

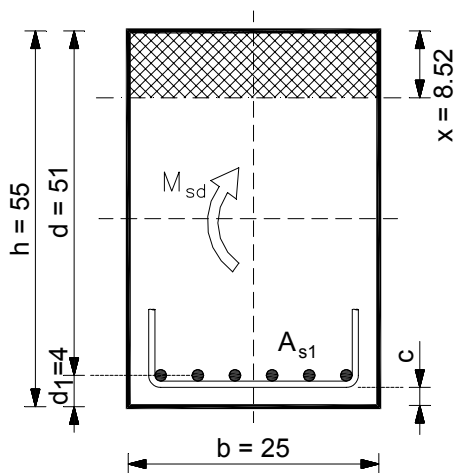
PRIPREMA ZA PRVI KOLOKVIJ (16.10.2013.)

ZADATAK 1:

Zadan je betonski presjek dimenzija $b/h=25/55$ cm, udaljenost težišta vlačne armature od ruba presjeka $d_1=4$ cm. Element je izrađen iz betona klase C 35/45, armiran s B 500B. Element je opterećen računskim opterećenjem $M_{sd}=130$ kNm.

Potrebno je odrediti (izračunati):

1. Za odabranu deformaciju armature ε_{s1} , odrediti deformaciju betona ε_{c2}
2. Izračunati položaj neutralne osi x
3. Izračunati krak unutrašnjih sila z
4. Izračunati potrebnu vlačnu armaturu A_{s1}
5. Za izračunatu armaturu A_{s1} odabrati odgovarajuće šipke i ucrtati ih u poprečni presjek.



materijal:

$$\text{C 35/45} \quad ; \quad f_{ck} = 35.0 \text{ MPa}$$

$$f_{cd} = f_{ck} / \gamma_c = 35.0 / 1.5 = 23.33 \text{ MPa}$$

$$\text{B 500B} \quad ; \quad f_{yk} = 500.0 \text{ MPa}$$

$$f_{yd} = f_{yk} / \gamma_s = 500.0 / 1.15 = 434.8 \text{ MPa}$$

opterećenje:

$$M_{sd} = 130.0 \text{ kNm}$$

$$\text{MPa} = \text{MN/m}^2 = 10^6 \text{ Pa} = 1000/100 \cdot 100 \text{ kN/cm}^2 \\ = 1/10 \text{ kN/cm}^2$$

geometrija:

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

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

$$d_1 = 4.0 \text{ cm}$$

$$d = h - d_1 = 55 - 4 = 51 \text{ cm}$$

$$\mu_{sd} = \frac{M_{sd}}{bd^2 f_{cd}} = \frac{130 \cdot 100}{25 \cdot 51^2 \cdot 23.33} = 0.085039$$

$$\text{iz tablica} \Rightarrow \varepsilon_{s1} = 10.0 \text{ ‰}; \quad \varepsilon_{c2} = 2.0 \text{ ‰}; \quad \zeta = 0.938; \quad \xi = 0.167$$

$$x = \xi \cdot d = 0.167 \cdot 51 = 8.52 \text{ cm}$$

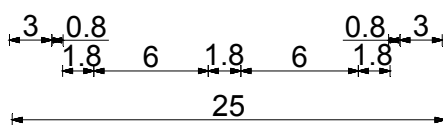
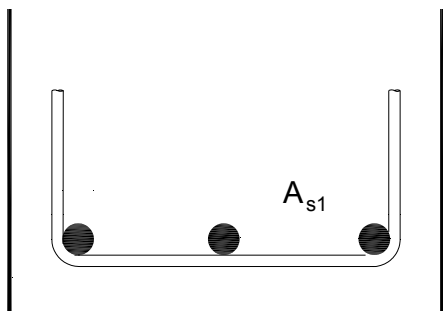
$$z = \zeta \cdot d = 0.938 \cdot 51 = 47.84 \text{ cm}$$

$$A_{s1} = \frac{M_{sd}}{\zeta d f_{yd}} = \frac{130 \cdot 100}{0.938 \cdot 51 \cdot 434.8} = 6.25 \text{ cm}^2 \Rightarrow \text{odabrano } 3\text{Ø}18 \text{ (} A_s = 7.63 \text{ cm}^2 \text{)}$$

⇒ odabrano 3Ø18 ($A_s=7.63 \text{ cm}^2$)

Provjera razmaka između šipki: $(25-2 \times 3 - 2 \times 0.8 - 3 \times 1.8) / 2 = 6.00 \text{ cm}$

SKICIRATI ODABRANU ARMATURU!!

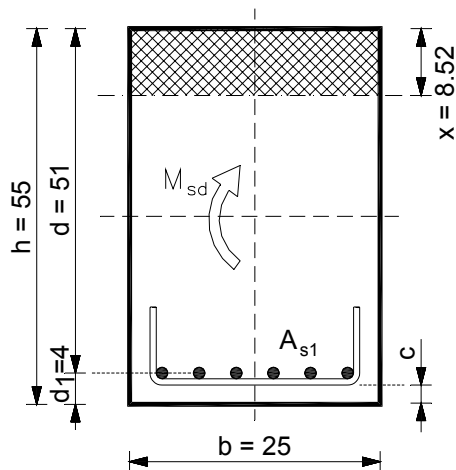


ZADATAK 2:

Zadan je betonski presjek dimenzija $b/h=25/55$ cm, udaljenost težišta vlačne armature od ruba presjeka $d_1=4$ cm. Element je izrađen iz betona klase C 35/45, armiran s B 500B.

Izračunati granične momente nosivosti presjeka za:

1. $\varepsilon_{s1} = 20.0 \text{ ‰}$
2. $\varepsilon_{s1} = 10.0 \text{ ‰}$
3. $\varepsilon_{s1} = 5.0 \text{ ‰}$



materijal:

$$\text{C 35/45} \quad ; \quad f_{ck} = 35.0 \text{ MPa}$$

$$f_{cd} = f_{ck} / \gamma_c = 35.0 / 1.5 = 23.33 \text{ MPa}$$

$$\text{B 500B} \quad ; \quad f_{yk} = 500.0 \text{ MPa}$$

$$f_{yd} = f_{yk} / \gamma_s = 500.0 / 1.15 = 434.8 \text{ MPa}$$

$$\text{MPa} = \text{MN/m}^2 = 10^6 \text{ Pa} = 1000/100 \cdot 100 \text{ kN/cm}^2 \\ = 1/10 \text{ kN/cm}^2$$

geometrija:

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

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

$$d_1 = 4.0 \text{ cm}$$

$$d = h - d_1 = 55 - 4 = 51 \text{ cm}$$

1. Pretpostavimo: $\varepsilon_{s1} = 20.0 \text{ ‰}$ i $\varepsilon_{c2} = 3.5 \text{ ‰}$

$$\text{iz tablica} \Rightarrow \mu_{sd,lim} = 0.096; \quad \zeta_{lim} = 0.938; \quad \xi_{lim} = 0.149$$

$$M_{Rd,lim} = \mu_{sd,lim} \cdot b d^2 \cdot f_{cd} = 0.096 \cdot 25 \cdot 51^2 \cdot 2.33 = 145.5 \text{ kNm}$$

2. Pretpostavimo: $\varepsilon_{s1} = 10.0 \text{ ‰}$ i $\varepsilon_{c2} = 3.5 \text{ ‰}$

$$\text{iz tablica} \Rightarrow \mu_{sd,lim} = 0.159; \quad \zeta_{lim} = 0.892; \quad \xi_{lim} = 0.259$$

$$M_{Rd,lim} = \mu_{sd,lim} \cdot b d^2 \cdot f_{cd} = 0.159 \cdot 25 \cdot 51^2 \cdot 2.33 = 240.9 \text{ kNm}$$

3. Pretpostavimo: $\varepsilon_{s1} = 5.0 \text{ ‰}$ i $\varepsilon_{c2} = 3.5 \text{ ‰}$

$$\text{iz tablica} \Rightarrow \mu_{sd,lim} = 0.235; \quad \zeta_{lim} = 0.829; \quad \xi_{lim} = 0.412$$

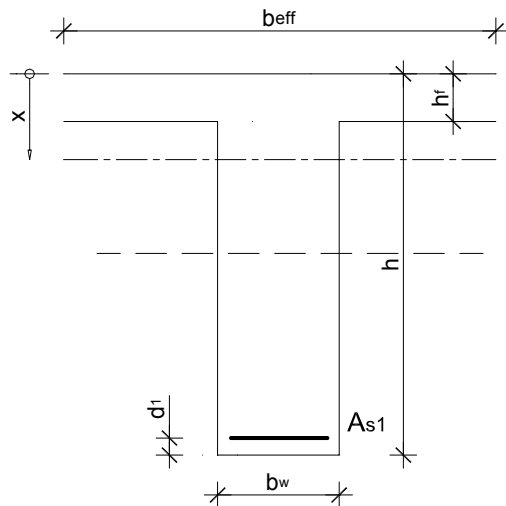
$$M_{Rd,lim} = \mu_{sd,lim} \cdot b d^2 \cdot f_{cd} = 0.235 \cdot 25 \cdot 51^2 \cdot 2.33 = 356.04 \text{ kNm}$$

ZADATAK 3:

Zadan je betonski T presjek, dimenzija prema crtežu. Element je izrađen iz betona klase C 35/45, armiran sa B 500B.

Potrebno je:

- 1) Za $M_{sd} = 500.0$ kNm odrediti položaj neutralne osi i vlačnu armaturu A_{s1} . Za izračunatu armaturu A_{s1} odabrati odgovarajuće armaturne šipke i ucrtati ih u poprečni presjek
- 2) Za $M_{sd} = 2000.0$ kNm odrediti položaj neutralne osi i vlačnu armaturu A_{s1} . Za izračunatu armaturu A_{s1} odabrati odgovarajuće armaturne šipke i ucrtati ih u poprečni presjek



geometrija:

$$b_{eff} = 145 \text{ cm}$$

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

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

$$h = 75 \text{ cm}$$

$$d_1 = 5 \text{ cm} \quad (\text{slučaj 1})$$

$$d_1 = 12 \text{ cm} \quad (\text{slučaj 2})$$

materijal:

$$C 35/45 \quad ; \quad f_{ck} = 35.0 \text{ MPa}$$

$$f_{cd} = f_{ck} / \gamma_c = 35.0 / 1.5 = 23.3 \text{ MPa}$$

$$B 500B \quad ; \quad f_{yk} = 500.0 \text{ MPa}$$

$$f_{yd} = f_{yk} / \gamma_s = 500.0 / 1.15 = 434.8 \text{ MPa}$$

1. slučaj

$$d_1 = 5.0 \text{ cm}$$

$$d = h - d_1 = 75 - 5 = 70 \text{ cm}$$

početni presjek: $\square b_{eff}/d = 145/70$:

$$\mu_{sd} = \frac{M_{sd}}{b_{eff} d^2 f_{cd}} = \frac{500 \cdot 100}{145 \cdot 70^2 \cdot 2.33} = 0.030$$

$$\text{iz tablica} \Rightarrow \varepsilon_{s1} = 10.0 \text{ ‰}; \quad \varepsilon_{c2} = 1.0 \text{ ‰}; \quad \zeta = 0.968; \quad \xi = 0.091$$

$$x = \xi \cdot d = 0.091 \cdot 70 = 6.37 \text{ cm} < h_f = 15.0 \text{ cm} \quad - \text{neutralna os siječe ploču!}$$

Proračun kao za pravokutni presjek dimenzija b_{eff}/h :

$$A_{s1} = \frac{M_{sd}}{\zeta \cdot d \cdot f_{yd}} = \frac{500 \cdot 100}{0.968 \cdot 70 \cdot 434.8} = 16.97 \text{ cm}^2 \Rightarrow \text{odabrano } 4\text{Ø}25 \text{ (} A_s = 19.63 \text{ cm}^2 \text{)}$$

$$\text{Provjera razmaka između šipki: } (35 - 2 \cdot 3 - 2 \cdot 0.8 - 4 \cdot 2.5) / 3 = 5.80 \text{ cm}$$

SKICIRATI ODABRANU ARMATURU!!

2. slučaj

$$d_1 = 12.0 \text{ cm}$$

$$d = h - d_1 = 75 - 12 = 63 \text{ cm}$$

$$\mu_{sd} = \frac{M_{sd}}{b_{eff} d^2 f_{cd}} = \frac{2000 \cdot 100}{145 \cdot 63^2 \cdot 2.33} = 0.149$$

iz tablica $\Rightarrow \varepsilon_{s1} = 10.0 \text{ ‰}; \varepsilon_{c2} = 3.3 \text{ ‰}; \zeta = 0.898; \xi = 0.248$

$$x = \xi \cdot d = 0.248 \cdot 63 = 15.62 \text{ cm} > h_f = 15.0 \text{ cm} - \text{neutralna os siječe rebro!}$$

$$\frac{b_{eff}}{b_w} = \frac{145}{35} = 5.8 > 5$$

Proračun uz pretpostavku da cijelu tlačnu silu preuzima ploča (pojasnica T- presjeka), odnosno dio rebra u tlaku se zanemaruje:

$$A_{s1} = \frac{M_{sd}}{(d - h_f/2) f_{yd}} = \frac{2000 \cdot 100}{(63 - 15/2) \cdot 43.48} = 82.87 \text{ cm}^2 \Rightarrow \text{odabrano } 14\text{Ø}28 \text{ (} A_s = 86.21 \text{ cm}^2 \text{)}$$

Provjera razmaka između šipki: $(35 - 2 \times 3 - 2 \times 0.8 - 5 \times 2.8) / 4 = 3.35 \text{ cm}$

SKICIRATI ODABRANU ARMATURU!!