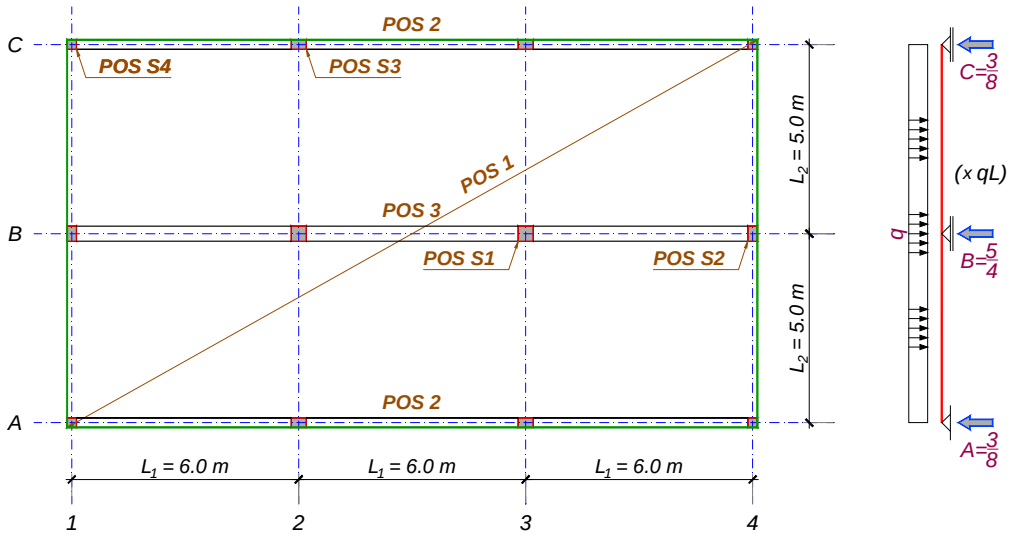
Ploča POS 1 na gredama u jednom pravcu



1.2 ANALIZA OPTEREĆENJA ZA POS 1

- sopstvena težina ploče	0.14×25		= 3.5 kN/m^2
- dodatno stalno opterećenje		Δg	= 2.5 kN/m^2
ukupno, stalno opterećenje		g	= 6.0 kN/m^2
povremeno opterećenje:		p	= 4.0 kN/m^2

1.3 STATIČKI UTICAJI ZA POS 1

Reakcije oslonaca se sračunavaju za svako pojedinačno opterećenje:

- *na gredu POS 2:*

$A_g = 0.375 \times 6.0 \times 5.0 = 11.25$ kN/m

$A_p = 0.375 \times 4.0 \times 5.0 = 7.5$ kN/m

- *na gredu POS 3:*

$B_g = 1.25 \times 6.0 \times 5.0 = 37.5$ kN/m

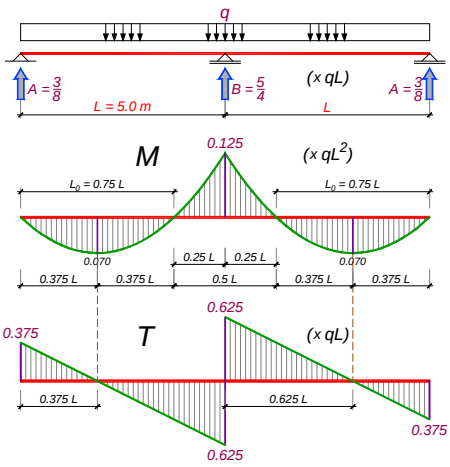
$B_p = 1.25 \times 4.0 \times 5.0 = 25.0$ kN/m

dok je momente savijanja i transverzalne sile dovoljno sračunati samo za granično opterećenje ukoliko se ne vrši kontrola napona, prslina i ugiba (graničnih stanja upotrebljivosti):

$q_u = 1.6 \times 6.0 + 1.8 \times 4.0 = 16.8$ kN/m^2

$M_{u,1} = 16.8 \times 5.0^2/8 = 52.5$ kNm/m

$M_{u,01} = 0.07 \times 16.8 \times 5.0^2 = 29.5$ kNm/m



2.2 ANALIZA OPTEREĆENJA ZA POS 3

Uobičajena visina greda je:

$$d \approx \frac{L}{10} \div \frac{L}{12} = \frac{600}{10} \div \frac{600}{12} = 60 \div 50\,cm \quad \Rightarrow \quad \text{pretp. } d = 50 \text{ cm}$$

Sa pretpostavljenom širinom grede POS 3 od b = 40 cm, sledi:

- *sopstvena težina POS 3* — $0.4\times0.5\times25$ = 5.0 kN/m
- *stalno opterećenje od POS 1* — B_g = 37.5 kN/m

ukupno, stalno opterećenje — g = 42.5 kN/m

povremeno opterećenje od POS 1: — $B_p = p$ = 25.0 kN/m

2.3 PRELIMINARNO DIMENZIONISANJE POS 3

$q_u = 1.6\times42.5 + 1.8\times25.0 = 113$ kN/m

$M_{u,1} = 113\times6.0^2/10 = 406.8$ kNm - gornja zona, oslonac

$$k = \frac{43}{\sqrt{\frac{406.8\times10^2}{40\times2.05}}} = 1.931 \Rightarrow \begin{cases} \varepsilon_b / \varepsilon_a = 3.5 / 5.316‰ \\ \mu = 32.138\% \end{cases}$$

$$A_a = 32.138 \times \frac{40\times43}{100} \times \frac{2.05}{40} = 28.33\,cm^2 \quad \Rightarrow \quad \text{usv.: } \mathbf{8RØ22}\ (30.41\ cm^2)$$

2.3.2 Kontrola glavnih napona zatezanja

$$T_u^{B,levo} = 0.6\times113\times6.0 = 406.8\ kN \quad \Rightarrow \quad \tau_n^{B,l} = \frac{406.8}{40\times0.9\times43} = 0.263\,\frac{kN}{cm^2} \begin{cases} > \tau_r \\ < 3\tau_r \end{cases}$$

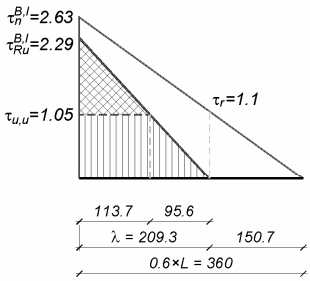
$$\lambda = 0.6\times600\times\left(1-\frac{0.11}{0.263}\right) = 209.3\,cm \qquad ; \tau_{Ru}^{B,l} = \frac{3}{2}\times(0.263-0.11) = 0.229\,\frac{kN}{cm^2}$$

$$m = 2\ ;\ \alpha = 90^o\ ;\ \theta = 45^o \quad \Rightarrow \quad e_u = \frac{2\times0.785}{40\times0.229}\times40\times(0+1\times1) = 6.85\,cm$$

Razmak uzengija će biti određen iz uslova zadovoljenja minimalnog procenta armiranja:

$$\mu_{uz} = \frac{m\times a_u^{(1)}}{b\times e_u} \Rightarrow e_u \le \frac{2\times0.785}{40\times0.2\times10^{-2}} = 19.6\ cm \Rightarrow \text{usv. } e_u = 15\ cm$$

$$\tau_{u,u} = \frac{2\times0.785}{40\times15}\times40 = 0.105\,\frac{kN}{cm^2}$$



Dužina na kojoj su potrebni koso povijeni profili je dužina na kojoj je napon τ_{Ru} veći od napona koji prihvataju ovako usvojene uzengije:

$$\lambda_1 = \lambda\times\left(1-\frac{\tau_{u,u}}{\tau_{Ru}}\right) = 209.3\times\left(1-\frac{0.105}{0.229}\right) = 113.7\,cm$$

$$H_{vu,k} = 40\times\frac{0.229-0.105}{2}\times113.7 = 283\,kN$$

$$A_{ak} = \frac{H_{vu,k}}{\sigma_v\times(\cos\alpha_k + \cot\theta\times\sin\alpha_k)} = \frac{283}{40\times\sqrt{2}} = 5.00\,cm^2 \quad \Rightarrow \quad \text{usvojeno: } \mathbf{2RØ22}\ (7.60\ cm^2)$$

2.4 ANALIZA OPTEREĆENJA ZA POS 2

Greda je iste visine kao POS 3, a širina je usvojena tako da odgovara dimenziji opekarskog proizvoda koji se koristi za fasadu (puna opeka širine 25 cm). Za datu spratnu visinu od H_{sp} = 3.50 m i datu fasadu (puna opeka + termoizolacija + kamen 3 cm na potkonstrukciji), težina fasade se dobija kao:

$$g_f = (H_{sp} - d)\times g_{25} + H_{sp}\times g_{kp} = (3.50 - 0.50)\times 4.60 + 3.50\times 0.90 = 16.95 \text{ kN/m}$$

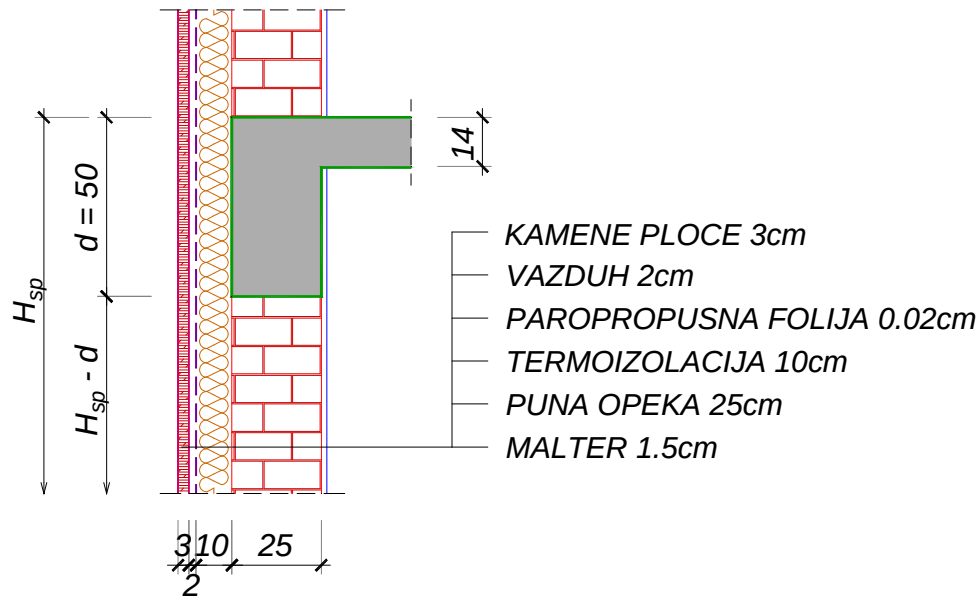
gde je: $g_{25} = 4.60$ kN/m^2 *– težina obostrano omalterisanog zida od pune opeke, a*

$g_{kp} = 0.90$ kN/m^2 *– težina kamenih ploča debljine 3 cm na potkonstrukciji*

Za datu fasadu i usvojene dimenzije grede b/d = 25/50 cm sledi:

- sopstvena težina POS 2	0.25×0.5×25	=	3.13 kN/m
- težina fasade	g_f		= 16.95 kN/m
- stalno opterećenje od POS 1		A_g	= 11.25 kN/m
ukupno, stalno opterećenje		g	= 31.33 kN/m
povremeno opterećenje od POS 1:		$A_p = p$	= 7.50 kN/m

Detalj fasade



2.5 PRELIMINARNO DIMENZIONISANJE POS 2

2.5.1 Dimenzionisanje prema momentu savijanja

$q_u = 1.6\times31.33 + 1.8\times7.5 = 63.62$ kN/m

$M_{u,1} = 63.62\times6.0^2/10 = 229.0$ kNm - gornja zona, oslonac

pretp. $a_1 = 7$ cm $\Rightarrow$ b/d/h = 25/50/43 cm

$$k = \frac{43}{\sqrt{\frac{229.0\times10^2}{25\times2.05}}} = 2.034 \Rightarrow \begin{cases}\varepsilon_b / \varepsilon_a = 3.5/6.519‰ \\ \mu = 28.278\%\end{cases}$$

$$A_a = 28.278\times\frac{25\times43}{100}\times\frac{2.05}{40} = 15.58\,cm^2 \Rightarrow \text{usvojeno: } \mathbf{5RØ22}\ (19.01\ cm^2)$$

2.5.2 Kontrola glavnih napona zatezanja

$$T_u^{B,levo} = 0.6\times63.62\times6.0 = 229.0\ kN \Rightarrow \tau_n^{B,I} = \frac{229.0}{25\times0.9\times43} = 0.237\frac{kN}{cm^2} \begin{cases}>\tau_r \\ <3\tau_r\end{cases}$$

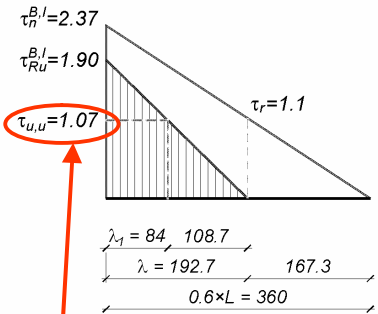
$$\lambda = 0.6\times600\times\left(1-\frac{0.11}{0.237}\right) = 192.7\,cm$$

$$\tau_{Ru}^{B,I} = \frac{3}{2}\times(0.237-0.11) = 0.190\frac{kN}{cm^2}$$

usvojeno: $m = 2$; $\alpha = 90°$; $\theta = 45°$:

$$e_u = \frac{2\times0.503}{25\times0.190}\times40\times(0+1\times1) = 8.5\,cm$$

usvojeno: **URØ8/7.5**



U bilo kojoj varijanti, s obzirom na relativno veliiku dužinu osiguranja, uzengije će biti proređene na dvosečne URØ8/15, koje mogu prihvatiti napon:

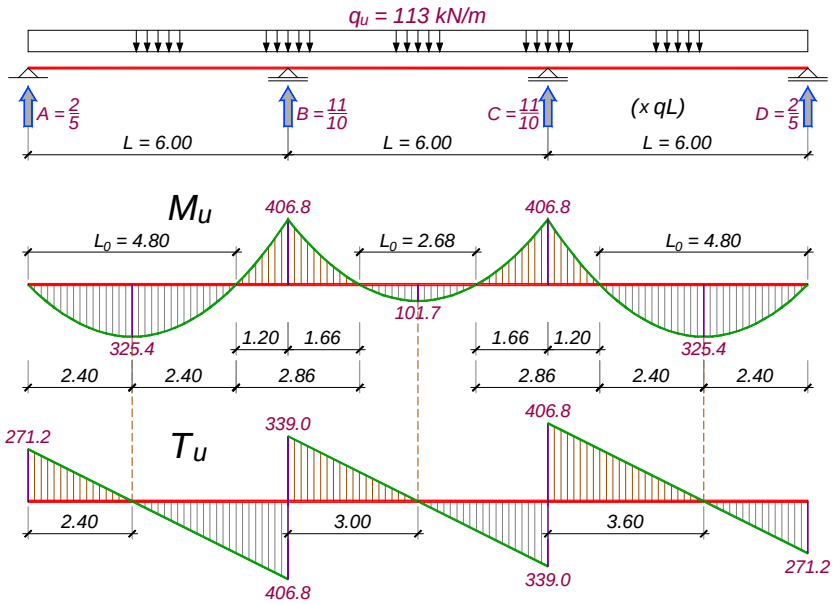
$$\mu = \frac{2\times0.503}{25\times15} = 0.268\% \Rightarrow \tau_{u,u} = \frac{2\times0.503}{25\times15}\times40 = 0.107\frac{kN}{cm^2}$$

Ovako usvojene uzengije nisu dovoljne na dužini:

$$\lambda_1 = 192.7\times\left(1-\frac{0.107}{0.190}\right) = 84.0\,cm$$

Dakle, na dužini $\lambda_1 = 84$ cm konačno su usvojene udvojene uzengije 2URØ8/15, a na preostalom delu dužine osiguranja jednostruke URØ8/15.

POS 3 - granično opterećenje (1.6×G+1.8×P)



2.7.1.2 Preseci u krajnjim poljima

$$L_0 = 0.8\times600 = 480\ cm \quad \Rightarrow \quad B = \min.\begin{Bmatrix} 40+20\times14 = 320 \\ 40+0.25\times480 = 160 \end{Bmatrix} = 160\,cm$$

$$k = \frac{45}{\sqrt{\frac{325.4\times10^2}{160\times2.05}}} = 4.518 \Rightarrow \begin{cases} \varepsilon_b/\varepsilon_a = 1.193/10‰ \\ s = 0.107 \Rightarrow x = 0.107\times45 = 4.8\,cm < d_p = 14\,cm \\ \bar{\mu} = 5.092\% \end{cases}$$

$$A_a = 5.092\times\frac{160\times45}{100}\times\frac{2.05}{40} = 18.79\,cm^2 \quad \Rightarrow \quad \text{usv.:} \quad \mathbf{5RØ22}\ (19.01\ cm^2)$$

2.7.1.3 Presek u srednjem polju

$$L_0 = \frac{L}{\sqrt{5}} = \frac{600}{\sqrt{5}} = 268\ cm \quad \Rightarrow \quad B = \min.\begin{Bmatrix} 40+20\times14 = 320 \\ 40+0.25\times268 = 107 \end{Bmatrix} = 107\,cm$$

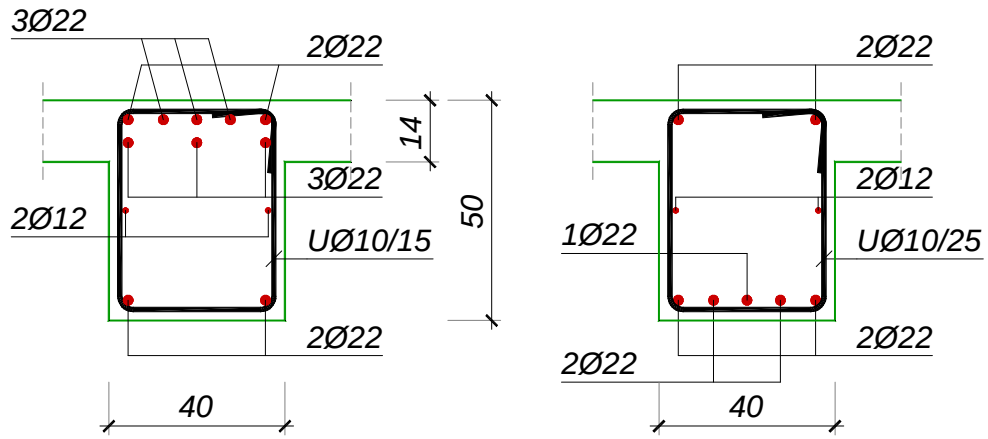
$$k = \frac{45}{\sqrt{\frac{101.7\times10^2}{107\times2.05}}} = 6.611 \Rightarrow \begin{cases} \varepsilon_b/\varepsilon_a = 0.76/10‰ \\ s = 0.071 \Rightarrow x = 0.071\times45 = 3.2\,cm < d_p = 14\,cm \\ \bar{\mu} = 2.345\% \end{cases}$$

$$A_a = 2.179\times\frac{107\times45}{100}\times\frac{2.05}{40} = 5.79\,cm^2 > A_{a,\min} = 0.2\times\frac{40\times50}{100} = 4.0\,cm^2$$

usvojeno: **2RØ22** (7.60 cm^2)

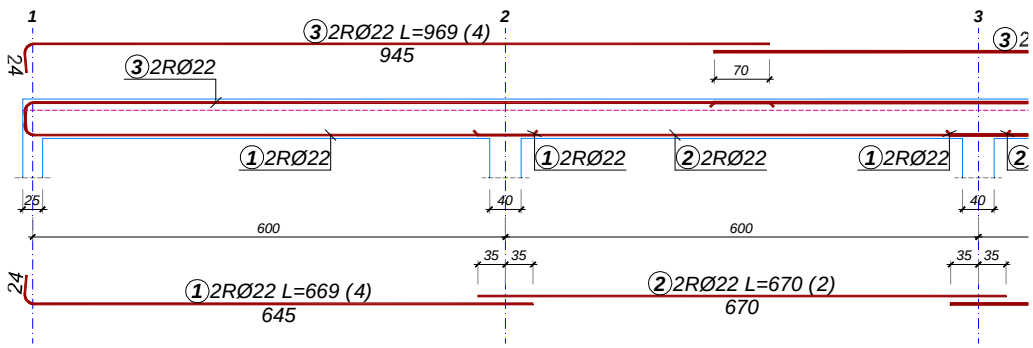
POS 3 – preseci nad osloncem i u krajnjem polju

11

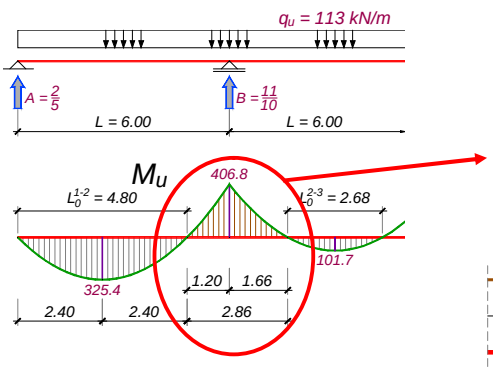


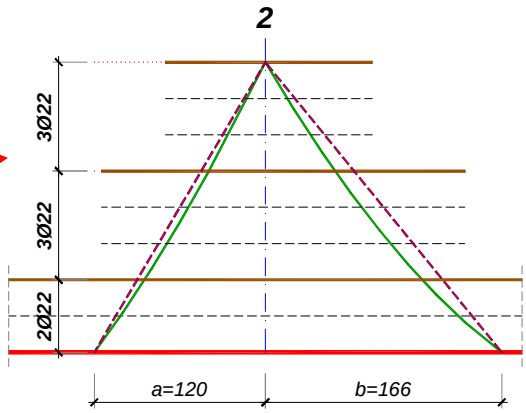
Armatura kontinualne grede – ugaone šipke

12



Procena dužine šipki u gornjoj zoni

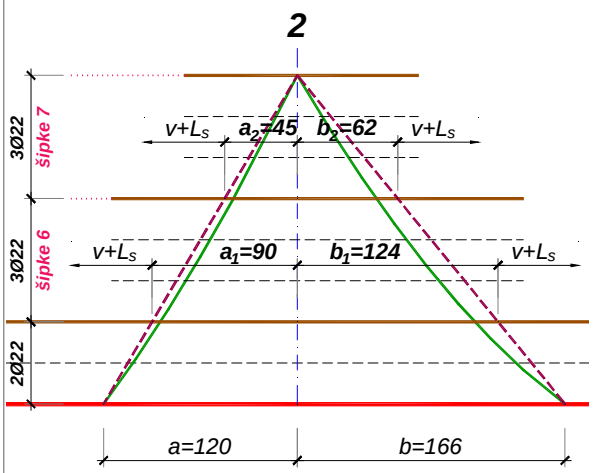




$$L_0^{1-2} = 0.8 \times L = 0.8 \times 600 = 480\,cm \Rightarrow a = L - L_0^{1-2} = 600 - 480 = 120\,cm$$

$$L_0^{2-3} = \frac{L}{\sqrt{5}} = \frac{600}{\sqrt{5}} = 268\,cm \Rightarrow b = \frac{L - L_0^{2-3}}{2} = \frac{600 - 268}{2} = 166\,cm$$

Procena dužine šipki u gornjoj zoni



$$v = 0.75 \times 43 \approx 32\,cm$$

$$MB\ 30 \Rightarrow \tau_p = 1.75\,MPa$$

$$L_{s1} = \frac{400}{4 \times 1.8 \times 1.75} Ø = 31.75 \times Ø$$

$$L_{s2} = 1.5 \times L_{s1} = 47.6 \times 2.2 \approx 105\,cm$$

$$v + L_{s2} = 32 + 105 = 137 \approx 140\,cm$$

$$a_1 = a \times \frac{6Ø22}{8Ø22} = 0.75 \times 120 = 90\,cm$$

$$a_2 = a \times \frac{3Ø22}{8Ø22} = 0.375 \times 120 = 45\,cm$$

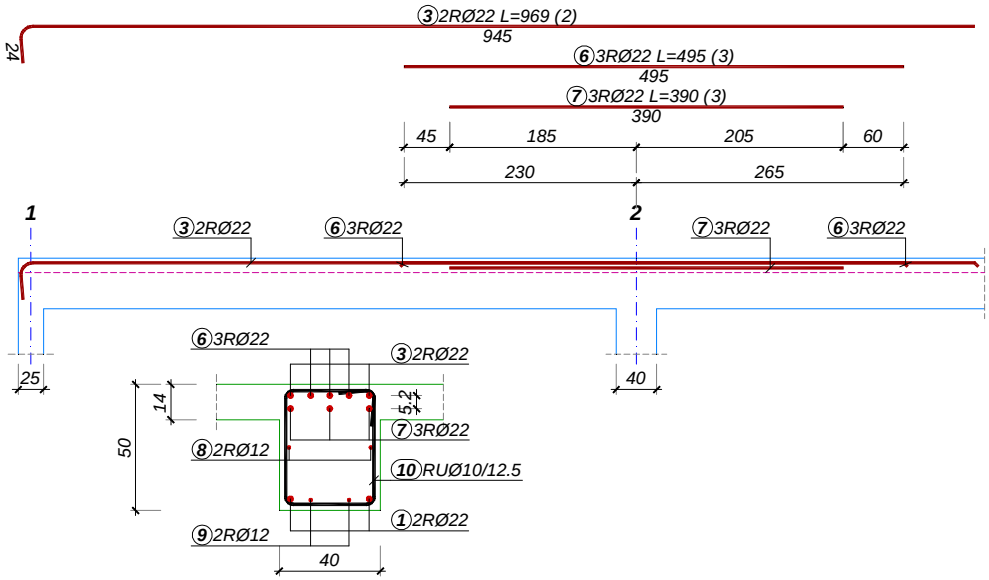
$$b_1 = b \times \frac{6Ø22}{8Ø22} = 0.75 \times 166 = 124\,cm$$

$$b_2 = b \times \frac{3Ø22}{8Ø22} = 0.375 \times 166 = 62\,cm$$

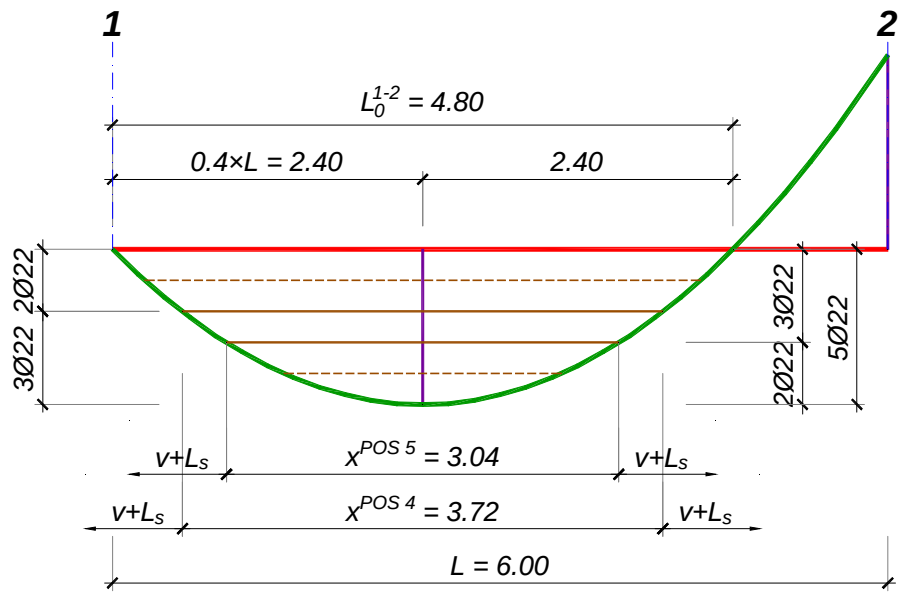
$$L^{POS6} = 140 + 90 + 124 + 140 = 494 \approx 495\,cm$$

$$L^{POS7} = 140 + 45 + 62 + 140 = 387 \approx 390\,cm$$

Procena dužine šipki u gornjoj zoni



Procena dužine šipki u donjoj zoni – krajnja polja



Procena dužine šipki u donjoj zoni

$$x^{POS5} = L_0 \times \sqrt{\frac{M_1}{M}} = L_0 \times \sqrt{\frac{2Ø22}{5Ø22}} = 4.80 \times \sqrt{0.4} = 3.04\,m$$

$$v + L_s = v + L_{s1} = 0.75 \times h + L_{s1} \approx 32 + 31.75 \times 2.2 \approx 102\,cm$$

$$L^{POS5} \approx v + L_s + x^{POS5} + v + L_s = 102 + 304 + 102 = 508 \approx 510\,cm$$

$$x^{POS4} = L_0 \times \sqrt{\frac{M_2}{M}} = L_0 \times \sqrt{\frac{3Ø22}{5Ø22}} = 4.80 \times \sqrt{0.6} = 3.72\,m$$

$$L^{POS4} \approx v + L_s + x_2 + v + L_s = 102 + 372 + 102 = 576 \approx 580\,cm$$

Šipke su simetrično postavljene u odnosu na mesto maksimalnog momenta u polju (x = 2.4 m od ose 1 ka osi 2)

Procena dužine šipki u donjoj zoni – krajnja polja