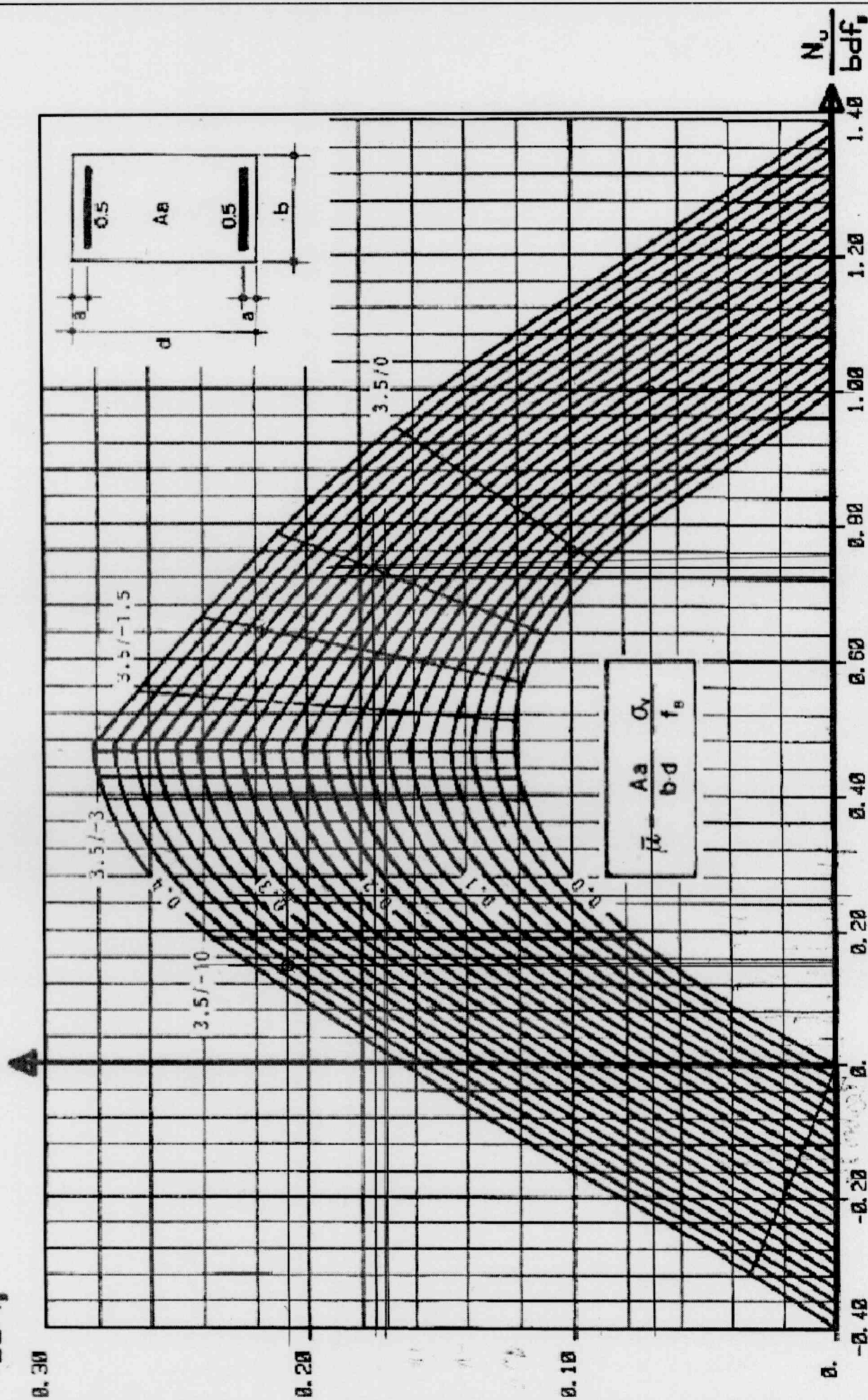
$$\bar{\mu}_{\max} = 0.4$$

$$\frac{m_y \gamma / b}{m_x M_x / d} = 0.0$$

$$\frac{a}{d} = 0.100$$



$$\frac{M_{xu}}{bd^2 f_s}$$





### GODIŠNJI ZADATAK – LIST 4

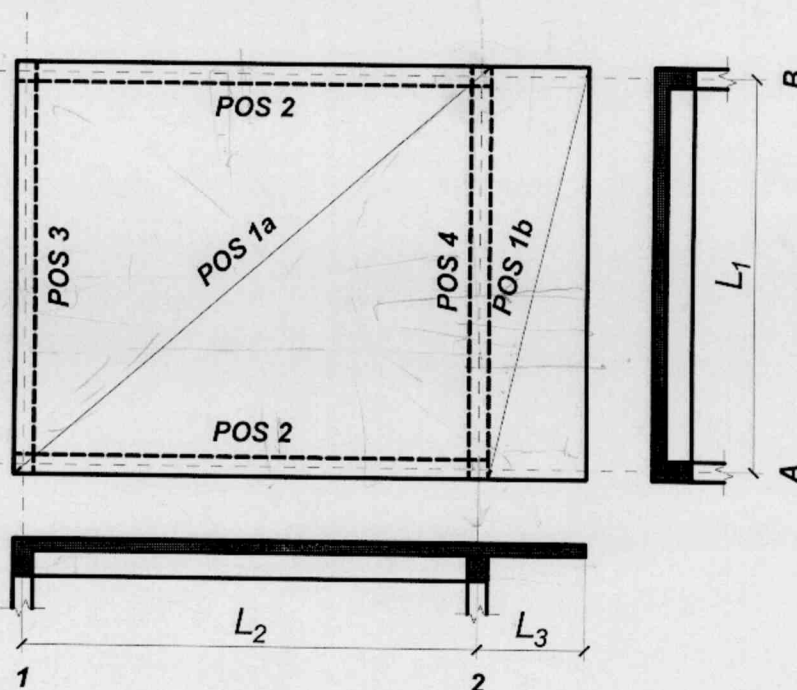
Za konstrukciju datu na skici, potrebno je:

- dimenzionisati ploče POS 1a, POS 1b, i gredu POS 4
- nacrtati planove oplata i armature (R 1:50) za POS 1a i POS 1b

Pored sopstvene težine, ploča je opterećena dodatnim stalnim opterećenjem  $\Delta g$ , kao i povremenim opterećenjem  $p$ .

Kvalitet materijala: **MB 30 ; RA 400/500**

$L_1 = 5.7 \text{ m}$        $L_2 = 6.8 \text{ m}$        $L_3 = 2 \text{ m}$        $\Delta g = 2.75 \text{ kN/m}^2$        $p = 3.5 \text{ kN/m}^2$



u Beogradu, 22.11.2010.  
asistent: Koković

Predmetni nastavnik:

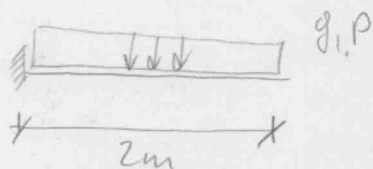
overa: \_\_\_\_\_

V.Prof.dr Snežana Marinković, s.r.

rok završetka zadatka: **06.12.2010.**



a) Kontrolna ploča, oslanjanje u jednom pravcu



POS 1b

$$\Delta g = 2,75 \text{ kN/m}^2$$

$$p = 3,5 \text{ kN/m}^2$$

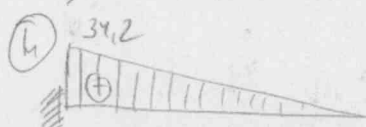
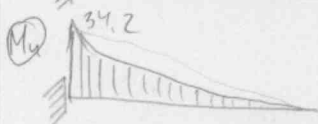
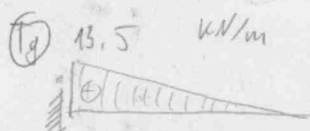
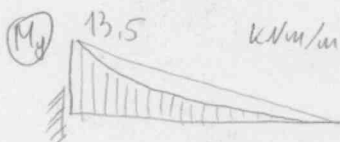
$$L = 2 \text{ m}$$

MB30

RA 400/500

$$f_b = 2,05 \text{ kN/cm}^2$$

$$z_v = 40 \text{ kN/cm}^2$$



$$d_p = 16 \text{ cm}$$

$$g = g' + \Delta g = 0,16 \cdot 25 + 2,75 = 6,75 \text{ kN/m}^2$$

$$p = 3,5 \text{ kN/m}^2$$

$$a_1 = 2,5 \text{ cm} \Rightarrow h = 13,5 \text{ cm}$$

$$k = \frac{13,5}{\sqrt{\frac{34,2 \cdot 100}{100 \cdot 2,05}}} = 3,305 \Rightarrow \mu = 9,704$$

$$A_{a, \text{potr}} = 9,704 \cdot \frac{100 \cdot 13,5}{100} \cdot \frac{2,05}{40} = 6,71 \text{ cm}^2/\text{m}$$

$$R\emptyset 10 \Rightarrow e_a = \frac{100 \cdot 0,785}{6,71} = 11,7 \text{ cm} \Rightarrow R\emptyset 10/10$$

$$A_{a, \text{st+st}} = \frac{100 \cdot 0,785}{10} = 7,85 \text{ cm}^2/\text{m}$$

$$A_{a, p} = 0,2 \cdot A_{a, \text{potr}} = 0,2 \cdot 6,71 = 1,342 \text{ cm}^2/\text{m} \quad R\emptyset 8$$

$$A_{a, p} = 0,085 \cdot \frac{100 \cdot 16}{100} = 1,36 \quad e_{a, p} = \frac{100 \cdot 0,503}{1,36} = 37$$

Usvaja se R\emptyset 8/30

# dimenzionisanje ploče (POS 12)

$$\left. \begin{array}{l} L_y = 6,8 \\ L_x = 5,7 \end{array} \right\} L_y / L_x = 1,19 \approx 1,20$$

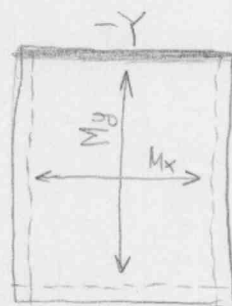
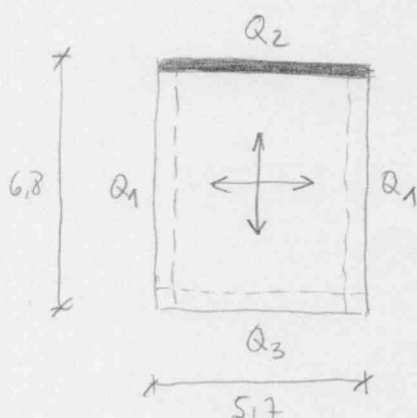
$$d_p = \frac{L_0}{35}$$

$$d_p = \frac{570}{35}$$

$$d_p = 16 \text{ cm}$$

$$g = 6,75 \text{ kN/m}^2$$

$$p = 3,5 \text{ kN/m}^2$$



## Čitanje koeficijenta iz tablice

$$M_x = 0,038$$

$$Q_1 = 0,244$$

$$M_y = 0,034$$

$$Q_2 = 0,298$$

$$-Y = 0,083$$

$$Q_3 = 0,214$$

## Opterećenja

$$G = g \cdot L_x \cdot L_y = 6,75 \cdot 6,8 \cdot 5,7 = 261,63 \text{ kN}$$

$$P = p \cdot L_x \cdot L_y = 3,5 \cdot 6,8 \cdot 5,7 = 135,66 \text{ kN}$$

$$Q_1 \cdot G = 63,84$$

$$Q_1 \cdot P = 33,10$$

$$g_i = 9,39$$

$$p_i = 4,87$$

$$Q_2 \cdot G = 78,00$$

$$Q_2 \cdot P = 40,43$$

$$g_i = 13,68$$

$$p_i = 7,09$$

$$Q_3 \cdot G = 55,99$$

$$Q_3 \cdot P = 29,03$$

$$g_i = 9,82$$

$$p_i = 5,09$$

$$M_x = 0,038 \cdot (1,6 \cdot G + 1,8 \cdot P) = 25,19 \text{ kNm/m}$$

$$M_y = 0,034 \cdot (1,6 \cdot G + 1,8 \cdot P) = 22,54 \text{ kNm/m}$$

$$-Y = 0,083 \cdot (1,6 \cdot G + 1,8 \cdot P) = 55,01 \text{ kNm/m}$$

$M_x$  - kraći pravac, polje

$M_y$  - duži pravac, polje

$Y$  - oslonac (gornja zona)

} donja zona

$$M_x: a = 2,5 \text{ cm} \Rightarrow k = \frac{13,5}{\sqrt{\frac{25,19 \cdot 100}{100 \cdot 7,05}}} = 3,851$$

$$\mu = 7,068 \Rightarrow A_{a, \text{potr}} = 4,89 \text{ cm}^2/\text{m}$$

$$M_y: a = 3 \text{ cm} \Rightarrow k = \frac{13}{\sqrt{\frac{22,54 \cdot 100}{100 \cdot 7,05}}} = 3,921$$

$$\mu = 6,815 \Rightarrow A_{a, \text{potr}} = 4,54 \text{ cm}^2/\text{m}$$

$$Y: a = 2,5 \text{ cm} \Rightarrow k = \frac{13,5}{\sqrt{\frac{44,605 \cdot 100}{100 \cdot 7,05}}} = 2,897$$

$$M = (M_{\text{pos1b}} + M_{\text{pos1A}}) / 2$$

$$M = 44,605 \text{ kNm/m}$$

$$\mu = 12,836 \Rightarrow A_{a, \text{potr}} = 8,88 \text{ cm}^2/\text{m}$$

Usvajanje armature u ploči:

Kraći pravac, polje  $A_a = 4,89 \text{ cm}^2/\text{m}$

$$R\emptyset 10 \Rightarrow e_a = \frac{0,785 \cdot 100}{4,89} = 16,05 \Rightarrow \boxed{R\emptyset 10 / 15}$$

duži pravac, polje  $A_a = 4,54 \text{ cm}^2/\text{m}$

$$R\emptyset 10 \Rightarrow e_a = \frac{0,785 \cdot 100}{4,54} = 17,29 \text{ cm} \Rightarrow \boxed{R\emptyset 10 / 15}$$

oslonac

$$R\emptyset 14 \Rightarrow e_a = \frac{1,54 \cdot 100}{8,88} = 17,34 \text{ cm} \Rightarrow \boxed{R\emptyset 14 / 15}$$

podleone usvajamo

$$\left. \begin{aligned} 0,12 \cdot A_a &= 0,12 \cdot 8,88 = 1,076 \\ 0,085 \cdot \frac{100 \cdot 16}{100} &= 1,36 \end{aligned} \right\}$$

$$R\emptyset 8 \Rightarrow e_{a,p} = \frac{100 \cdot 0,503}{1,076} = 28,32 \Rightarrow \boxed{R\emptyset 8 / 25}$$

dimenzionisanje grede POS 4

Opterećenja:

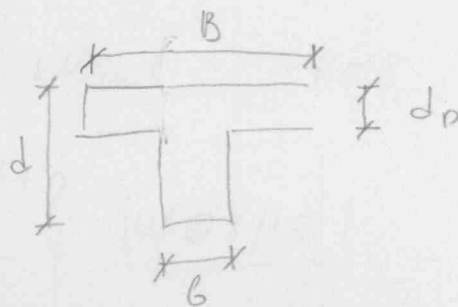
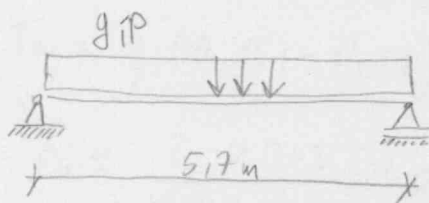
Od ploče POS 1b:  $g_{1b} = 13,5$   $P_{1b} = 7$

Od ploče POS 1a:  $g_{1a} = 13,68$   $P_{1a} = 7,09$   $[kN/m]$

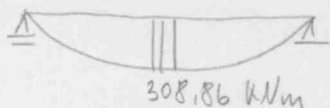
Sopstvena težina:  $g' = 25 \cdot 0,3 \cdot 0,6 = 4,5$

Konačno:  $g = g_{1b} + g_{1a} + g' = 31,68$   $kN/m$

$P = P_{1b} + P_{1a} = 14,09$   $kN/m$

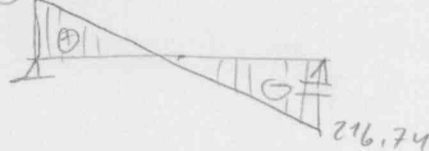


$M_u$



$M_u = 308,86$   $kNm$

$T_u$  216,74



$T_u = 216,74$   $kN$

$a_1 = 7$   $cm$

$h = 53$   $cm$

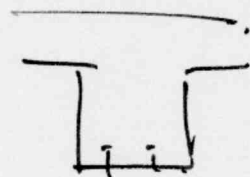
$$B = \begin{cases} b + 0,125l_0 \\ b + 20 = d_p \\ e \end{cases} = \begin{cases} 30 + 0,125 \cdot 570 \\ 30 + 20 \cdot 16 \\ 680 \end{cases} = 172,5$$

$$k = \frac{53}{\sqrt{\frac{308,86 \cdot 100}{172,5 \cdot 2,05}}} = 5,671 \Rightarrow \mu = 3,2035$$

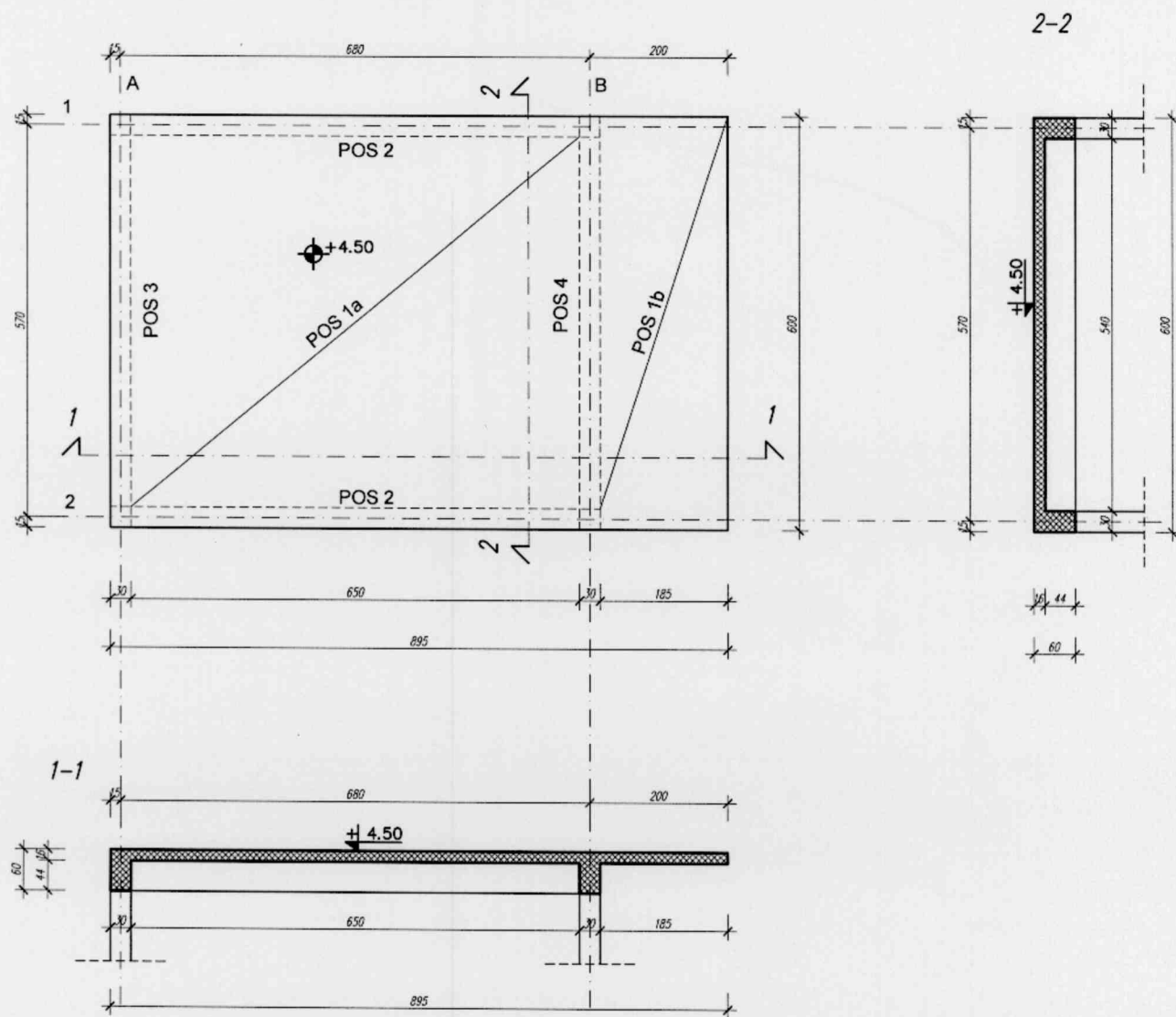
$$A_{u, potr} = 3,2035 \cdot \frac{172,5 \cdot 53}{100} \cdot \frac{2,05}{40} = 15,04$$

Ustavljamo GRØ 19 ( $A_u = 17,04$   $cm^2$ )

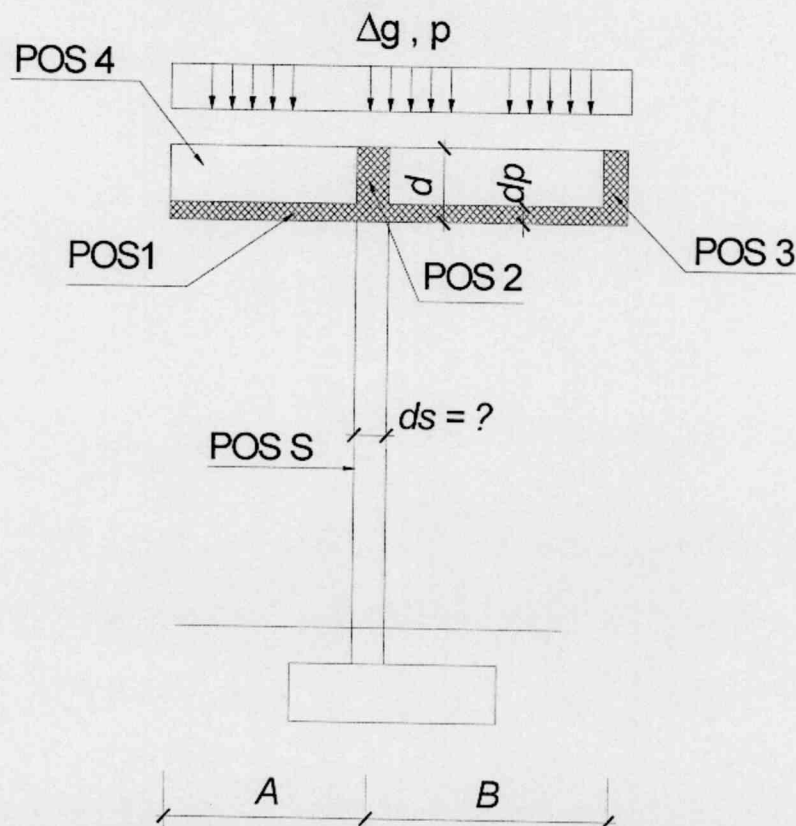
$$x = \xi \cdot h = 0,084 \cdot 53 = 4,452 < 16 \text{ kao pravougaoni}$$



Plan oplate POS 1a i POS 1b  
R= 1:100



### ZADATAK 5



Za neko srednje polje konstrukcije prikazane na skici (rastojanje ramova  $\lambda = 8.6$  m), potrebno je:

1. Dimenzionisati ploču POS 1 u karakterističnim presecima ( $d_p = 14$  cm)
2. Dimenzionisati POS 2 ( $b/d = 30/65$  cm)
3. Dimenzionisati POS 4 ( $b/d = 30/65$  cm)
4. Dimenzionisati POS S ( $ds = ?$ )
5. Nacrtati plan armature ploče POS 1

$$A = 2.4 \text{ m}$$

$$B = 3.6 \text{ m}$$

$$\Delta g = 5.0 \text{ kN/m}^2$$

$$p = 5.0 \text{ kN/m}^2$$

Kvalitet materijala:

**MB 30, RA 400/500**

u Beogradu, 8.12.2010.

asistent: Koković

Predmetni nastavnik:

overa: \_\_\_\_\_

V.prof.dr Snežana Marinković, s.r.

rok završetka zadatka: **24.12.2010.**

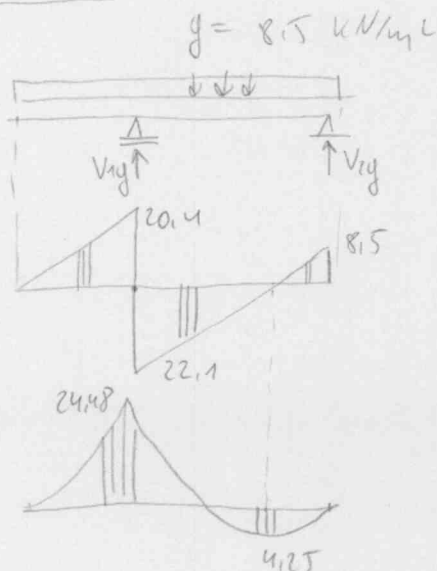
# List 5 - Zadatak 1

Greda sa prepuhom - statički sistem ploče

$$g = 0,14 \cdot 25 + 5 = 8,5 \text{ kN/m}^2$$

$$p = 5 \text{ kN/m}^2$$

Stalno



$$V_{1g} + V_{2g} - 51 = 0$$

$$-30,6 \cdot 3,6/2 + V_{1g} \cdot 3,6 - 20,4(2,4/2 + 3,6) = 0$$

$$V_{1g} = 42,5 \text{ kN/m}$$

$$V_{2g} = 8,5 \text{ kN/m}$$

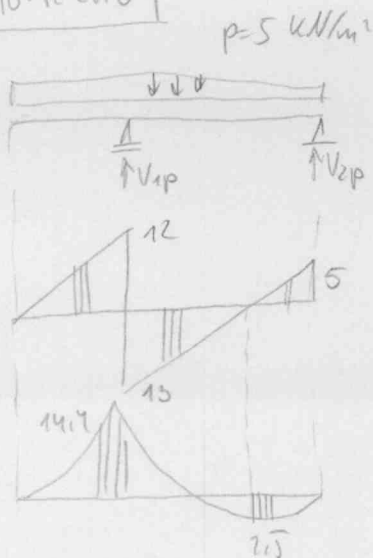
$$V_{1p} + V_{2p} = 30$$

$$-10 \cdot 3,6/2 + V_{1p} \cdot 3,6 - 12(2,4/2 + 3,6) = 0$$

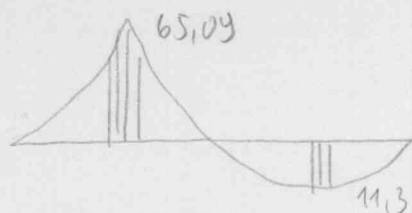
$$V_{1p} = 25 \text{ kN/m}$$

$$V_{2p} = 5 \text{ kN/m}$$

Pokretno



$$u = 1,6g + 1,8p$$



Usvajanje armature u ploči

Presek nad osloncem  $M_u = 65,09 \text{ kN/m/m}$

pretp. RØ19  $a_1 = 2,5 \text{ cm}$   $h = 14 - 2,5 = 11,5 \text{ cm}$

$$k = \frac{11,5}{\sqrt{\frac{65,09 \cdot 100}{100 \cdot 2,05}}} = 2,041 \Rightarrow \mu = 28,053$$



$$A_a = 28,053 \cdot \frac{11,5 \cdot 100}{100} \cdot \frac{2,05}{40} = 16,53 \text{ cm}^2/\text{m}$$

$$e_a = \frac{100 \cdot 2,84}{16,53} = 17,18 \text{ cm} \Rightarrow \boxed{R\emptyset 19/15} \quad (18,93 \text{ cm}^2/\text{m})$$

Podreona:  $0,2 \cdot A_a = 3,306 \text{ cm}^2 \Rightarrow \text{pretip } R\emptyset 8$

$$e_a = \frac{100 \cdot 0,503}{3,306} = 15,21 \text{ cm} \Rightarrow \boxed{R\emptyset 8/15}$$

Presek u polju  $M_u = 11,3 \text{ kNm/m}$

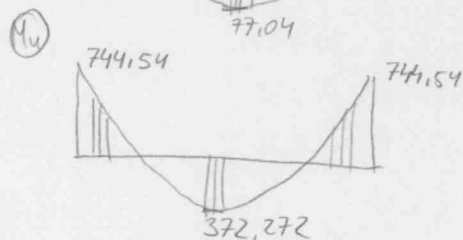
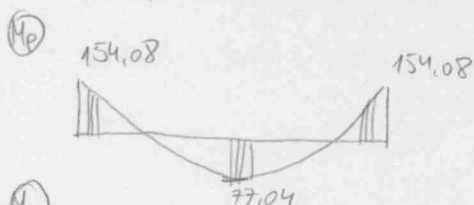
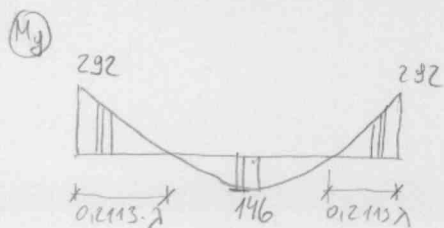
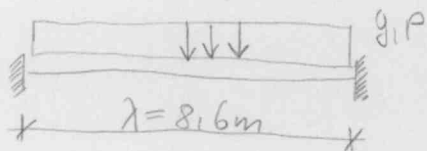
pretip  $R\emptyset 8$   $a_1 = 2 \text{ cm}$   $h = 12 \text{ cm}$

$$k = \frac{12}{\sqrt{\frac{11,3 \cdot 100}{100 \cdot 2,05}}} = 5,111 \Rightarrow \mu = 4,116$$

$$A_a = 4,116 \cdot \frac{12 \cdot 100}{100} \cdot \frac{2,05}{40} = 2,53 \text{ cm}^2$$

$$e_a = \frac{100 \cdot 0,503}{2,53} = 19,88 \Rightarrow \boxed{R\emptyset 20} \quad \text{podreona } \boxed{R\emptyset 8/30}$$

Dimenzionisanje POS 2

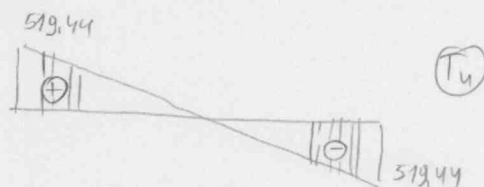
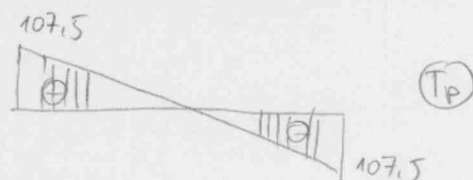
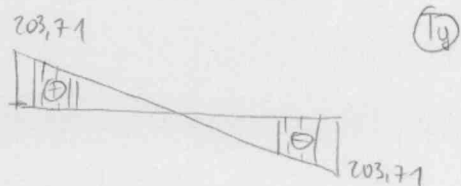


$$g' = 93 \cdot 0,65 \cdot 25 = 4,875$$

od POS 1  $V_{g1} = 42,5 \text{ kN/m}$

$$g = 47,375 \text{ kN/m}$$

$$p = 25 \text{ kN/m}$$



Oslonac  $M_{u0} = 744,54 \text{ kNm}$   $a_2 = 9 \text{ cm}$   $h = 65 - 9 = 56 \text{ cm}$

$$k = \frac{56}{\sqrt{\frac{744,54 \cdot 100}{154,14 \cdot 2,05}}} = 3,648 \Rightarrow \mu = 7,903$$

$$B = \begin{cases} 30 + 0,25 (8,6 - 2 \cdot 0,2113 \cdot 8,6) \cdot 100 \\ 30 + 20 \cdot 14 \end{cases} = 154,14$$

$$A_a = 7,903 \cdot \frac{56 \cdot 154,14}{100} \cdot \frac{2,05}{40} = 34,96 \text{ cm}^2$$

Usvaja se  $[8R\emptyset 25] (39,28 \text{ cm}^2)$

Polje  $M_{up} = 372,272 \text{ kNm}$   $a_1 = 7 \text{ cm}$   $h = 58 \text{ cm}$

$$k = \frac{58}{\sqrt{\frac{372,27 \cdot 100}{30 \cdot 2,05}}} = 2,357 \Rightarrow \mu = 20,100$$

$$\Delta A = \frac{T_u}{2\sigma_v} = 6,48 \text{ cm}^2$$

$$A_a = 20,100 \cdot \frac{58 \cdot 30}{100} \cdot \frac{2,05}{40} = 17,92 \text{ cm}^2$$

$[2R\emptyset 25]$

Usvajamo  $5R\emptyset 22 (19 \text{ cm}^2)$

Uzengije  $T_r = 1,1 \text{ MPa} = 0,11 \text{ kN/cm}^2$

$$T_n = \frac{T_u}{0,9 \cdot b \cdot h} = \frac{519,44}{0,9 \cdot 30 \cdot 56} = 0,3435 \text{ kN/cm}^2$$

$$e_u \leq \frac{4 \cdot 0,785}{30 \cdot 0,3435} \cdot 40 = 12,19 \text{ cm} \Rightarrow [RU\emptyset 10/10]$$

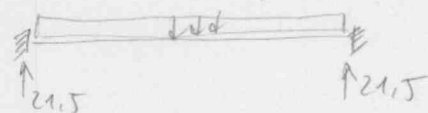
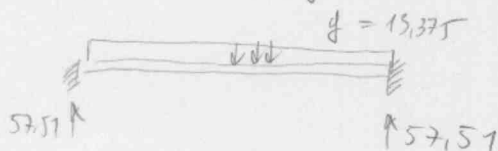
Analiza opterećenja za POS 3

$$g' = 0,13 \cdot 0,65 \cdot 25 = 4,875 \text{ kN/m}$$

od ploče  $V_{zy} = 8,5 \text{ kN/m}$

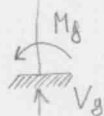
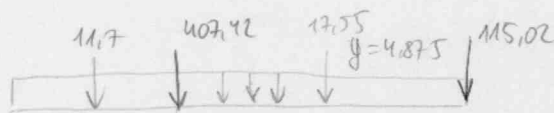
$$g = 13,375 \text{ kN/m}$$

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

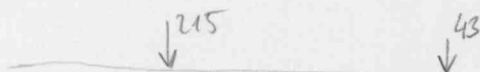


# POS 4 Dimenzionisanje grede

Q



P



Stalno:

Sopstvena težina  $g' = 4,875$

od POS 3:  $R_g = 2 \cdot 57,51 = 115,02 \text{ kN}$

od POS 2:  $R_g = 2 \cdot 203,71 = 407,42$

Korisno

od POS 3:  $R_p = 2 \cdot 21,5 = 43 \text{ kN}$

od POS 2:  $R_p = 2 \cdot 107,5 = 215 \text{ kN}$

Reakcije oslonaca.

$$V_g = 531,69 \text{ kN}$$

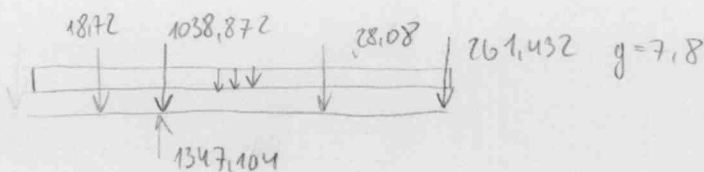
$$M_g = 431,622 \text{ kNm}$$

$$V_p = 258 \text{ kN}$$

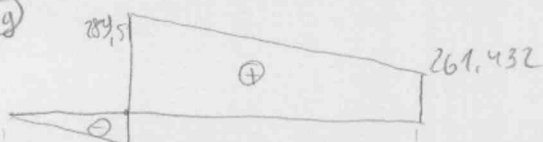
$$M_p = 154,8 \text{ kNm}$$

$$V_u = 1,6 \cdot 531,69 + 1,8 \cdot 258 = 1347,104 \text{ kN}$$

$$M_u = 969,24 \text{ kNm}$$



Tg



Mg



$$B = \begin{cases} 30 + 0,25 \cdot 600 \\ 30 + 20 \cdot 14 \end{cases} = 180 \text{ cm}$$

$$a_1 = 9 \text{ cm}$$

$$h = 56 \text{ cm}$$

$$k = \frac{56}{\sqrt{\frac{991,7 \cdot 100}{180 \cdot 2,05}}} = 3,416 \Rightarrow \mu = 9,231$$

$$A_a = 9,231 \cdot \frac{180 \cdot 56}{100} \cdot \frac{2,05}{40} = 47,69 \text{ cm}^2$$

Uznap se 8RØ28 (49,28 cm²)

$$T_u = 289,5 \text{ kN} \Rightarrow T_r = \frac{289,5}{0,9 \cdot 50 \cdot 56} = 0,191 \text{ kN/cm}^2$$

$$0,191 < 3,3$$

$$\lambda = \frac{L}{2} \left( 1 - \frac{T_r}{T_u} \right) = \frac{3,6}{2} \left( 1 - \frac{1,1}{1,91} \right) = 0,763 \quad \lambda = 0,8 \text{ m}$$

$$T_m = \frac{3}{2} (T_u - T_r) = \frac{3}{2} (0,191 - 0,11) = 0,1215$$

$$m = 2 \quad \text{UR } \emptyset 10 \Rightarrow c_u = \frac{2 \cdot 0,785}{0,1215 \cdot 50} \cdot 40 = 17,23 \quad \boxed{\text{UR } \emptyset 10/15}$$

Dimensioniranje stuba POS S

pretp. dilatacije  $\epsilon_a = 3\%$   $\epsilon_b = 3,5\%$   $k = 1,714$

iterativno dobijeno

$$\mu = 43,590$$

$$M_u = 969,24 \text{ kNm} \quad N_u = 1347,1 \text{ kN}$$

$$\left. \begin{aligned} M_{au} &= M_u + N_u \left( \frac{d}{2} - a_1 \right) \quad a_1 = 9 \text{ cm} \\ h &= k \cdot \sqrt{\frac{M_{au}}{b \cdot f_b}} \end{aligned} \right\} \Rightarrow \begin{aligned} M_{au} &= 1475,80 \text{ kNm} \\ d &= 95 \text{ cm} \\ h &= 85 \text{ cm} \\ a_1 &= 10 \text{ cm} \end{aligned}$$

$$A_{a1} = 43,590 \cdot \frac{85 \cdot 50}{100} \cdot \frac{2,05}{40} - \frac{1347,1}{40} = 23,96 \text{ cm}^2$$

Usvojeno  $5R\emptyset 25 (24,55 \text{ cm}^2)$