PRORAČUN TEMELJNE STOPE	POZ.	TS1	stup S4B

1. Geometrijske karakteristike

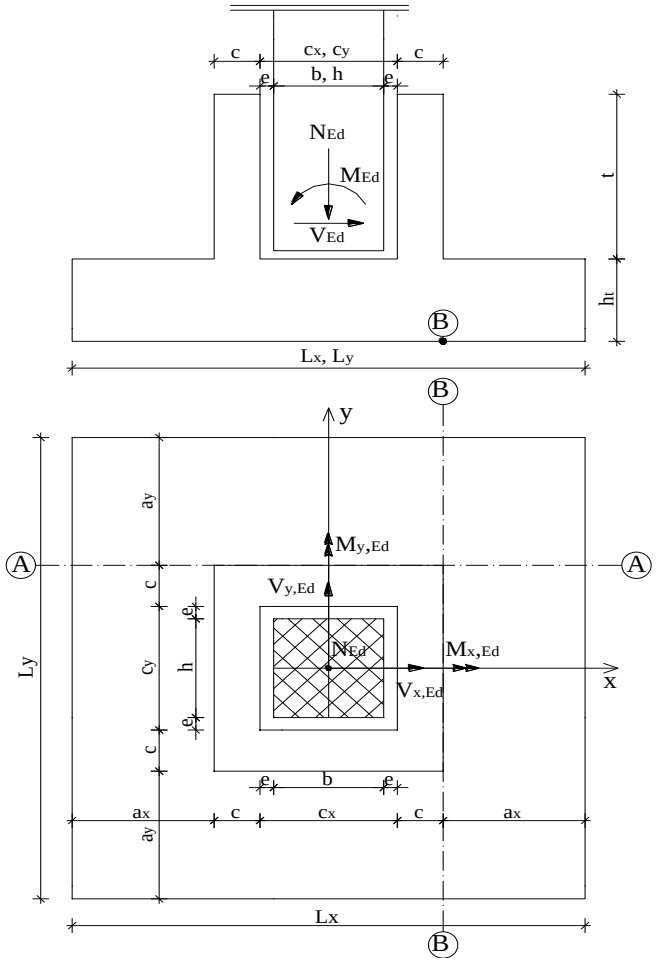
L_x=	**270,0**	cm
L_y=	**270,0**	cm
b=	**50,0**	cm
h=	**50,0**	cm
t=	**100,0**	cm
h_t=	**50,0**	cm
c=	**25,0**	cm
e=	**7,5**	cm

c_x=	65,0	cm
c_y=	65,0	cm
a_x=	77,5	cm
a_y=	77,5	cm

A_t=	7,290	m^2
W_x=	3,281	m^3
W_y=	3,281	m^3
I_x=	4,429	m^4
I_y=	4,429	m^4

d_1=	**5,0**	cm
d=	45,0	cm

d_1 - udaljenost od dna temelja do težišta armature
d - statička visina



2. Gradivo

Beton:

Klasa:	**C 25/30**	
f_{ck} =	25,00	MPa
f_{cd} =	16,67	MPa
τ_{Rd} =	0,30	MPa

Armatura:

Tip:	**B 500B**	
f_{yk} =	500,00	MPa
f_{yd} =	434,78	MPa

Koficijenti sigurnosti - materijala:

γ_c =	1,50
γ_s =	1,15

3. Opterećenje

KO1 - Rijetka kombinacija: 1,0·(g + Δg) + 1,0·(q)

KO2 - Uobičajena (stalna) konbinacija: 1,35·(g + Δg) + 1,5·(q)

KO3 - Seizmička kombinacija: 1,0·(g + Δg) + $\psi_{2,1}$·(q) + A_d

NAPOMENA:

- Kombinacije KO1 i KO3 koriste se za kontrolu naprezanja ispod temeljne stope;
- Kombinacije KO2 i KO3 koriste se za dimenzioniranje temeljne stope.

Kombinacija opterećenja:	N_{Ed} (kN)	$M_{x,Ed}$ (kNm)	$M_{y,Ed}$ (kNm)	$V_{x,Ed}$ (kN)	$V_{y,Ed}$ (kN)	$M_{x,Eds}$ (kNm)	$M_{y,Eds}$ (kNm)	N_{Eds} (kN)
KO1	350,0	0,0	0,0	0,0	20,0	30,0	0,0	583,0
KO2	464,0	36,0	20,0	4,0	6,0	45,0	26,0	778,5
KO3	253,0	363,0	302,0	52,0	61,0	454,5	380,0	486,0

N_t=	113,6	kN	vlastita težina temelja i čašice
γ_z=	20,00	kN/m^3	zapremina zemlje
N_z=	119,4	kN	težina zemlje iznad temeljne stope

$$N_{Eds} = N_{Ed} + N_t + N_z$$

$$M_{x,Eds} = M_{x,Ed} + V_{y,Ed} \cdot (t + h_t)$$

$$M_{y,Eds} = M_{y,Ed} + V_{x,Ed} \cdot (t + h_t)$$

4. Kontrola naprezanja ispod temeljne stope

$$e_x = \frac{M_{x,Eds}}{N_{Eds}} \qquad \sigma_{x,max} = \frac{N_{Eds}}{A_t} + \frac{M_{x,Eds}}{W_x} \qquad \sigma_{y,max} = \frac{N_{Eds}}{A_t} + \frac{M_{y,Eds}}{W_y} \qquad \sigma_A = \frac{N_{Eds}}{A_t} + \frac{M_{x,Eds}}{I_x} \cdot \left(\frac{c_y}{2} + c\right)$$

$$e_y = \frac{M_{y,Eds}}{N_{Eds}} \qquad \sigma_{x,min} = \frac{N_{Eds}}{A_t} - \frac{M_{x,Eds}}{W_x} \qquad \sigma_{y,min} = \frac{N_{Eds}}{A_t} - \frac{M_{y,Eds}}{W_y} \qquad \sigma_B = \frac{N_{Eds}}{A_t} + \frac{M_{y,Eds}}{I_y} \cdot \left(\frac{c_x}{2} + c\right)$$

$$L'_x = \frac{L_x}{2} - e_y \qquad \sigma_{x,Red} = \frac{2 \cdot N_{Eds}}{3 \cdot (L'_y \cdot L_x)}$$

$$L'_y = \frac{L_y}{2} - e_x \qquad \sigma_{y,Red} = \frac{2 \cdot N_{Eds}}{3 \cdot (L'_x \cdot L_y)}$$

Ako je e > L/6 potrebna je redukcija temeljne stope

Kombinacija opterećenja:	e_x (cm)	$L_x/6$ (cm)	e_y (cm)	$L_y/6$ (cm)	L_x' (cm)	L_y' (cm)
KO1	5,1	45,0	0,0	45,0		
KO3	93,5	45,0	78,2	45,0	56,8	41,5

Kombinacija opterećenja:	$\sigma_{x,max}$ (kN/m^2)	$\sigma_{x,min}$ (kN/m^2)	σ_A (kN/m^2)	$\sigma_{y,max}$ (kN/m^2)	$\sigma_{y,min}$ (kN/m^2)	σ_B (kN/m^2)	$\sigma_{x,Red}$ (kN/m^2)	$\sigma_{y,Red}$ (kN/m^2)
KO1	89,1	70,8	83,9	80,0	80,0	80,0		
KO3	205,2	-71,9	125,7	182,5	-49,2	116,0	289,3	211,2

Dozvoljeno naprezanje tla ispod temeljne stope:	σ_{doz}=	**319,0**	kN/m^2
Maksimalno proračunsko naprezanje tla ispod temeljne stope:	σ_{max}=	**289,3**	kN/m^2

σ_{doz}= **319,0** kN/m^2 **>** σ_{max}= **289,3** kN/m^2 **Zadovoljava!**

5. Dimenzioniranje temeljne stope na savijanje

Kombinacija opterećenja:	$\sigma_{x,max}$ (kN/m^2)	$\sigma_{x,min}$ (kN/m^2)	σ_A (kN/m^2)	$\sigma_{y,max}$ (kN/m^2)	$\sigma_{y,min}$ (kN/m^2)	σ_B (kN/m^2)	$\sigma_{x,Red}$ (kN/m^2)	$\sigma_{y,Red}$ (kN/m^2)
KO2	120,5	93,1	112,6	114,7	98,9	110,2		
KO3	205,2	-71,9	125,7	182,5	-49,2	116,0	289,3	211,2

	SMJER Y (presjek A-A)				**SMJER X (presjek B-B)**			
Kombinacija opterećenja:	$M_{A,Ed}$ (kNm/m)	$\mu_{A,Rd}$	ζ	A_{s1y} (cm^2/m)	$M_{B,Ed}$ (kNm/m)	$\mu_{B,Rd}$	ζ	A_{s1x} (cm^2/m)
KO2	35,4	0,004	0,987	**1,83**	34,0	0,004	0,987	**1,76**
KO3	86,9	0,010	0,981	**4,53**	63,4	0,007	0,984	**3,29**

$$M_{A,Ed} = a_y^2 \cdot (2 \cdot \sigma_{x,max} + \sigma_A) \cdot \frac{L_x}{6} \qquad \mu_{Rd} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}}$$

$$M_{B,Ed} = a_x^2 \cdot (2 \cdot \sigma_{y,max} + \sigma_B) \cdot \frac{L_y}{6} \qquad A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}}$$

Minimalna armatura u temeljnoj stopi: $A_{s1,min}$=0,0006·b·h= **3,00** cm^2/m

Potrebna armatura smjer x (presjek B-B): $A_{s1x,pot}$= **3,29** cm^2/m

Odabrano: **1 x R-385** + **Ø 5** / **25** cm

$A_{s1x,odab.}$ = **4,64** cm^2/m

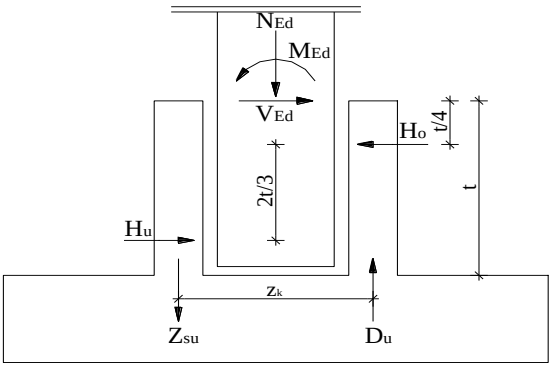
Potrebna armatura smjer y (presjek A-A): $A_{s1y,pot}$= **4,53** cm^2/m

Odabrano: **1 x R-385** + **Ø 5** / **25** cm

$A_{s1y,odab}$ = **4,64** cm^2/m

6. Dimenzioniranje temeljne čašice

$z_{x,k}$ =	90,0	cm
$z_{y,k}$ =	90,0	cm
t =	100,0	cm



Armatura čašice u smjeru osi x:

$M_{y,Ed}$ =	302,0	kNm
$V_{x,Ed}$ =	52,0	kN

$H_0 = 3M_{y,Ed}/(2t)+5V_{x,Ed}/4$ = 518,0 kN

$A_s^g = H_0/f_{yd}$ =	11,9	cm^2
5	Ø 10	
m=	4	
$A^g_{s,\,odabrano}$ =	15,7	cm^2

$H_u = 3M_{y,Ed}/(2t)+V_{x,Ed}/4$ = 466,0 kN

$A_s^d = H_u/f_{yd}$ =	10,7	cm^2
5	Ø 10	
m=	4	
$A^d_{s,\,odabrano}$ =	15,7	cm^2

$Z_{su} = H_0 t/z_k$ = 575,6 kN

$A_s^v = Z_{su}/f_{yd}$ =	13,2	cm^2
Odabrano: 8	Ø 12	
m=	2	
$A^v_{s,\,odabrano}$ =	18,1	cm^2

Armatura čašice u smjeru osi y:

$M_{x,Ed}$ =	363,0	kNm
$V_{y,Ed}$ =	61,0	kN

$H_0 = 3M_{y,Ed}/(2t)+5V_{x,Ed}/4$ = 620,8 kN

$A_s^g = H_0/f_{yd}$ =	14,3	cm^2
5	Ø 10	
m=	4	
$A^g_{s,\,odabrano}$ =	15,7	cm^2

$H_u = 3M_{y,Ed}/(2t)+V_{x,Ed}/4$ = 559,8 kN

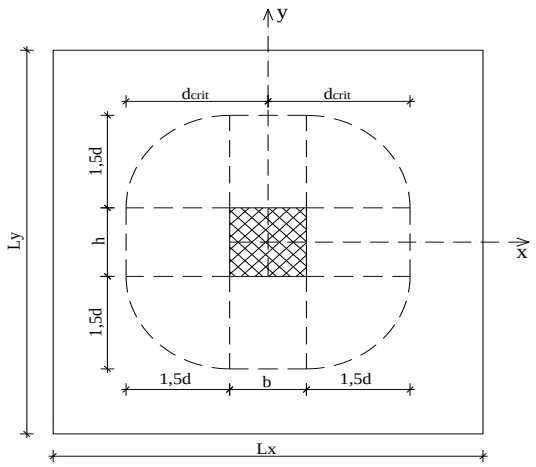
$A_s^d = H_u/f_{yd}$ =	12,9	cm^2
5	Ø 10	
m=	4	
$A^d_{s,\,odabrano}$ =	15,7	cm^2

$Z_{su} = H_0 t/z_k$ = 689,7 kN

$A_s^v = Z_{su}/f_{yd}$ =	15,9	cm^2
Odabrano: 8	Ø 12	
m=	2	
$A^v_{s,\,odabrano}$ =	18,1	cm^2

7. Dimenzioniranje temeljne stope na proboj

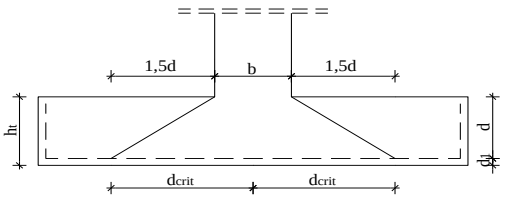
$d_{crit,\,x}$ =b/2 + 1,5d=	92,5	cm
$d_{crit,\,y}$ =h/2 + 1,5d=	92,5	cm
u_{crit} =2(b+h)+2(1,5·d)·π =	624,1	cm
A_{crit} =b·h+2(b+h)1,5·d+(1,5·d)^2·π=	30313,9	cm^2



Koeficijent armiranja ploče u x smjeru: ρ_x =	0,00103	
Koeficijent armiranja ploče u y smjeru: ρ_y =	0,00103	
ρ_1 =√(r_x·r_y) =	0,00103	

Uzdužna sila u stupu: N_{Ed} =	**464,0**	kN
σ_{Ed} =	**48,0**	kN/m^2
β_p=	**1,15**	

Reducirana uzdužna sila: $V_{Ed} = N_{Ed} - (\sigma_{Ed} \cdot A_{crit})$ =	318,5	kN
$\nu_{Ed} = (V_{Ed}/u_{crit})\cdot\beta_p$ =	**0,59**	kN/cm
k =1,6-d=	1,15	
$\nu_{Rd1} = \tau_{Rd} \cdot k\,(1,2+40\cdot\rho_1)\cdot d$ =	**1,93**	kN/cm



ν_{Ed} = **0,59** kN/cm < ν_{Rd1} = **1,93** kN/cm

Nije potrebna poprečna armatura za osiguranje od proboja ploče!

$\nu_{Rd2} = 1,6\cdot\nu_{Rd1}$ =	**3,08**	kN/cm

ν_{Ed} = **0,59** kN/cm < ν_{Rd2} = **3,08** kN/cm

Zadovoljava!