Studijski program: **Građevinarstvo**
Modul: Konstrukcije
Godina/Semestar: **III godina / V semestar**

Naziv predmeta (šifra): **Teorija betonskih konstrukcija 1 (b2κ3b1)**

Nastavnik: **Ivan Ignjatović**

Naslov vežbi: **Plan armature grede**

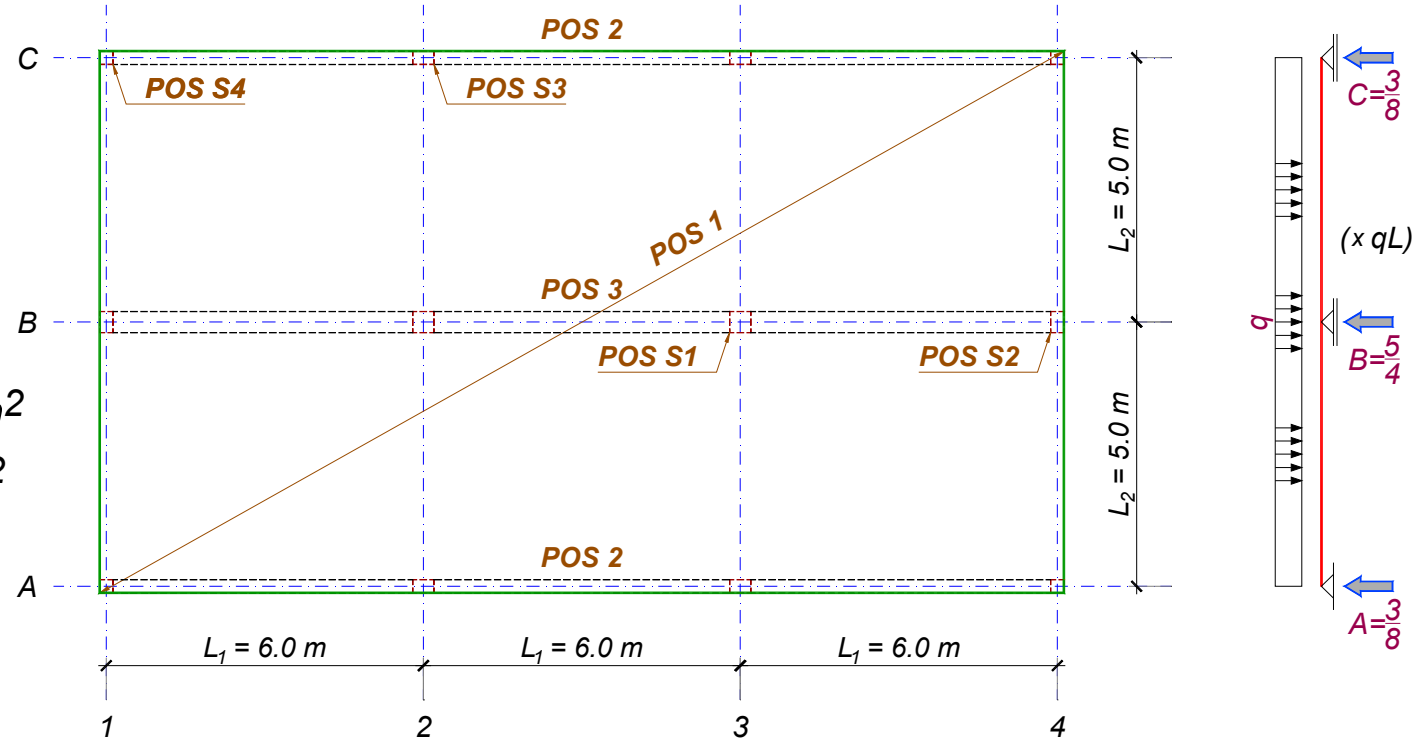
Datum : 20.12.2022.

Zadatak 30– PLOČA U JEDNOM PRAVCU

Za konstrukciju koja je prikazana na skici, dimenzionisati ploču POS 1 (h=14 cm) i gredu POS 3 (b/h=40/50). Osim sopstvene težine konstrukcije, u obzir uzeti dodatno stalno (Δg) i korisno (q) opterećenje na ploči.

$\Delta g = 2.5\ kN/m^2$
$q = 4.0\ kN/m^2$

C25/30
B420
XC1



Zadatak 30– PLOČA U JEDNOM PRAVCU

POS 1 - PLOČA

1. ANALIZA OPTEREĆENJA

Debljina (visina) ploče

Zapreminska masa betona

Stalno opterećenje

sopstvena težina ploče → $h_p \cdot \rho_c = 0.14m \times 25kN/m^3 = 3.5\ kN/m^2$

dodatno stalno opterećenje $\Delta g = 2.5\ kN/m^2$

ukupno, stalno opterećenje $g = 6.0\ kN/m^2$

Povremeno opterećenje $q = 4.0\ kN/m^2$

Zadatak 30– PLOČA U JEDNOM PRAVCU

2. PRORAČUN STATIČKIH UTICAJA

- *na gredu POS 2:*

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

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

- *na gredu POS 3:*

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

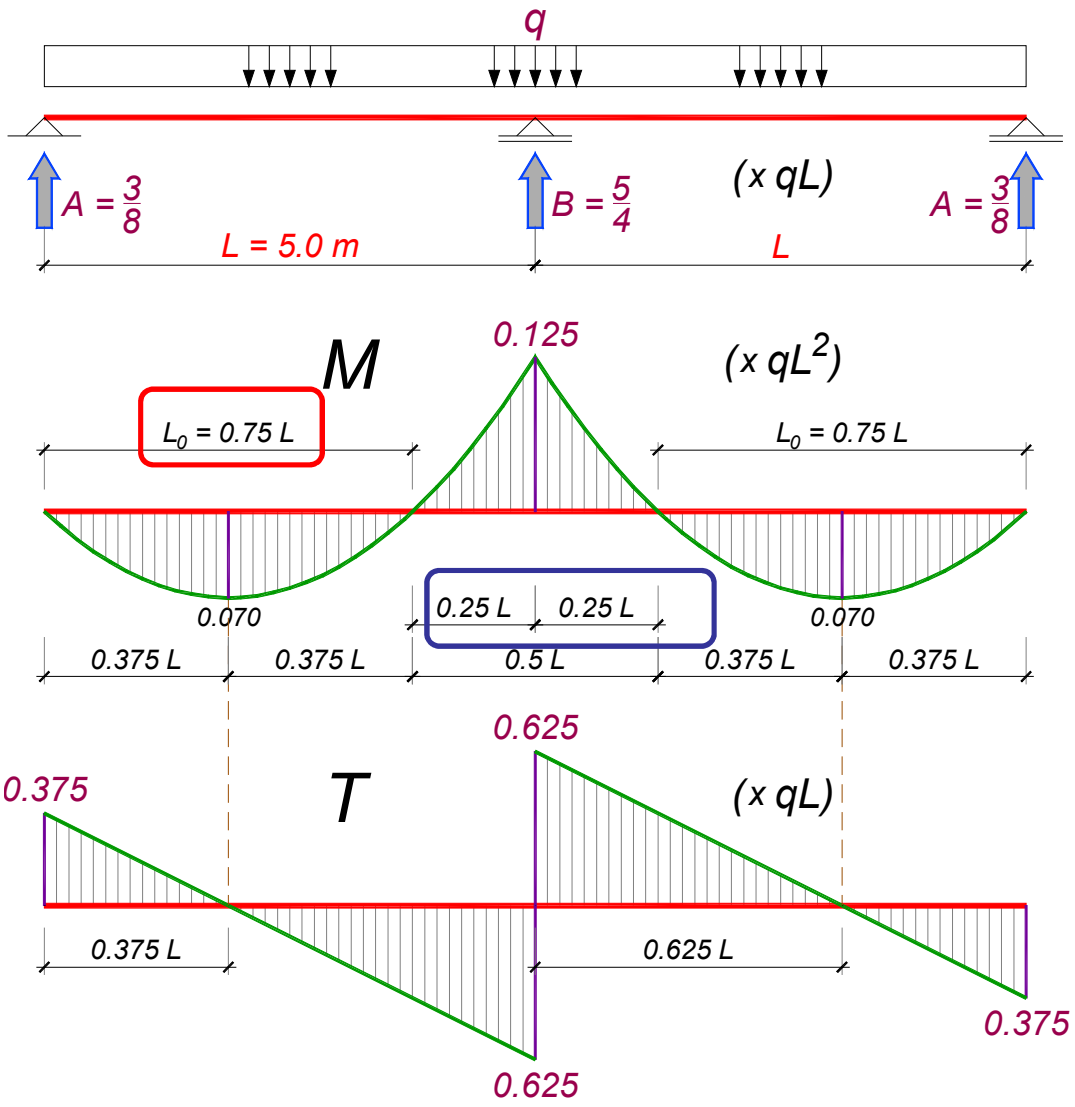
$B_p = 1.25 \times 4.0 \times 5.0 = 25.0$ kN/m

Koeficijenti reakcija oslonaca za **prikazan** statički sistem.

TABLICE !

Koeficijenti za proračun momenata savijanja za **prikazan** statički sistem.

Zadatak 30– PLOČA U JEDNOM PRAVCU



Moment u polju:

$M_g = 0.07 \times 6.0 \times 5.0^2 = 10.5$ kNm/m

$M_q = 0.07 \times 4.0 \times 5.0^2 = 7.0$ kNm/m

Moment iznad oslonca:

$M_g = 0.125 \times 6.0 \times 5.0^2 = 18.75$ kNm/m

$M_q = 0.125 \times 4.0 \times 5.0^2 = 12.5$ kNm/m

Zadatak 30– PLOČA U JEDNOM PRAVCU

3. DIMENZIONISANJE

C25/30 f_{cd} = 0.85·25/1.5= 14.2MPa = 1.42 kN/cm^2

B420 f_{yd} = 420/1.15 = 365 MPa = 36.5 kN/cm^2

XC1 c_{nom}= 2.5 cm/ iz uslova $c_{min,b}$, **vidi vežbe 2V** /

3.1 Gornja zona – presek iznad oslonca

1. M_{Ed}=1.35·18.75+1.35 ·12.5 = 44.1 kNm/m
2. pretp. d_1 = 3.5 cm , d = h – d_1 = 14– 3.5 = 10.5 cm
3. $$k = \frac{d}{\sqrt{\frac{M_{Ed}}{b \cdot f_{cd}}}} = \frac{10.5}{\sqrt{\frac{44.1 \cdot 10^2}{10^2 \cdot 1.42}}} = 1.884$$

$\varepsilon_c / \varepsilon_{s1}$ =3.5/4.8‰

Zadatak 30 – PLOČA U JEDNOM PRAVCU

Glavna armatura:

$$A_{s1} = \omega_1 bd \frac{f_{cd}}{f_{yd}} = 34.137 \cdot \frac{100 \cdot 10.5}{100} \cdot \frac{1.42}{36.5} = 13.95 cm^2 / m$$

$$prp.\text{Ø}16 (a_s^{(1)} = 2.01 cm^2) \qquad s = \frac{100 \cdot a_s^{(1)}}{A_s} = \frac{201}{13.95} = 14.4 cm$$

komentar ?

Usvojeno: Ø16/15 (2.01·100/15=13.4 cm²/m)

Podeona armatura:

$$A_{sp} = 0.2 \cdot 13.95 = 2.79 cm^2 / m$$

$$prp.\text{Ø}10 (a_s^{(1)} = 0.785 cm^2) \qquad s = \frac{100 \cdot a_s^{(1)}}{A_s} = \frac{78.5}{2.79} = 28.1 cm$$

Usvojeno: Ø10/25 (0.785·100/25=3.14 cm²/m)

Zadatak 30 – PLOČA U JEDNOM PRAVCU

3.2 Donja zona – presek u polju

M_{Ed}=1.35·10.5+1.35 ·7 = 23.6 kNm/m

$k = 2.576$ $\varepsilon_c / \varepsilon_{s1}$ =3.5/13.5‰

Glavna armatura:

$A_{s1} = 6.81 cm^2 / m$ $prp.Ø12 (a_s^{(1)} = 1.13 cm^2)$ $s = \frac{100 \cdot a_s^{(1)}}{A_s} = \frac{113}{6.81} = 16.6 cm$

Usvojeno: Ø12/15 (1.13·100/15=7.53 cm²/m)

Podeona armatura:

$A_{sp} = 0.2 \cdot 6.81 = 1.36 cm^2 / m$

$prp.Ø8 (a_s^{(1)} = 0.503 cm^2)$ $s = \frac{100 \cdot a_s^{(1)}}{A_s} = \frac{50.3}{1.36} = 36.9 cm$

Usvojeno: Ø8/30 (0.503·100/30=1.68 cm²/m)

$$A_{s,min} = A_{sp,min} = 0.0013 \cdot 100 \cdot d = 0.13 \cdot 10.5 = 1.365 cm^2 / m \begin{cases} < A_{s,usv} \\ < A_{sp,usv} \end{cases}$$

Zadatak 30 – PLOČA U JEDNOM PRAVCU

3.4 Kontrola smicanja – krajnji oslonac (A)

$$V_{Ed} = 1.35 \cdot 11.25 + 1.5 \cdot 7.5 = 26.4 \frac{kN}{m}$$

$$\rho_l = \frac{7.5/2}{12} = 0.313\%; \qquad k = 1 + \sqrt{\frac{200}{105}} = 2.38 > 2! \Rightarrow \quad k = 2$$

$$V_{Rd,c} = 0.12 \cdot 2 \cdot (0.313 \cdot 25)^{\frac{1}{3}} \cdot 100 \cdot \frac{12}{10} = 57.2 \frac{kN}{m} > V_{Ed}$$

3.4 Kontrola smicanja – srednji oslonac (B)

$$V_{Ed} = 1.35 \cdot 37.5 + 1.5 \cdot 25 = 88.1 \frac{kN}{m}$$

$$\rho_l = \frac{13.4}{10.5} = 1.276\%; \qquad k = 1 + \sqrt{\frac{200}{105}} = 2.38 > 2! \Rightarrow \quad k = 2$$

$$V_{Rd,c} = 0.12 \cdot 2 \cdot (1.276 \cdot 25)^{\frac{1}{3}} \cdot 100 \cdot \frac{12}{10} = 91.3 \frac{kN}{m} > V_{Ed}$$

Nije potrebno osiguranje ploče od smicanja

Zadatak 30– PLOČA U JEDNOM PRAVCU

POS 3 - GREDA

1. ANALIZA OPTEREĆENJA

Dimenzije grede (b,h)

Zapreminska masa betona

Stalno opterećenje

sopstvena težina POS 3 → $b \cdot h \cdot \rho_c = 0.4 \cdot 0.5 \cdot 25 kN/m^3 = 5$ kN/m

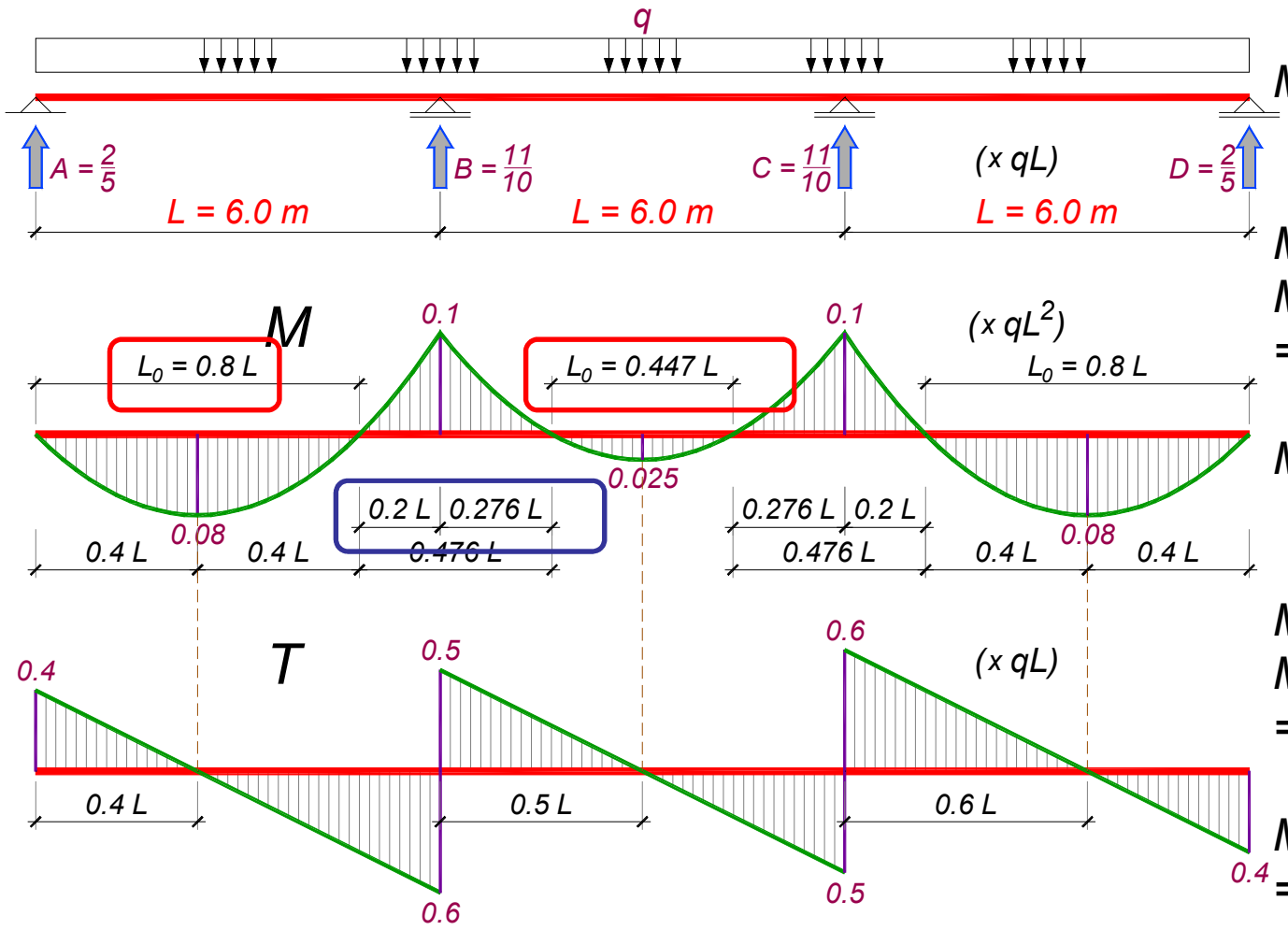
stalno opterećenje sa POS 1 $B_g = 37.5$ kN/m

ukupno stalno opterećenje $g = 42.5$ kN/m

Povremeno opterećenje sa POS 1 $q = B_q = 25.0$ kN/m

Zadatak 30– PLOČA U JEDNOM PRAVCU

2. STATIČKI UTICAJI



Moment u prvom polju:

$M_g = \mathbf{0.08} \times 42.5 \times 6.0^2$
$= 122.4 kNm$

$M_q = \mathbf{0.08} \times 25 \times 6.0^2$
$= 72\ kNm$

Moment u srednjem polju:

$M_g = \mathbf{0.025} \times 42.5 \times 6.0^2$
$= 38.25\ kNm$

$M_q = \mathbf{0.025} \times 25 \times 6.0^2$
$= 22.5\ kNm$

Moment iznad oslonca:

$M_g = \mathbf{0.1} \times 42.5 \times 6.0^2$
$= 153\ kNm$

$M_q = \mathbf{0.1} \times 25 \times 6.0^2$
$= 90\ kNm$

Zadatak 30– PLOČA U JEDNOM PRAVCU

3. DIMENZIONISANJE

3.1.1 Prema momentima savijanja – **PRVO POLJE**

1. M_{Ed}=1.35·122.4+ 1.5·72 = 273.2 kNm
2. pretp. d_1 = 7 cm

   d = h – d_1 = 50– 7 = 43 cm

$$b_{eff} = \Sigma b_{eff,i} + b_w \le b$$
$$b_{eff,i} = 0.2 b_i + 0.1 l_0 \le 0.2 l_0$$
$$b_{eff,i} \le b_i$$

/ Vidi 4V_TBK1, slajd 8 /

$$b_{eff,1} = b_{eff,2} = 0.2\frac{(500-40)}{2} + 0.1(0.8\cdot 600) = 94 < 0.2(0.8\cdot 600) = 96$$
$$b_{eff,1} = b_{eff,2} = 94 < 230 = b_i$$
$$b_{eff} = 94 + 94 + 40 = 228 \le b = 500$$

Zadatak 30– PLOČA U JEDNOM PRAVCU

3. Pretpostavka: **$x < h_f$**

$$k = \frac{d}{\sqrt{\frac{M_{Ed}}{b \cdot f_{cd}}}} = \frac{43}{\sqrt{\frac{273.2 \cdot 10^2}{228 \cdot 1.42}}} = 4.681$$

$\varepsilon_c / \varepsilon_{s1} \approx 3.5/58‰$ $\quad \xi = 0.057$

$x = 0.057 \cdot 43 = 2.45$ cm $< 14 = h_f$!

Presek se dimenzioniše kao pravougaoni sa širinom pritisnute zone beff

4. Potrebna površina zategnute armature

$$A_{s1} = \omega_1 bd \frac{f_{cd}}{f_{yd}} = 4.609 \cdot \frac{228 \cdot 43}{100} \cdot \frac{1.42}{36.5} = 17.58 cm^2$$

$$A_{s1,\min} = \max \left\{ \begin{array}{l} 0.26 \cdot \frac{2.9}{420} \cdot 40 \cdot 43 = 3.09 cm^2 \\ 0.0013 \cdot 40 \cdot 43 = 2.24 cm^2 \end{array} \right\} = 3.09 < 17.89 cm^2 = A_{s1,pot}$$

5. Usvojeno: 6Ø20 (18.84 cm^2)

Zadatak 30– PLOČA U JEDNOM PRAVCU

3. DIMENZIONISANJE

3.1.2 Prema momentima savijanja – **SREDNJE POLJE**

1. M_{Ed}=1.35·38.25+ 1.5·22.5= 85.4 kNm
3. Pretpostavka: **x < h_f ;** d=45 cm

$$b_{eff,1} = b_{eff,2} = 0.2\frac{(500-40)}{2} + 0.1(0.447\cdot 600) = 72.82 > 0.2(0.447\cdot 600) = 53.64$$

$$b_{eff,1} = b_{eff,2} = 53.64 < 230 = b_i$$

$$b_{eff} = 53.64 + 53.64 + 40 = 147.28 \le b = 500$$

$k = 7.042$ $\quad \varepsilon_c / \varepsilon_{s1} \approx 3.5/136‰ \quad \xi = 0.025 \quad x = 1.125\ cm < 14 = h_f$

4. Potrebna armatura: $A_{s1} = 5.2cm^2 > A_{s1,\min}$

5. Usvojeno: 3Ø16 (6.03 cm^2)

Zadatak 30– PLOČA U JEDNOM PRAVCU

3. DIMENZIONISANJE

3.1.2 Prema momentima savijanja – **OSLONAC**

1. M_{Ed}=1.35·153+ 1.5·90= 341.55 kNm
2. Pretpostavka: d_1=8 cm d= 50 – 8 = 42 cm

$k = 1.713$ $\varepsilon_c / \varepsilon_{s1} \approx 3.5/2.953‰$ $\omega_1 \approx 43.905$

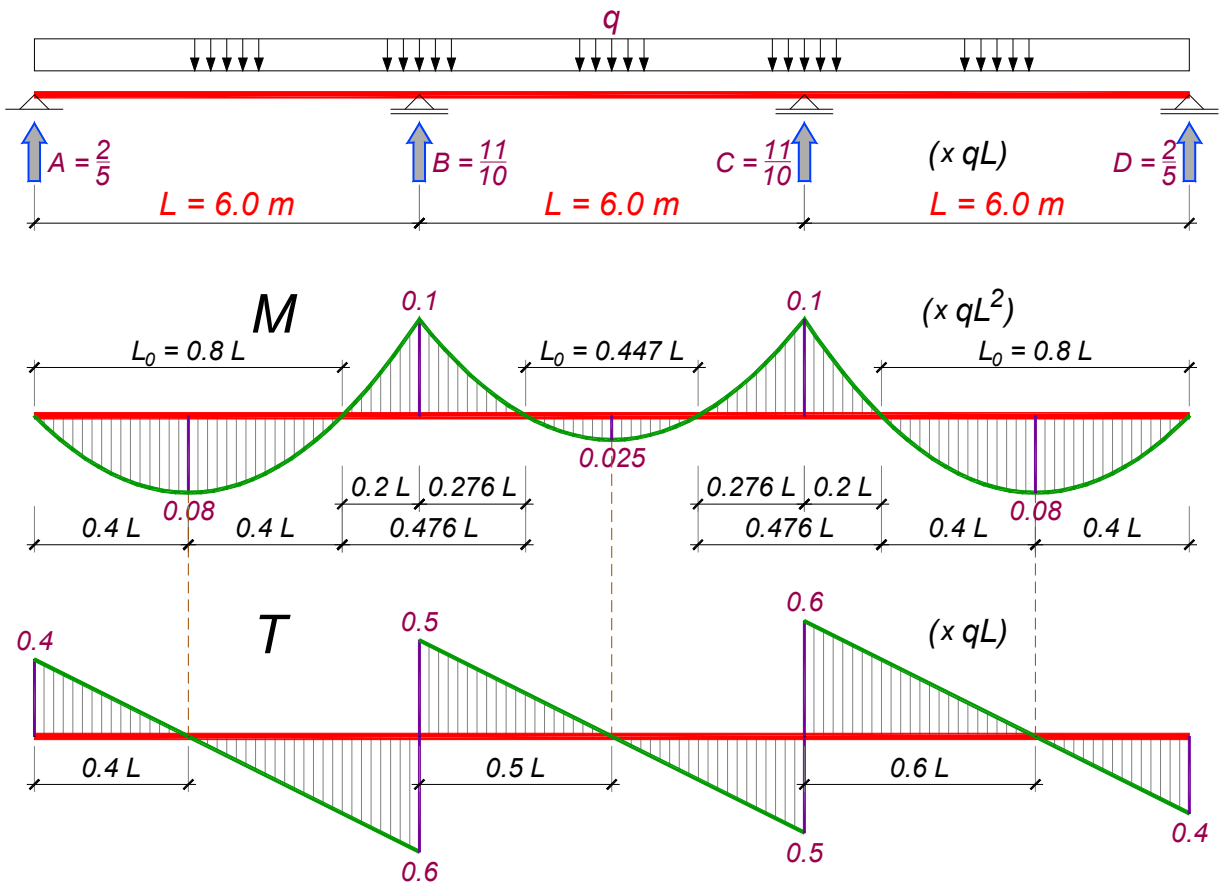
3. Potrebna armatura: $A_{s1} = 28.7 cm^2 > A_{s1,\min}$

4. Usvojeno: 6Ø25 (29.46 cm^2)

Zadatak 30– PLOČA U JEDNOM PRAVCU

3. DIMENZIONISANJE

3.2. Prema transverzalnim silama



V sila na ivičnom osloncu:

V_g = ***0.4***×42.5×6.0=102 kN

V_q = ***0.4***×25×6.0 = 60 kN

V_{Ed}=1.35·102+1.5·60=***227.7*** kN

V sila na srednjem osloncu:

V_g = ***0.6***×42.5×6.0=153 kN

V_q = ***0.6***×25×6.0 = 90 kN

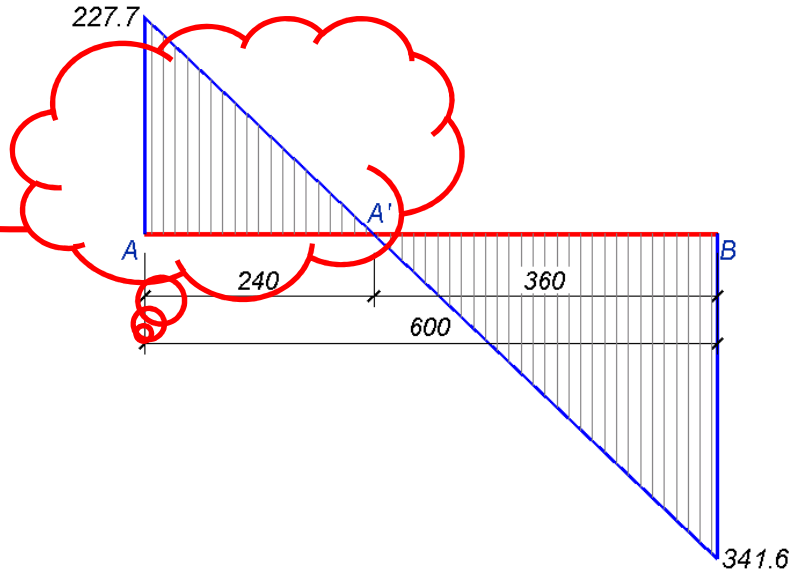
V_{Ed}=1.35·153+1.5·90=***341.6*** kN

Zadatak 30– PLOČA U JEDNOM PRAVCU

1. Proračunske vrednosti uticaja:

segment: A-A'

$V_{Ed,max}$=227.7 kN



2. Proračun nosivosti betona na smicanje: / vidi vežbe 10V /

$$C_{Rd,c} = \frac{0.18}{\gamma_c} = \frac{0.18}{1.5} = 0.12 \qquad k = 1 + \sqrt{\frac{200}{d}} = 1 + \sqrt{\frac{200}{420}} = 1.69$$

Vidi plan armature!

$$\rho_1 = \frac{A_{sl}}{b_w \cdot d} = \frac{2 \cdot 3.14}{40 \cdot 43} = 0.0036 < 0.02$$

$$V_{Rd,c} = \left[0.12 \cdot 1.69 \cdot \left(100 \cdot 0.0036 \cdot 25\right)^{1/3}\right] \cdot \frac{40 \cdot 43}{10} = 70.1kN$$

Zadatak 30– PLOČA U JEDNOM PRAVCU

3. Minimalna nosivost betona na smicanje:

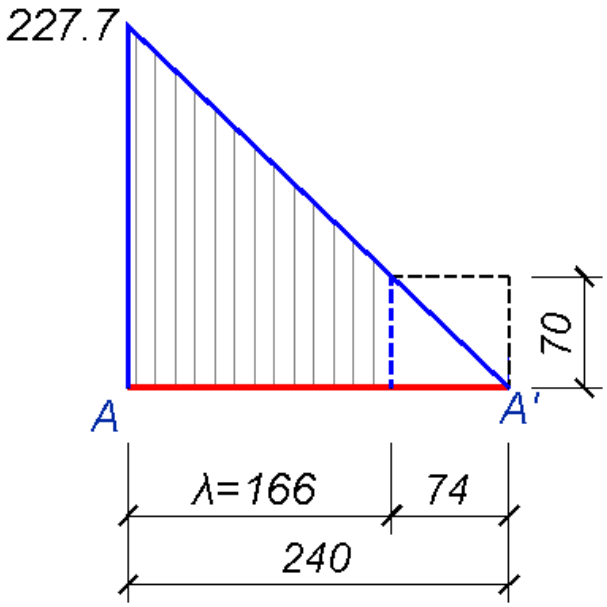
$$V_{\min} = \left[v_{\min} + k_1 \cdot \sigma_{cp} \right] \cdot b_w \cdot d = \left[0.0035 \cdot k^{3/2} \cdot f_{ck}^{1/2} \right] \cdot b_w \cdot d$$

$$V_{\min} = \left[0.0035 \cdot 1.632^{3/2} \cdot 25^{1/2} \right] \cdot 40 \cdot 43 = 62.7 kN$$

4. Nosivost betona na smicanje:

$$V_{Rd,c} = \max \begin{Bmatrix} 70.1 kN \\ 62.7 kN \end{Bmatrix} 70.1 kN < 227.7 kN$$

Na delu nosača – **dužini osiguranja (λ)** potrebno osiguranje poprečnom armaturom!



Zadatak 25 – SMICANJE

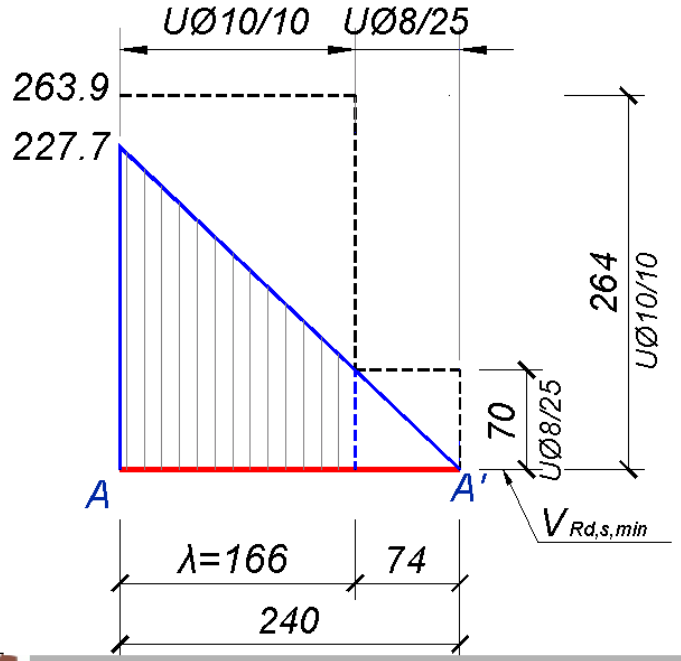
5. Određivanje potrebne armature za smicanje

Pretpostavljeno: θ=45⁰, ctgθ=1, m=2, ***Ø10****,* $a_{sw}^{(1)}=0.785\ cm^2$

$$s_{rač} \le \frac{m \cdot a_{sw}^{(1)}}{V_{Ed}} \cdot z \cdot f_{ywd} \cdot ctg\theta = \frac{2 \cdot 0.785}{227.7} \cdot 0.9 \cdot 43 \cdot 36.5 \cdot 1.0 = 9.7cm$$

Usvojeno: θ=40⁰, ctgθ=1.19, m=2, ***Ø10****,* $a_{sw}^{(1)}=0.785\ cm^2$

$$s_{rač} \le \frac{m \cdot a_{sw}^{(1)}}{V_{Ed}} \cdot z \cdot f_{ywd} \cdot ctg\theta = \frac{2 \cdot 0.785}{227.7} \cdot 0.9 \cdot 43 \cdot 36.5 \cdot 1.19 = 11.6cm$$



Usvojeno: UØ10/10

V_{Rd} (UØ10/10) = 263.9 kN

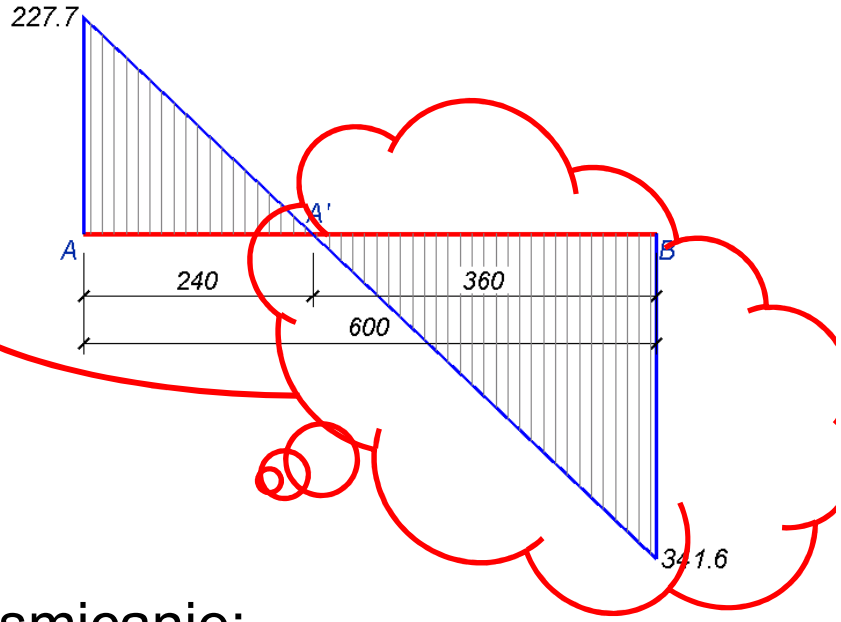
Kontrolisati: **$V_{Rd,max}$; $\rho_{w,min}$**

Zadatak 30– PLOČA U JEDNOM PRAVCU

1. Proračunske vrednosti uticaja:

   segment: B-A'

   $V_{Ed,max}$=341.6 kN



2. Proračun nosivosti betona na smicanje:

$$C_{Rd,c} = \frac{0.18}{\gamma_c} = \frac{0.18}{1.5} = 0.12 \qquad k = 1 + \sqrt{\frac{200}{d}} = 1 + \sqrt{\frac{200}{420}} = 1.69$$

Vidi plan armature!

$$\rho_i = \frac{A_{sl}}{b_w \cdot d} = \frac{6 \cdot 4.91}{40 \cdot 42} = 0.0175 < 0.02$$

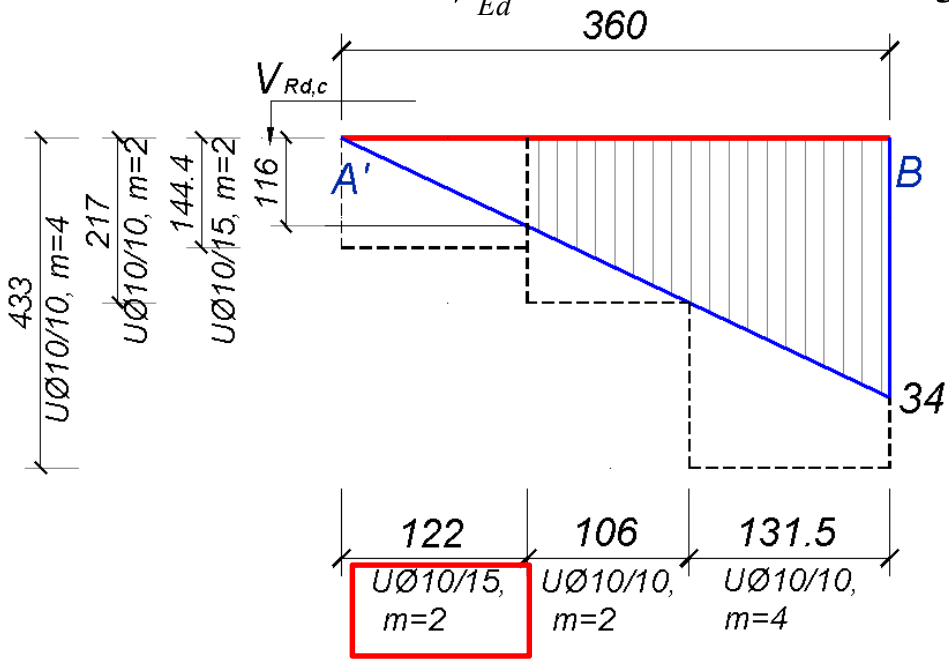
$$V_{Rd,c} = \left[0.12 \cdot 1.69 \cdot \left(100 \cdot 0.0175 \cdot 25\right)^{1/3}\right] \cdot \frac{40 \cdot 42}{10} = 115.9kN$$

Zadatak 25 – SMICANJE

5. Određivanje potrebne armature za smicanje

Pretpostavljeno: θ=45⁰, ctgθ=1, ***m=4****,* ***Ø10****,* $a_{sw}^{(1)}=0.785\ cm^2$

$$s_{rač} \le \frac{m \cdot a_{sw}^{(1)}}{V_{Ed}} \cdot z \cdot f_{ywd} \cdot ctg\theta = \frac{4 \cdot 0.785}{341.6} \cdot 0.9 \cdot 42 \cdot 36.5 \cdot 1.0 = 12.7cm$$



Usvojeno: **UØ10/10 (m=4) + UØ10/10 (m=2)**

V_{Rd} (UØ10/10, m=4) = 433.2 kN

V_{Rd} (UØ10/10, m=2) = 216.6 kN

V_{Rd} (UØ10/15, m=2) = 144.4 kN

„pokrivamo“ $V_{Rd,c}$ **jer ne znamo da li u preseku na 122 cm od A' imamo podužnu armaturu sa kojom smo računali** $V_{Rd,c}$

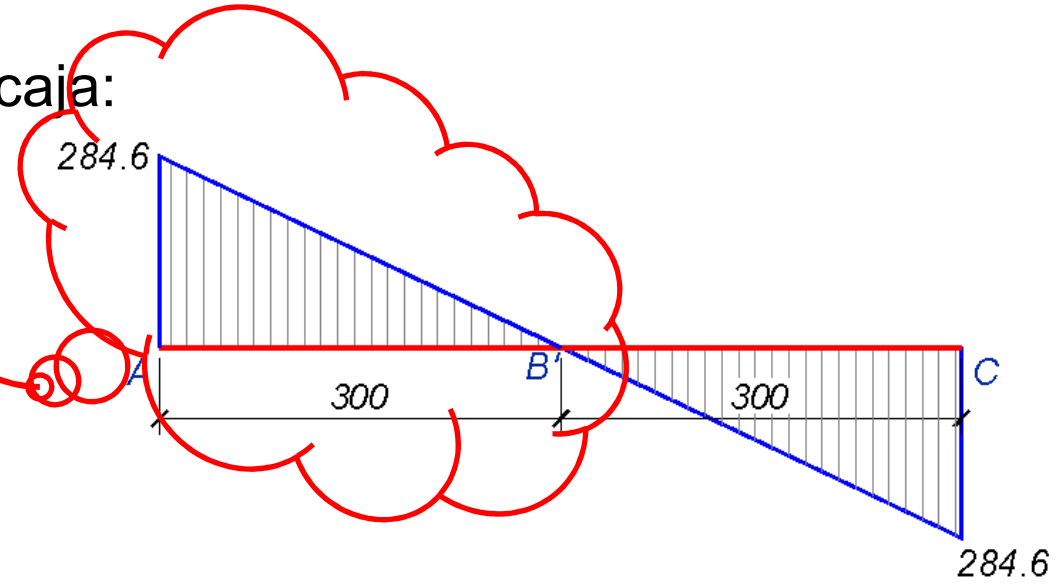
Kontrolisati: **$V_{Rd,max}$; $\rho_{w,min}$**

Zadatak 30– PLOČA U JEDNOM PRAVCU

1. Proračunske vrednosti uticaja:

segment: B-B'

$V_{Ed,max}$=284.6 kN



2. Proračun nosivosti betona na smicanje:

$$C_{Rd,c} = \frac{0.18}{\gamma_c} = \frac{0.18}{1.5} = 0.12 \qquad k = 1 + \sqrt{\frac{200}{d}} = 1 + \sqrt{\frac{200}{420}} = 1.69$$

$$\rho_i = \frac{A_{sl}}{b_w \cdot d} = \frac{6 \cdot 4.91}{40 \cdot 42} = 0.0175 < 0.02$$

Vidi plan armature!

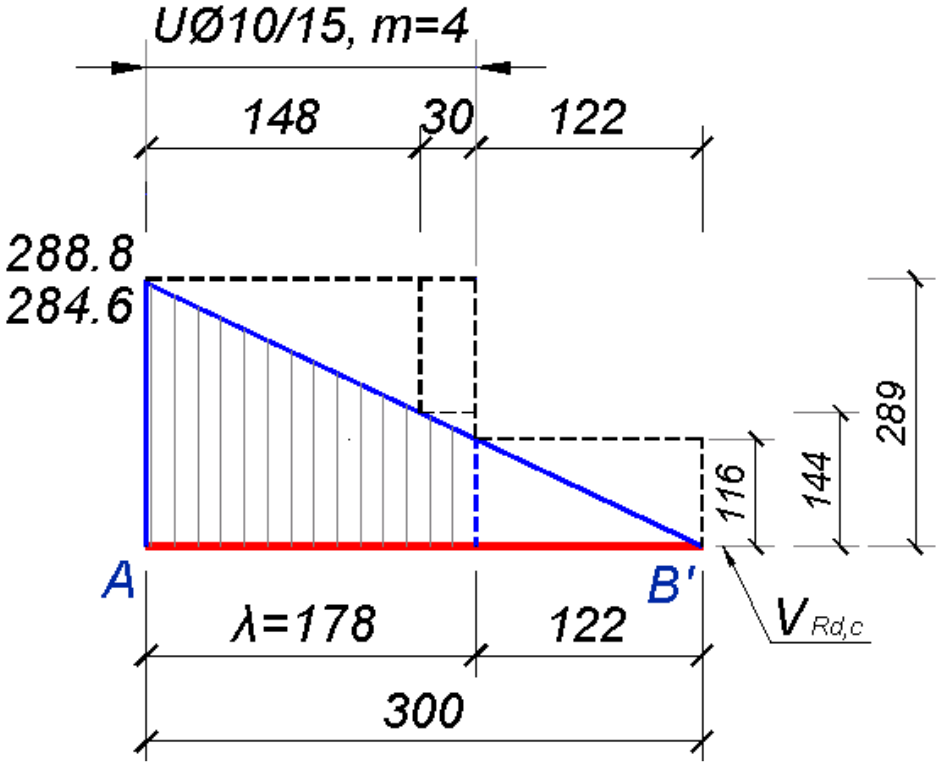
$$V_{Rd,c} = \left[0.12 \cdot 1.69 \cdot \left(100 \cdot 0.0175 \cdot 25\right)^{1/3} \right] \cdot \frac{40 \cdot 42}{10} = 115.9kN$$

Zadatak 30– PLOČA U JEDNOM PRAVCU

5. Određivanje potrebne armature za smicanje

Pretpostavljeno: θ=45⁰, ctgθ=1, ***m=4****,* ***Ø10****,* $a_{sw}^{(1)}=0.785\ cm^2$

$$s_{rač} \le \frac{m \cdot a_{sw}^{(1)}}{V_{Ed}} \cdot z \cdot f_{ywd} \cdot ctg\theta = \frac{2 \cdot 0.785}{284.6} \cdot 0.9 \cdot 42 \cdot 36.5 \cdot 1.0 = 15.2cm$$



Usvojeno: **UØ10/15 (m=4)**

V_{Rd} (UØ10/15, m=4) = 288.83 kN

V_{Rd} (UØ10/15, m=2) = 144.4 kN

Kontrolisati: **$V_{Rd,max}$; $\rho_{w,min}$**

Zadatak 30– PLOČA U JEDNOM PRAVCU

6. Određivanje dodatne sile zatezanja u podužnoj armaturi:

$$\Delta F_{td} = 0.5 \cdot V_{Ed} \cdot \left(ctg\theta - ctg\alpha \right)$$

Ali:

$$\frac{M_{Ed}}{z} + \Delta F_{td} \le \frac{M_{Ed,\max}}{z}$$

7. Dodatne sile zatezanja u podužnoj armaturi:

- Segment A-A': $\Delta F_{td,1} = 0.5 \cdot 227.7 \cdot \left(ctg40 - ctg90 \right) = 135.5kN$
- Segment B-A': $\Delta F_{td,2} = 0.5 \cdot 341.6 \cdot \left(ctg45 - ctg90 \right) = 170.8kN$
- Segment B-B': $\Delta F_{td,3} = 0.5 \cdot 284.6 \cdot \left(ctg45 - ctg90 \right) = 142.3kN$

$$\Delta A_{s1,i} = \frac{\Delta F_{td,i}}{f_{yd}}$$

Na ovim segmentima **NE TREBA** računati dodatnu zategnutu armaturu! Srednji oslonac – „špic“ dijagrama momenta savijanja!

Ankerovanje armature

Proračunska dužina ankerovanja, l_{bd}

$$l_{bd} = \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot l_{b,rqd} \geq l_{b,\min}$$

Табела 8.2 – Вредности коефицијената α_1, α_2, α_3, α_4 и α_5

Фактор који утиче на величине коефицијената	Врста сидрења	Шипка арматуре	
		Затегнута	Притиснута
Облик шипки	Права шипка	$\alpha_1 = 1{,}0$	$\alpha_1 = 1{,}0$
	Другачији облици осим праве шипке [видети слике 8.1(b), (c) и (d)]	$\alpha_1 = 0{,}7$ ако је $c_d > 3\phi$ ако то није случај $\alpha_1 = 1{,}0$ (видети слику 8.3 за вредности c_d)	$\alpha_1 = 1{,}0$
Заштитни слој бетона	Права шипка	$\alpha_2 = 1 - 0{,}15\,(c_d - \phi)/\phi$ $\geq 0{,}7$ $\leq 1{,}0$	$\alpha_2 = 1{,}0$
	Другачији облици осим праве шипке [(видети слике 8.1(b), (c) и (d)]	$\alpha_2 = 1 - 0{,}15\,(c_d - 3\phi)/\phi$ $\geq 0{,}7$ $\leq 1{,}0$ (видети слику 8.3 за вредности c_d)	$\alpha_2 = 1{,}0$
Утезање попречном арматуром која није заварена за главну арматуру	Све врсте	$\alpha_3 = 1 - K\lambda$ $\geq 0{,}7$ $\leq 1{,}0$	$\alpha_3 = 1{,}0$
Утезање завареном попречном арматуром*	Све врсте, положај и величина као што је утврђено на слици 8.1(e)	$\alpha_4 = 0{,}7$	$\alpha_4 = 0{,}7$
Утезање попречним притиском	Све врсте	$\alpha_5 = 1 - 0{,}04p$ $\geq 0{,}7$ $\leq 1{,}0$	–

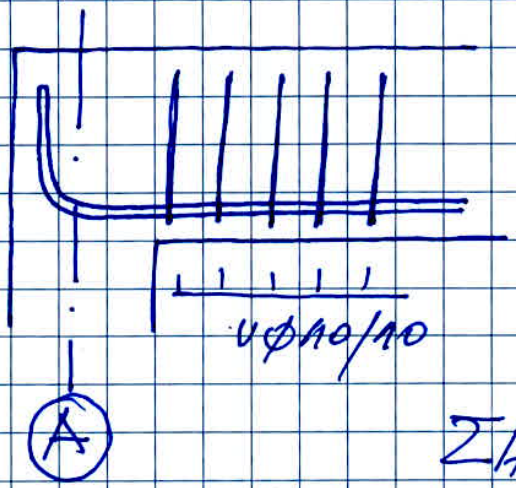
Utezanje (EC2: Slika 8.4)

(ΣAst-ΣAst,min)/As

$$\rho_{w,min} = \frac{0{,}08\sqrt{25}}{420} = 0{,}00095$$

$$s_{g,max} = \frac{2 \cdot 0{,}503}{0{,}00095 \cdot 40} = 26{,}5\ cm$$

усвојено: $U\phi 8/25$



$l_{bd,req} \approx 40\phi$ (C25/30)

$l_{bd,req} \approx 80\ cm\ (\phi 20)$

$$\Sigma A_{st} = 2 \cdot 0{,}785 \cdot \frac{80}{10} = 12{,}56\ cm^2$$

$$\Sigma A_{st,min} = 2 \cdot 0{,}503 \cdot \frac{80}{25} = 3{,}22\ cm^2$$

$\lambda = (\Sigma A_{st} - \Sigma A_{s,min}) / A_s$

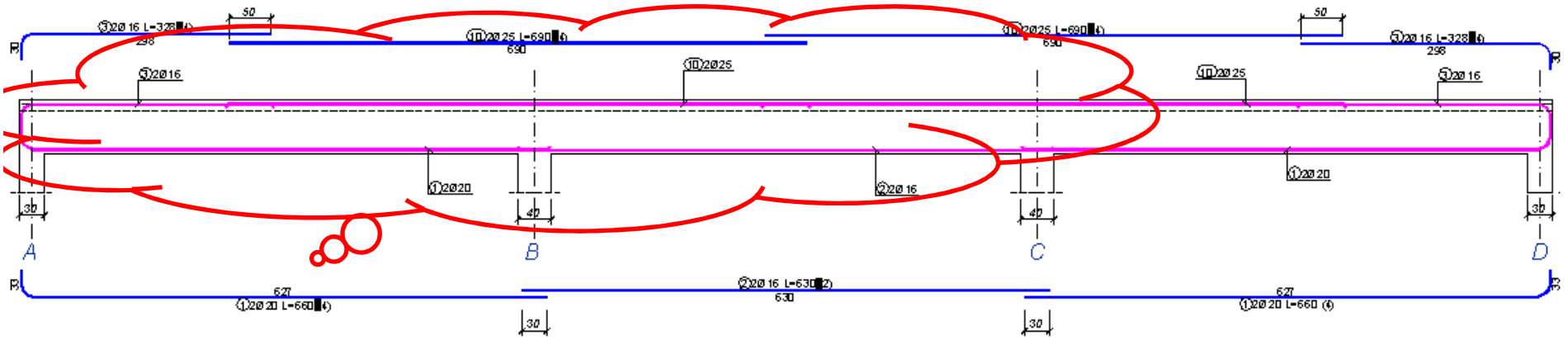
$\lambda = (12{,}56 - 3{,}22) / 3{,}14 = 2{,}97$

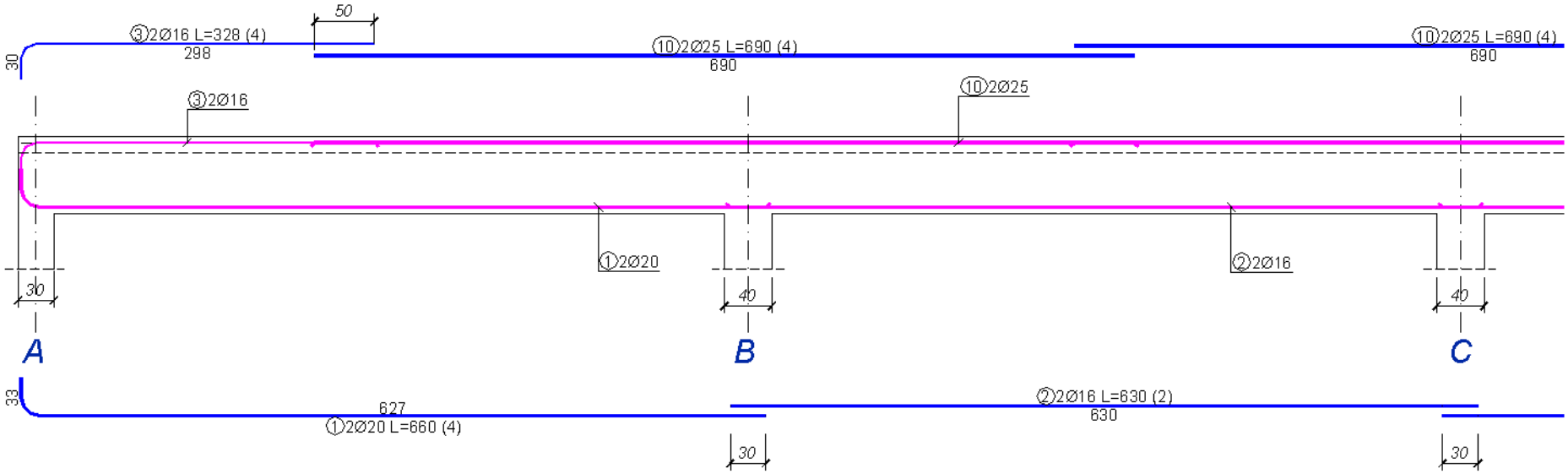
$K = 0{,}1$

$\alpha_3 = 1 - 0{,}1 \cdot 2{,}97 = 0{,}703 > 0{,}7$

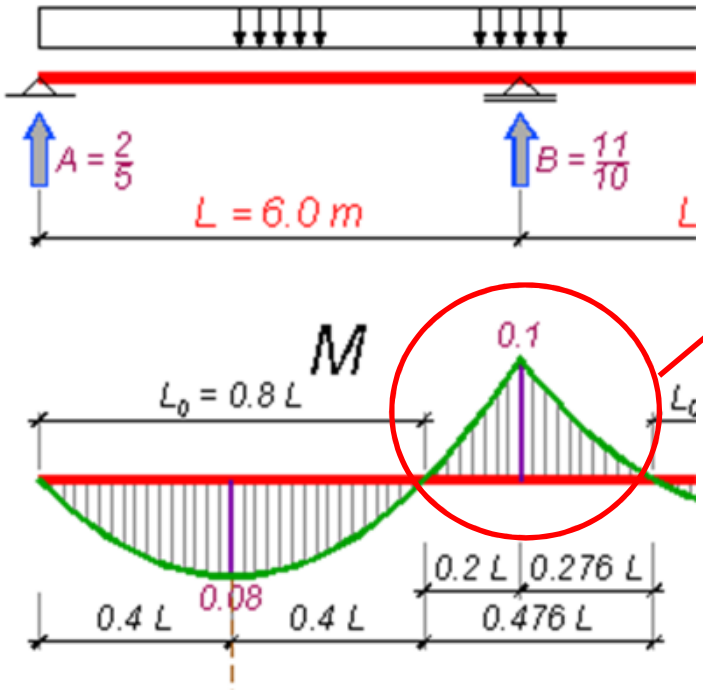
$l_{bd} = \alpha_3 \cdot l_{bd,req} = 0{,}7 \cdot 40\phi = 28\phi \sim 30\phi\ (= 60\ cm)$

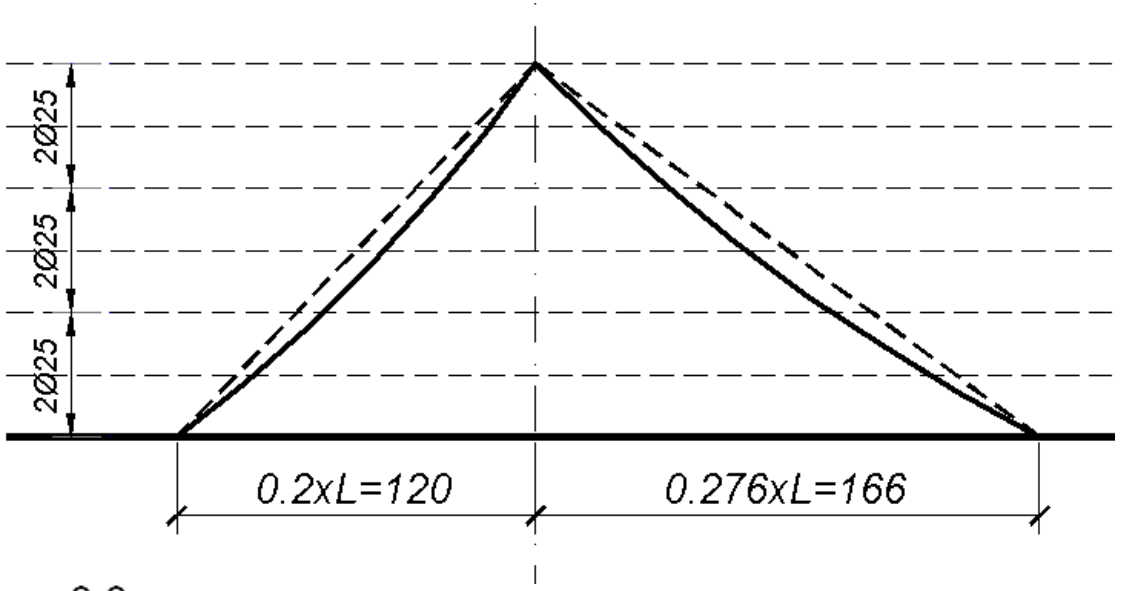
Zadatak 30– PLOČA U JEDNOM PRAVCU

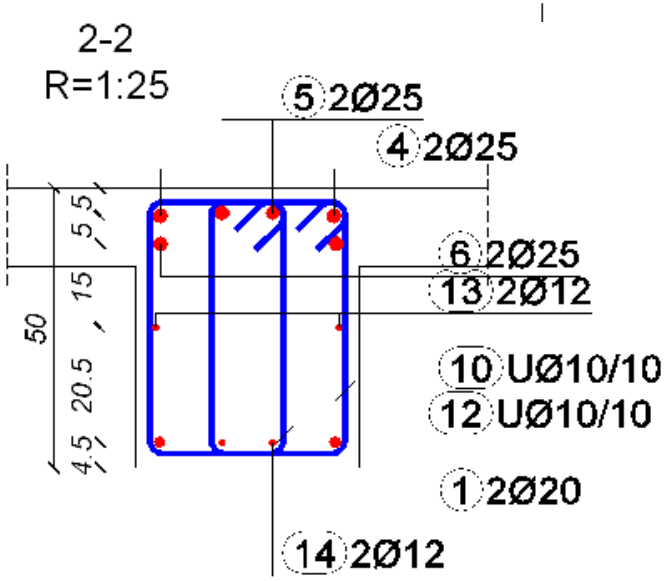




Zadatak 30– PLOČA U JEDNOM PRAVCU







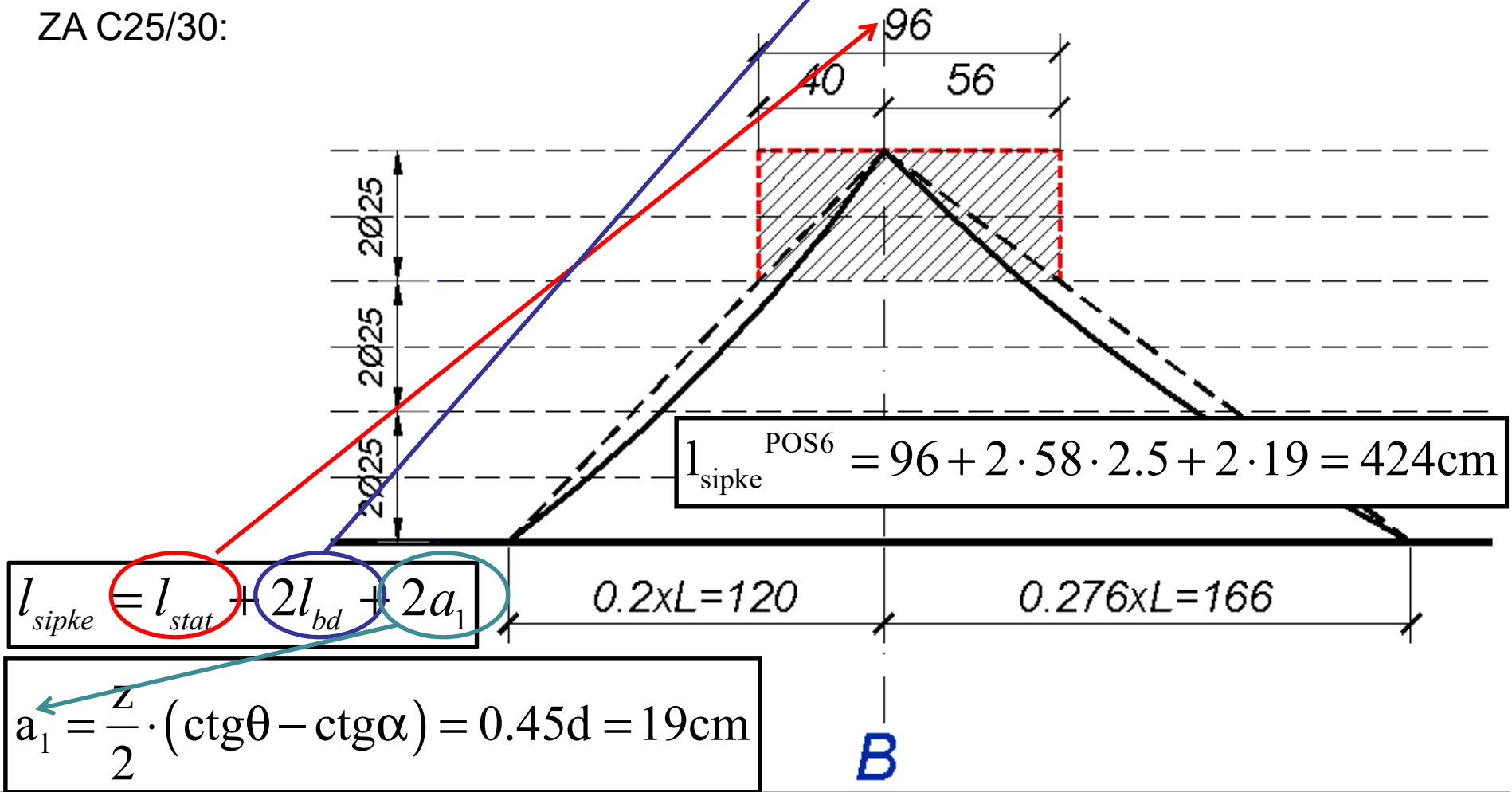
Zadatak 30– PLOČA U JEDNOM PRAVCU

Proračunska dužina ankerovanja, l_{bd}

$$l_{bd} = \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot l_{b,rqd} \geq l_{b,\min}$$

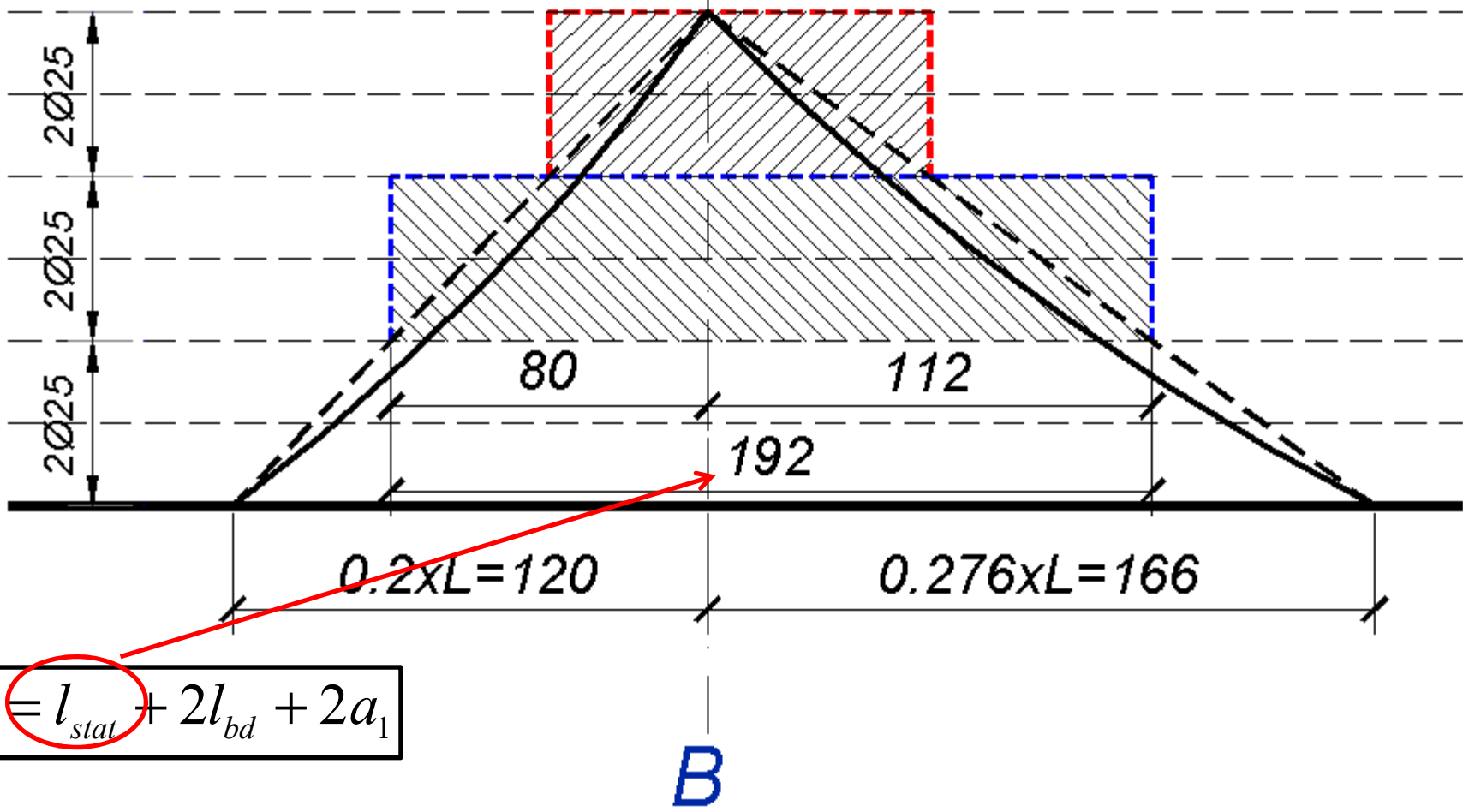
$$l_{b,rqd} = l_{bd} = \begin{cases} 40\text{Ø}, dobri\ uslovi\ prianjanja \\ 58\text{Ø}, loši\ uslovi\ prianjanja \end{cases}$$

ZA C25/30:



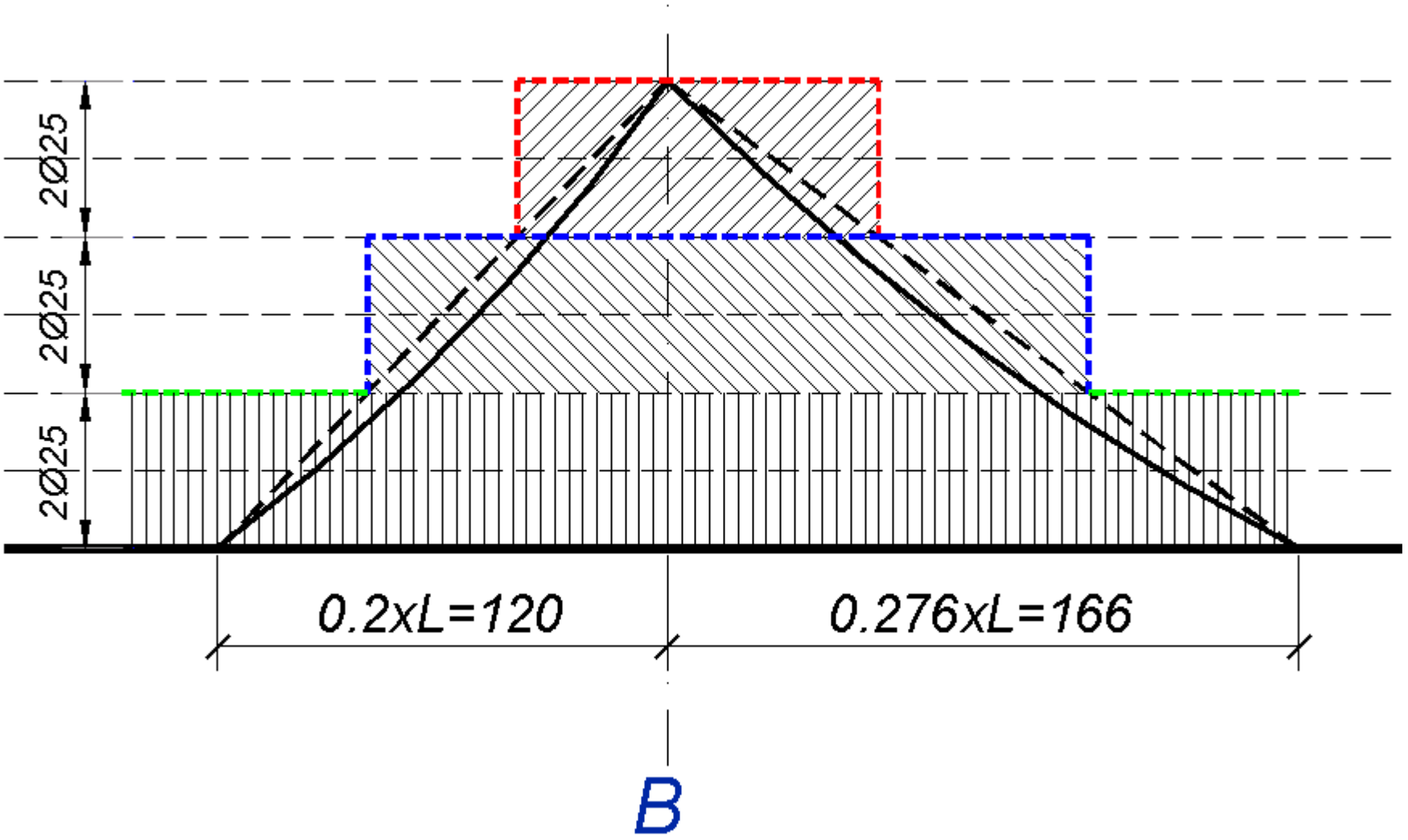
Zadatak 30– PLOČA U JEDNOM PRAVCU

$$l_{sipke}^{POS5} = 192 + 2 \cdot 58 \cdot 2.5 + 2 \cdot 19 = 520\text{cm}$$

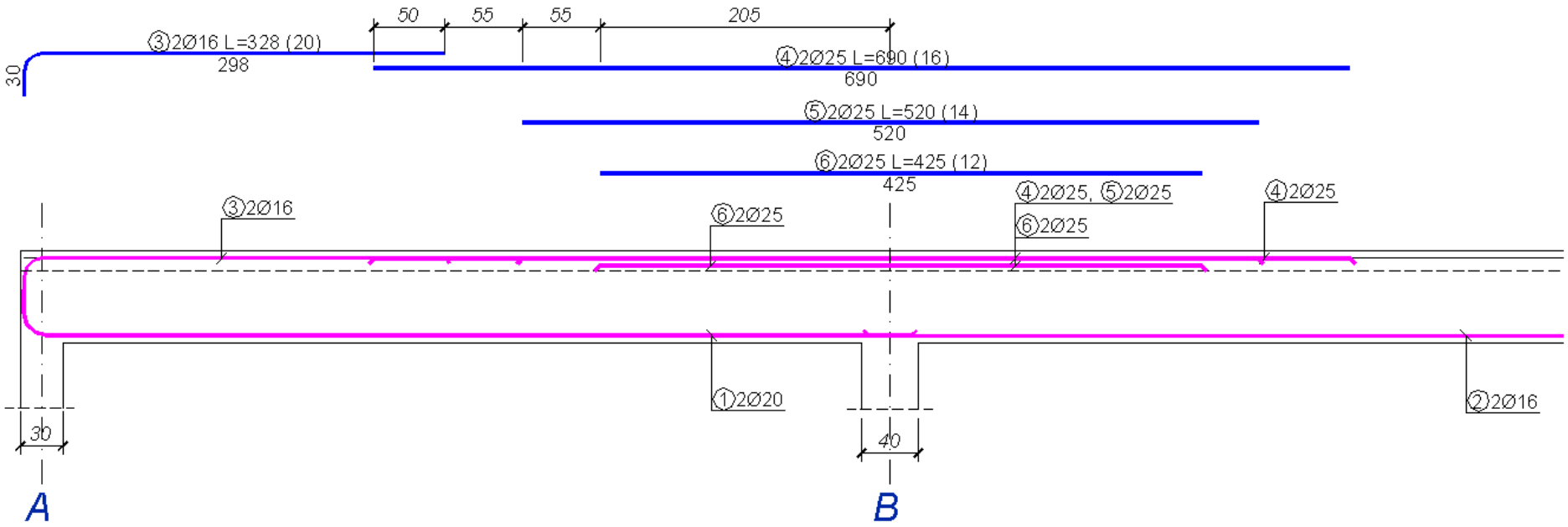


$$l_{sipke} = l_{stat} + 2l_{bd} + 2a_1$$

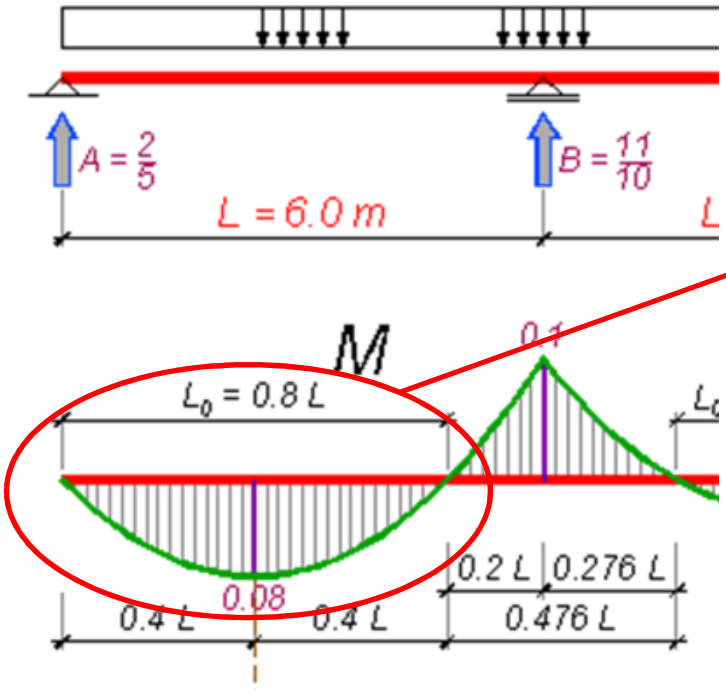
Zadatak 30– PLOČA U JEDNOM PRAVCU

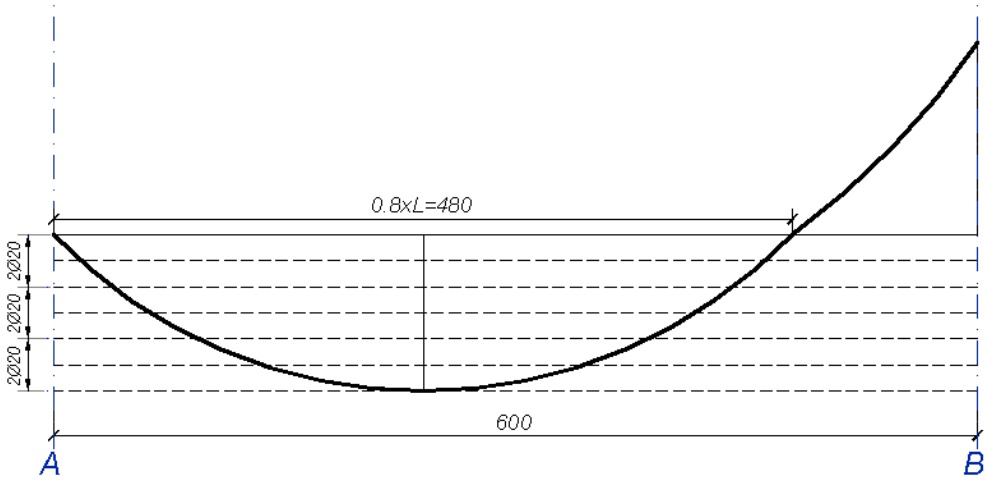


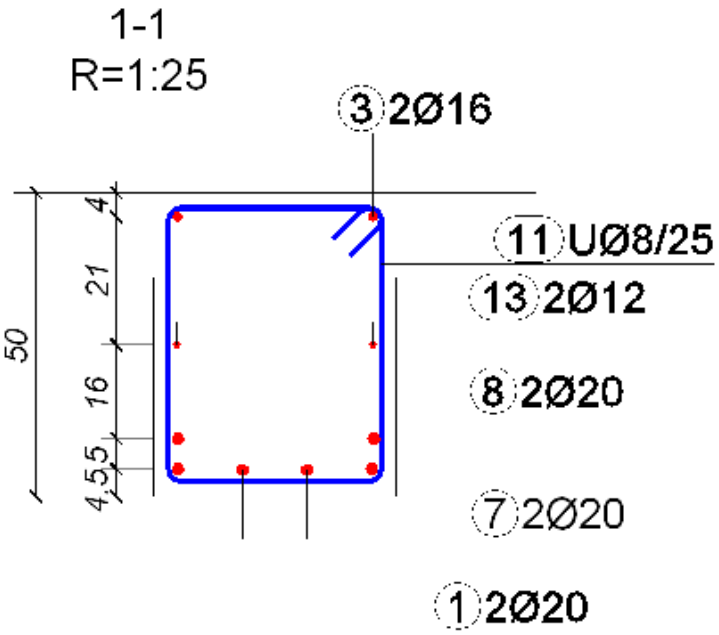
Zadatak 30– PLOČA U JEDNOM PRAVCU

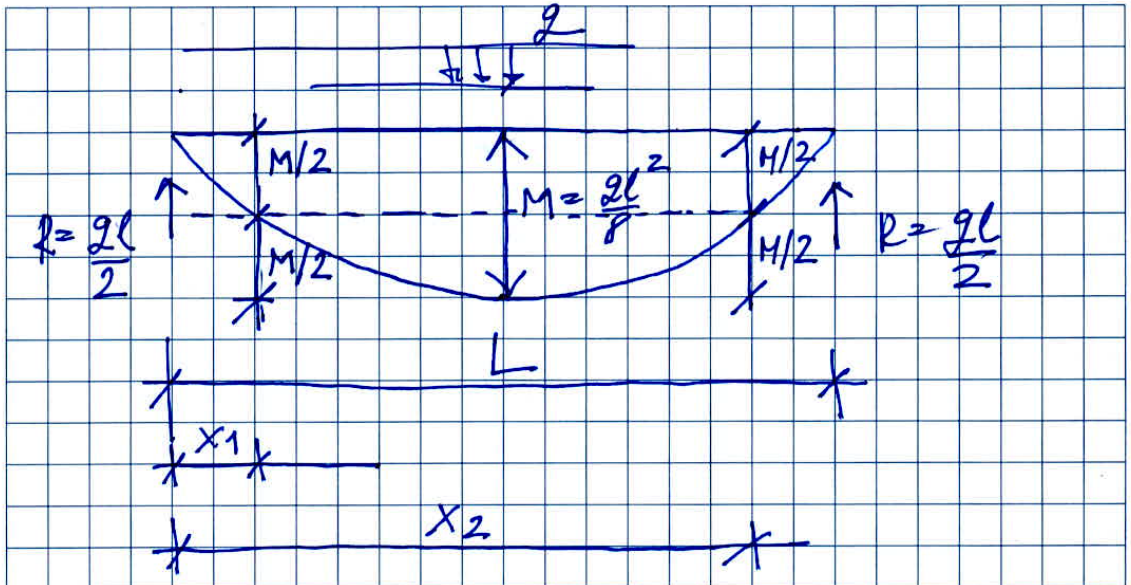


Zadatak 30– PLOČA U JEDNOM PRAVCU









$$R \cdot x - q\frac{x^2}{2} = \frac{ql^2}{16} \quad (= M/2)$$

$$\frac{ql}{2} \cdot x - q\frac{x^2}{2} = \frac{ql^2}{16} \;/\cdot \frac{16}{2}$$

$$8lx - 8x^2 - l^2 = 0$$

$$x_{1,2} = \frac{2 \pm \sqrt{2}}{4} \cdot l$$

$$x_1 = \frac{2-\sqrt{2}}{4} l \qquad x_2 = \frac{2+\sqrt{2}}{4} l$$

• дужина шипке (статички): $x_2 - x_1 = \frac{2\sqrt{2}}{4} l$

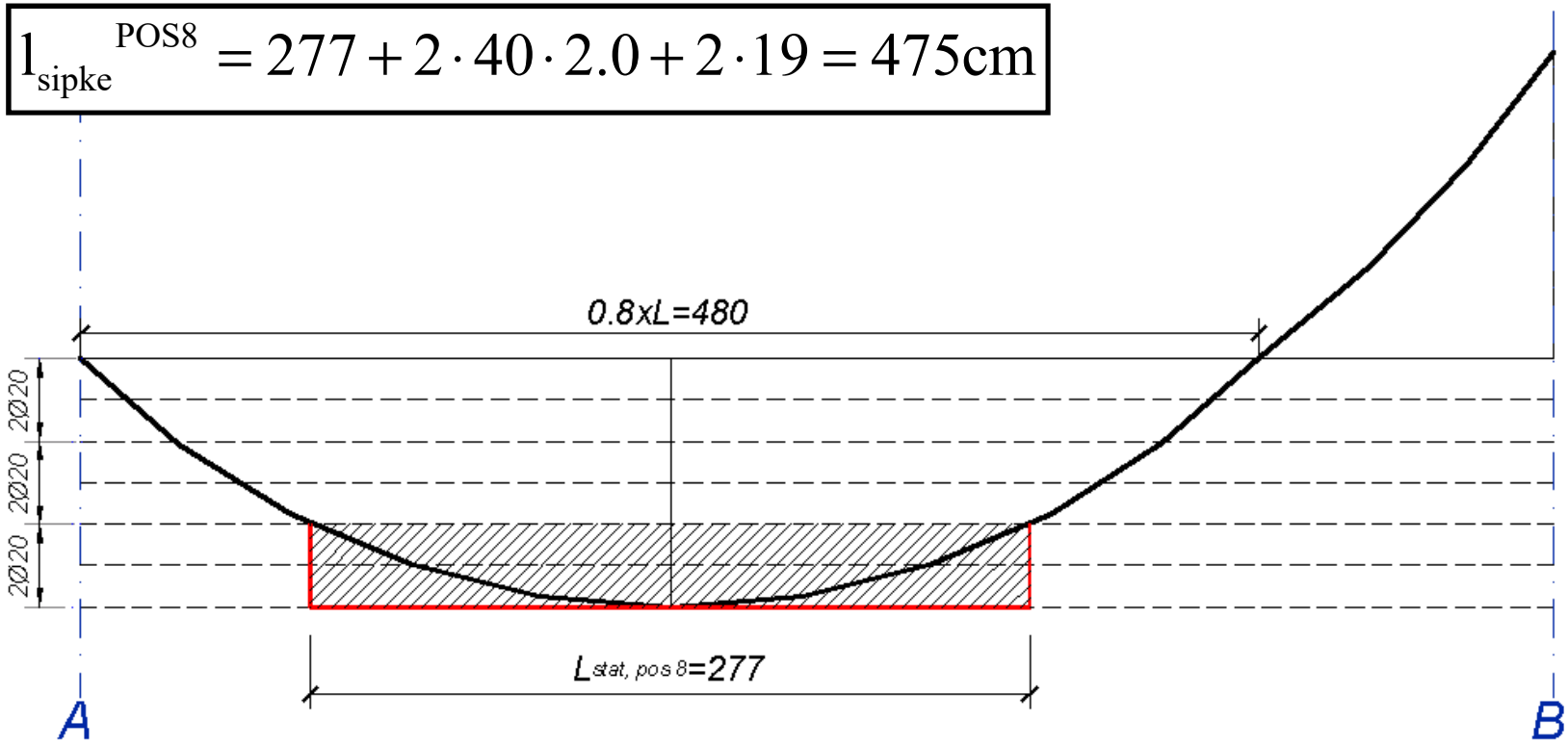
$$x_2 - x_1 = l \cdot \sqrt{\frac{1}{2}} \quad \left(= l \cdot \sqrt{\frac{M_1}{M}}\right)$$

Zadatak 30– PLOČA U JEDNOM PRAVCU

Procena dužine šipki u donjoj zoni:

$$l_{stat}^{POS8} = L_0 \cdot \sqrt{\frac{M_{POS8}}{M}} = L_0 \cdot \sqrt{\frac{2Ø20}{6Ø20}} = 480 \cdot \sqrt{\frac{1}{3}} = 277\text{cm}$$

$$\boxed{l_{sipke}^{POS8} = 277 + 2 \cdot 40 \cdot 2.0 + 2 \cdot 19 = 475\text{cm}}$$

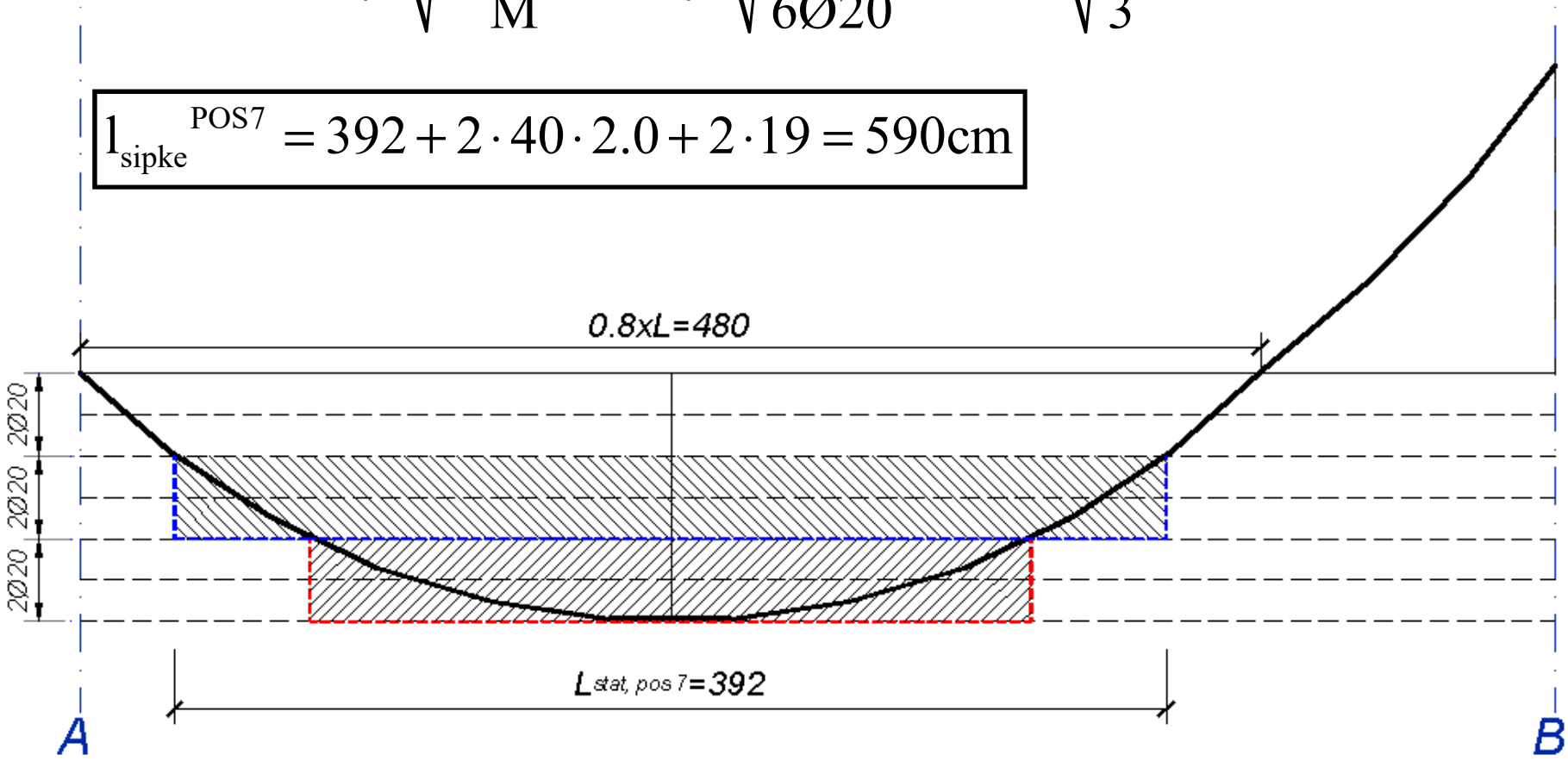


Zadatak 30– PLOČA U JEDNOM PRAVCU

Procena dužine šipki u donjoj zoni:

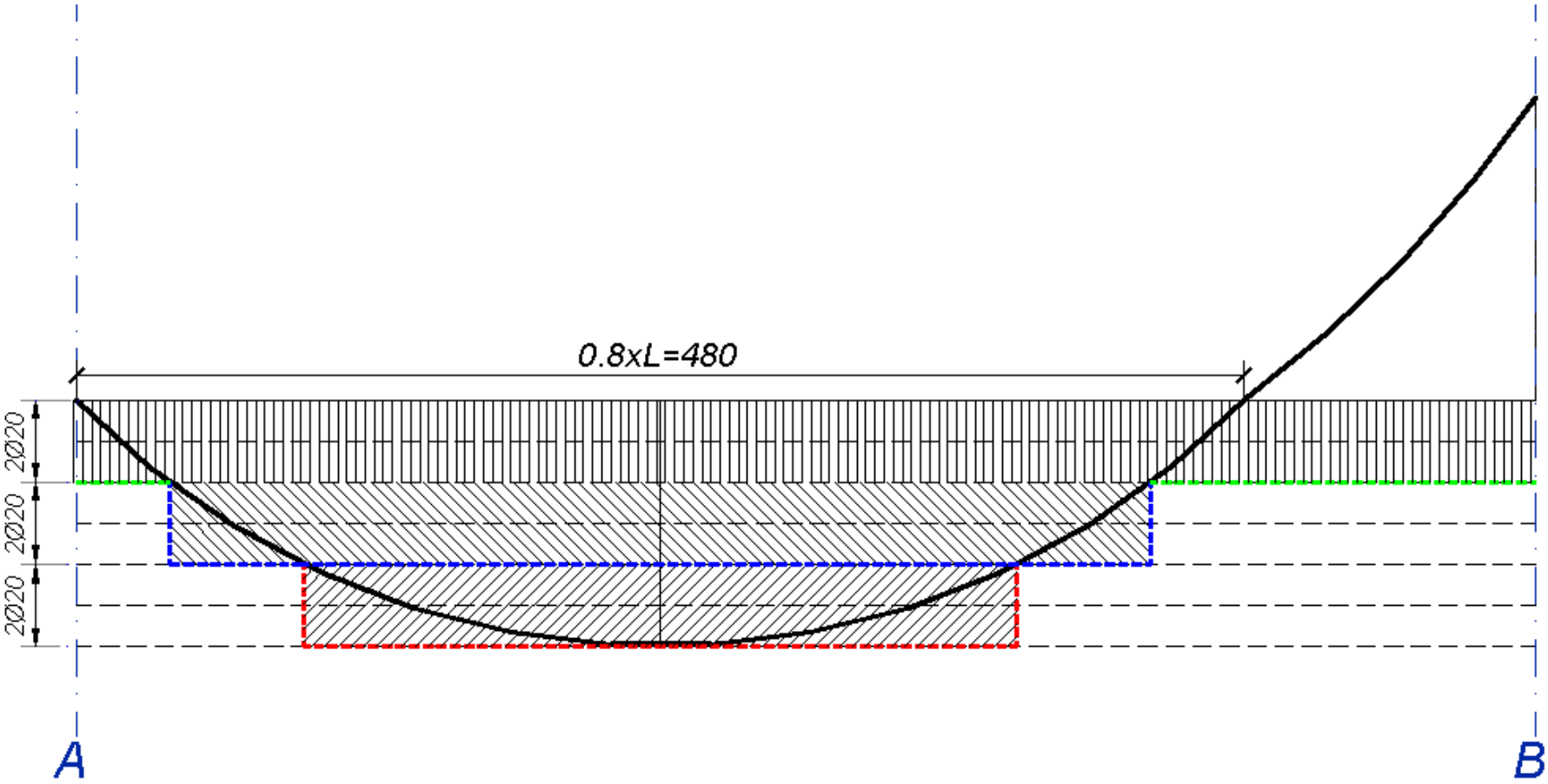
$$l_{stat}^{POS7} = L_0 \cdot \sqrt{\frac{M_{POS7}}{M}} = L_0 \cdot \sqrt{\frac{4Ø20}{6Ø20}} = 480 \cdot \sqrt{\frac{2}{3}} = 392\text{cm}$$

$$\boxed{l_{sipke}^{POS7} = 392 + 2 \cdot 40 \cdot 2.0 + 2 \cdot 19 = 590\text{cm}}$$

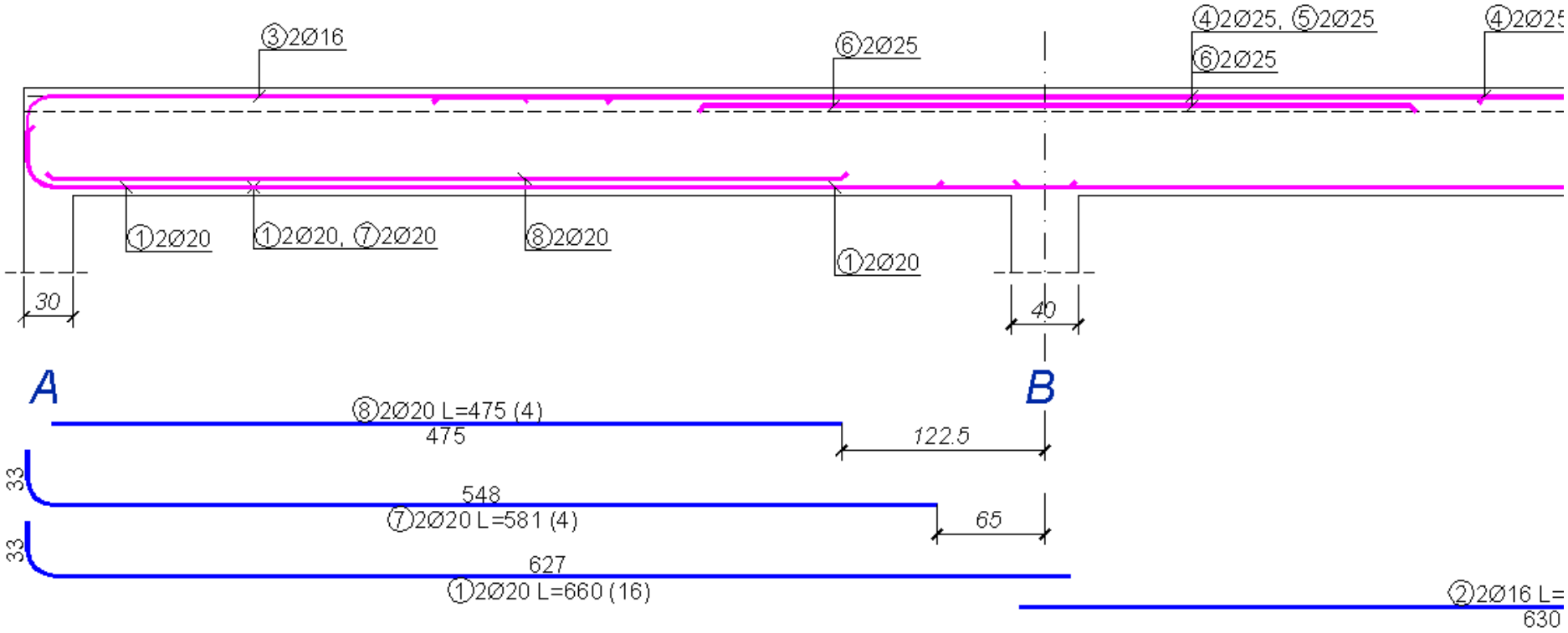


Zadatak 30– PLOČA U JEDNOM PRAVCU

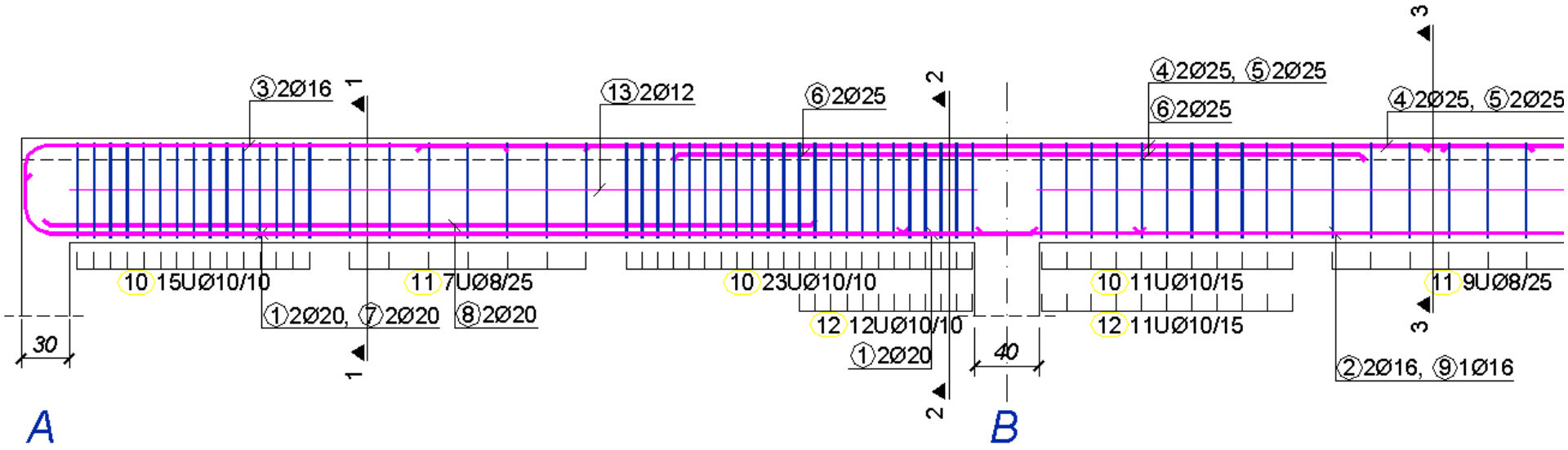
Procena dužine šipki u donjoj zoni:



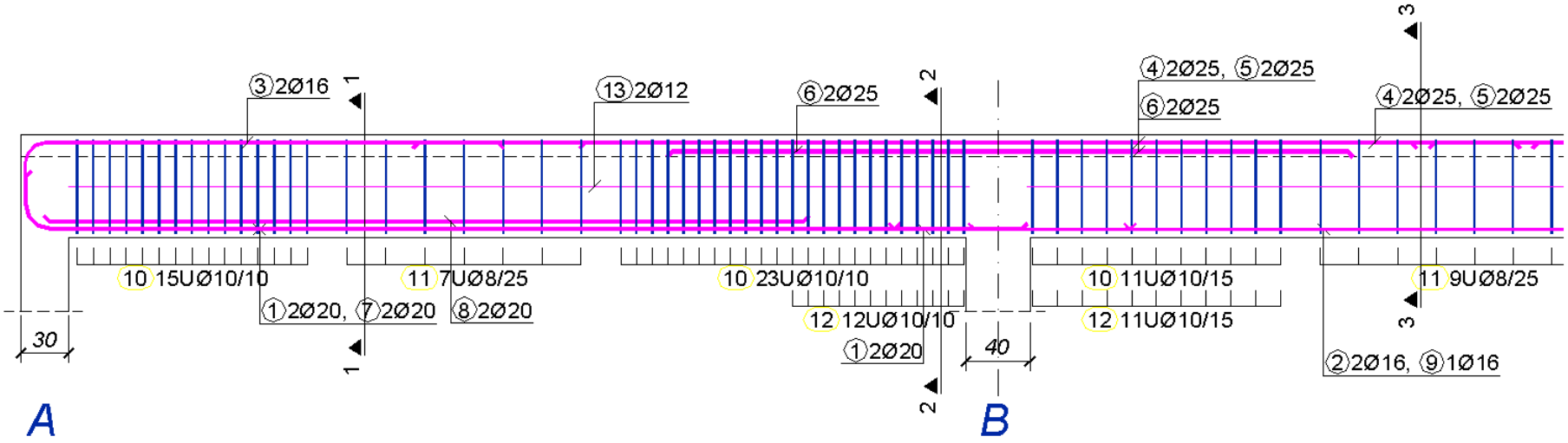
Zadatak 30– PLOČA U JEDNOM PRAVCU

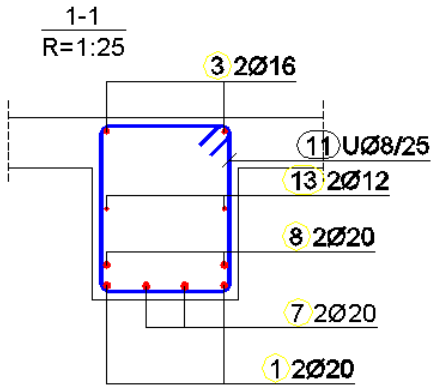


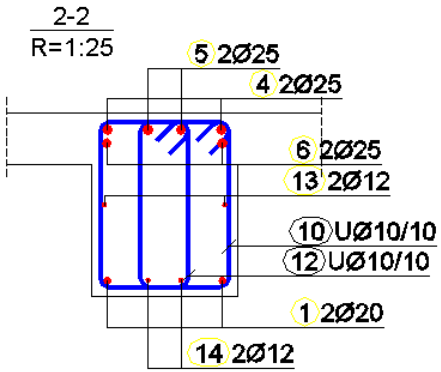
Zadatak 30– PLOČA U JEDNOM PRAVCU

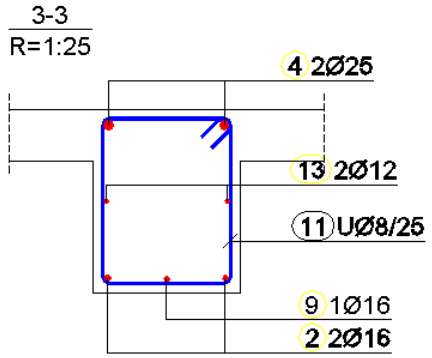


Zadatak 30– PLOČA U JEDNOM PRAVCU





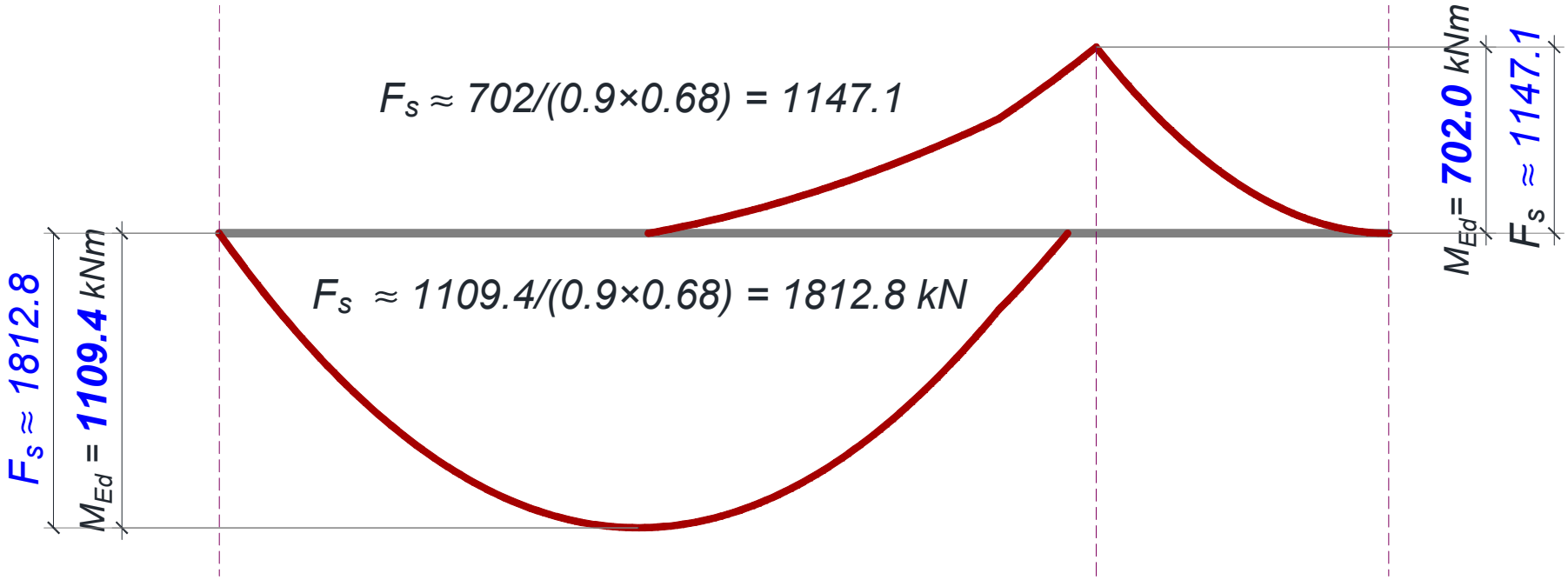




+ KOTIRANJE PRESEKA!

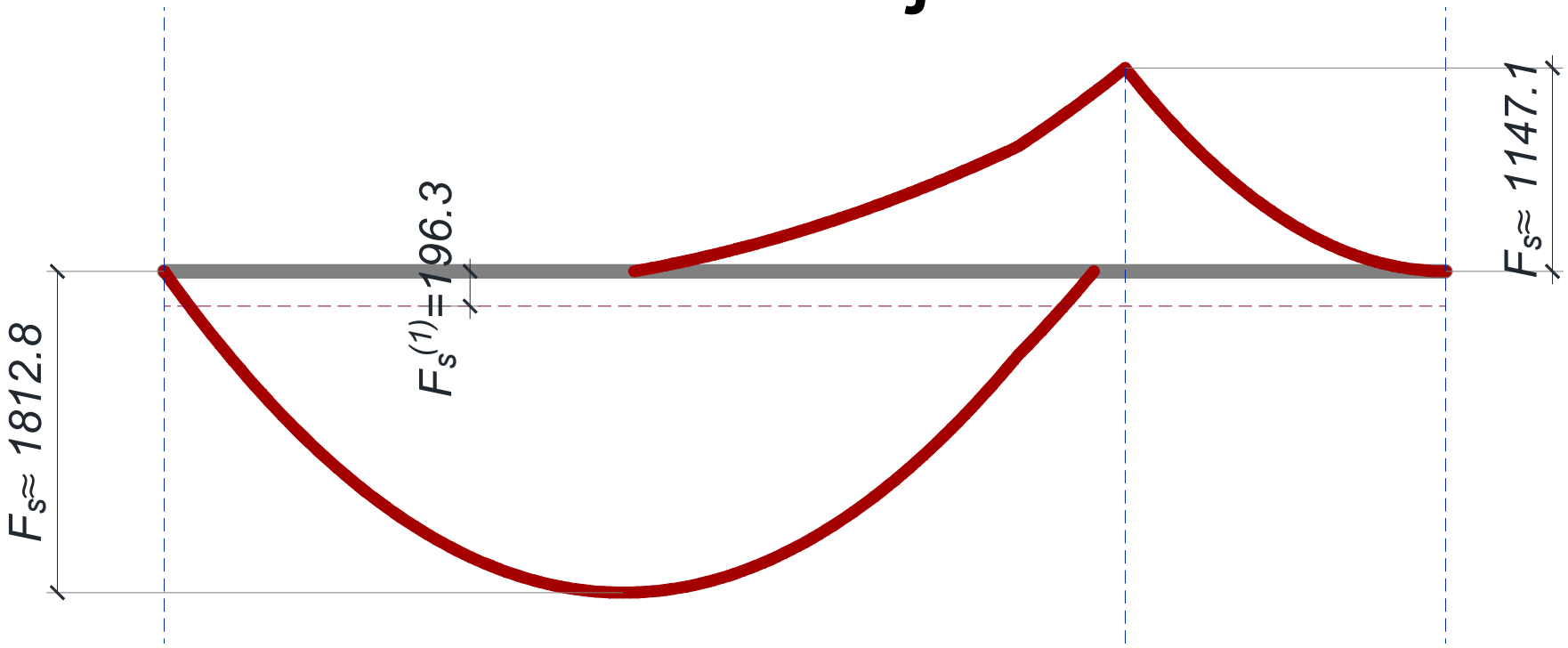
2. način

M/z linija



$$F_s = A_s \times f_{yd} \approx \frac{M_{Ed}}{0.9 \times d_{\min.}} - N_{Ed} = \frac{M_{Ed}}{0.9 \times d_{\min.}}$$

M/z linija

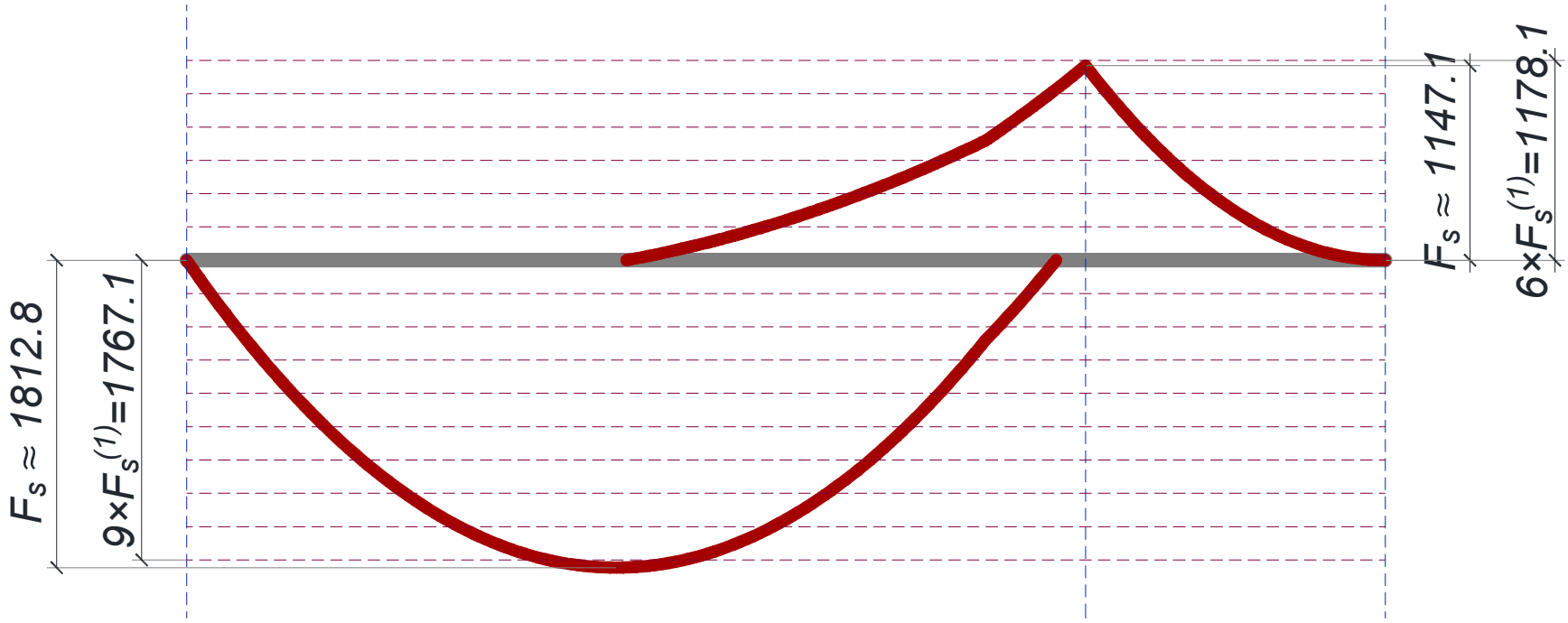


$$F_s^{(1)} = a_s^{(1)} \times f_{yd} = 4.91 \times 40 = 196.3\,kN$$

M/z linija

ζ = ***0.894***

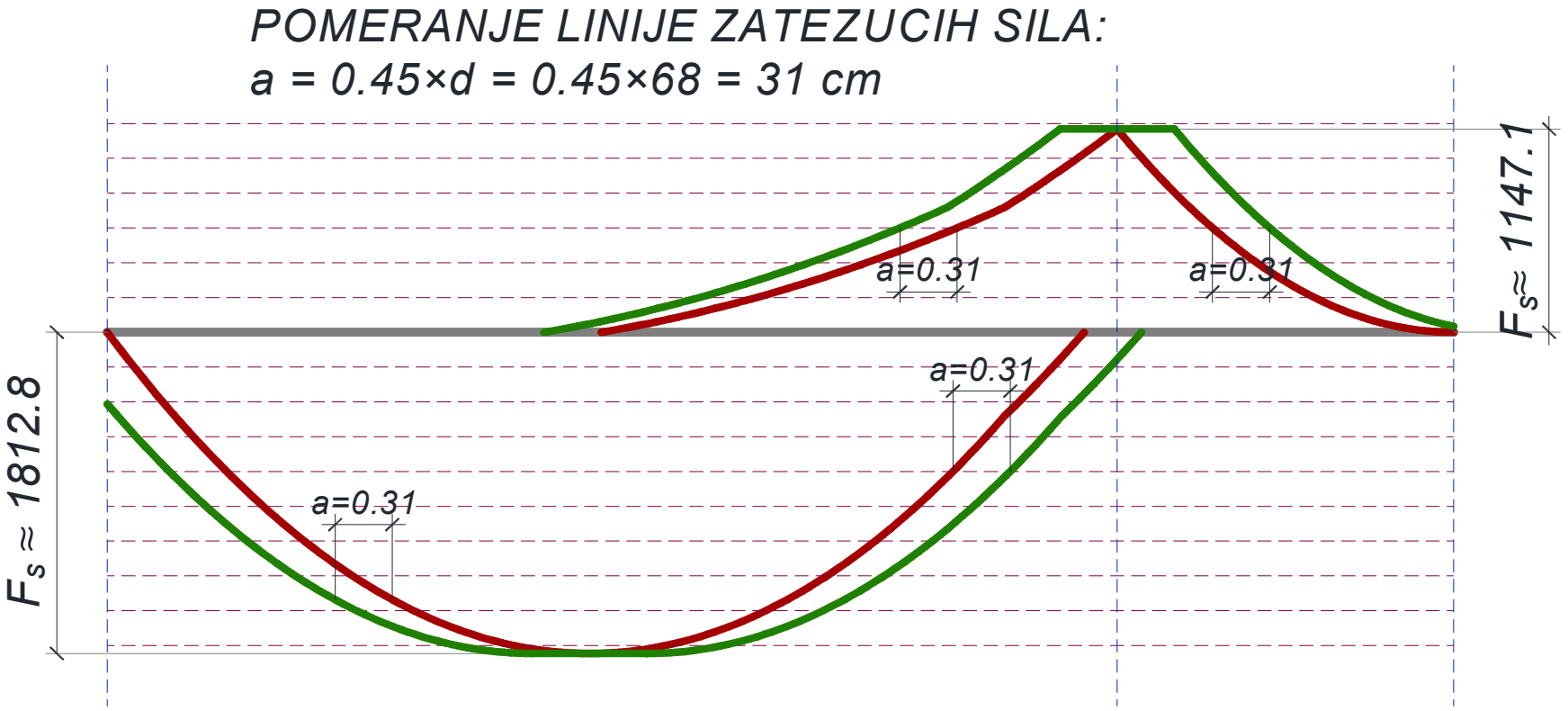
$A_{s,potr.}$ = 28.85 cm^2 (usv. 29.45 cm^2)



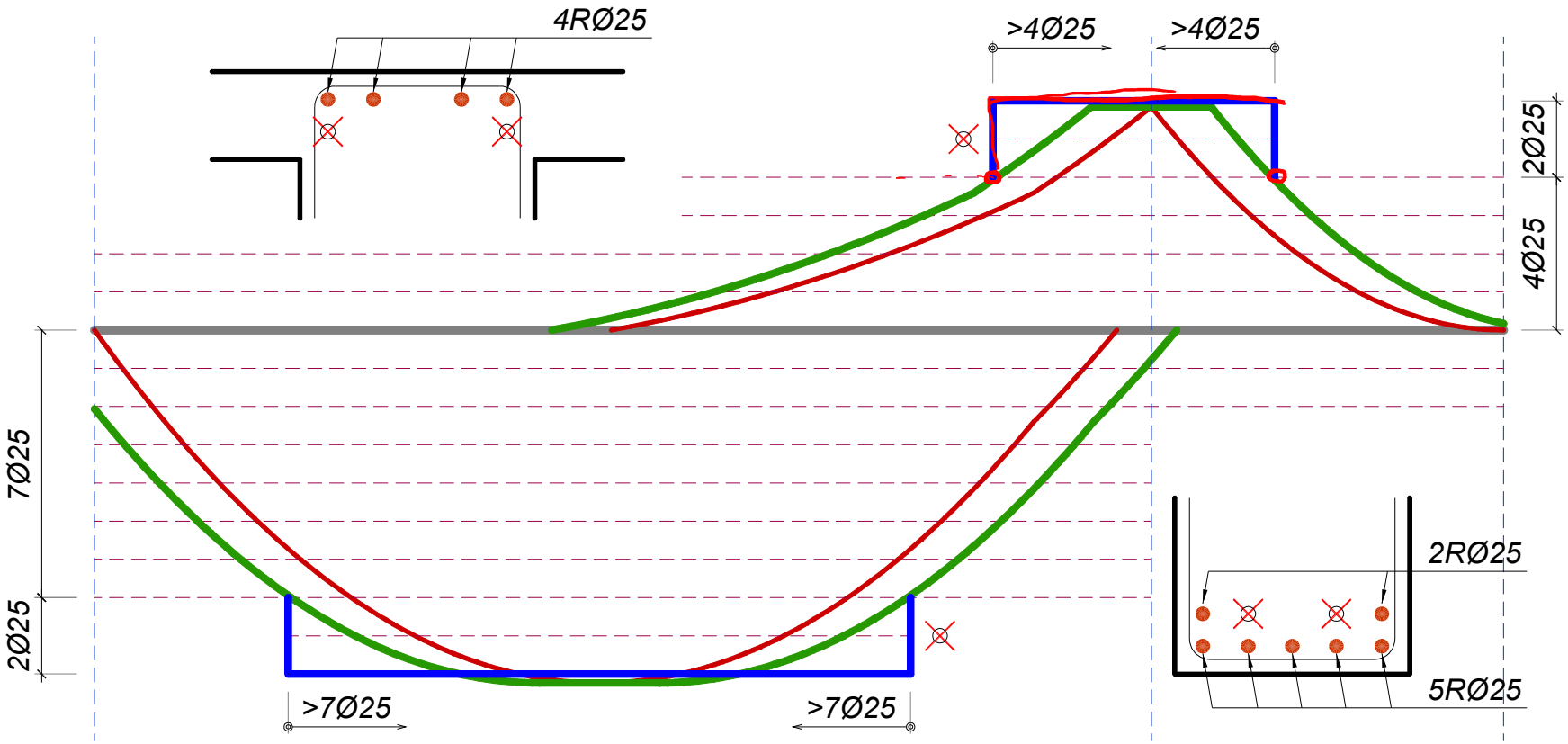
ζ = ***0.964***

$A_{s,potr.}$ = 42.33 cm^2 (usv. 44.18 cm^2)

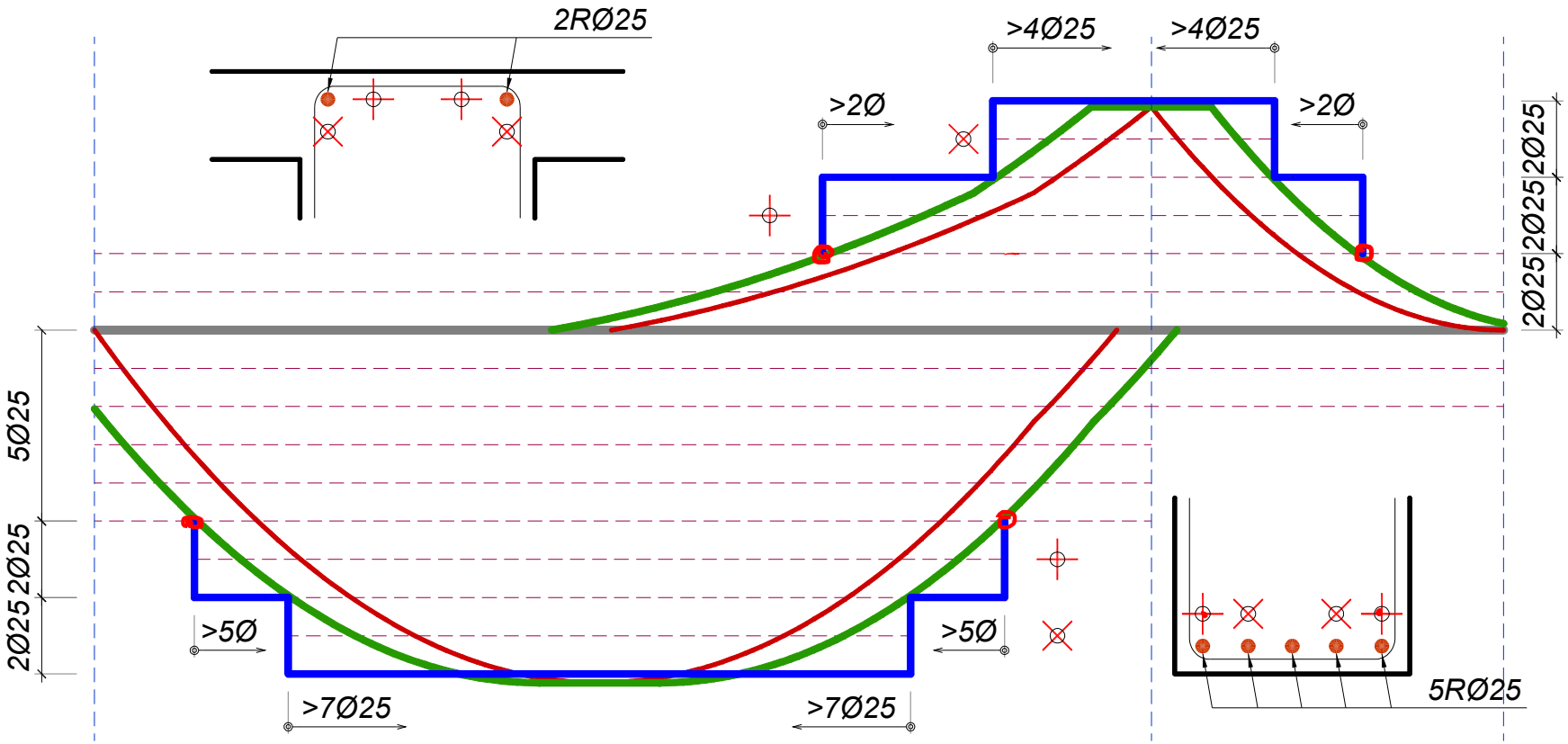
Linija zatežućih sila



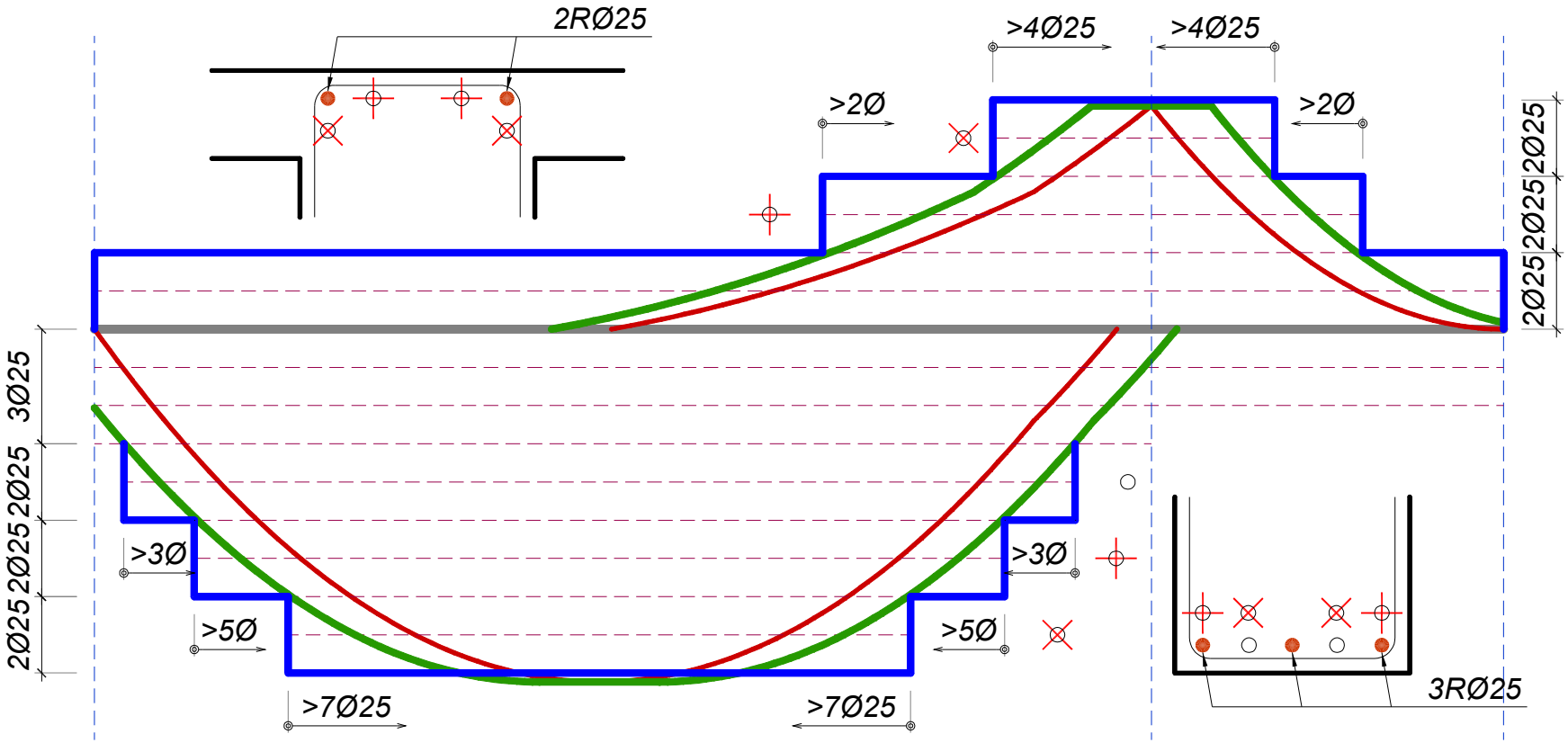
Linija pokrivanja armaturom



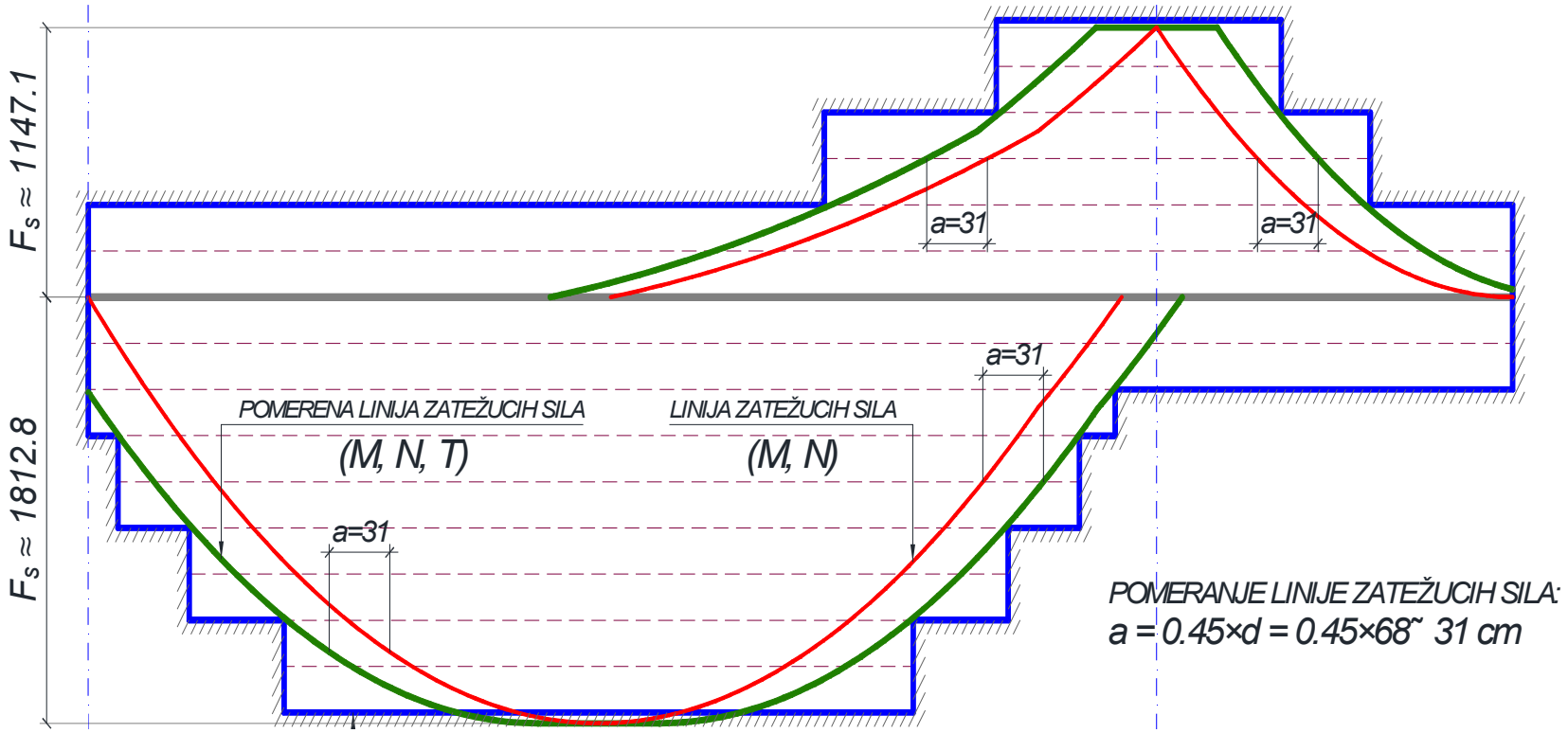
Linija pokrivanja armaturom



Linija pokrivanja armaturom



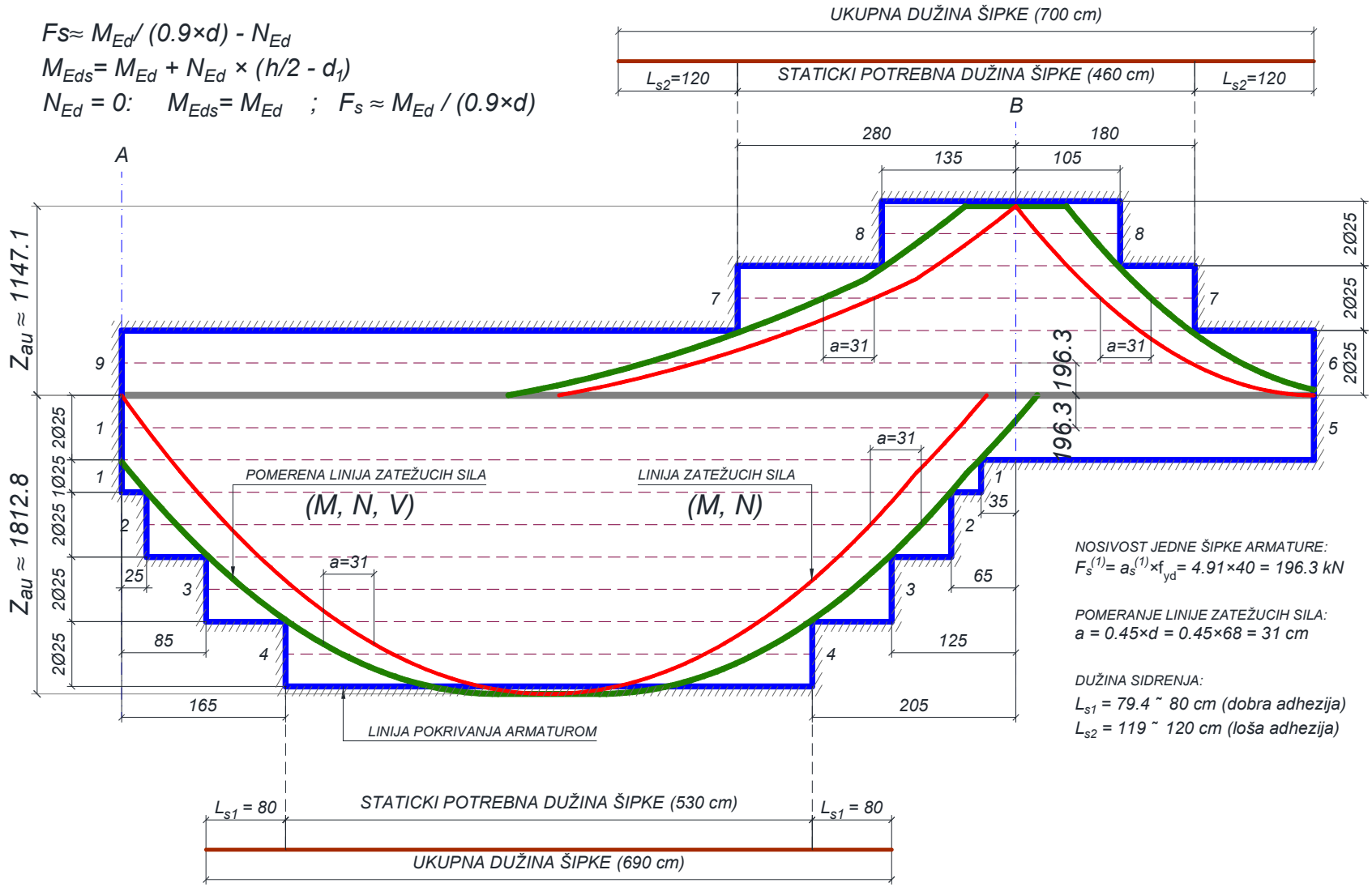
Linija pokrivanja armaturom



$Fs \approx M_{Ed} / (0.9 \times d) - N_{Ed}$

$M_{Eds} = M_{Ed} + N_{Ed} \times (h/2 - d_1)$

$N_{Ed} = 0$: $M_{Eds} = M_{Ed}$; $F_s \approx M_{Ed} / (0.9 \times d)$



NOSIVOST JEDNE ŠIPKE ARMATURE:

$F_s^{(1)} = a_s^{(1)} \times f_{yd} = 4.91 \times 40 = 196.3$ kN

POMERANJE LINIJE ZATEŽUCIH SILA:

$a = 0.45 \times d = 0.45 \times 68 = 31$ cm

DUŽINA SIDRENJA:

$L_{s1} = 79.4 \sim 80$ cm (dobra adhezija)

$L_{s2} = 119 \sim 120$ cm (loša adhezija)