

# BETONSKE KONSTRUKCIJE 1

HVE PŽA

**Vežba br.3**

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***Semestar: V***

***ESPБ: 6***

## Primer 1.

Odrediti potrebnu površinu armature za stub poznatih dimenzija, pravougaonog poprečnog preseka, opterećen momentima savijanja usled stalnog ( $M_g$ ) i povremenog ( $M_w$ ) opterećenja vetrom. Podaci za proračun:

$$M_g = 100 \text{ kNm}$$

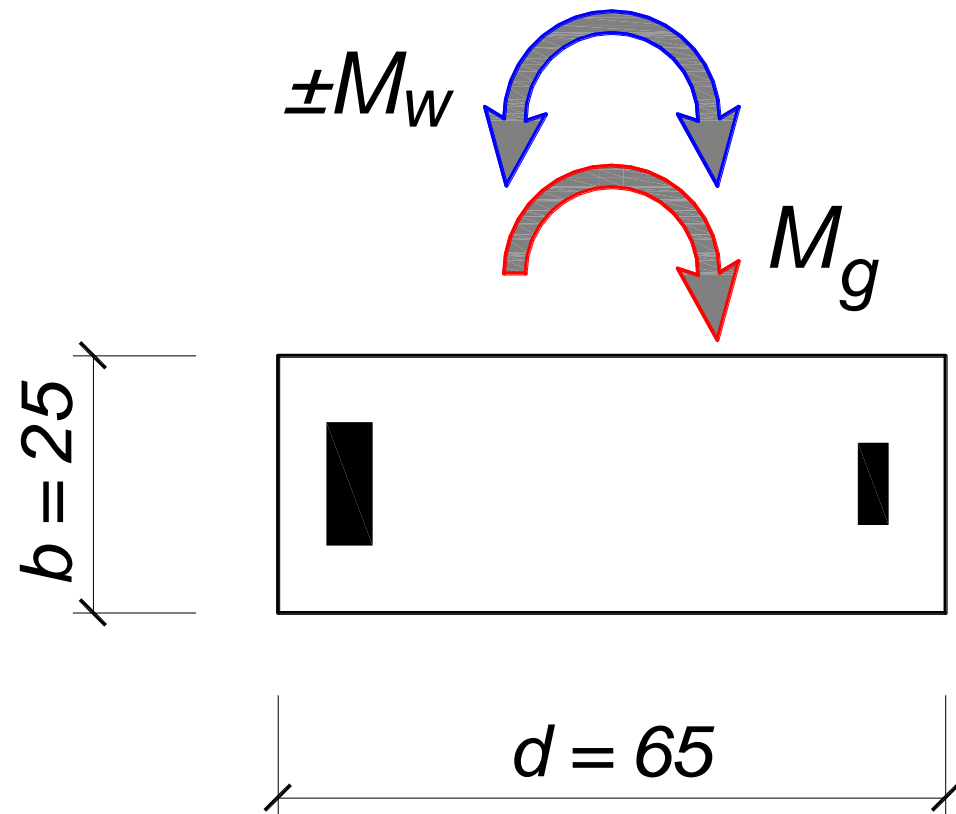
$$M_w = \pm 200 \text{ kNm}$$

$$b = 25 \text{ cm}$$

$$d = 65 \text{ cm}$$

MB 30

RA 400/500



## a. zategnuta spoljašnja ivica stuba

$$M_u = 1.6 \times 100 + 1.8 \times 200 = 520 \text{ kNm}$$

$$\text{pretp. } a_1 = 7 \text{ cm}$$

$$h = 65 - 7 = 58 \text{ cm}$$

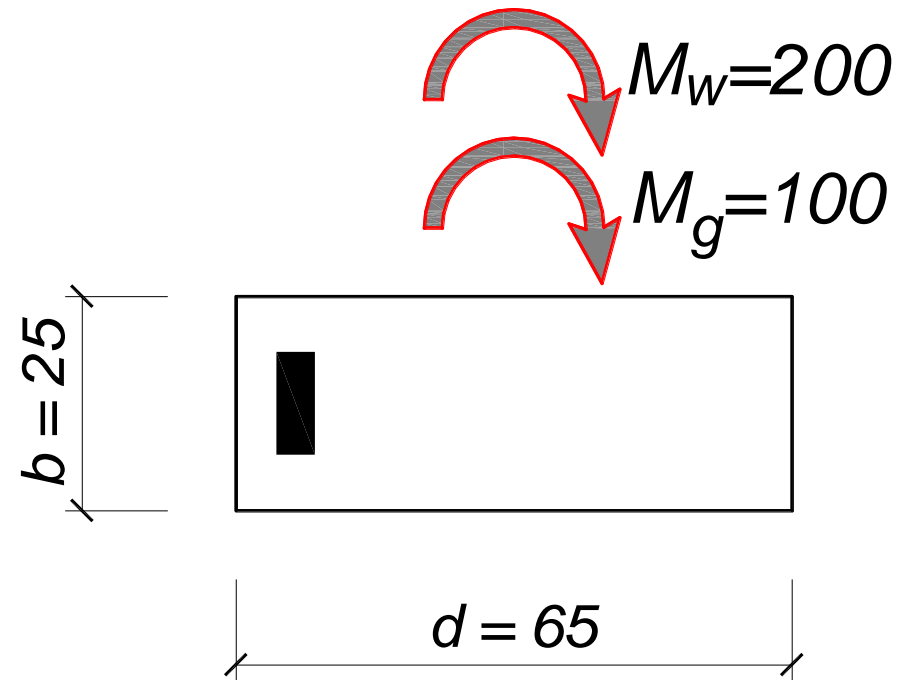
$$MB 30 \Rightarrow f_B = 20.5 \text{ MPa}$$

$$k = \frac{58}{\sqrt{\frac{520 \times 10^2}{25 \times 2.05}}} = 1.821$$

$$\varepsilon_b / \varepsilon_a = 3.5 / 4.10\% \Rightarrow \bar{\mu} = 37.281\%$$

$$A_a = 37.281 \times \frac{25 \times 58}{100} \times \frac{2.05}{40} = 27.70 \text{ cm}^2$$

usvojeno: **6RØ25** (29.45 cm<sup>2</sup>)



## **b. zategnuta unutrašnja ivica stuba**

$$M_u = 1.0 \times (-100) + 1.8 \times 200 = 260 \text{ kNm}$$

$$\text{pretp. } a_1 = 5 \text{ cm}$$

$$h = 65 - 5 = 60 \text{ cm}$$

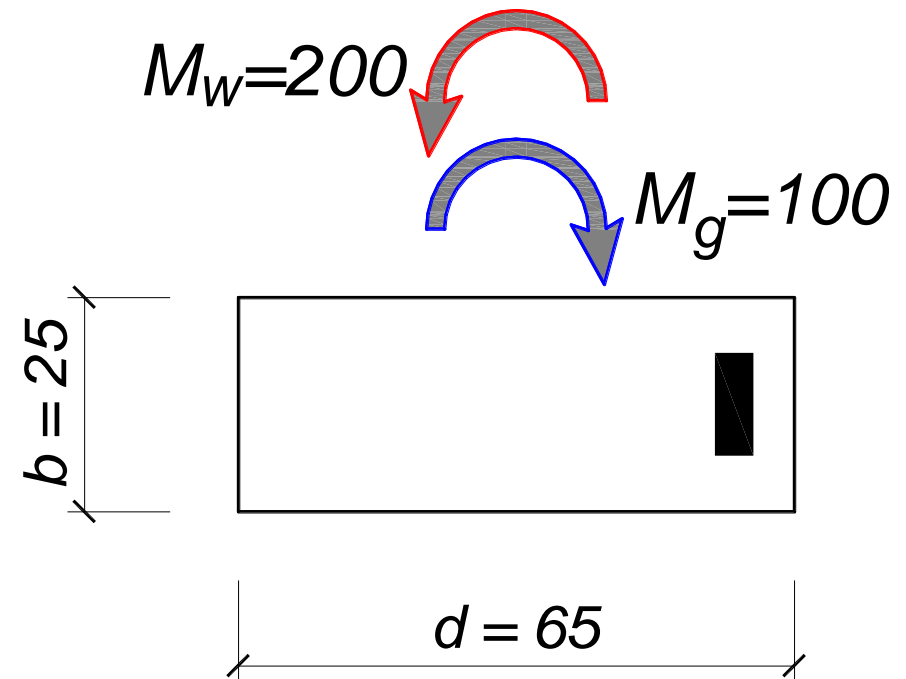
$$MB \ 30 \Rightarrow f_B = 20.5 \text{ MPa}$$

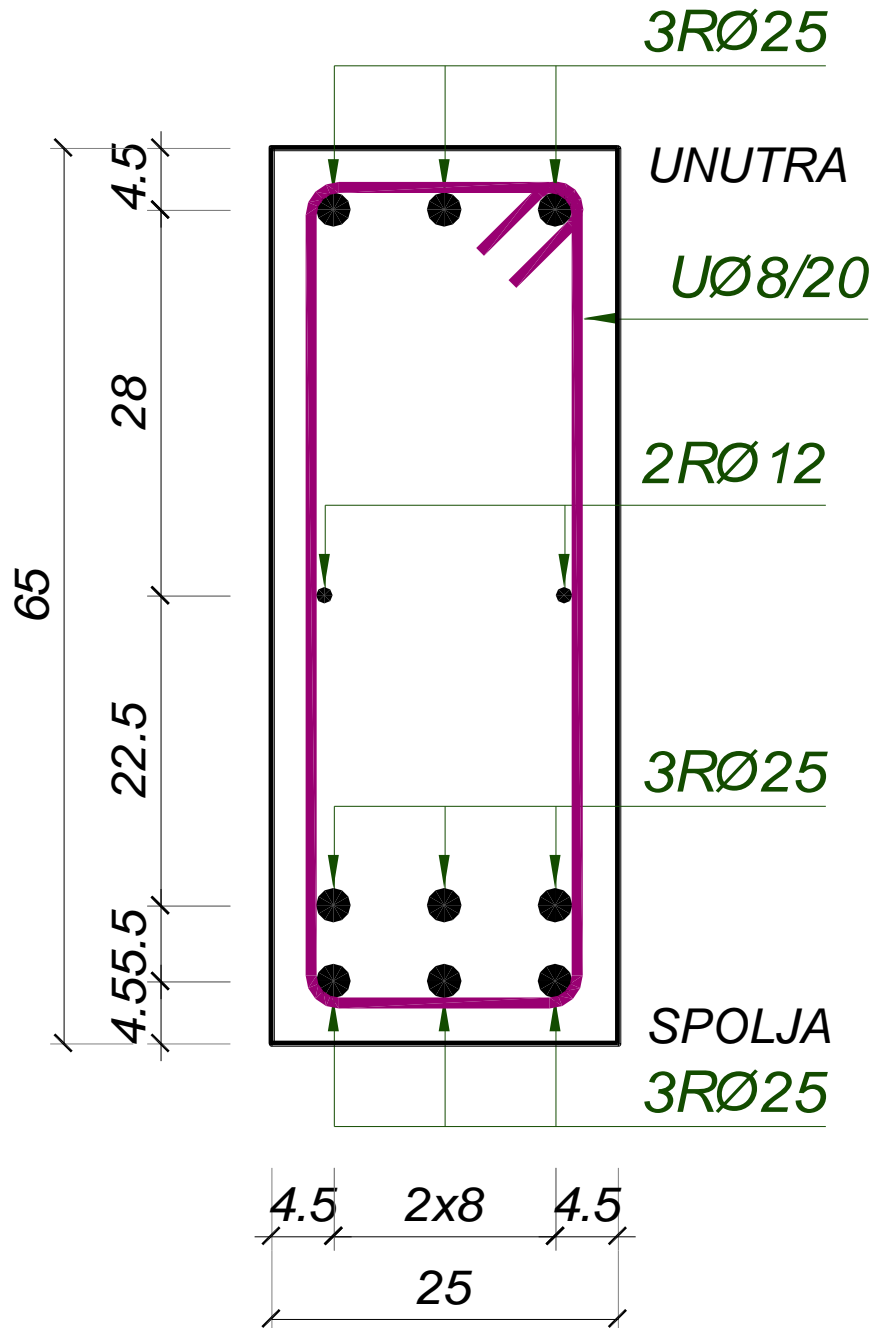
$$k = \frac{60}{\sqrt{\frac{260 \times 10^2}{25 \times 2.05}}} = 2.664$$

$$\varepsilon_b / \varepsilon_a = 2.6 / 10\text{‰} \Rightarrow \bar{\mu} = 15.344\%$$

$$A_a = 15.344 \times \frac{25 \times 60}{100} \times \frac{2.05}{40} = 11.80 \text{ cm}^2$$

*usvojeno:*                      **3RØ25** (14.73 cm<sup>2</sup>)





$$a' = 2.5 + 0.8 + 2.5/2 = 4.55 \text{ cm}$$

$$\text{usv. } a' = 4.5 \text{ cm}$$

$$a'' = 4.5 + 3.0 + 2.5 = 10 \text{ cm}$$

$$a_1 = (4.5 + 10)/2 = 7.25 \text{ cm}$$

$$a_2 = 4.5 \text{ cm}$$

$$h = 65 - 7.25 = 57.75 \text{ cm}$$

$$h \approx 58 \text{ cm} = h_{\text{rač.}}$$

## Primer 2.

Odrediti potrebnu površinu armature za stub poznatih dimenzija, pravougaonog poprečnog preseka, opterećen zadatim uticajima. Podaci za proračun:

$$M_g = 100 \text{ kNm}$$

$$N_g = 500 \text{ kN}$$

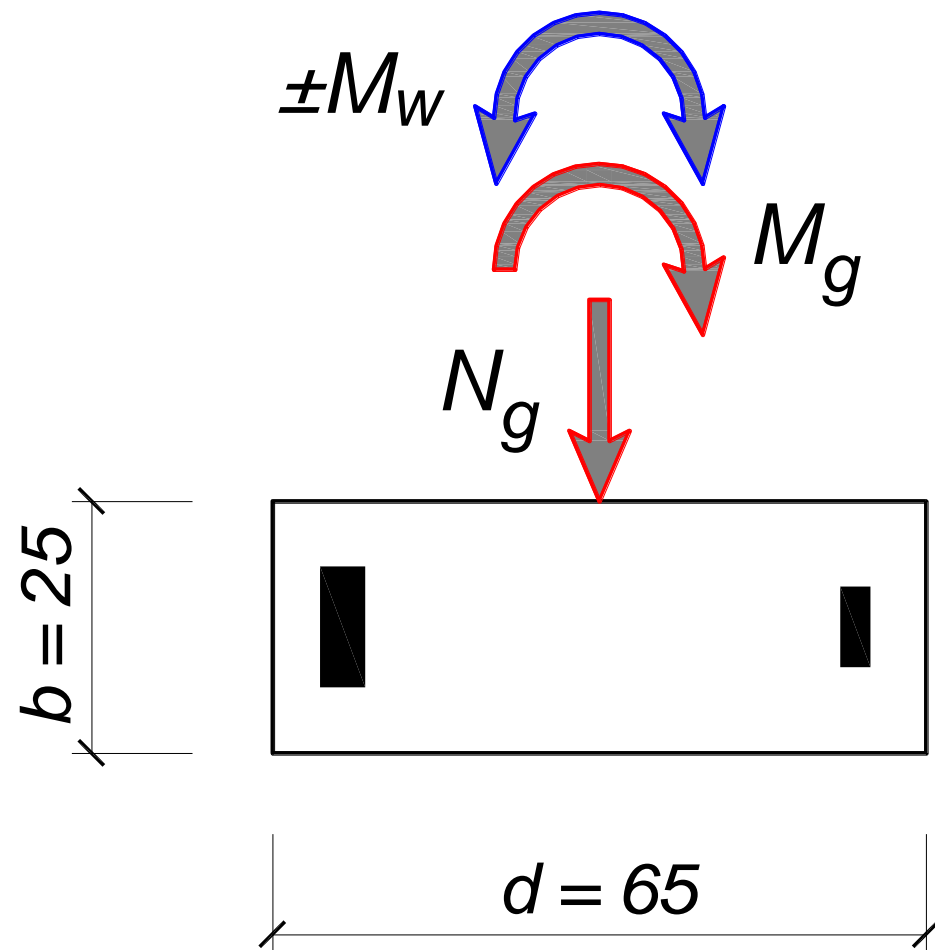
$$M_w = \pm 200 \text{ kNm}$$

$$b = 25 \text{ cm}$$

$$d = 65 \text{ cm}$$

MB 30

RA 400/500



### a. zategnuta spoljašnja ivica stuba

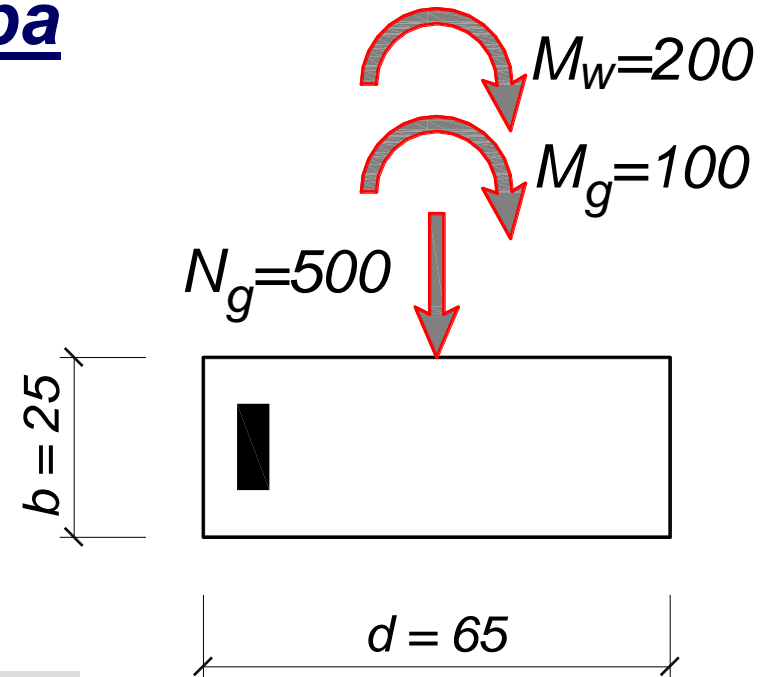
$$M_u = 1.6 \times 100 + 1.8 \times 200 = 520 \text{ kNm}$$

$$N_u = 1.6 \times 500 = 800 \text{ kN}$$

$$\text{pretp. } a_1 = 7 \text{ cm}$$

$$h = 65 - 7 = 58 \text{ cm}$$

$$MB \ 30 \Rightarrow f_B = 20.5 \text{ MPa}$$



$$M_{au} = 520 + 800 \times \left( \frac{0.65}{2} - 0.07 \right) = 724 \text{ kNm}$$

$$k = \frac{58}{\sqrt{\frac{724 \times 10^2}{25 \times 2.05}}} = 1.543 \Rightarrow \varepsilon_a < 3\text{‰}$$

**Kako je  $\varepsilon_{a1} < 3\text{‰}$ , presek se **DVOSTRUKO ARMIRA.****

**usvojeno  $\varepsilon_{a1}^* = 3\text{‰} \Rightarrow k^* = 1.719, \mu_{1M}^* = 43.590\%$**

$$M_{abu} = \left( \frac{58}{1.719} \right)^2 \times 25 \times 2.05 \times 10^{-2} = 583.2 \text{ kNm}$$

$$\Delta M_{au} = 724 - 583.2 = 140.8 \text{ kNm}$$

$$\text{pretp. } a_2 = 5 \text{ cm} \Rightarrow A_{a2} = \frac{140.8 \times 10^2}{(68 - 5) \times 40} = 6.64 \text{ cm}^2$$

$$A_{a1} = 43.590 \times \frac{25 \times 58}{100} \times \frac{2.05}{40} - \frac{800}{40} + 6.64 = 19.03 \text{ cm}^2$$



## **b. zategnuta unutrašnja ivica stuba**

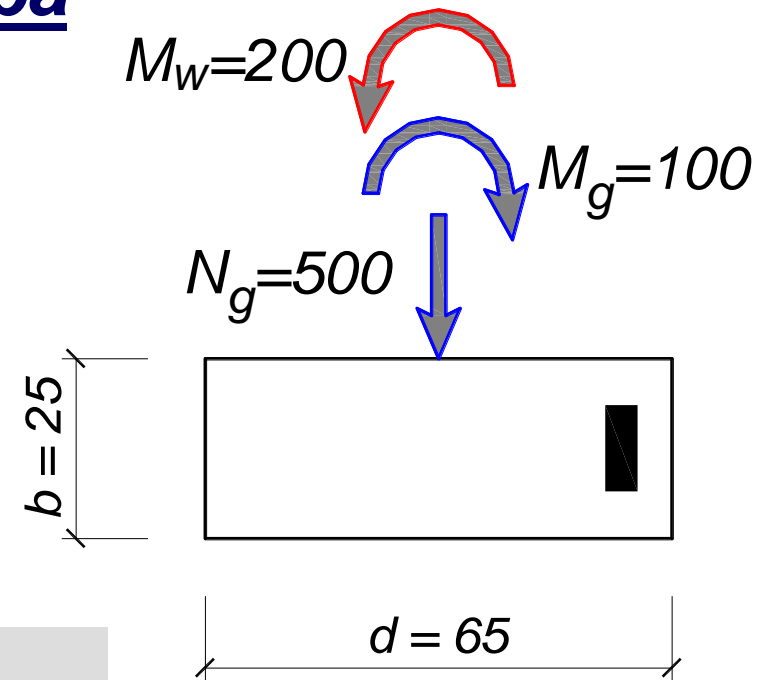
$$M_u = 1.0 \times (-100) + 1.8 \times 200 = 260 \text{ kNm}$$

$$N_u = 1.0 \times 500 = 500 \text{ kN}$$

$$\text{pretp. } a_1 = 5 \text{ cm}$$

$$h = 65 - 5 = 60 \text{ cm}$$

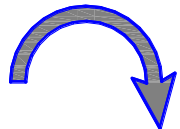
$$MB \ 30 \Rightarrow f_B = 20.5 \text{ MPa}$$



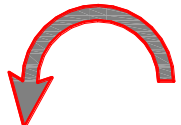
$$M_{au} = 260 + 500 \times \left( \frac{0.65}{2} - 0.05 \right) = 397.5 \text{ kNm}$$

$$k = \frac{60}{\sqrt{\frac{397.5 \times 10^2}{25 \times 2.05}}} = 2.154 \Rightarrow \frac{\varepsilon_b}{\varepsilon_a} = 3.5 / 8.0\% \\ \mu = 24.638\%$$

$$A_{a1} = 24.638 \times \frac{25 \times 60}{100} \times \frac{2.05}{40} - \frac{500}{40} = 6.44 \text{ cm}^2$$

19.03  6.64



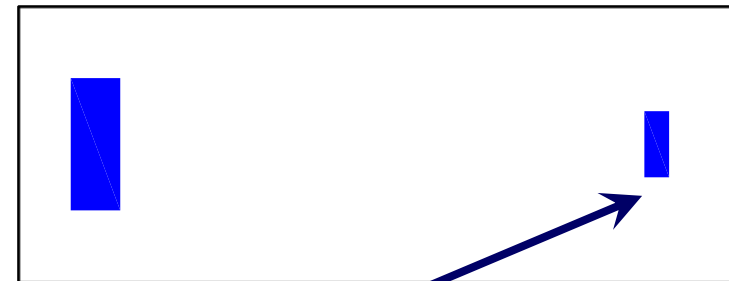
 6.44



**POTREBNO:**

19.03

6.64

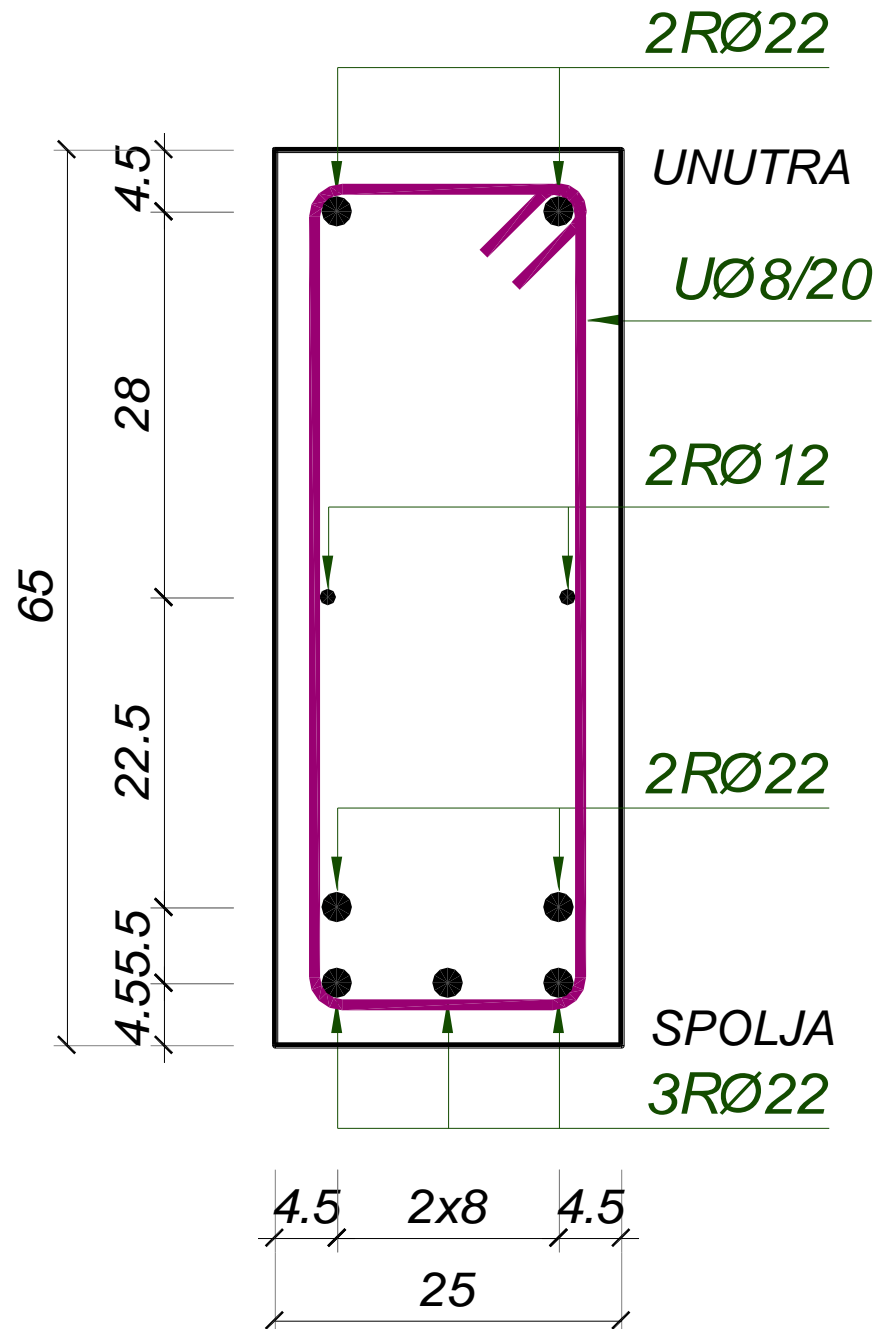


$$\text{unutra : } A_{a,potr.} = \max. \left\{ \begin{array}{l} 6.64 \\ 6.44 \end{array} \right\} = 6.64 \text{ cm}^2$$

*usvojeno: 2RØ22 (7.60 cm<sup>2</sup>)*

$$\text{spolja : } A_{a,potr.} = 19.03 \text{ cm}^2$$

*usvojeno: 5RØ22 (19.01 cm<sup>2</sup>)*



$$a' = 2.5 + 0.8 + 2.2/2 = 4.4 \text{ cm}$$

usv.  $a' = 4.5 \text{ cm}$

$$a'' = 4.5 + 3.0 + 2.2 = 9.7 \text{ cm}$$

usv.  $a'' = 10 \text{ cm}$

$$a_1 = (3 \times 4.5 + 2 \times 10) / 5 = 6.7 \text{ cm}$$

$$a_2 = 4.5 \text{ cm}$$

$$h = 65 - 6.7 = 58.3 \text{ cm} > h_{rač.}$$

### Primer 3.

Dimenzionisati stub poznatih dimenzija, pravougaonog poprečnog preseka, opterećen zadatim uticajima.

Opterećenja **p** i **w** su povremena i NE MORAJU delovati istovremeno. Podaci za proračun:

$$M_g = 100 \text{ kNm}$$

$$N_p = 500 \text{ kN}$$

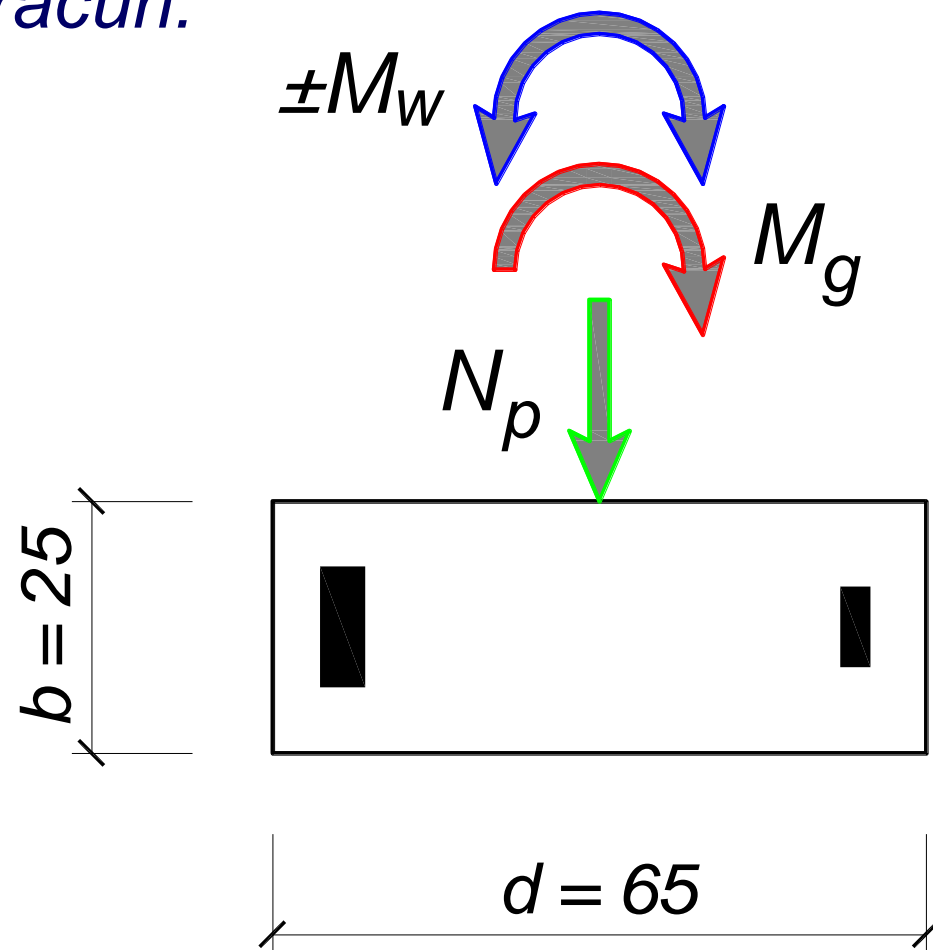
$$M_w = \pm 200 \text{ kNm}$$

$$b = 25 \text{ cm}$$

$$d = 65 \text{ cm}$$

MB 30

RA 400/500



## a. zategnuta spoljašnja ivica stuba

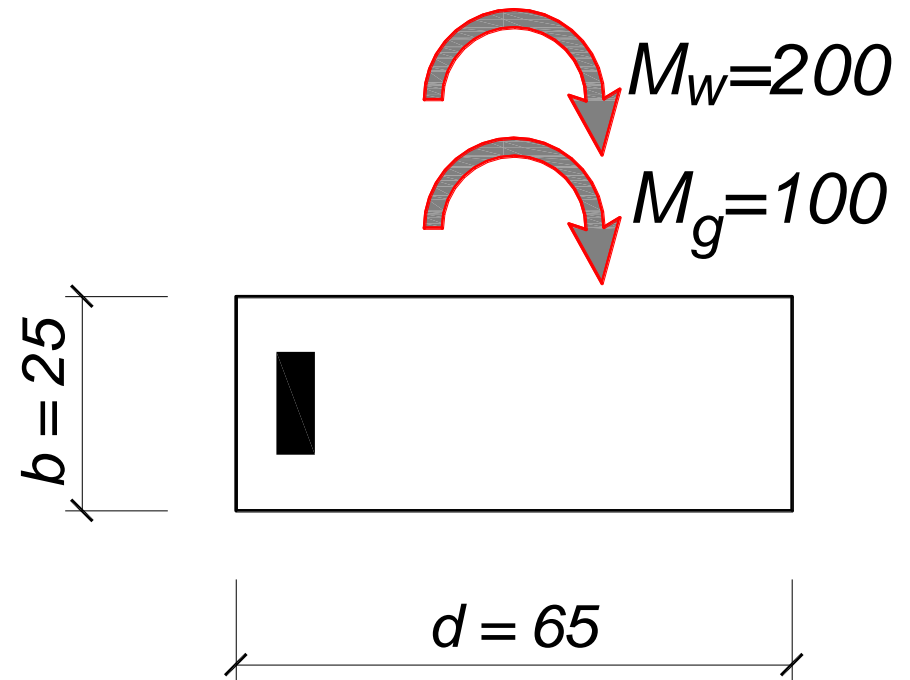
### a.1 MINIMALNA sila pritiska

$$M_u = 1.6 \times 100 + 1.8 \times 200 = 520 \text{ kNm}$$

$$N_u = 0$$

$$\text{pretp. } a_1 = 7 \text{ cm} \Rightarrow h = 65 - 7 = 58 \text{ cm}$$

$$MB \ 30 \Rightarrow f_B = 20.5 \text{ MPa}$$



$$k = \frac{58}{\sqrt{\frac{520 \times 10^2}{25 \times 2.05}}} = 1.821$$

$$\varepsilon_b / \varepsilon_a = 3.5 / 4.10\% \Rightarrow \bar{\mu} = 37.281\%$$

$$A_a = 37.281 \times \frac{25 \times 58}{100} \times \frac{2.05}{40} = 27.70 \text{ cm}^2$$

## a. zategnuta spoljašnja ivica stuba

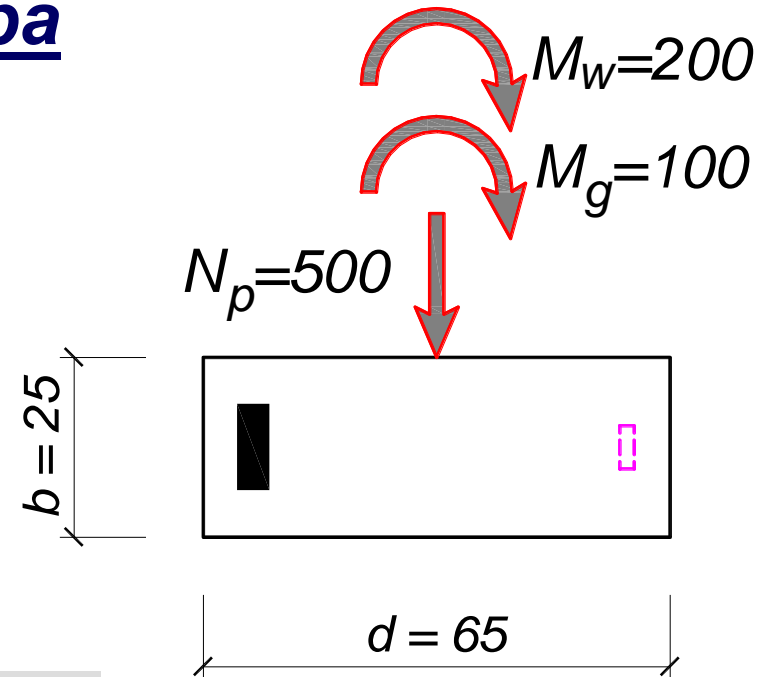
### a.2 MAKSIMALNA sila pritiska

$$M_u = 1.6 \times 100 + 1.8 \times 200 = 520 \text{ kNm}$$

$$N_u = 1.8 \times 500 = 900 \text{ kN}$$

$$\text{pretp. } a_1 = 7 \text{ cm} \Rightarrow h = 65 - 7 = 58 \text{ cm}$$

$$\text{MB 30} \Rightarrow f_B = 20.5 \text{ MPa}$$



$$M_{au} = 520 + 900 \times \left( \frac{0.65}{2} - 0.07 \right) = 749.5 \text{ kNm}$$

$$k = \frac{58}{\sqrt{\frac{749.5 \times 10^2}{25 \times 2.05}}} = 1.517 \Rightarrow \varepsilon_a < 3\text{‰}$$

**Kako je  $\varepsilon_{a1} < 3\text{‰}$ , presek se **DVOSTRUKO** ARMIRA.**

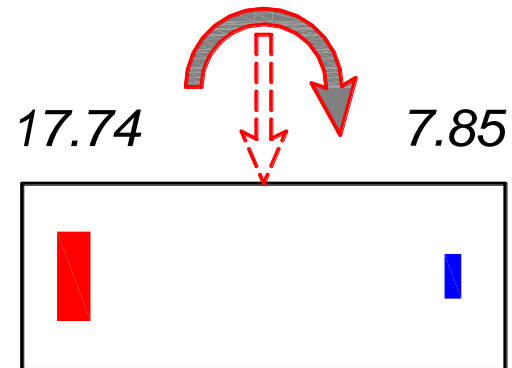
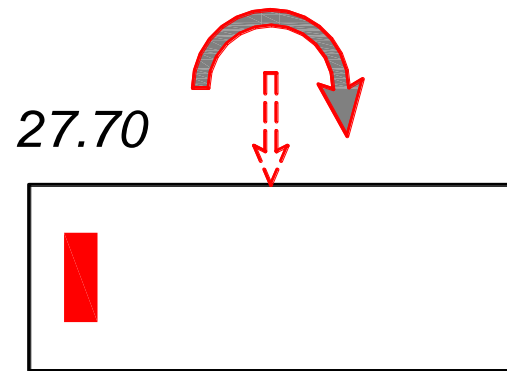
**usvojeno  $\varepsilon_{a1}^* = 3\text{‰} \Rightarrow k^* = 1.719, \mu_{1M}^* = 43.590\%$**

$$M_{abu} = \left( \frac{58}{1.719} \right)^2 \times 25 \times 2.05 \times 10^{-2} = 583.2 \text{ kNm}$$

$$\Delta M_{au} = 749.5 - 583.2 = 166.3 \text{ kNm}$$

$$\text{pretp. } a_2 = 5 \text{ cm} \Rightarrow A_{a2} = \frac{166.3 \times 10^2}{(68 - 5) \times 40} = 7.85 \text{ cm}^2$$

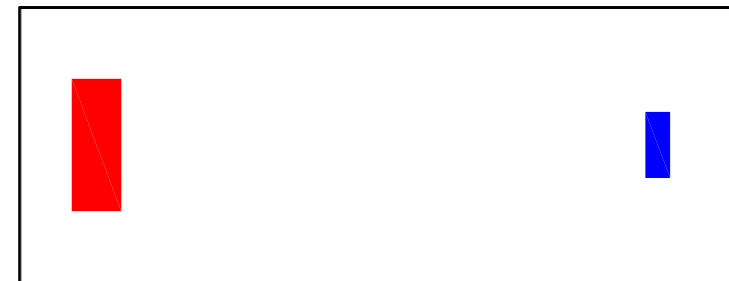
$$A_{a1} = 43.590 \times \frac{25 \times 58}{100} \times \frac{2.05}{40} - \frac{900}{40} + 7.85 = 17.74 \text{ cm}^2$$



*POTREBNO:*

27.70

7.85



$$\textit{spolja} : A_{a,potr.} = \max \left\{ \begin{array}{l} 27.70 \\ 17.74 \end{array} \right\} = 27.70 \text{ cm}^2$$

$$\textit{unutra} : A_{a,potr.} = \max \left\{ \begin{array}{l} 0 \\ 7.85 \end{array} \right\} = 7.85 \text{ cm}^2$$



## **b. zategnuta unutrašnja ivica stuba**

### **b.1 MINIMALNA sila pritiska**

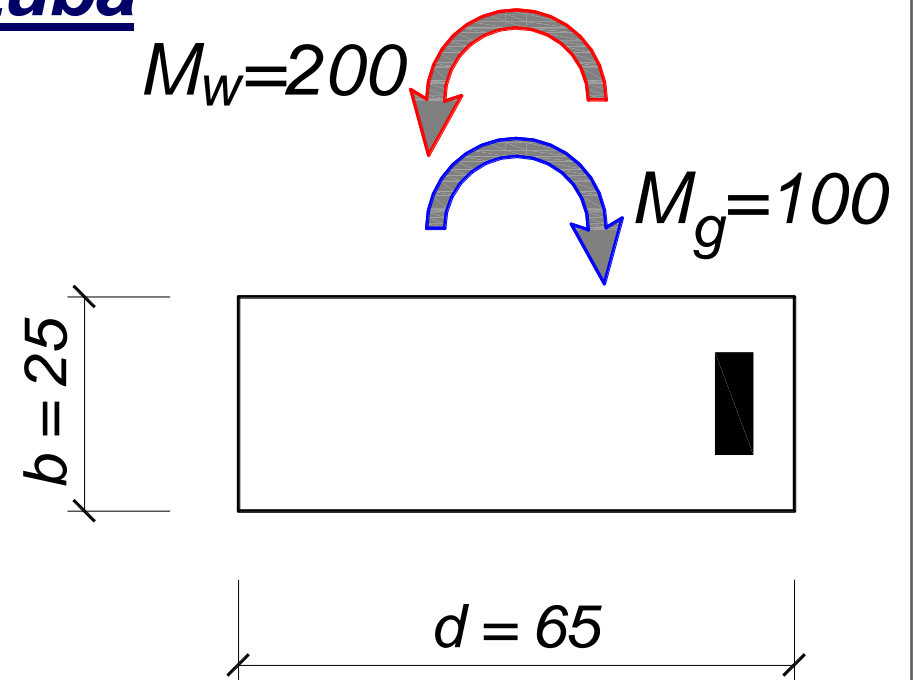
$$M_u = 1.0 \times (-100) + 1.8 \times 200 = 260 \text{ kNm}$$

$$N_u = 0$$

(videti primer 1b)

pretp.  $a_1 = 5 \text{ cm} \Rightarrow h = 65 - 5 = 60 \text{ cm}$

MB 30  $\Rightarrow f_B = 20.5 \text{ MPa}$



$$k = \frac{60}{\sqrt{\frac{260 \times 10^2}{25 \times 2.05}}} = 2.664 \Rightarrow \frac{\varepsilon_b}{\mu} = 2.6 / 10\text{‰}$$

$$\mu = 15.344\%$$

$$A_a = 15.344 \times \frac{25 \times 60}{100} \times \frac{2.05}{40} = 11.80 \text{ cm}^2$$

## b. zategnuta unutrašnja ivica stuba

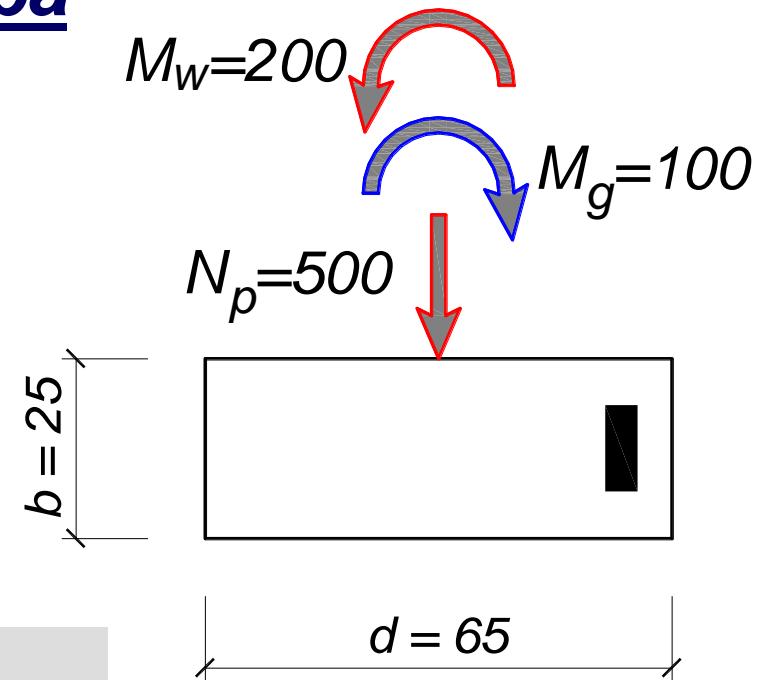
### b.2 MAKSIMALNA sila pritiska

$$M_u = 1.0 \times (-100) + 1.8 \times 200 = 260 \text{ kNm}$$

$$N_u = 1.8 \times 500 = 900 \text{ kN}$$

$$\text{pretp. } a_1 = 5 \text{ cm} \Rightarrow h = 65 - 5 = 60 \text{ cm}$$

$$\text{MB 30} \Rightarrow f_B = 20.5 \text{ MPa}$$

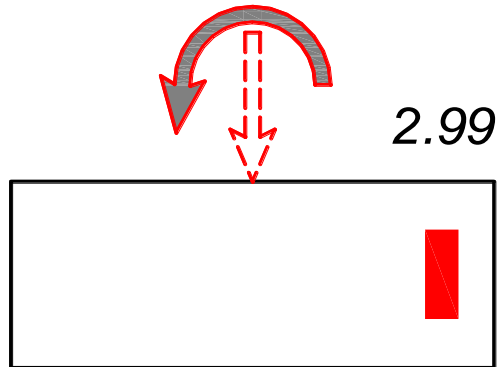
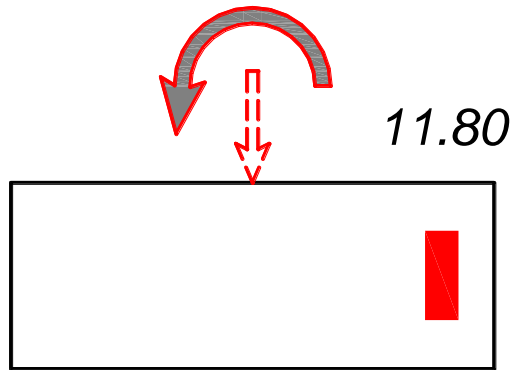


$$M_{au} = 260 + 900 \times \left( \frac{0.65}{2} - 0.05 \right) = 507.5 \text{ kNm}$$

$$k = \frac{60}{\sqrt{\frac{507.5 \times 10^2}{25 \times 2.05}}} = 1.907 \Rightarrow \frac{\varepsilon_b}{\varepsilon_a} = 3.5 / 5.05\%$$

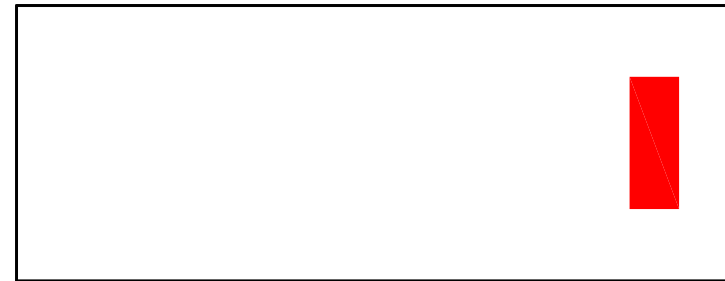
$$\mu = 33.138\%$$

$$A_{a1} = 33.138 \times \frac{25 \times 60}{100} \times \frac{2.05}{40} - \frac{900}{40} = 2.99 \text{ cm}^2$$



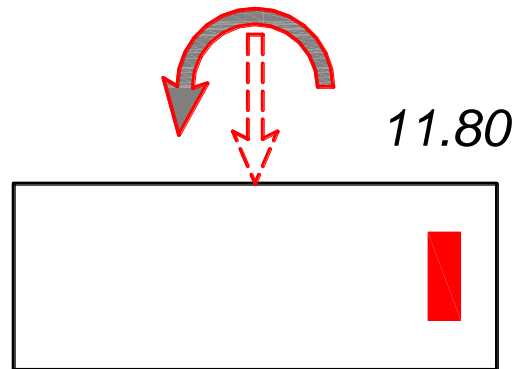
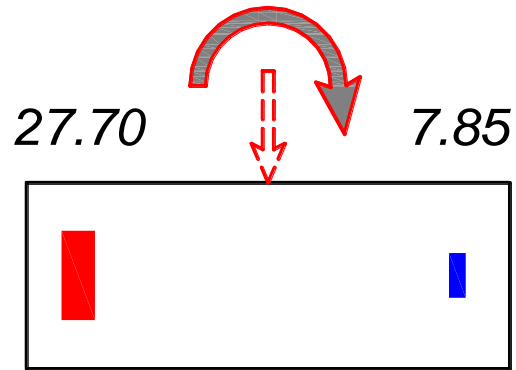
*POTREBNO:*

11.80



*spolja* :  $A_{a,potr.} = 0$

*unutra* :  $A_{a,potr.} = \max \left\{ \begin{matrix} 11.80 \\ 2.99 \end{matrix} \right\} = 11.80 \text{ cm}^2$



**POTREBNO:**

27.70                      11.80

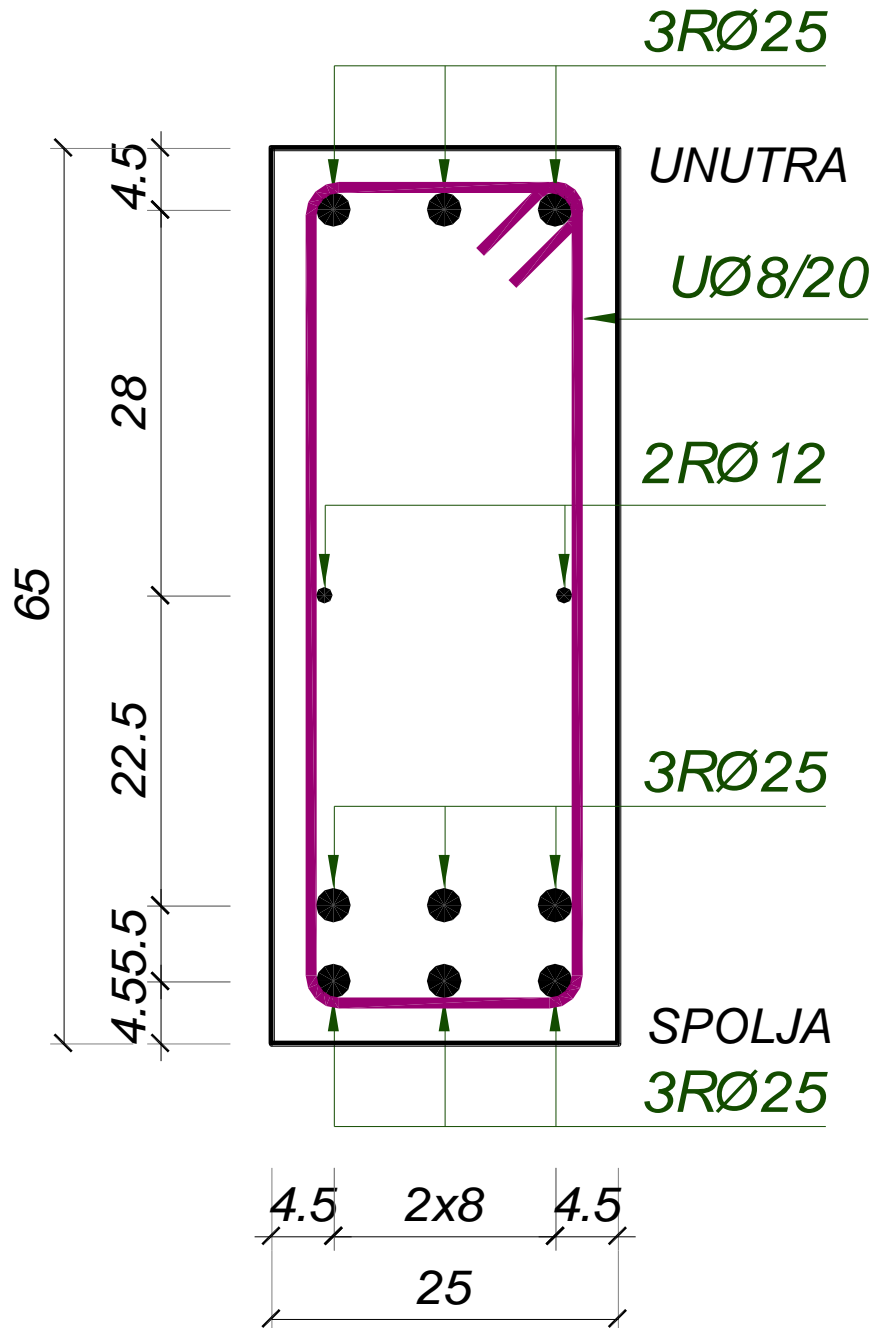


$$\text{spolja : } A_{a,\text{potr.}} = \max \left\{ \begin{array}{l} 27.70 \\ 0 \end{array} \right\} = 27.70 \text{ cm}^2$$

**6RØ25 (29.45 cm<sup>2</sup>)**

$$\text{unutra : } A_{a,\text{potr.}} = \max \left\{ \begin{array}{l} 7.85 \\ 11.80 \end{array} \right\} = 11.80 \text{ cm}^2$$

**3RØ25 (14.73 cm<sup>2</sup>)**



$$a' = 2.5 + 0.8 + 2.5/2 = 4.55 \text{ cm}$$

$$\text{usv. } a' = 4.5 \text{ cm}$$

$$a'' = 4.5 + 3.0 + 2.5 = 10 \text{ cm}$$

$$a_1 = (4.5 + 10)/2 = 7.25 \text{ cm}$$

$$a_2 = 4.5 \text{ cm}$$

$$h = 65 - 7.25 = 57.75 \text{ cm}$$

$$h \approx 58 \text{ cm} = h_{\text{rač.}}$$