

TEMELJI STUBOVA OSVETLJENJA VISINE 8m

OPIS TEMELJNE KONSTRUKCIJE

Stubovi osvetljenja 8m visine se fundiraju na temeljima samcima. Temelji se fundiraju na zdravom nosivom tlu na dubini većoj od 90 cm od kote terena. Ispod temelja samaca se izvodi sloj tucanika debljine 30 cm sa zbijanjem do postizanja zbijenosti 40 Mpa. Preko temelja se izvodi sloj mršavog betona debljine 5 cm. Stopa temelja je dimenzija 130x130 cm, a stub temelja je dimenzija 60x60 cm. Kompletно armirano prema detaljima.

2. MATERIJALI

Beton C25/30

Armatura B500B

3. STATIČKI PRORAČUN

3.1. Analiza opterećenja

1. Sopstvena težina

Sopstvena težina stuba sa svetiljkom:

8m stub = 4.00 kN

Nasip iznad temeljne stope:

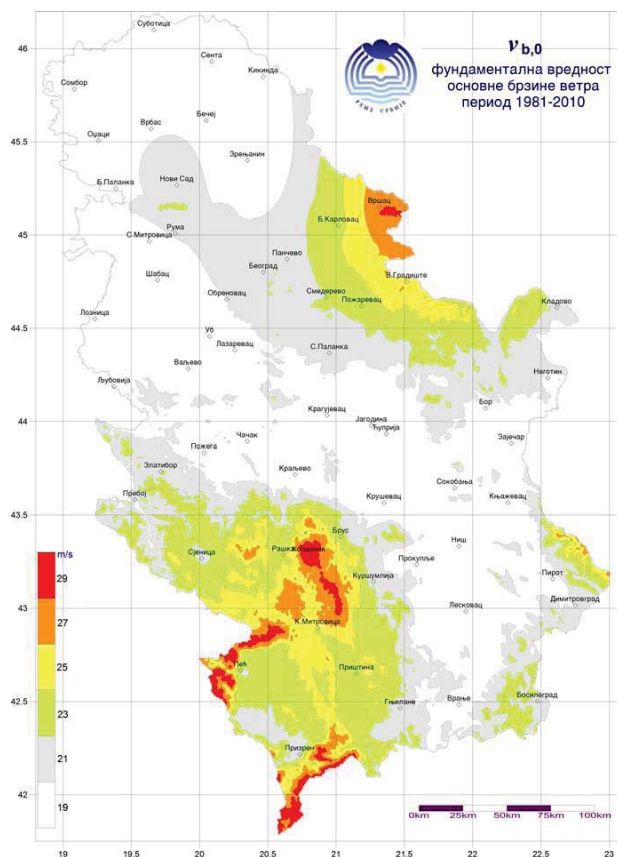
8m stub – 1.3m*21.0kN/m³ = 27.30 kN/m²

Tower automatski uzima u obzir sopstvenu težinu modeliranih elemenata.

2. Opterećenje snegom (EC1.3):

8m stub = 1.00 kN

3. Opterećenje vetrom (EC1.4):



Osnovna brzina vetra [V_b]	
Koeficijent pravca, C_{dir}	1
Koeficijent sezonskog delovanja, C_{season}	1
Fundamentalna vrednost osnovne brzine vetra, $V_{b,0}$	19 m/s
Osnovna brzina vetra, V_b	19 m/s

Kategorija terena	
Kategorija terena	2
Dužina hrapavosti, Z_0 (m)	0.05
Minimalna visina, Z_{min} (m)	2
$Z_{0,11}$ (m)	0.05

Koeficijent terena, K_t	0.190
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Visina zgrade, Z (m)	8
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Faktor topografije C_s	1
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Koeficijent hrapavosti, C_r	0.964
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Koeficijent turbulencije K_t	1
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Gustina vazduha, ρ (kg/m ³)	1.225
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Srednja brzina vetra, $V_m(z)$	18.32 m/s
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Turbulencija vetra, $I_v(z)$	0.197
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Osnovni pritisak vetra, q_b	221.1 N/m ²
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Standardna devijacija turbulencije, σ_v	3.610
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Udarni pritisak vetra, q_p	489.18 N/m ²
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Udarni pritisak vetra, q_p	0.49 kN/m ²
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8m stub

$$g(z_e) = \sqrt{\frac{2q_p}{\rho}} = 27,98 \text{ m/s}^2$$

$$R_e = \frac{b \cdot g(z_e)}{v} = 0,292 \cdot 10^6$$

$$\frac{k}{b} = 0,385 \quad A_{ref} = 0,13 \cdot 8 = 1,04 \text{ m}^2$$

$$C_{f,0} = 1,2 + \frac{0,18 \log(10^k/b)}{1 + 0,4 \log(R_e/10^5)} = 1,289$$

$$\lambda = \frac{2 \cdot l}{b} = 123,08 > 70; \quad \varphi = \frac{A}{A_c} = 1; \quad \psi_\lambda = 0,91$$

$$C_f = C_{f,0} \cdot \psi_\lambda = 1,173, \quad C_s C_d = 1$$

$$F_w = 0,87 \text{ kN}$$

4. Seizmičko opterećenje (EC8.1 sect. 4.3.3.2.2)

8m stub

$$S_d(T1) = 0,306 \frac{m}{s^2} \cdot 1,4 \cdot 9,81 \frac{m}{s^2} \cdot 1,15 \cdot \frac{2,5}{1,5} = 8,05 \frac{m}{s^2}$$

$$F_b = S_d(T1) \cdot m \cdot \lambda = \underline{0,926 \text{ kN}}$$

3.2. Proračun

Za statički proračun je korišćen programski paket Radimpex Tower 8.4.

U sledećem delu su prikazani rezultati proračuna.

Ulazni podaci - Konstrukcija

Šema nivoa

Naziv	z [m]	h [m]
Vrh temelja	1.45	1.45
Temeljna stopa	0.00	

Tabela materijala

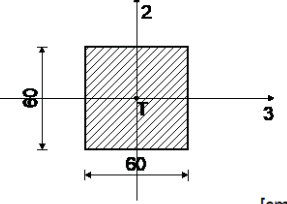
No	Naziv materijala	E[kN/m ²]	μ	γ [kN/m ³]	α [1/C]	Em[kN/m ²]	μ_m
1	C 25/30	3.100e+7	0.20	25.00	1.000e-5	3.100e+7	0.20

Setovi ploča

No	d[m]	e[m]	Materijal	Tip proračuna	Ortotropija	E2[kN/m ²]	G[kN/m ²]	α
<1>	0.400	0.200	1	Debela ploča	Izotropna			

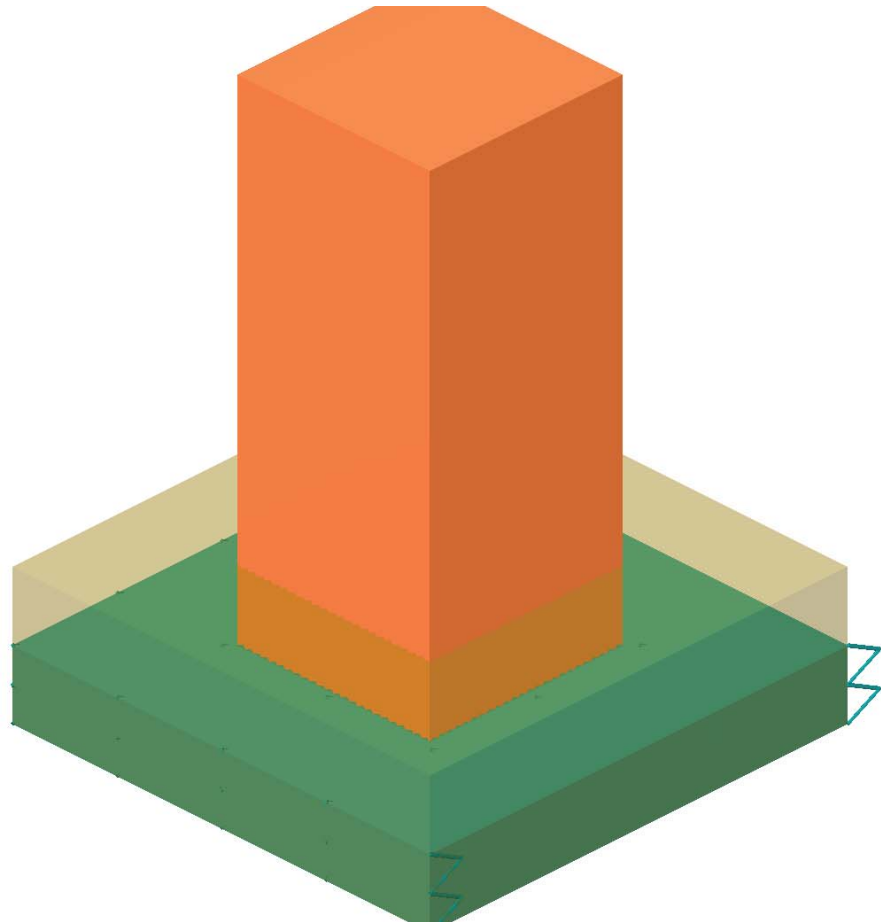
Setovi greda

Set: 1 Presek: b/d=60/60, Fiktivna ekscentričnost

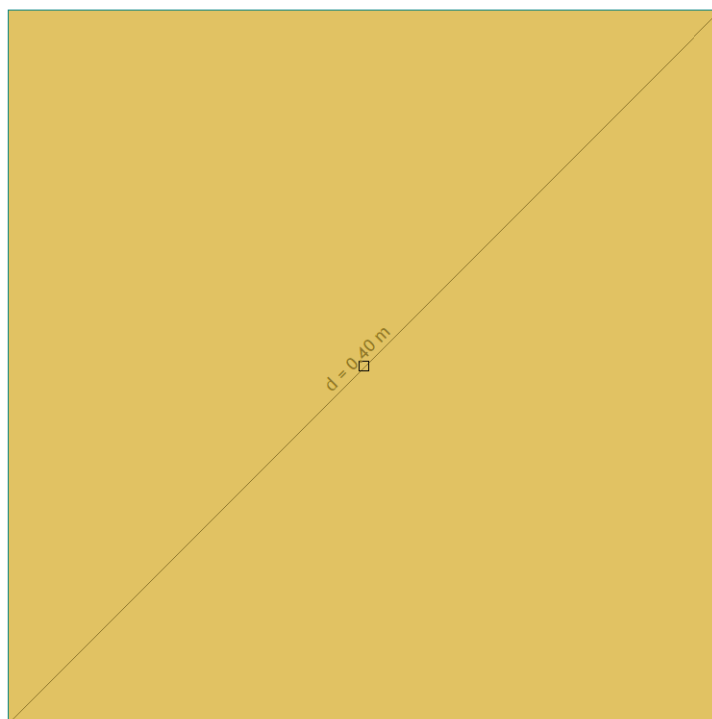
	Mat.	A1	A2	A3	I1	I2	I3
	1 - C 25/30	3.600e-1	3.000e-1	3.000e-1	1.825e-2	1.080e-2	1.080e-2

Setovi površinskih oslonaca

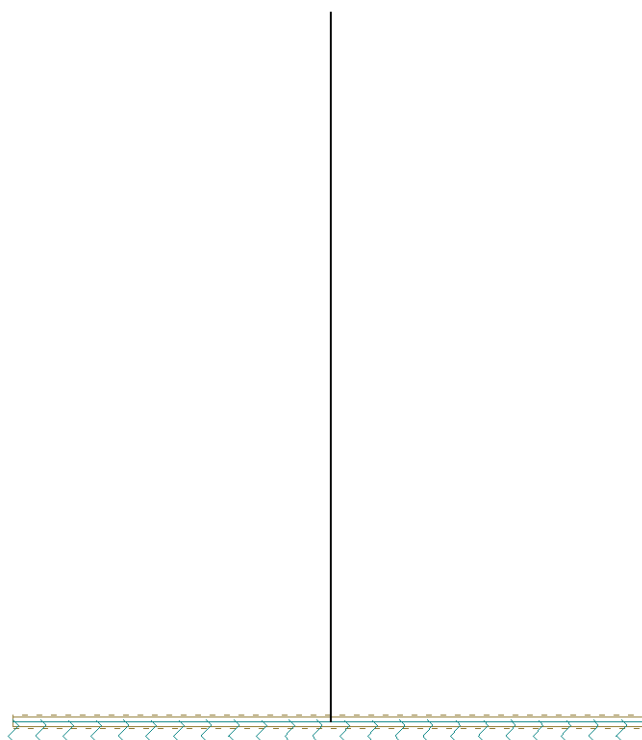
Set	K,R1	K,R2	K,R3
1	1.000e+10	1.000e+10	1.000e+4



Izometrija



Nivo: Temeljna stopa [0.00 m]



Ram: H_3

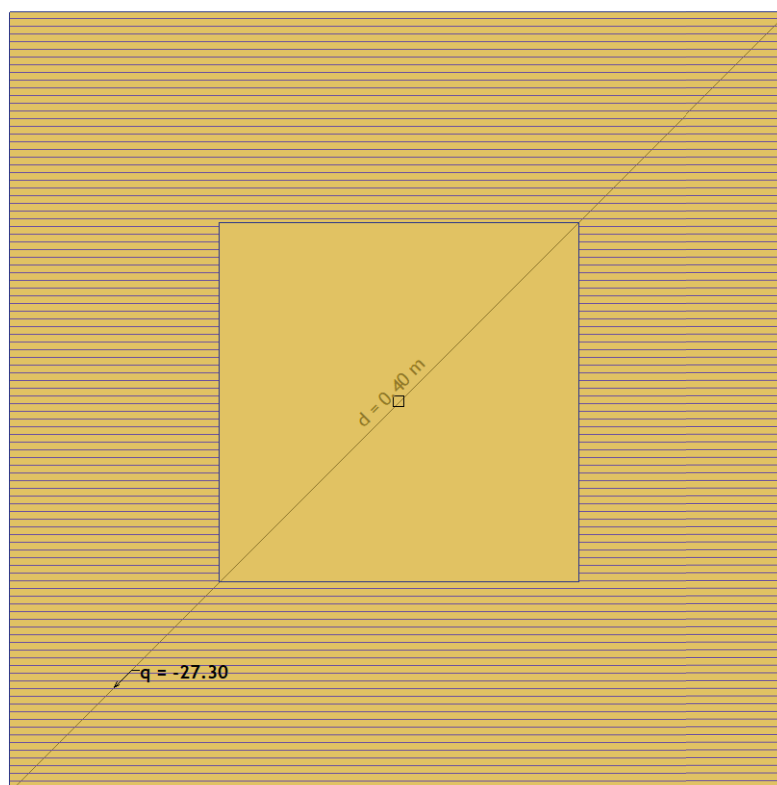
Ulazni podaci - Opterećenje

Lista slučajeva opterećenja

LC	Naziv
1	Stalno opterećenje (g)
2	Opterećenje snegom
3	Opterećenje vetrom
4	Seizmičko opterećenje
5	Komb.: 1.35xI+1.5xII+0.9xIII
6	Komb.: 1.35xI+0.75xII+1.5xIII
7	Komb.: I+1.5xII+0.9xIII
8	Komb.: I+0.75xII+1.5xIII
9	Komb.: 1.35xI+1.5xIII
10	Komb.: 1.35xI+1.5xII

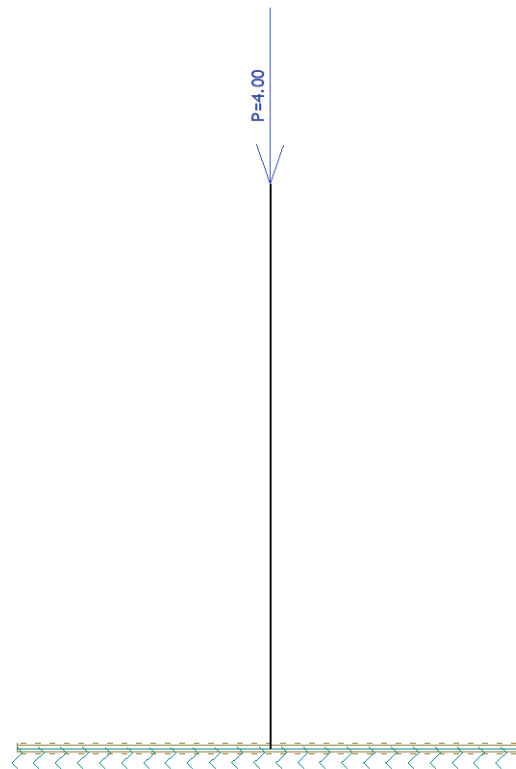
11	Komb.: I+1.5xIII
12	Komb.: I+1.5xII
13	Komb.: I-1xIV
14	Komb.: I+IV
15	Komb.: 1.35xI
16	Komb.: I
17	Komb.: I
18	Komb.: I+II
19	Komb.: I+III
20	Komb.: I+II+III
21	Komb.: I+IV
22	Komb.: I+II+IV

Opt. 1: Stalno opterećenje (g)



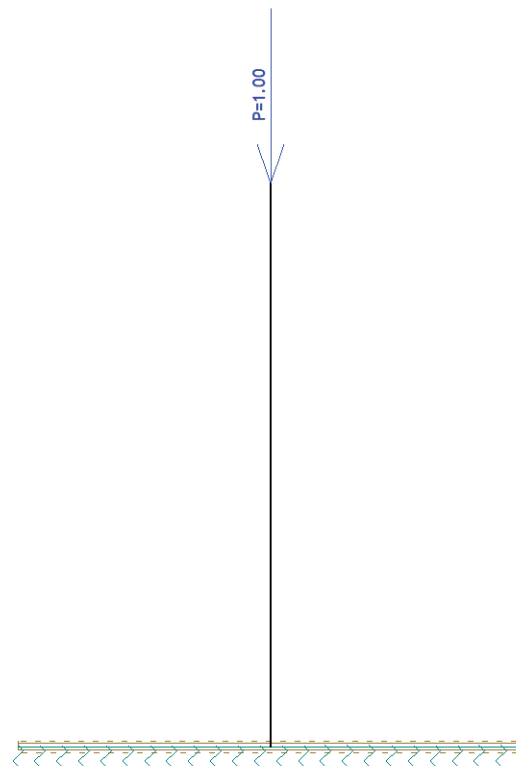
Nivo: Temeljna stopa [0.00 m]

Opt. 1: Stalno opterećenje (g)



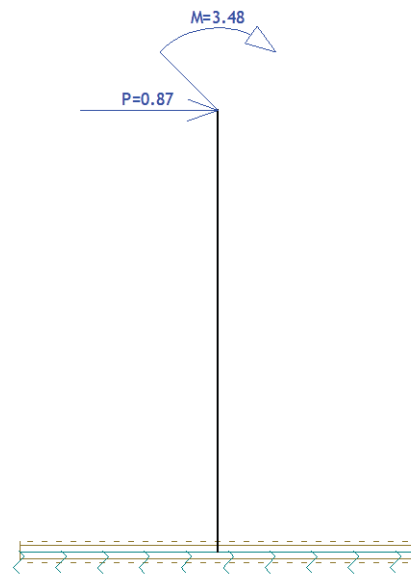
Ram: H_3

Opt. 2: Opterećenje snegom



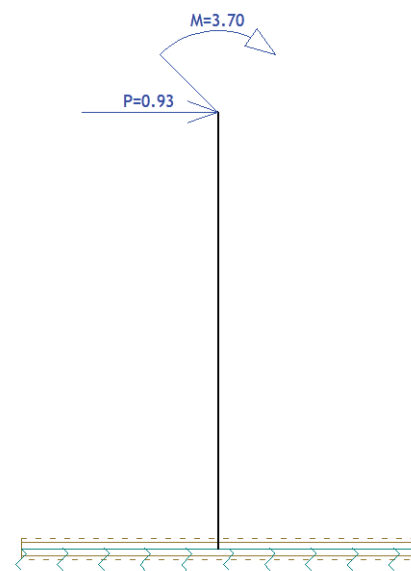
Ram: H_3

Opt. 3: Opterećenje vetrom



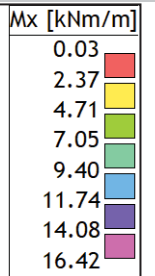
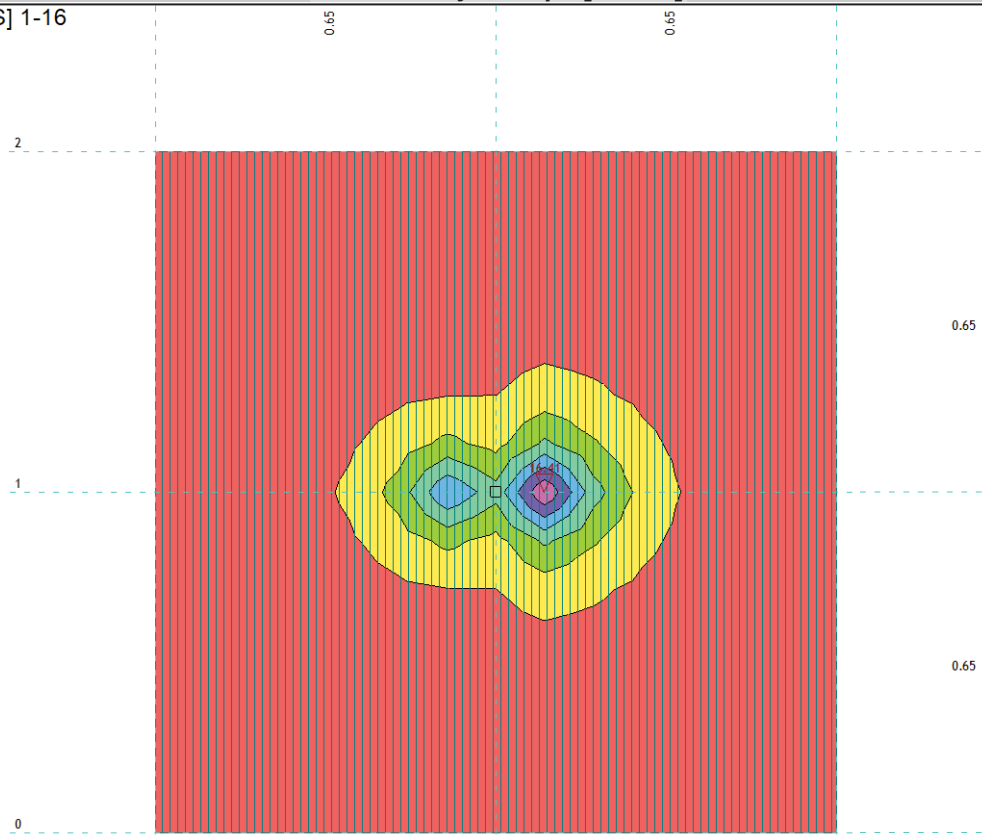
Ram: H_3

Opt. 4: Seizmičko opterećenje



Ram: H_3

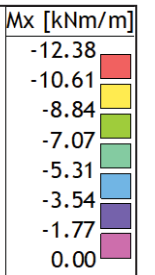
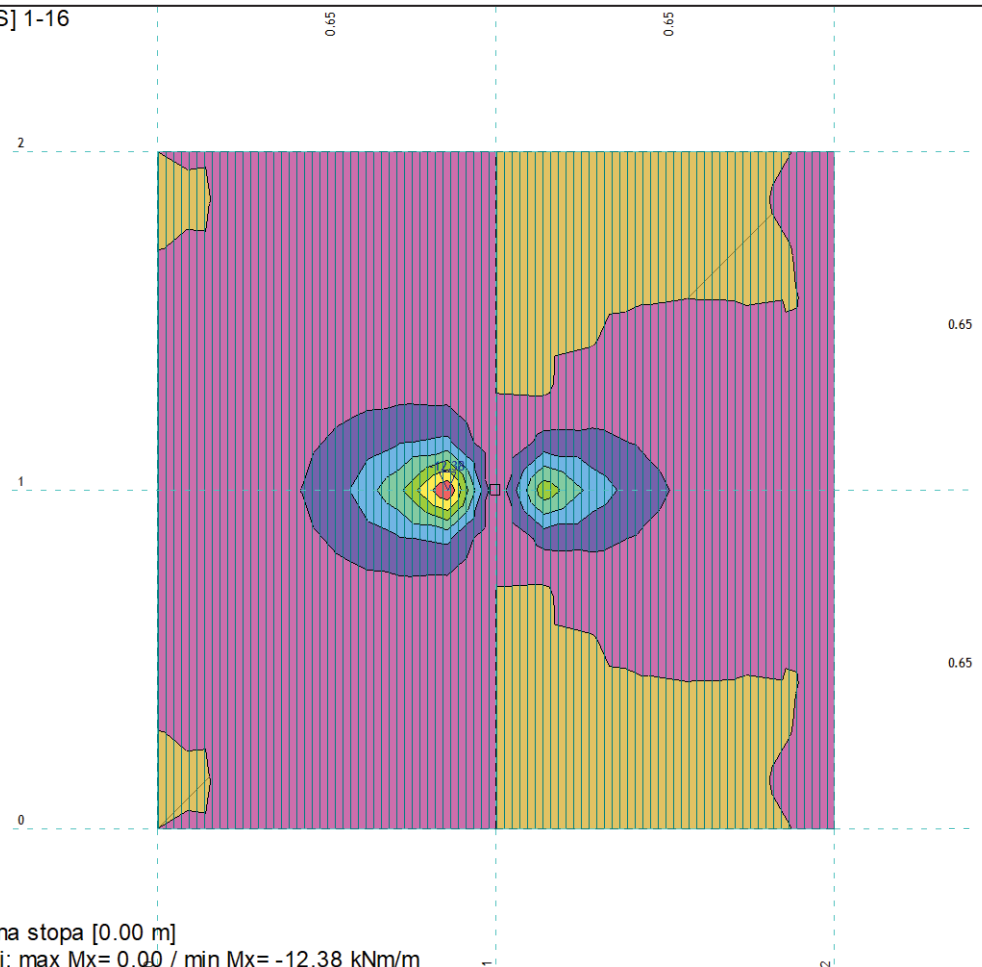
Opt. 23: [ULS] 1-16



Nivo: Temeljna stopa [0.00 m]

Utjecaji u ploči: max Mx= 16.41 / min Mx= 0.03 kNm/m

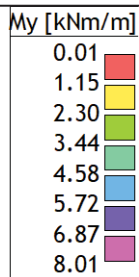
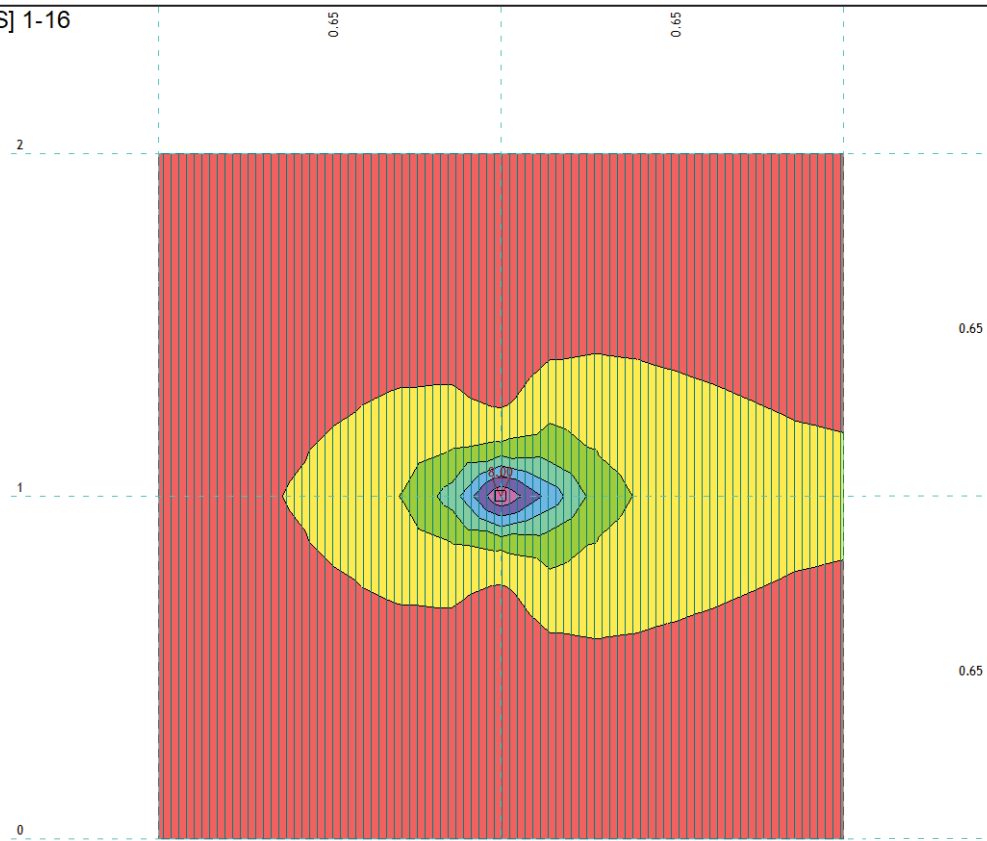
Opt. 23: [ULS] 1-16



Nivo: Temeljna stopa [0.00 m]

Utjecaji u ploči: max Mx= 0.00 / min Mx= -12.38 kNm/m

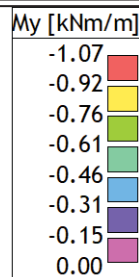
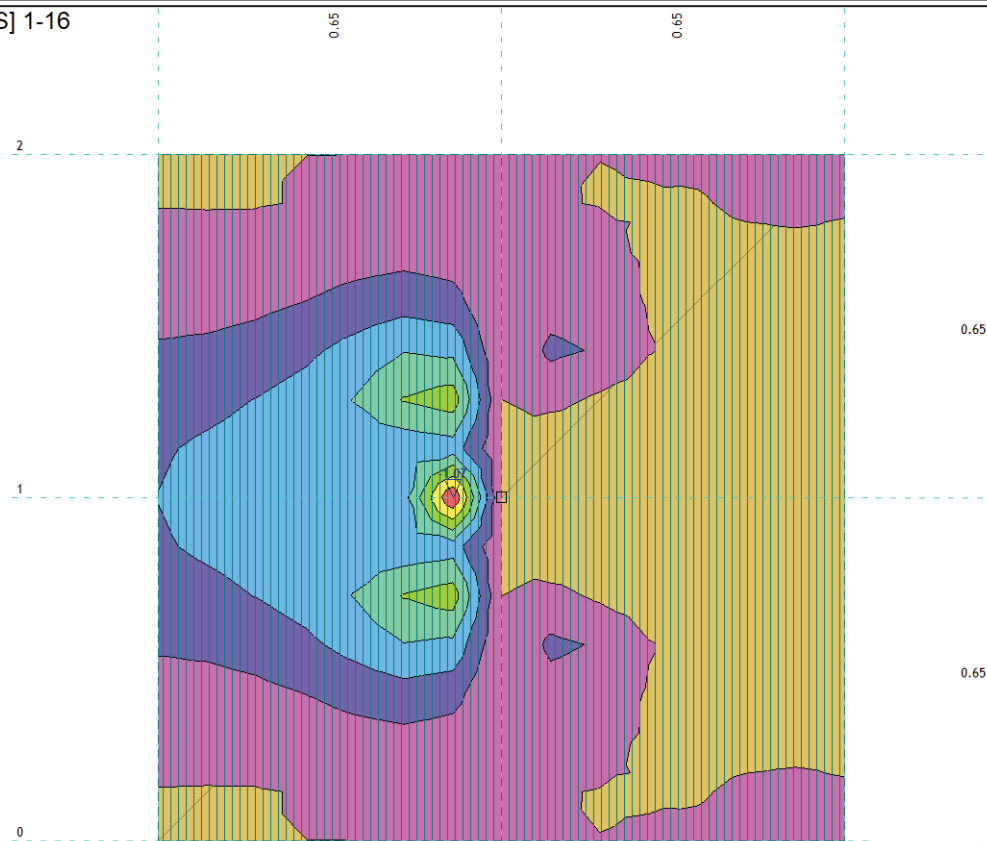
Opt. 23: [ULS] 1-16



Nivo: Temeljna stopa [0.00 m]

Uticaji u ploči: max My= 8.00 / min My= 0.01 kNm/m

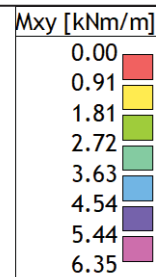
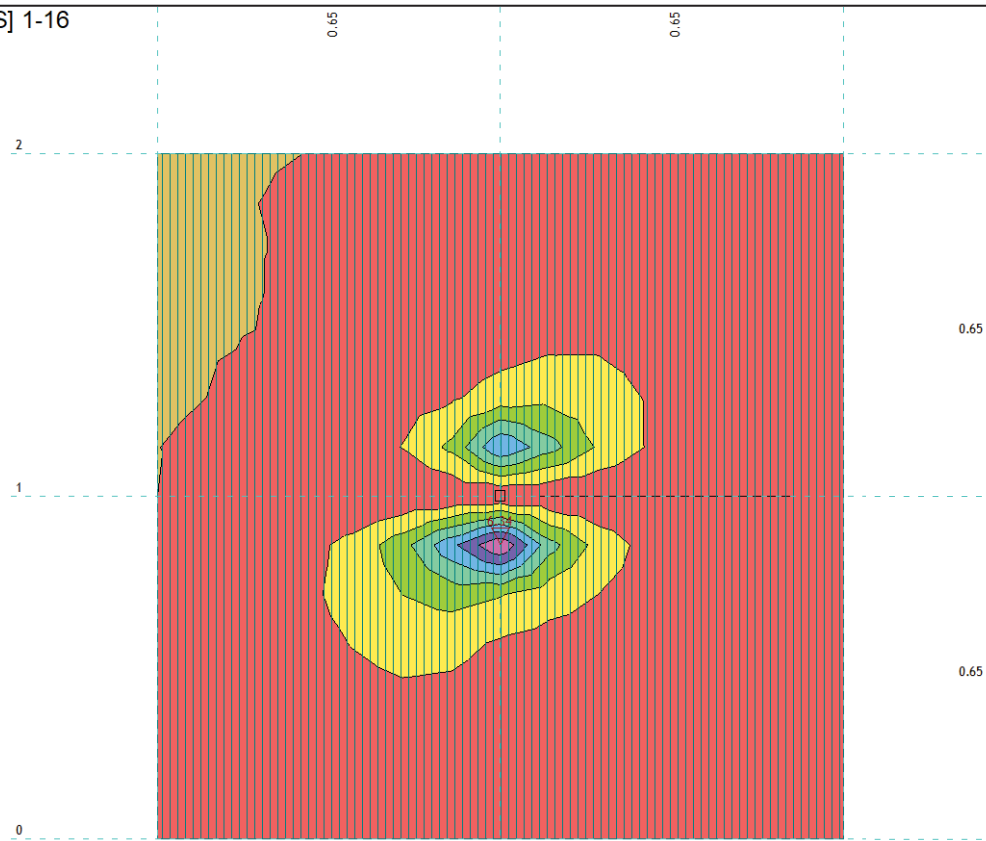
Opt. 23: [ULS] 1-16



Nivo: Temeljna stopa [0.00 m]

Uticaji u ploči: max My= 0.00 / min My= -1.07 kNm/m

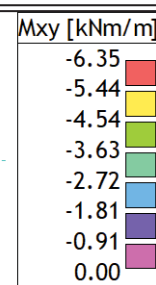
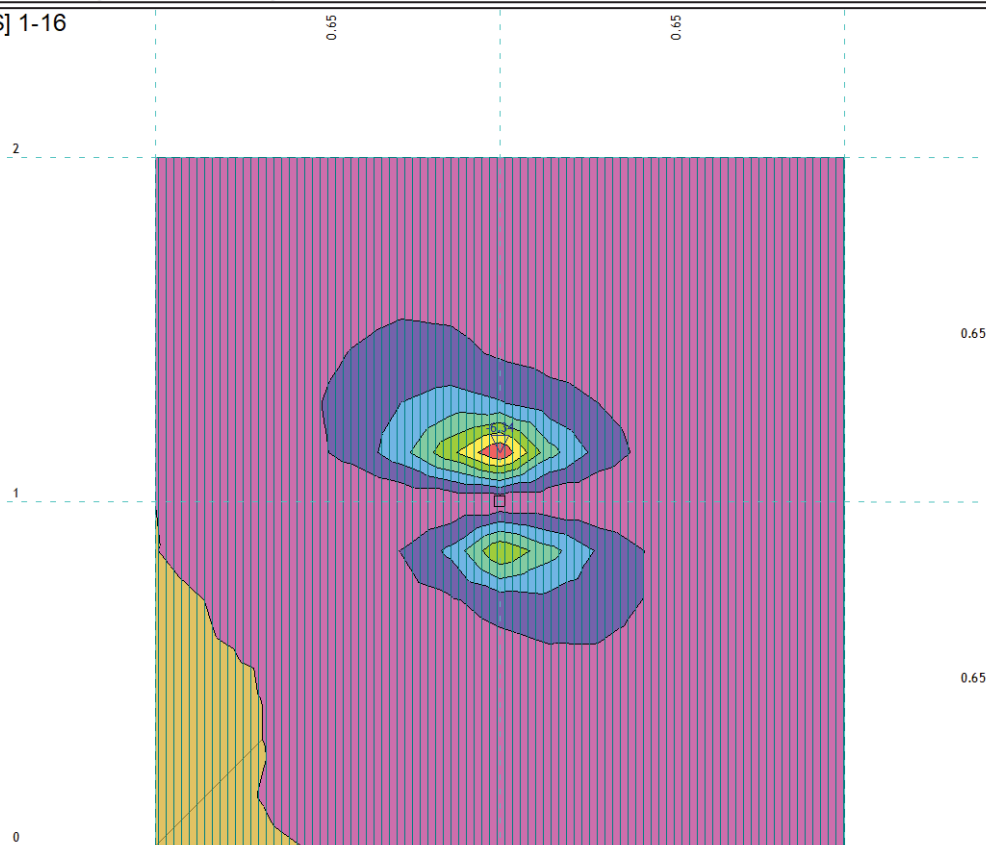
Opt. 23: [ULS] 1-16



Nivo: Temeljna stopa [0.00 m]

Uticaji u ploči: max M_{xy} = 6.34 / min M_{xy} = 0.00 kNm/m

Opt. 23: [ULS] 1-16

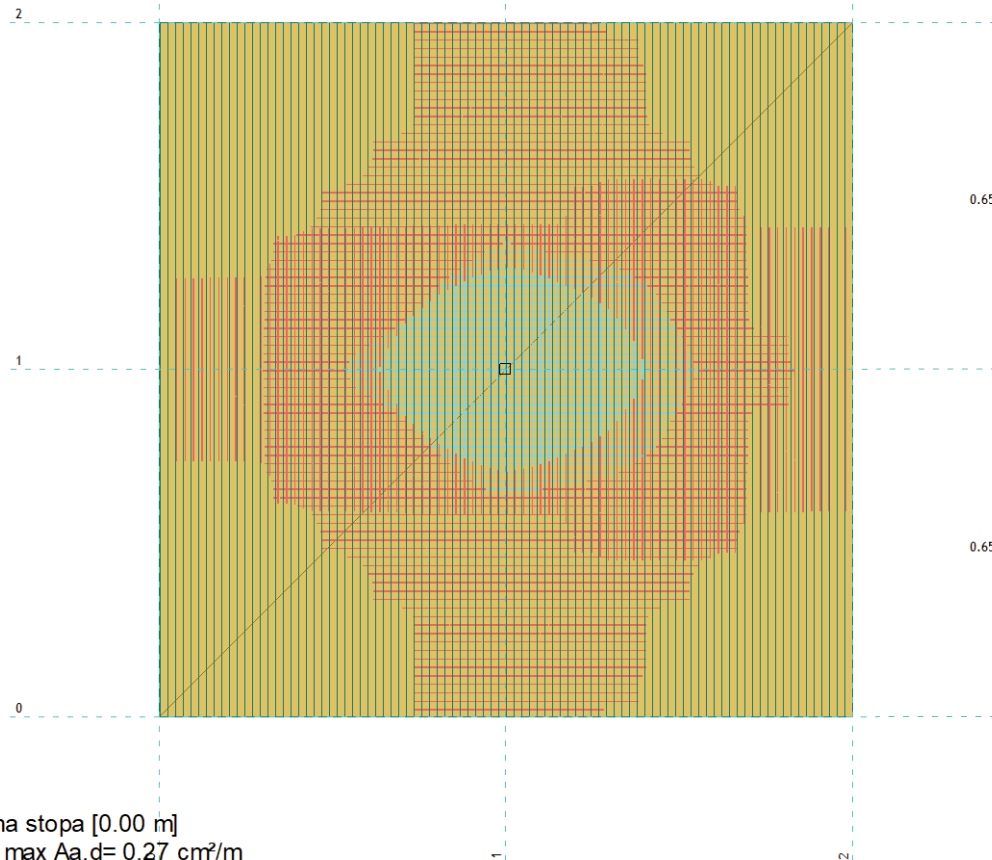


Nivo: Temeljna stopa [0.00 m]

Uticaji u ploči: max M_{xy} = 0.00 / min M_{xy} = -6.34 kNm/m

Merodavno opterećenje: Kompletna šema
SRPS EN 1992-1-1, C25/30, B500B, a=2.00 cm

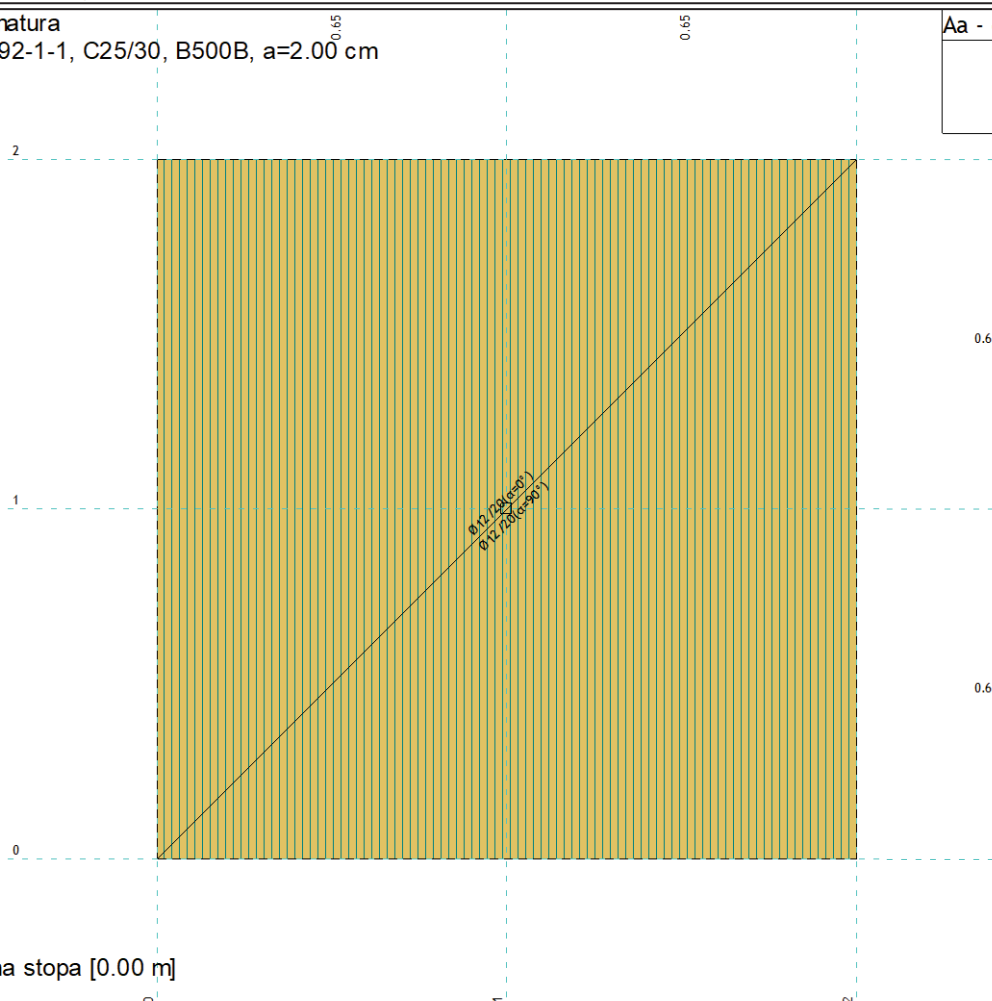
Aa - d.zona [cm ² /m]	
0.00	
0.14	
0.28	



Nivo: Temeljna stopa [0.00 m]
Aa - d.zona - max Aa,d= 0.27 cm²/m

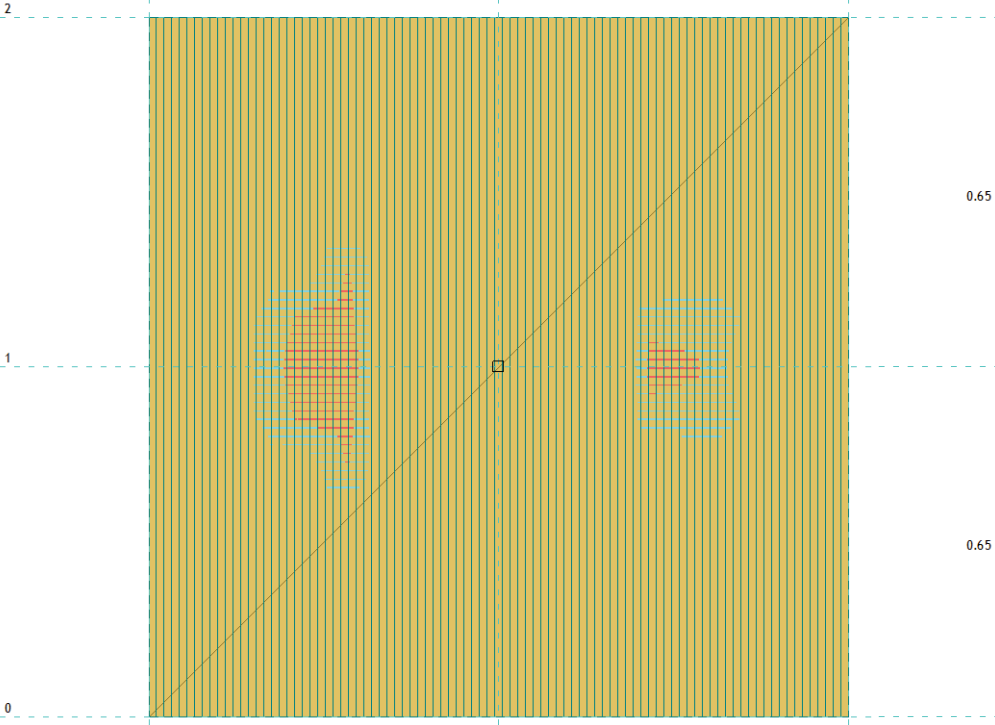
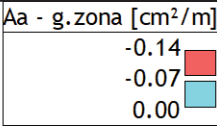
Usvojena armatura
SRPS EN 1992-1-1, C25/30, B500B, a=2.00 cm

Aa - d.zona [cm ² /m]	
0.00	
0.14	
0.28	



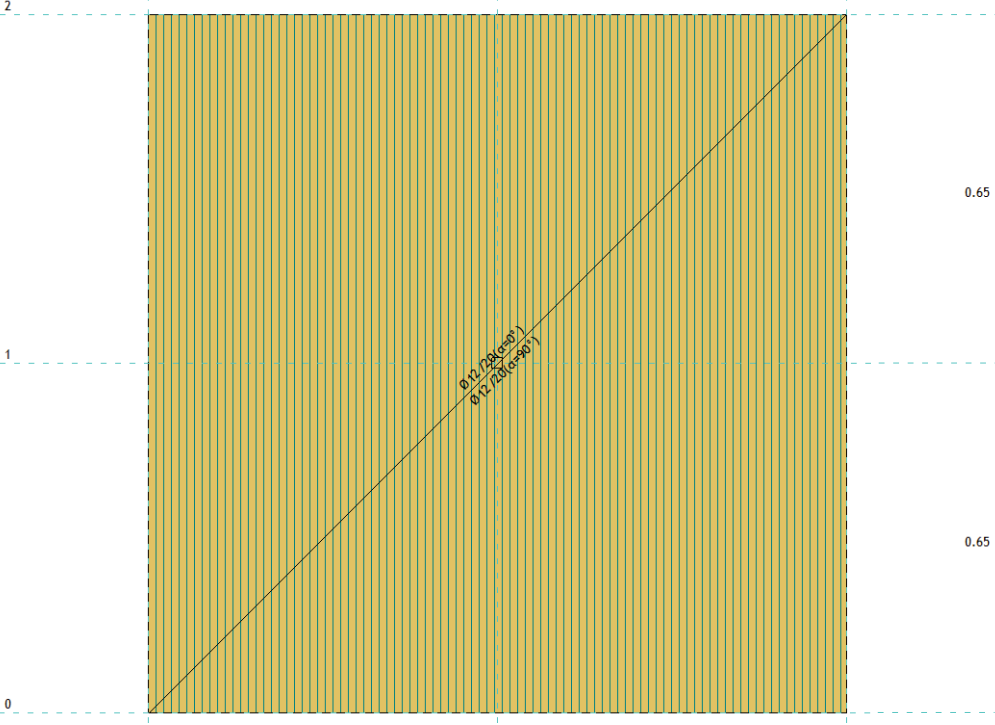
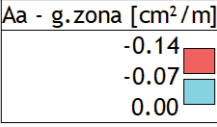
Nivo: Temeljna stopa [0.00 m]
Aa - d.zona

Merodavno opterećenje: Kompletna šema
SRPS EN 1992-1-1, C25/30, B500B, a=2.00 cm



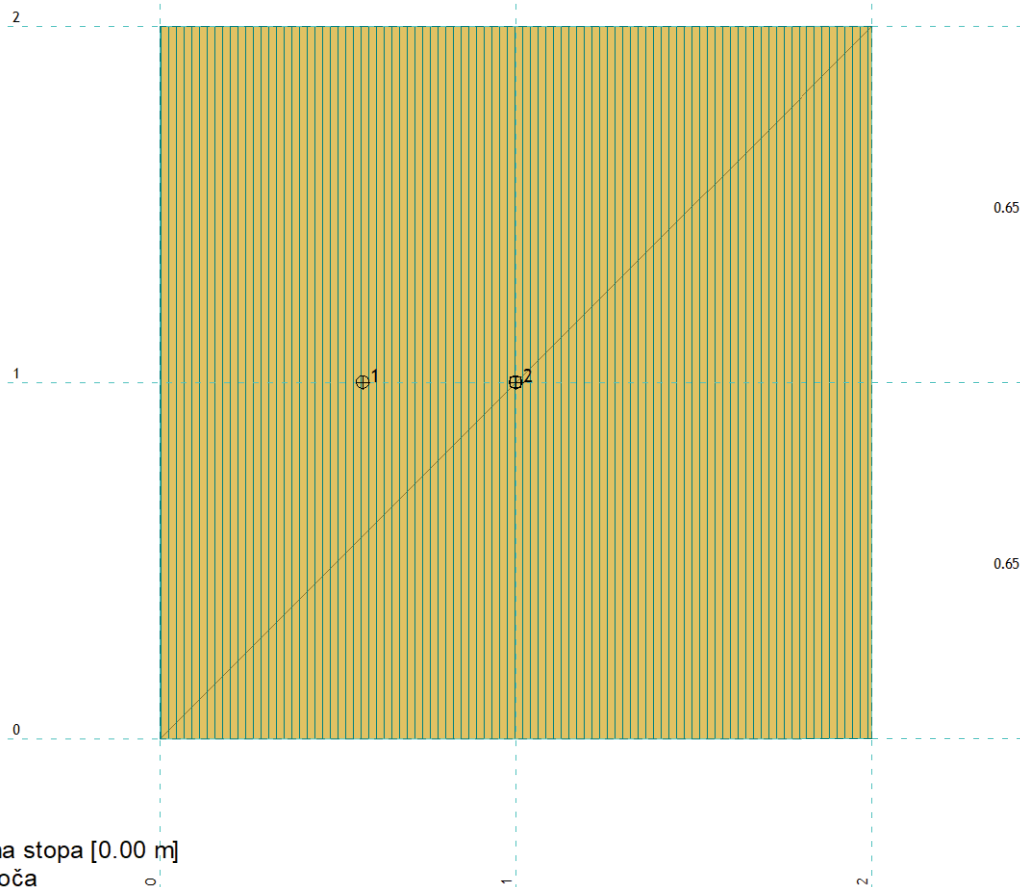
Nivo: Temeljna stopa [0.00 m]
Aa - g.zona - max Aa,g= -0.13 cm²/m

Usvojena armatura
SRPS EN 1992-1-1, C25/30, B500B, a=2.00 cm



Nivo: Temeljna stopa [0.00 m]
Aa - g.zona

SRPS EN 1992-1-1, C25/30, B500B, a=2.00 cm



Nivo: Temeljna stopa [0.00 m]

SRPS EN 1992-1-1

$\alpha_{cc} = 0.85$

d,pl=40.0 cm

C25/30 ($\gamma_C = 1.50$, $\gamma_S = 1.15$) [SP]

Gornja zona: B500B (a=2.0 cm)

Donja zona: B500B (a=2.0 cm)

Kompletna šema opterećenja

Tačka 1

X=-0.28 m; Y=0.00 m; Z=0.00 m

Pravac 1: ($\alpha=0^\circ$)

Merodavna kombinacija:

1.00xI+1.50xIII

Med = -2.19 kNm

Ned = 0.00 kN

$\epsilon_b/\epsilon_a = -0.254/20.000\text{‰}$

Ag1 = 0.13 cm²/m

Ad1 = 0.16 cm²/m

Usvojeno (gornja zona):

Ø12/20 (5.65 cm²/m)

Usvojeno (donja zona):

Ø12/20 (5.65 cm²/m)

Procenat armiranja: 0.28%

Pravac 2: ($\alpha=90^\circ$)

Merodavna kombinacija:

1.35xI+1.50xII

Med = 1.73 kNm

Ned = 0.00 kN

$\epsilon_b/\epsilon_a = -0.188/20.000\text{‰}$

Ag2 = 0.00 cm²/m

Ad2 = 0.10 cm²/m

Usvojeno (gornja zona):

Ø12/20 (5.65 cm²/m)

Usvojeno (donja zona):

Ø12/20 (5.65 cm²/m)

Procenat armiranja: 0.28%

Tačka 2

X=0.00 m; Y=0.00 m; Z=0.00 m

Pravac 1: ($\alpha=0^\circ$)

Merodavna kombinacija:

1.35xI+1.50xII+0.90xIII

Med = 4.44 kNm

Ned = 0.00 kN

$\epsilon_b/\epsilon_a = -0.306/20.000\text{‰}$

Ag1 = 0.00 cm²/m

Ad1 = 0.27 cm²/m

Usvojeno (gornja zona):

Ø12/20 (5.65 cm²/m)

Usvojeno (donja zona):

Ø12/20 (5.65 cm²/m)

Procenat armiranja: 0.28%

Pravac 2: ($\alpha=90^\circ$)

Merodavna kombinacija:

1.35xI+1.50xII+0.90xIII

Med = 4.44 kNm

Ned = 0.00 kN

$\epsilon_b/\epsilon_a = -0.306/20.000\text{‰}$

Ag2 = 0.00 cm²/m

Ad2 = 0.27 cm²/m

Usvojeno (gornja zona):

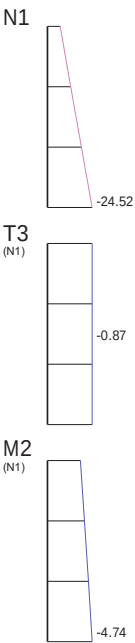
Ø12/20 (5.65 cm²/m)

Usvojeno (donja zona):

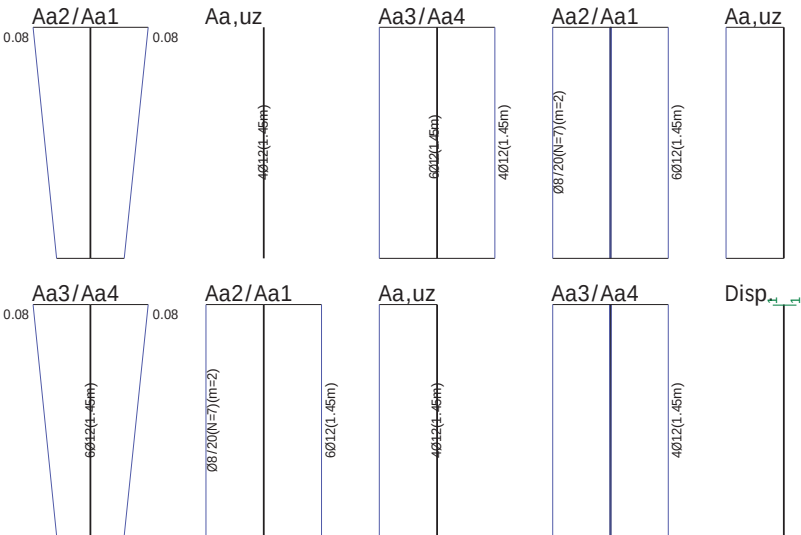
Ø12/20 (5.65 cm²/m)

Procenat armiranja: 0.28%

Opt. 23: [ULS] 1-16



Uticaji u gredi: (113-226)
 N1 [kN], T3 [kN], M2 [kNm]



Armatura u gredi: (113-226)

Greda 226-113

SRPS EN 1992-1-1

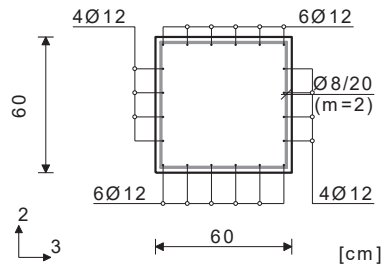
 $\alpha_{cc} = 0.85$ C25/30 ($\gamma_C = 1.50$, $\gamma_S = 1.15$) [SP]

B500B

Kompletna šema opterećenja

 $l_{i,2} = 1.45 \text{ m}$ ($\lambda_2 = 8.37$) $l_{i,3} = 1.45 \text{ m}$ ($\lambda_3 = 8.37$)

Nepomerljiva konstrukcija

Presek 1-1 $x = 0.00 \text{ m}$ 

Merodavna kombinacija za savijanje:

1.00xI+1.50xIII

N1ed = -4.00 kN

M2ed = -5.22 kNm

M3ed = 0.00 kNm

Uvećanje momenta savijanja usled izvijanja

 $\Delta e_2 = 2.0 \langle e_0 \rangle + 0.0 \langle e_{ll} \rangle = 2.0 \text{ cm}$ $|\Delta M_2| = 0.08 \text{ kNm}$ $\Delta e_3 = 2.0 \langle e_0 \rangle + 0.0 \langle e_{ll} \rangle = 2.0 \text{ cm}$ $|\Delta M_3| = 0.08 \text{ kNm}$

Merodavna kombinacija za smicanje:

1.35xI+0.75xII+1.50xIII

V2ed = 0.00 kN

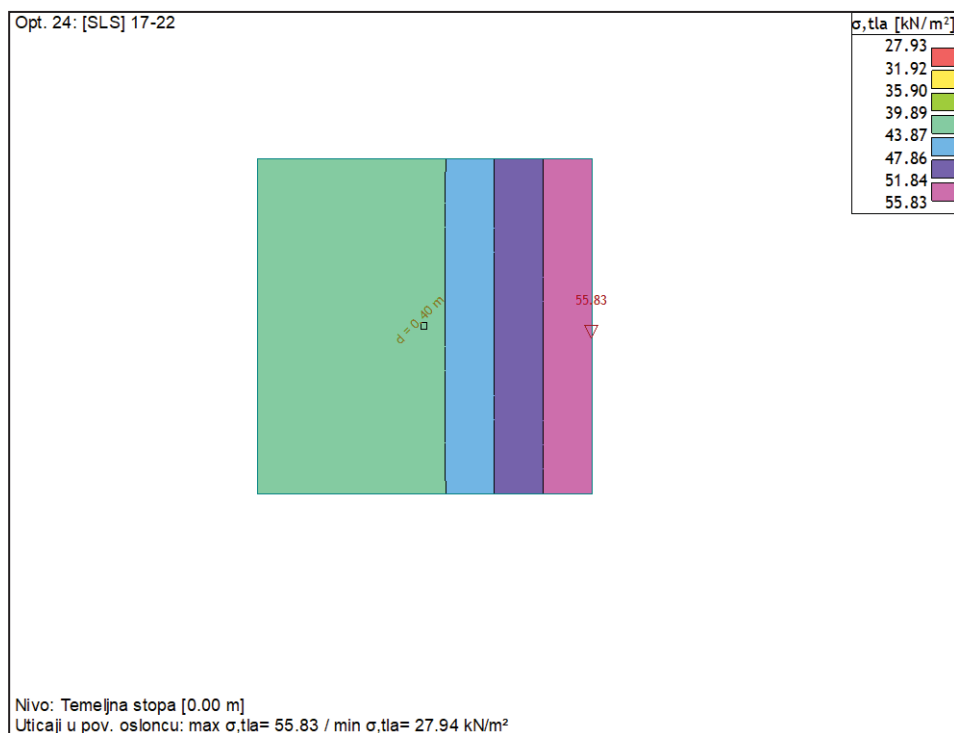
V3ed = -1.31 kN

M1ed = 0.00 kNm

 $V_{rd,max,2} = 1115.37 \text{ kN}$ $V_{rd,max,3} = 1115.37 \text{ kN}$ $\epsilon_b/\epsilon_a = -0.419/20.000 \text{ ‰}$ Aa1 = 0.08 cm²Aa2 = 0.08 cm²Aa3 = 0.08 cm²Aa4 = 0.08 cm²Aa,uz = 0.00 cm²/m (m=2)[Usvojeno Aa,uz = Ø8/20(m=2) = 2.51 cm²/m]

Procenat armiranja: 0.63%

GEOTEHNIČKA PROVERA TEMELJA



$$\max \delta, tlo = 55.83 \text{ kN/m}^2 \leq \delta, tlo, \lim = 80.0 \text{ kN/m}^2$$

Kontrola napona na kontaktnoj površini je sprovedena prema "postupku propisanih mera" (EN 1997 - 1 deo. 6.5.2.4) prema kojoj je napon u tlu ograničen na kapacitet nosivosti. S obzirom da ne postoji geomehanički elaborat, pretpostavlja se granična nosivost tla na 80 kN/m².

PROVERA NA KLIZANJE I PRETURANJE

Provera klizanja

$$T_d < H_{rd}$$

$$H_{rd} = ((1,3 \cdot 1,3 \cdot 0,25 + 0,6 \cdot 0,6 \cdot 1,45) \cdot 25 + 1,33 \cdot 1,3 \cdot 18,5 + 1,15) \cdot \tan 33^\circ / 1,1 = 33,50 \text{ kN}$$

$$T_d = 1,35 \cdot 0,926 = 1,25 \text{ kN} < 33,50 \text{ kN}$$

Provera preturanja

$$M_{Ed, pret} < M_{Ed, stab}$$

$$M_{Ed, pret} = 1,35 \cdot 0,926 \cdot 0,65 = 0,81 \text{ kNm}$$

$$M_{Ed, stab} = 1,0 \cdot (((1,3 \cdot 1,3 \cdot 0,25 + 0,6 \cdot 0,6 \cdot 1,45) \cdot 25 + 1,33 \cdot 1,3 \cdot 18,5 + 1,15) \cdot 0,65) = 36,89 \text{ kNm}$$

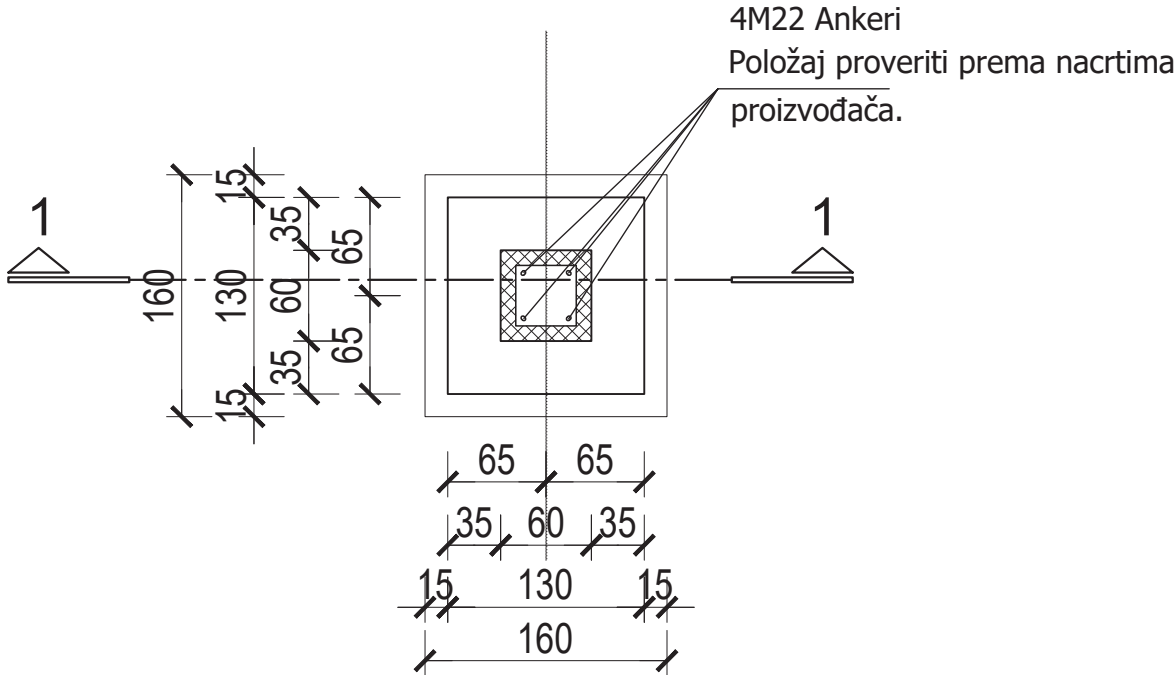
ZAKLJUČAK

Proračun temelja stubova rasvete visine 8m je sproveden zadovoljivši uslove nosivosti i upotrebljivosti. Minimalne količine armature su usvojene prema EC8-1.

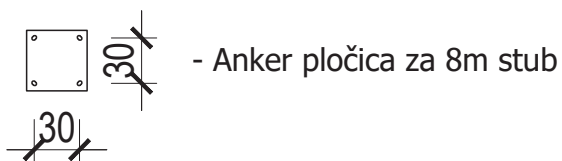
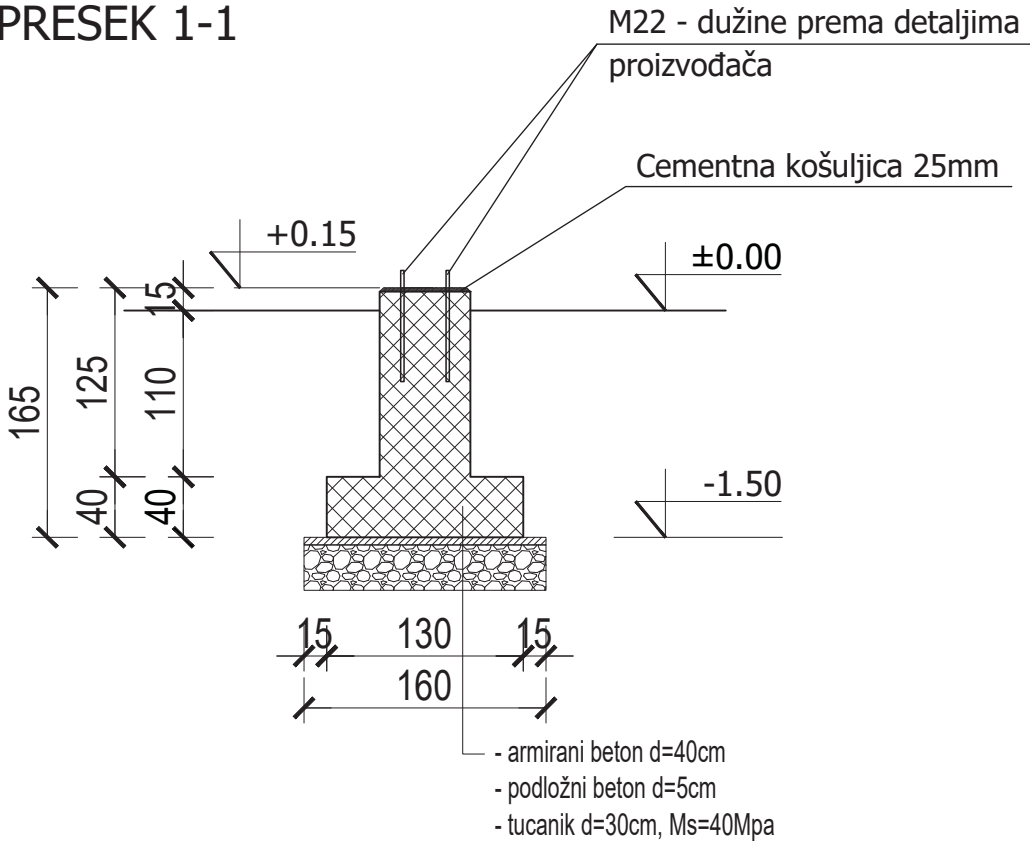
Odgovorni projektant konstrukcije temelja:
Peter Benka, mast. ing. građ.
Licenca IKS: 341 I029 21

Peter Benka

OSNOVA TEMELJA I PRESEK - R=1:50



PRESEK 1-1



1-1
R=1:50

② 6Ø12
④ Ø8/15
② 2Ø12
② 2Ø12
③ Ø8/15
② 6Ø12
④ Ø8/15

60
60

35 60 35

125
40

① 7Ø12
① Ø12/20
① 7Ø12
① Ø12/20

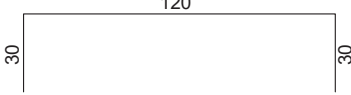
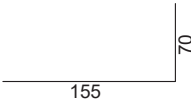
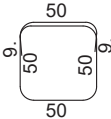
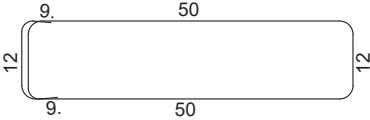
130

① Ø12 L=180 (28)
120
30
30
50
50
50
50
③ Ø8 L=268 (11)
② 6Ø12 L=225 (20)
155
70
④ Ø8 L=154 (22)
12
50
12
50

Technical drawing of a square reinforcement cage. The overall dimensions are 130 (width) and 130 (height). The reinforcement consists of 7 bars of diameter 12 mm, spaced at 20 mm intervals, labeled as 7Ø12/20. The drawing shows a top-down view of the cage with internal cross-sections indicated by dashed lines.

SPECIFIKACIJA I REKAPITULACIJA ARMATURE

Šipke - specifikacija

ozn.	oblik i mere [cm]	Ø	lg [m]	n [kom]	lgn [m]	Napomena
8m stub rasvete (1 kom)						
1		12	1.80	28	50.40	
2		12	2.25	20	45.00	
3		8	2.68	11	29.48	
4		8	1.54	22	33.88	

Šipke - rekapitulacija

Ø [mm]	lgn [m]	Jedinična težina [kg/m']	Težina [kg]
B500B			
8	63.36	0.40	25.03
12	95.40	0.89	84.72
Ukupno (B500B)			109.74
Ukupno			109.74