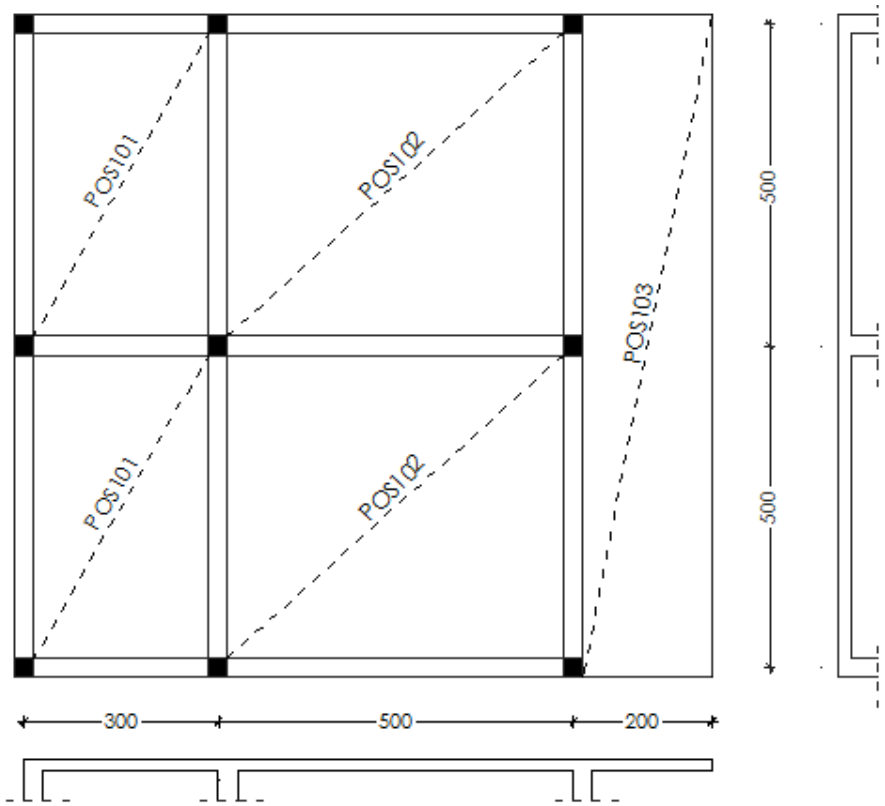
Univerzitet Crne Gore
Građevinski fakultet u Podgorici
Menađment u građevinarstvu

BETONSKE KONSTRUKCIJE

VJEŽBA 5.

Zadatak1.

Izvršiti analizu opterećenja, izračunati statičke uticaje i dimenzionisati ploče POS101, POS102 i POS103. Nacrtati plan armature u osnovi i poprečnim presjecima.
Povremeno opterećenje iznosi p=4kN/m^2.



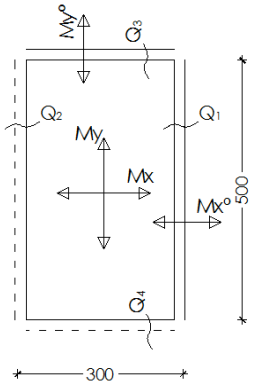
Kvalitet materijala:

I Varijanta	MB30, GA240/360.
II Varijanta	MB30, MA500/560.

Rješenje:

POS101

1.1. Statička šema



Debljina ploče se odredi na samom početku i ima istu vrijednost za sve pozicionirane ploče.

Za ploču POS101 i POS 102:

$$\min d_p = \frac{l_0}{35(40 - krovne\ \ ploce)} = \frac{0.8 \cdot 500}{35} = 11.4cm$$

Za ploču POS 103:

$$\min d_p = \frac{2 \cdot 200}{35} = 11.4cm$$

Debljina ploče usvaja se na osnovu veće vrijednosti
Usvojeno d_p=12cm

l_y/l_x=5.0/3.0=1.67

1.2. Analiza opterećenja

1.2.1 Stalno

-sopstvena težina $0.12 \cdot 25 = 3.0kN/m^2$

g=3.0 kN/m^2

1.2.2 Povremeno

p=4.0 kN/m^2

Granično opterećenje $q = 1.6 \cdot g + 1.8 \cdot p = 1.6 \cdot 3 + 1.8 \cdot 4 = 12kN/m^2$

1.3. Statički uticaji

$M_u = k \cdot q \cdot l_x \cdot l_y$

$Q_u = k \cdot q \cdot l_x \cdot l_y / l$

$M_{ux} = 0.031 \cdot 12 \cdot 3 \cdot 5 = 5.58kNm/m$

$M_{uy} = 0.014 \cdot 12 \cdot 3 \cdot 5 = 2.52kNm/m$

$M_{ux}^{\ 0} = 0.065 \cdot 12 \cdot 3 \cdot 5 = 11.7kNm/m$

$M_{uy}^{\ 0} = 0.046 \cdot 12 \cdot 3 \cdot 5 = 8.28kNm/m$

$Q_{u1} = 0.39 \cdot 12 \cdot 3 \cdot 5/5 = 14.04kN/m$

$Q_{u2} = 0.256 \cdot 12 \cdot 3 \cdot 5/5 = 9.22kN/m$

$Q_{u3} = 0.204 \cdot 12 \cdot 3 \cdot 5/3 = 12.24kN/m$

$Q_{u4} = 0.15 \cdot 12 \cdot 3 \cdot 5/3 = 9.0kN/m$

1.4. Dimenzionsanje

$MB30 \Rightarrow f_b = 2.05kN/cm^2$

$GA240/360 \Rightarrow \sigma_v = 24kN/cm^2$

$MA500/600 \Rightarrow \sigma_v = 50kN/cm^2$

1.4.1 Dimenzionsanje iznad oslonca

$$h = d_p - a_o - \frac{\phi}{2} = 12 - 2 - \frac{0.8}{2} = 9.6cm$$

$$k_b = \frac{h}{\sqrt{\frac{M_u}{b \cdot f_b}}} = \frac{9.6}{\sqrt{\frac{11.7}{1.0 \cdot 2.05}}} = 4.01 \Rightarrow \left\{ \begin{matrix} \overline{\mu} = 6.41\% \\ \varepsilon_a / \varepsilon_b = 10 / 1.38‰ \end{matrix} \right\} \Rightarrow \text{lom po armaturi}$$

Važi približni proračun armature.

X pravac

$M_{ux}{}^0 = 11.7kNm/m$

$$h = d_p - a_o - \frac{\phi}{2} = 12 - 2 - \frac{0.8}{2} = 9.6cm$$

$$_{potr.}A = \frac{M_u}{z \cdot \sigma_v} = \frac{11.7 \cdot 100}{9.6 \cdot 24} = 5.07cm^2/m$$

$usvojeno: \phi 8/10(5.0cm^2/m)$

$$A_{ap} > \left\{ \begin{matrix} 0.2 \cdot 5 = 1.0cm^2/m \\ 0.1/100 \cdot 12 \cdot 100 = 1.2cm^2/m \end{matrix} \right\}$$

$usvojeno: \phi 6/20(1.4cm^2/m)$

$$A_a^{MA} = A_a^{GA} \cdot \frac{\sigma_v^{GA}}{\sigma_v^{MA}} = 5.07 \cdot \frac{24}{50} = 2.43cm^2/m$$

$usvojeno: R257(2.57cm^2/m)$

Y pravac

$M_{ux}{}^0 = 8.28kNm/m$

$$h = d_p - a_o - \frac{\phi}{2} = 12 - 2 - \frac{0.8}{2} = 9.6cm$$

$$_{potr.}A = \frac{M_u}{z \cdot \sigma_v} = \frac{8.28 \cdot 100}{9.6 \cdot 24} = 3.6cm^2/m$$

$usvojeno: \phi 8/10(5.0cm^2/m)$

$$A_{ap} > \left\{ \begin{matrix} 0.2 \cdot 5 = 1.0cm^2/m \\ 0.1/100 \cdot 12 \cdot 100 = 1.2cm^2/m \end{matrix} \right\}$$

$usvojeno: \phi 6/20(1.4cm^2/m)$

$$A_a^{MA} = A_a^{GA} \cdot \frac{\sigma_v^{GA}}{\sigma_v^{MA}} = 3.6 \cdot \frac{24}{50} = 1.728cm^2/m$$

$usvojeno: R196(1.96cm^2/m)$

1.4.2 Dimenzionsanje u polju

X pravac

$M_{ux} = 5.58kNm/m$

$$h = d_p - a_o - \frac{\phi}{2} = 12 - 2 - \frac{0.8}{2} = 9.6cm$$

$$_{potr.}A = \frac{M_u}{z \cdot \sigma_v} = \frac{5.58 \cdot 100}{9.6 \cdot 24} = 2.42cm^2/m$$

$usvojeno: \phi 8/20(2.5cm^2/m)$

$$A_a^{MA} = A_a^{GA} \cdot \frac{\sigma_v^{GA}}{\sigma_v^{MA}} = 2.42 \cdot \frac{24}{50} = 1.16cm^2/m$$

$usvojeno: Q131(1.31cm^2/m)$

Ypravac

$M_{uy} = 2.52kNm/m$

$$h = d_p - a_o - \frac{\phi}{2} = 12 - 2 - 0.8 - \frac{0.8}{2} = 8.8cm$$

$$_{potr.}A = \frac{M_u}{z \cdot \sigma_v} = \frac{2.52 \cdot 100}{8.8 \cdot 24} = 1.2cm^2/m$$

$$_{\min}A_a = 0.15/100 \cdot 12 \cdot 100 = 1.8cm^2/m$$

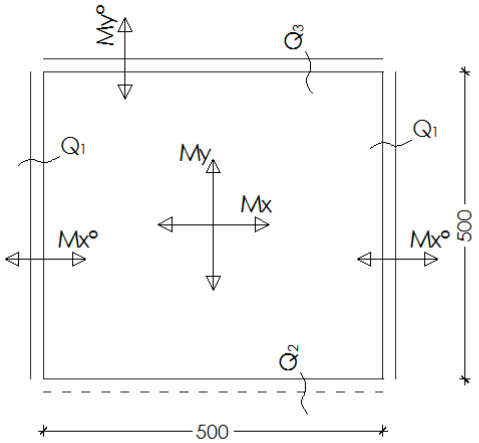
$usvojeno: \phi 6/15(1.86cm^2/m)$

$$A_a^{MA} = A_a^{GA} \cdot \frac{\sigma_v^{GA}}{\sigma_v^{MA}} = 1.8 \cdot \frac{24}{50} = 0.86cm^2/m$$

$usvojeno: Q131(1.31cm^2/m)$

POS102

1.1 Statička šema



Usvojeno d_p=12cm
l_y/l_x=5.0/5.0.0=1.0

1.2 Analiza opterećenja

1.2.1 Stalno

-sopstvena težina $0.12 \cdot 25 = 3.0 kN/m^2$

g=3.0 kN/m^2

1.2.2 Povremeno

p=4.0 kN/m^2

Granično opterećenje $q = 1.6 \cdot g + 1.8 \cdot p = 1.6 \cdot 3 + 1.8 \cdot 4 = 12 kN/m^2$

1.3 Statički uticaji

$M_u = k \cdot q \cdot l_x \cdot l_y$

$Q_u = k \cdot q \cdot l_x \cdot l_y / l$

$M_{ux} = 0.026 \cdot 12 \cdot 5 \cdot 5 = 7.8 kNm/m$

$M_{uy} = 0.021 \cdot 12 \cdot 5 \cdot 5 = 6.3 kNm/m$

$M_{ux}^{\ 0} = 0.06 \cdot 12 \cdot 5 \cdot 5 = 18 kNm/m$

$M_{uy}^{\ 0} = 0.055 \cdot 12 \cdot 5 \cdot 5 = 16.5 kNm/m$

$Q_{u1} = 0.274 \cdot 12 \cdot 5 \cdot 5/5 = 16.44 kN/m$

$Q_{u2} = 0.19 \cdot 12 \cdot 5 \cdot 5/5 = 11.4 kN/m$

$Q_{u3} = 0.262 \cdot 12 \cdot 5 \cdot 5/5 = 15.72 kN/m$

1.4 Dimenzionsanje

$MB30 \Rightarrow f_b = 2.05 kN/cm^2$

$GA240/360 \Rightarrow \sigma_v = 24 kN/cm^2$

$MA500/600 \Rightarrow \sigma_v = 50 kN/cm^2$

1.4.1 Dimenzionsanje iznad oslonca

$$h = d_p - a_o - \frac{\phi}{2} = 12 - 2 - \frac{1.0}{2} = 9.5cm$$

$$k_b = \frac{h}{\sqrt{\frac{M_u}{b \cdot f_b}}} = \frac{9.5}{\sqrt{\frac{18}{1.0 \cdot 2.05}}} = 3.21 \Rightarrow \left\{ \begin{matrix} \bar{\mu} = 10.36\% \\ \varepsilon_a / \varepsilon_b = 10/1.9‰ \end{matrix} \right\} \Rightarrow \text{lom po armaturi}$$

Važi približni proračun armature.

X pravac

$M_{ux}{}^0 = 18kNm/m$

$$h = d_p - a_o - \frac{\phi}{2} = 12 - 2 - \frac{1.0}{2} = 9.5cm$$

$$_{potr.}A = \frac{M_u}{z \cdot \sigma_v} = \frac{18 \cdot 100}{9.5 \cdot 24} = 7.9cm^2/m$$

$usvojeno: \phi 10/10(7.85cm^2/m)$

$$A_{ap} > \left\{ \begin{matrix} 0.2 \cdot 7.85 = 1.6cm^2/m \\ 0.1/100 \cdot 12 \cdot 100 = 1.2cm^2/m \end{matrix} \right\}$$

$usvojeno: \phi 6/15(1.86cm^2/m)$

$$A_a^{MA} = A_a^{GA} \cdot \frac{\sigma_v^{GA}}{\sigma_v^{MA}} = 7.9 \cdot \frac{24}{50} = 3.792cm^2/m$$

$usvojeno: R378(3.78cm^2/m)$

Y pravac

$M_{ux}{}^0 = 16.5kNm/m$

$$h = d_p - a_o - \frac{\phi}{2} = 12 - 2 - \frac{1.0}{2} = 9.5cm$$

$$_{potr.}A = \frac{M_u}{z \cdot \sigma_v} = \frac{16.5 \cdot 100}{9.5 \cdot 24} = 7.23cm^2/m$$

$usvojeno: \phi 10/10(7.85cm^2/m)$

$$A_{ap} > \left\{ \begin{matrix} 0.2 \cdot 7.85 = 1.6cm^2/m \\ 0.1/100 \cdot 12 \cdot 100 = 1.2cm^2/m \end{matrix} \right\}$$

$usvojeno: \phi 6/15(1.86cm^2/m)$

$$A_a^{MA} = A_a^{GA} \cdot \frac{\sigma_v^{GA}}{\sigma_v^{MA}} = 7.23 \cdot \frac{24}{50} = 3.47cm^2/m$$

$usvojeno: R378(3.78cm^2/m)$

1.4.2 Dimenzionsanje u polju

X pravac

$M_{ux} = 7.8kNm/m$

$$h = d_p - a_o - \frac{\phi}{2} = 12 - 2 - \frac{0.8}{2} = 9.6cm$$

$$_{potr.}A = \frac{M_u}{z \cdot \sigma_v} = \frac{7.8 \cdot 100}{9.6 \cdot 24} = 3.38cm^2/m$$

$usvojeno: \phi 8/15(3.33cm^2/m)$

$$A_a^{MA} = A_a^{GA} \cdot \frac{\sigma_v^{GA}}{\sigma_v^{MA}} = 3.38 \cdot \frac{24}{50} = 1.62cm^2/m$$

$usvojeno: Q188(1.88cm^2/m)$

Y pravac

$M_{uy} = 6.3kNm/m$

$$h = d_p - a_o - \frac{\phi}{2} = 12 - 2 - 0.8 - \frac{0.8}{2} = 8.8cm$$

$$_{potr.}A = \frac{M_u}{z \cdot \sigma_v} = \frac{6.3 \cdot 100}{8.8 \cdot 24} = 2.98cm^2/m$$

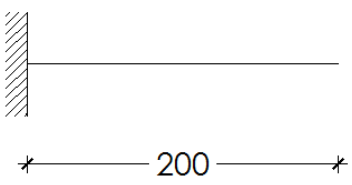
$usvojeno: \phi 8/15(3.33cm^2/m)$

$$A_a^{MA} = A_a^{GA} \cdot \frac{\sigma_v^{GA}}{\sigma_v^{MA}} = 2.98 \cdot \frac{24}{50} = 1.43cm^2/m$$

$usvojeno: Q188(1.88cm^2/m)$

POS103

1.1 Statička šema



Usvojeno d_p=12cm

1.2 Analiza opterećenja

1.2.1 Stalno

-sopstvena težina $0.12 \cdot 25 = 3.0 kN/m^2$

g=3.0 kN/m^2

1.2.2 Povremeno

p=4.0 kN/m^2

Granično opterećenje $q = 1.6 \cdot g + 1.8 \cdot p = 1.6 \cdot 3 + 1.8 \cdot 4 = 12 kN/m^2$

1.3 Statički uticaji

$$M_u = q \cdot \frac{l^2}{2} = 12 \cdot \frac{2.0^2}{2} = 24 kNm/m'$$

$$Q_u = q \cdot l = 12 \cdot 2.0 = 24 kN/m'$$

1.4 Dimenzionsanje

$$MB30 \Rightarrow f_b = 2.05 kN/cm^2$$

$$GA240/360 \Rightarrow \sigma_v = 24 kN/cm^2$$

$$_{\min} A_a = 0.15/100 \cdot 12 \cdot 100 = 1.8 cm^2/m$$

1.4.1 Dimenzionsanje iznad oslonca

X pravac

$$M_{ux} = 24 kNm/m$$

$$h = d_p - a_o - \frac{\phi}{2} = 12 - 2 - \frac{1.0}{2} = 9.5 cm$$

$$_{potr.} A = \frac{M_u}{z \cdot \sigma_v} = \frac{24 \cdot 100}{9.5 \cdot 24} = 10.5 cm^2/m$$

$$usvojeno: \phi 12/10 (11.3 cm^2/m)$$

$$A_{ap} > \left\{ \begin{matrix} 0.2 \cdot 11.3 = 2.26 cm^2/m \\ 0.1/100 \cdot 12 \cdot 100 = 1.2 cm^2/m \end{matrix} \right\}$$

$$usvojeno: \phi 8/20 (2.5 cm^2/m)$$

$$A_a^{MA} = A_a^{GA} \cdot \frac{\sigma_v^{GA}}{\sigma_v^{MA}} = 10.5 \cdot \frac{24}{50} = 5.04 cm^2/m$$

$$usvojeno: R503 (5.03 cm^2/m)$$