

1 Level:

- Cracking : permissible
- Exposure : 1 - dry

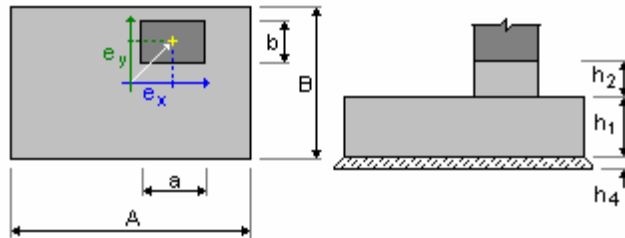
2 Spread footing: Foundation1

Number: 1

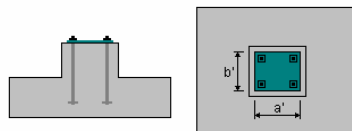
2.1 Material properties:

- Concrete : C20/25; Characteristic strength = 20.00 MPa
Unit weight = 2501.36 (kG/m³)
- Longitudinal reinforcement : type A500HW Characteristic strength = 500.00 MPa
- Transversal reinforcement : type Characteristic strength = 220.00 MPa

2.2 Geometry:



A	= 1.60 (m)	a	= 0.45 (m)
B	= 2.30 (m)	b	= 0.45 (m)
h1	= 0.30 (m)	e _x	= 0.00 (m)
h2	= 0.60 (m)	e _y	= 0.00 (m)
h4	= 0.00 (m)		



a'	= 35.0 (cm)
b'	= 35.0 (cm)
c	= 5.0 (cm)

2.3 Calculation options:

- Geotechnic calculations according to : ENV 1997-1:1994
- Concrete calculations according to : ENV 1992-1-1:1991
- Include seismic dispositions
- Shape selection : without limits
- Conditions without drainage

Partial factors for soil properties:

	$\tan(\phi)$	c'	Cu	q _{max}
Case B	1.00	1.00	1.00	1.00

2.4 Loads:

2.4.1 Foundation loads:

Case	Nature	Group	N (kN)	F _x (kN)	F _y (kN)	M _x (kN*m)	M _y (kN*m)
LC1	design	----	23.08	-1.24	0.00	-0.13	-1.94
LC2	design	----	-21.21	1.20	0.00	0.11	1.89
LC3	design	----	-9.59	0.55	-0.01	-9.01	0.87
LC4	design	----	-0.58	0.08	0.01	9.05	0.12
LC5	design	----	-0.58	0.06	-0.01	-9.06	0.10
LC6	design	----	-9.59	0.57	0.01	9.10	0.89
DSGN7	design	----	14.42	-0.37	-21.26	28.34	-0.57
DSGN8	design	----	-4.50	0.35	21.15	-28.53	0.55
DSGN9	design	----	13.78	-0.37	-21.25	28.37	-0.57
DSGN10	design	----	-5.00	0.36	21.16	-28.50	0.55
DSGN11	design	----	9.64	-0.23	-12.78	18.77	-0.35
DSGN12	design	----	-4.71	0.21	12.67	-18.95	0.32
DSGN13	design	----	9.00	-0.22	-12.77	18.79	-0.34
DSGN14	design	----	-5.35	0.21	12.68	-18.93	0.33

2.4.2 Backfill loads:

Case	Nature	Q1 (kN/m ²)
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2.4.3 Combination list

1/	ULS : LC1 N=23.08 Mx=-0.13 My=-1.94 Fx=-1.24
2/	ULS : LC2 N=-21.21 Mx=0.11 My=1.89 Fx=1.20
3/	ULS : LC3 N=-9.59 Mx=-9.01 My=0.87 Fx=0.55 Fy=-0.01
4/	ULS : LC4 N=-0.58 Mx=9.05 My=0.12 Fx=0.08 Fy=0.01
5/	ULS : LC5 N=-0.58 Mx=-9.06 My=0.10 Fx=0.06 Fy=-0.01
6/	ULS : LC6 N=-9.59 Mx=9.10 My=0.89 Fx=0.57 Fy=0.01
7/	ULS : DSGN7 N=14.42 Mx=28.34 My=-0.57 Fx=-0.37 Fy=-21.26
8/	ULS : DSGN8 N=-4.50 Mx=-28.53 My=0.55 Fx=0.35 Fy=21.15
9/	ULS : DSGN9 N=13.78 Mx=28.37 My=-0.57 Fx=-0.37 Fy=-21.25
10/	ULS : DSGN10 N=-5.00 Mx=-28.50 My=0.55 Fx=0.36 Fy=21.16
11/	ULS : DSGN11 N=9.64 Mx=18.77 My=-0.35 Fx=-0.23 Fy=-12.78
12/	ULS : DSGN12 N=-4.71 Mx=-18.95 My=0.32 Fx=0.21 Fy=12.67
13/	ULS : DSGN13 N=9.00 Mx=18.79 My=-0.34 Fx=-0.22 Fy=-12.77
14/	ULS : DSGN14 N=-5.35 Mx=-18.93 My=0.33 Fx=0.21 Fy=12.68
15/*	ULS : LC1 N=23.08 Mx=-0.13 My=-1.94 Fx=-1.24
16/*	ULS : LC2 N=-21.21 Mx=0.11 My=1.89 Fx=1.20
17/*	ULS : LC3 N=-9.59 Mx=-9.01 My=0.87 Fx=0.55 Fy=-0.01
18/*	ULS : LC4 N=-0.58 Mx=9.05 My=0.12 Fx=0.08 Fy=0.01
19/*	ULS : LC5 N=-0.58 Mx=-9.06 My=0.10 Fx=0.06 Fy=-0.01
20/*	ULS : LC6 N=-9.59 Mx=9.10 My=0.89 Fx=0.57 Fy=0.01
21/*	ULS : DSGN7 N=14.42 Mx=28.34 My=-0.57 Fx=-0.37 Fy=-21.26
22/*	ULS : DSGN8 N=-4.50 Mx=-28.53 My=0.55 Fx=0.35 Fy=21.15
23/*	ULS : DSGN9 N=13.78 Mx=28.37 My=-0.57 Fx=-0.37 Fy=-21.25
24/*	ULS : DSGN10 N=-5.00 Mx=-28.50 My=0.55 Fx=0.36 Fy=21.16
25/*	ULS : DSGN11 N=9.64 Mx=18.77 My=-0.35 Fx=-0.23 Fy=-12.78
26/*	ULS : DSGN12 N=-4.71 Mx=-18.95 My=0.32 Fx=0.21 Fy=12.67
27/*	ULS : DSGN13 N=9.00 Mx=18.79 My=-0.34 Fx=-0.22 Fy=-12.77
28/*	ULS : DSGN14 N=-5.35 Mx=-18.93 My=0.33 Fx=0.21 Fy=12.68

2.5 Soil:

Soil level:	N ₁	= 0.00 (m)	
Column pier level:	N _a	= 0.00 (m)	
Minimum reference level:	N _f	= -0.90 (m)	
Water level:	N _{max.}	= -4.40 (m)	N _{min.} = -4.10 (m)

C-Cs

- Soil level: 0.00 (m)
- Unit weight:2000.00 (kG/m³)

- Unit weight of solid: 2000.00 (kG/m³)
- Internal friction angle: 0.0 (Deg)
- Cohesion: 0.12 (MPa)

2.6 Calculation results:

2.6.1 Required reinforcement

Spread footing:

bottom:

ULS : LC1 N=23.08 Mx=-0.13 My=-1.94 Fx=-1.24
 Mx = 3.37 (kN*m) $A_{sx} = 3.60$ (cm²/m)

ULS : DSGN7 N=14.42 Mx=28.34 My=-0.57 Fx=-0.37 Fy=-21.26
 Mx = 19.79 (kN*m) $A_{sy} = 3.60$ (cm²/m)

$A_{s \min} = 3.60$ (cm²/m)

top:

ULS : LC2 N=-21.21 Mx=0.11 My=1.89 Fx=1.20
 My = -2.98 (kN*m) $A'_{sx} = 3.60$ (cm²/m)

ULS : DSGN10 N=-5.00 Mx=-28.50 My=0.55 Fx=0.36 Fy=21.16
 Mx = -16.57 (kN*m) $A'_{sy} = 3.60$ (cm²/m)

$A_{s \min} = 3.60$ (cm²/m)

Column pier:

Longitudinal reinforcement $A = 11.38$ (cm²) $A_{\min.} = 6.08$ (cm²)
 $A = 2 * (Asx + Asy)$
 $Asx = 0.50$ (cm²) $Asy = 5.19$ (cm²)

2.6.2 Real reference level = -0.90 (m)

2.6.3 Stability analysis

Stress calculations

Soil type under foundation: not layered

Design combination **ULS : DSGN7 N=14.42 Mx=28.34 My=-0.57**

Fx=-0.37 Fy=-21.26

Load factors:

1.35 * Foundation weight

1.35 * Soil weight

1.00 * Archimedes pressure

Calculation results: On the foundation level

Weight of foundation and soil over it: Gr = 95.83 (kN)

Design load:

Nr = 110.25 (kN) Mx = 47.47 (kN*m) My = -0.90 (kN*m)

Soil profile parameters:

C = 0.00 (MPa)

$\phi = 0.00$

$\gamma = 0.00$ (kG/m³)

Stress in soil: 0.06 (MPa)

Design soil pressure 0.10 (MPa)

Safety factor: 1.465 > 1.4

Uplift

Uplift in ULS

Fx=0.36 Fy=21.16

Design combination

ULS : DSGN10 N=-5.00 Mx=-28.50 My=0.55

Load factors:

1.00 * Foundation weight

1.00 * Soil weight

1.35 * Archimedes pressure

Contact area:

s = 0.31

slim = 0.33

Sliding

Fx=0.36 Fy=21.16

Design combination

ULS : DSGN10 N=-5.00 Mx=-28.50 My=0.55

Load factors:

1.00 * Foundation weight

1.00 * Soil weight

1.35 * Archimedes pressure

Weight of foundation and soil over it: Gr = 70.98 (kN)

Design load:

Nr = 65.98 (kN) Mx = -47.54 (kN*m) My = 0.87 (kN*m)

Equivalent foundation dimensions: A_u = 1.60 (m) B_u = 2.30 (m)

Sliding area: 2.06 (m²)

Foundation/soil friction coefficient: tg(φ) = 0.00

Cohesion: C = 0.12 (MPa)

Soil pressure considered:

Hx = 0.36 (kN) Hy = 21.16 (kN)

Ppx = -5.07 (kN) Ppy = -3.53 (kN)

Pax = 5.07 (kN) Pay = 3.53 (kN)

Sliding force value F = 21.16 (kN)

Value of force preventing foundation sliding:

- On the foundation level: F(stab) = 26.39 (kN)

Stability for sliding: 1.247 > 1.1

Shear

Fx=-0.37 Fy=-21.26

Design combination

ULS : DSGN7 N=14.42 Mx=28.34 My=-0.57

Load factors:

1.35 * Foundation weight

1.35 * Soil weight

1.00 * Archimedes pressure

Design load:

Nr = 110.25 (kN) Mx = 47.47 (kN*m) My = -0.90 (kN*m)

Length of critical circumference: 1.60 (m)

Shear force: 29.38 (kN)

Section effective height heff = 0.24 (m)

Shear area: A = 0.38 (m²)

Reinforcement ratio: ρ = 0.15 %

Shear stress: 0.08 (MPa)

Admissible shear stress: 0.44 (MPa)

Safety factor: 5.775 > 1

Rotation

Fx=0.36 Fy=21.16

About OX axis

Design combination

ULS : DSGN10 N=-5.00 Mx=-28.50 My=0.55

Load factors:

1.00 * Foundation weight

1.00 * Soil weight

1.35 * Archimedes pressure

Weight of foundation and soil over it: Gr = 70.98 (kN)

Design load:

Nr = 65.98 (kN) Mx = -47.54 (kN*m) My = 0.87 (kN*m)

Stability moment: M_{stab} = 81.63 (kN*m)

Rotation moment: M_{renv} = 53.29 (kN*m)

Stability for rotation: 1.532 > 1

About OY axis

Design combination:

ULS : LC2 N=-21.21 Mx=0.11 My=1.89 Fx=

1.20

Load factors:

1.00 * Foundation weight

1.00 * Soil weight

1.35 * Archimedes pressure

Weight of foundation and soil over it: Gr = 70.98 (kN)

Design load:

Nr = 49.77 (kN) Mx = 0.11 (kN*m) My = 2.97 (kN*m)

Stability moment: M_{stab} = 56.79 (kN*m)

Rotation moment: M_{renv} = 19.94 (kN*m)

Stability for rotation: 2.848 > 1