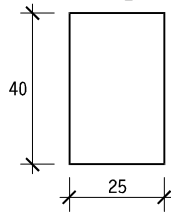


**Primer 6**

Za zadati presek i podatke odrediti potrebnu količinu armature.



$b = 25 \text{ cm}$        $M_g = 30 \text{ kNm}$       **MB 35**  
 $d = 40 \text{ cm}$        $M_p = 15 \text{ kNm}$       **RA 400/500**  
 $a_0 = 2 \text{ cm}$   
**uzengije uØ8/20**

**Rešenje**

$$MB 35 \quad \rightarrow f_B = 23 \text{ MPa}$$

$$RA 400/500 \quad \rightarrow \sigma_V = 400 \text{ MPa}$$

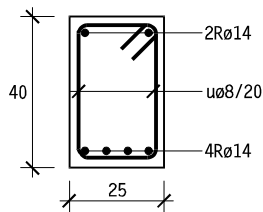
$$M_u = 1.6 \cdot M_g + 1.8 \cdot M_p = 1.6 \cdot 30 + 1.8 \cdot 15 = 75 \text{ kNm}$$

$$h \approx 0.9 \cdot d = 0.9 \cdot 40 = 36 \text{ cm}; \quad a_1 \approx 0.1 \cdot d = 0.1 \cdot 40 = 4 \text{ cm}$$

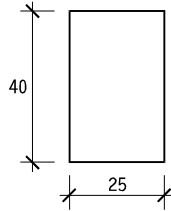
$$k = h \cdot \sqrt{\frac{b \cdot f_B}{M_u}} = 0.36 \cdot \sqrt{\frac{0.25 \cdot 23 \cdot 10^3}{75}} = 3.152 \Rightarrow \varepsilon_b / \varepsilon_{a1} = 1.94 / 10 \text{ ‰}$$

$$\bar{\mu}_{1M} = 10.6646 \text{ ‰}$$

$$A_{a1} = \bar{\mu}_{1M} \cdot b \cdot h \cdot \frac{f_B}{\sigma_V} = \frac{10.6646}{100} \cdot 25 \cdot 36 \cdot \frac{23}{400} = 5.52 \text{ cm}^2$$

Usvojeno  $A_{a1}$  **4RØ14 (6.16 cm<sup>2</sup>)****Uzengije uØ8/20**

$$a_1 = a_0 + \phi_u + \phi / 2 = 2.0 + 0.8 + 1.4 / 2 = 3.5 \text{ cm} > 4 \text{ cm}$$

**Primer 7****Odrediti potrebnu količinu armature.**

$b=25$  cm       $M_g=6$  kNm  
 $d=40$  cm       $M_p=3$  kNm  
 $a_0=2$  cm  
 uzengije uØ6/20

**MB 35**  
**RA 400/500**

**Rešenje**

$$MB\ 35 \quad \rightarrow \quad f_B = 23\ MPa$$

$$RA\ 400/500 \quad \rightarrow \quad \sigma_v = 400\ MPa$$

$$M_u = 1.6 \cdot M_g + 1.8 \cdot M_p = 1.6 \cdot 6 + 1.8 \cdot 3 = 15\ kNm$$

$$h \approx 0.9 \cdot d = 0.9 \cdot 40 = 36\ cm ; \quad a_1 \approx 0.1 \cdot d = 0.1 \cdot 40 = 4\ cm$$

$$k = h \cdot \sqrt{\frac{b \cdot f_B}{M_u}} = 0.36 \cdot \sqrt{\frac{0.25 \cdot 23 \cdot 10^3}{15}} = 7.048 \Rightarrow \varepsilon_b / \varepsilon_{a1} = 0.72 / 10\ ‰$$

$$\bar{\mu}_{IM} = 2.1278\ ‰$$

**Ukoliko je  $\varepsilon_{b2} \approx 1\ ‰$ , ili je  $\varepsilon_{b2} < 1\ ‰$ , potrebno je izvršiti kontrolu minimalnog procenta armiranja**

$$\mu_l = \bar{\mu}_{IM} \cdot \frac{f_B}{\sigma_v} = 2.1278 \cdot \frac{23}{400} = 0.122\ ‰$$

**Minimalni procenat armiranja:**

$$\mu_{l,min} = 5.1 \cdot \frac{\sqrt[3]{f_{bk}^2}}{\sigma_v} = 5.1 \cdot \frac{\sqrt[3]{35^2}}{400} = 0.136\ ‰$$

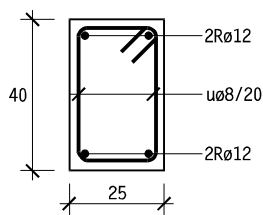
**Ukoliko je u pitanju mesto sa ekstremnim momentom savijanja, minimalni procenat armiranja iznosi:**

$$\mu_{l,min} = 0.2\ ‰ \text{ (usvaja se kao merodavno)}$$

$$A_{a1} = \frac{0.2}{100} \cdot 25 \cdot 36 = 1.8\ cm^2$$

**Usvojeno  $A_{a1}$  2RØ12 (2.26 cm<sup>2</sup>)**

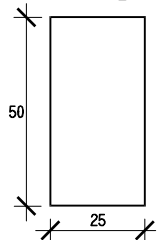
**Uzengije uØ6/20**



$$a_1 = a_0 + \phi_u + \phi / 2 = 2.0 + 0.6 + 1.2 / 2 = 3.2 \text{ cm} > 4 \text{ cm}$$

### Primer 8

Odrediti potrebnu količinu armature za presek na skici i zadate podatke



$b = 25 \text{ cm}$

$M_g = 100 \text{ kNm}$

MB 30

$d = 50 \text{ cm}$

$M_p = 80 \text{ kNm}$

RA 400/500

$a_0 = 2 \text{ cm}$

uzengije uø8/25

### Rešenje

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

RA 400/500  $\rightarrow \sigma_V = 400 \text{ MPa}$

$$M_u = 1.6 \cdot M_g + 1.8 \cdot M_p = 1.6 \cdot 100 + 1.8 \cdot 80 = 304 \text{ kNm}$$

$$h \approx 0.9 \cdot d = 0.9 \cdot 50 = 45 \text{ cm};$$

$$a_1 \approx 0.1 \cdot d = 0.1 \cdot 50 = 5 \text{ cm}$$

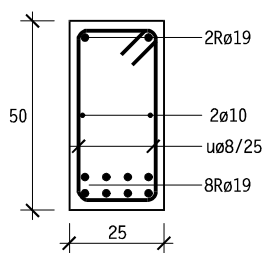
$$k = h \cdot \sqrt{\frac{b \cdot f_B}{M_u}} = 0.45 \cdot \sqrt{\frac{0.25 \cdot 20.5 \cdot 10^3}{304}} = 1.847 \Rightarrow \epsilon_b / \epsilon_{a1} = 3.5 / 4.38 \%$$

$$\bar{\mu}_{IM} = 35.9562 \%$$

$$A_{a1} = \bar{\mu}_{Im} \cdot b \cdot h \cdot \frac{f_B}{\sigma_V} = \frac{35.9562}{100} \cdot 25 \cdot 45 \cdot \frac{20.5}{400} = 20.73 \text{ cm}^2$$

Usvojeno  $A_{a1} \text{ 8R}\phi 19 \text{ (22.68 cm}^2\text{)}$

Uzengije uø8/25



$$a_1 = a_0 + \phi_u + \phi + a / 2 = 2.0 + 0.8 + 1.9 + 3 / 2 = 6.2 \text{ cm}$$

**Ša stvarnom veličinom za  $a_1$ :**

$$h = d - a_1 = 50 - 6.2 = 43.8 \text{ cm}$$

$$k = 1.798 \Rightarrow \epsilon_b / \epsilon_{a1} = 3.5 / 3.84 \%$$

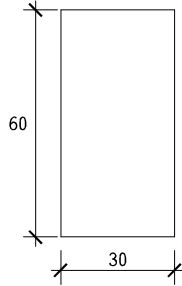
$$\bar{\mu}_{IM} = 38.6015 \%$$

$$A_{a1} = \frac{38.6015}{100} \cdot 25 \cdot 43.8 \cdot \frac{20.5}{400} = 21.66 \text{ cm}^2$$

Usvojena armatura odgovara

**Primer 9**

**Odrediti potrebnu količinu armature.**



**b=30 cm**      **M<sub>g</sub>=260 kNm**      **MB 25**  
**d=60 cm**      **M<sub>p</sub>=180 kNm**      **RA 400/500**  
**a<sub>0</sub>=2 cm**  
**uzengije uØ8/25**

**Rešenje**

$$MB\ 35 \quad \rightarrow \quad f_B = 17.25\ MPa$$

$$RA\ 400/500 \quad \rightarrow \quad \sigma_V = 400\ MPa$$

$$M_u = 1.6 \cdot M_g + 1.8 \cdot M_p = 1.6 \cdot 260 + 1.8 \cdot 180 = 740\ kNm$$

$$h \approx 0.9 \cdot d = 0.9 \cdot 60 = 54\ cm; \quad a_1 \approx 0.1 \cdot d = 0.1 \cdot 60 = 6\ cm$$

$$k = h \cdot \sqrt{\frac{b \cdot f_B}{M_u}} = 0.54 \cdot \sqrt{\frac{0.25 \cdot 17.25 \cdot 10^3}{740}} = 1.304 \Rightarrow \varepsilon_{a1} < 0\ ‰$$

$$\varepsilon_{a1} < 3\ ‰ \rightarrow \text{dvostruko armiranje}$$

**Usvajaju se dilatacije:**

$$\varepsilon_b / \varepsilon_{a1} = 3.5 / 3\ ‰ \rightarrow k = 1.7194$$

$$m = 0.3383$$

$$\bar{\mu}_{1M} = 43.590\ \%$$

$$s = 0.5385$$

$$M_{bu} = m \cdot b \cdot h^2 \cdot f_B = 0.3383 \cdot 0.30 \cdot 0.54^2 \cdot 17.25 \cdot 10^3 = 510.50\ kNm$$

$$\Delta M_u = M_u - M_{bu} = 740 - 510.50 = 229.50\ kNm$$

$$x = s \cdot h = 0.5385 \cdot 54 = 29.08\ cm$$

**pretpostavka:**  $a_2 = a_0 + \phi_u + \phi / 2 = 2.0 + 0.8 + 2.2 / 2 = 3.9\ cm$

$$\varepsilon_{a2} = \frac{x - a_2}{x} \cdot \varepsilon_{b2} = \frac{29.08 - 3.9}{29.08} \cdot 3.5 = 3.03\ ‰ \rightarrow \sigma_{a2} = \sigma_V$$

$$A_{a2} = \frac{\Delta M_u}{\sigma_{a2} \cdot (h - a_2)} = \frac{229.50}{40 \cdot (0.54 - 0.039)} = 11.45 \text{ cm}^2$$

Usvojeno  $A_{a2}$  **3RØ22 (11.40 cm<sup>2</sup>)**

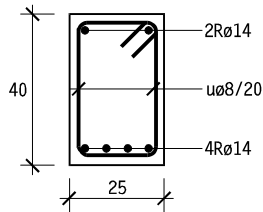
razlika **0.8%**

$$A_{a1} = \bar{\mu}_{lm} \cdot b \cdot h \cdot \frac{f_B}{\sigma_V} + \frac{\Delta M_u}{\sigma_V \cdot (h - a_2)} = \frac{43.59}{100} \cdot 30 \cdot 54 \cdot \frac{17.25}{400} + \frac{229.50}{40(0.54 - 0.039)} =$$

$$= 30.45 + 11.45 = 41.90 \text{ cm}^2$$

Usvojeno  $A_{a1}$  **12RØ22 (45.62 cm<sup>2</sup>)**

Uzengije **uØ8/25**



$$a_1 = 2.0 + 0.8 + 2.2 + 3 + 2.2 / 2 = 9.1 \text{ cm} > 6 \text{ cm}$$

$$\frac{a_{1,pret}}{a_1} = \frac{9.1}{6} = 1.52 > 1.3 \rightarrow \text{ponovni proračun}$$

$$a_2 = 2.0 + 0.8 + .2 / 2 = 3.9 \text{ cm}$$

Pošto je pretpostavljeno  $a_1$  manje od stvarnog, vrši se ponovni proračun sa stvarnom vrednošću za  $a_1$ :

$$h = d - a_1 = 60 - 9.1 = 50.9 \text{ cm}$$

$$M_{bu} = m \cdot b \cdot h^2 \cdot f_B = 0.3383 \cdot 0.30 \cdot 0.509^2 \cdot 17.25 \cdot 10^3 = 453.57 \text{ kNm}$$

$$\Delta M_u = M_u - M_{bu} = 740 - 453.57 = 286.43 \text{ kNm}$$

$$x = s \cdot h = 0.5385 \cdot 50.9 = 27.41 \text{ cm}$$

$$\varepsilon_{a2} = \frac{x - a_2}{x} \cdot \varepsilon_{b2} = \frac{27.41 - 3.9}{27.41} \cdot 3.5 = 3.00 \% \rightarrow \sigma_{a2} = \sigma_V$$

$$A_{a2} = \frac{\Delta M_u}{\sigma_{a2} \cdot (h - a_2)} = \frac{286.43}{40 \cdot (0.509 - 0.039)} = 15.24 \text{ cm}^2$$

Usvojeno  $A_{a2}$  **4RØ22 (15.21 cm<sup>2</sup>)**

razlika **0.2%**

$$A_{a1} = \bar{\mu}_{lm} \cdot b \cdot h \cdot \frac{f_B}{\sigma_V} + \frac{\Delta M_u}{\sigma_V \cdot (h - a_2)} = \frac{43.59}{100} \cdot 30 \cdot 50.9 \cdot \frac{17.25}{400} + \frac{286.43}{40(0.509 - 0.039)} =$$

$$= 28.70 + 15.24 = 43.94 \text{ cm}^2$$

Usvojeno  $A_{a1}$  **12RØ22 (45.62 cm<sup>2</sup>)**

Uzengije **uØ8/25**

