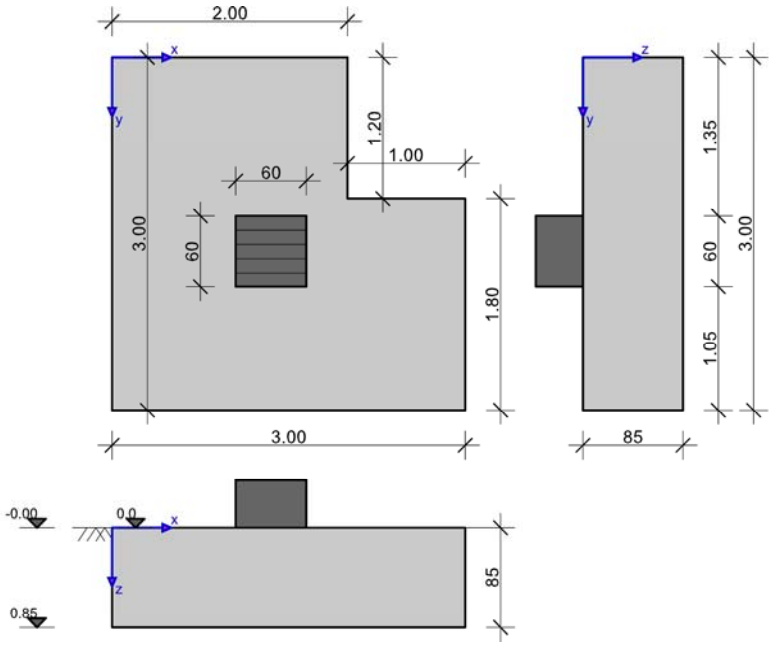
RIB Software SE	Funda V18.0 Build-No. 31102018	Type: polygonal foundation
File: FundamentPolygonal.RTfun		

System information



Soil engineering: DIN 1054:2010	Design:DIN 1045-1:2008
Design situation: permanent	

Polygon points

No	x [m]	y [m]	No	x [m]	y [m]	No	x [m]	y [m]	No	x [m]	y [m]
1	0.000	0.000	2	2.000	0.000	3	2.000	1.200	4	3.000	1.200
5	3.000	3.000	6	0.000	3.000						

Material coefficient, reinforced concrete (C20/25, B500M)

Concrete	γ_c	$\gamma_{c,accid.}$	α_{cc}	γ_B [kN/m³]	f_{ck} [MN/m²]	f_{cd} [MN/m²]
C20/25	1.50	1.30	0.85	25.00	20.00	11.33

Reinforcement	γ_s	$\gamma_{s,accid.}$	f_{yd} [MN/m²]	f_{yk} [MN/m²]	f_{tk} [MN/m²]
B500M	1.15	1.00	434.78	500.00	525.00

Subsoil geometry and material

h_e [m]	t_w [m]	φ [°]	c [kN/m²]	tan $\delta_{s,f}$	γ_1 [kN/m³]	γ_2 [kN/m³]
0.000	0.850	30.00	0.00	0.577	20.00	20.00
σ_{Rd}= 160.00 kN/m², User-defined						

Loading

Load cases

LC	I	LC_I	Source	Type of action	Name
0				Dead load	
1				Permanent load	LAST 2
2				Permanent load	LAST 3

Dead load sum - Load case 0

LC	P_z [kN]
0	165.8

Column loads and imported loads

Type: S = column loads; I = imported loads; c = characteristic; d = design

LC	Type	P_z [kN]	H_x [kN]	H_y [kN]	M_x [kNm]	M_y [kNm]	ΔM_{xII} [kNm]	ΔM_{yII} [kNm]	e_x [m]	e_y [m]
1	S,c	534.0	40.0	62.0	105.0	-214.0	95.0	-127.0	1.350	1.650

2	S.c	583.0	-38.0	-69.0	-110.0	230.0	-85.0	143.0	1.350	1.650

Load case combinations

decis.= 'yes' ... Combination is decisive in an analysis

LCC	decis.	Type	Crit.	Combination
1	yes	G+Q	GK	1.35*LC1
2	yes	G+Q	GK	1.35*LC2

Geotechnical analyses

Analysis of the safety against displacement (2nd order theory γ-fold)

Analysis format: $M_{dst,d} \leq M_{stb,d}$, Analysis is carried out with the substitute rectangle.

LCC	$M_{x,stb}$ [kNm]	$M_{x,dst}$ [kNm]	$M_{y,stb}$ [kNm]	$M_{y,dst}$ [kNm]	dst/stb
1	793.0	128.0	984.8	483.6	0.49

Decisive load case combination: LCC1, η=0.49 **Analysis fulfilled**

Sliding analysis (2nd order theory γ-fold)

Analysis format: $T_d/R_{td} \leq 1.0$

LCC	V [kN]	H_x [kN]	H_y [kN]	R_{tk} [kN]	R_{td} [kN]	T_d [kN]	T_d/R_{td}
1	699.8	40.0	62.0	404.0	367.3	99.6	0.271
2	748.8	-38.0	-69.0	432.3	393.0	106.3	0.271

Decisive load case combination: LCC1, η=0.27 **Analysis fulfilled**

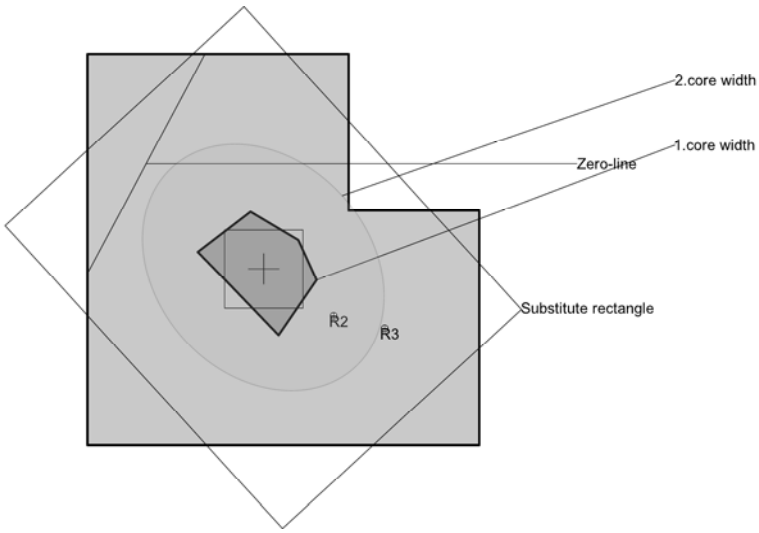
Base failure analysis (2nd order theory γ-fold)

Analysis format: $V_d \leq R_{nd}$, Analysis is carried out with the substitute rectangle.

LCC	b_x' [m]	b_y' [m]	N_b	N_d	N_c	$E_{pc,50}$[kN]	$R_{n,c}$ [kN]	$R_{n,d}$ [kN]	V_d [kN]	V_d / R_{nd}
2	2.13	1.93	5.6	22.7	37.4	4.8	2562.0	1830.0	1010.8	0.552

Decisive load case combination: LCC2, η=0.55 **Analysis fulfilled**

Gaping joint



R1/2: Decisive resultant of the core widths;
R3: Decisive resultant safety against displacement = maximum utilization [%] * foundation width (bx or by)
Substitute rectangle: For the calculation of the 2nd core width and R3.

Foundation rotation and limitation of a gaping joint (2nd order theory, characteristic)

Analysis format: $e_x/b_x \leq 1/6$; $e_y/b_y \leq 1/6$; $(e_x/b_x)^2+(e_y/b_y)^2 \leq 1/9$, Analysis of the 2nd core width is carried out at the substitute rectangle.

LCC	$P_{res,G,c}$ [kN]	$e_{x,G}$ [m]	$e_{y,G}$ [m]	$P_{res,P,c}$ [kN]	$e_{x,P}$ [m]	$e_{y,P}$ [m]	$CW1_x$	$CW1_y$	CW2	$1.KW_x$ [%]	$1.KW_y$ [%]	1.CW [%]	2.CW [%]
1	700	0.54	0.37	700	0.54	0.37	**	**	0.04	**	**	**	40.1

2.core width (2.o.th) Decisive LCC1, η=0.40 **Analysis fulfilled**

Reinforced concrete design

Increase due to the punching analysis

Design sections

Section	As-direction	Design section [m]			Design for
		Pos.	Width	Height	
1	y	1.650	3.000	0.850	Bending+Shear
2	x	1.350	3.000	0.850	Bending+Shear

Bending design

Reinforcement layer [cm]

$d_{1,b,x}$	$d_{1,b,y}$	$d_{1,t,x}$	$d_{1,t,y}$	$c_{vl,b,x}$	$c_{vl,b,y}$	$c_{vl,t,x}$	$c_{vl,t,y}$
6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0

Bending design

	decisi.comb.		M_{max}	M_{min}	h	b	ε_b	ε_s	$z_{i,B}$	$A_{s,b}$	$A_{s,o}$
Section	$A_{s,b}$	$A_{s,o}$	[kNm]	[kNm]	[m]	[m]	[‰]	[‰]	[m]	[cm²]	[cm²]
1	2	1	280.7	223.2	0.850	3.000	-0.56	10.00	0.776	8.2	0.0
2	1	2	252.6	234.7	0.850	3.000	-0.53	10.00	0.776	7.4	0.0

distribute bottom x reinforcement as follows (ya=-0.000 m)

sb_y [m]	1.200	0.900	0.900							
A_{su} [cm²]	2.94	2.44	2.21							
A_{su} [cm²/m]	2.45	2.71	2.45							

distribute bottom y reinforcement as follows (xa=-0.000 m)

sb_x [m]	3.000									
A_{su} [cm²]	8.19									
A_{su} [cm²/m]	2.73									

Shear design

Analysis of the shear bearing capacityCalculation asBeam

Angle of the stirrup reinforcement: 90.00 °

Shear design - Design values based on 2nd order theory γ-fold

No.	decis. Comb.	V_{Ed} [kN]	$V_{Rd,ct}$ [kN]	$V_{Rd,max}$ [kN]	$V_{Rd,sy}$ [kN]	$z_{i,S}$ [m]	ρ_l [%]	θ [°]	$a_{sb,min}$ [cm²/m]	$a_{ss,min}$ [cm²/m]	a_{sb} [cm²/m]	a_{ss} [cm²/m]
1	1	829.0	498.1	8643.7	829.0	0.700	0.03	37.8	21.12	0.00	21.12	0.00
2	2	1240.4	498.1	7291.9	1240.4	0.700	0.03	27.4	21.12	0.00	21.12	0.00

Req. shear reinforcement, stirrups 21.12 cm²/m in section: 2, Distribution:Evenly

Req. shear reinforcement, bent-up bars 0.00 cm²/m in section: 1, Distribution:Evenly

Punching analysis

Punching analysis - Design values based on2nd order theory γ-fold

LCC ρ_l [%]	V_{Ed} [kN] A_{crit} [m²]	σ_{0d} [kN/m²] u_{crit} [m]	$V_{Ed,red}$ [kN] u_{out} [m]	β [-] u_0 [m]	a_{crit} [m] L_w [m]	d_m [m] a_{crit}/d_m [-]	$as_{x,t}$ [cm²/m] $as_{x,b}$ [cm²/m]	$as_{y,t}$ [cm²/m] $as_{y,b}$ [cm²/m]	v_{Ed} [MN/m²] $v_{Rd,c}$ [MN/m²]	$v_{Rd,max}$ [MN/m²] $v_{Ed}/v_{Rd,c}$ [-]
1	720.9	102.4	258.7	2.23	0.79	0.79	0.00	0.00	0.151	0.259
0.032	4.51	3.82	3.82	2.40	0.24	1.00	2.41	2.73	0.173	0.876

No punching reinforcement required.

Minimum bending moment for inside columns DIN EN 1992-1-1, 6.4.5 (NA.6)

Distribution width onto at least 0,3*foundation width or critical circumference.						
LCC	V_{Ed} [kN]	$V_{Ed,red}$ [kN]	$m_{Ed,x}$ [kNm/m]	$m_{Ed,y}$ [kNm/m]	$as_{x,b}$ [cm²/m]	$as_{y,b}$ [cm²/m]
2	787.1	744.0	93.0	93.0	2.71	2.71

The longitudinal reinforcement has been increased for the punching analysis.

Analysis overview

Analysis	Status	LCC	Utilization
Safety against displacement	fulfilled	1	0.49
Sliding analysis (2.o.th)	fulfilled	1	0.27
Base failure (2.o.th)	fulfilled	2	0.55
2.core width (2.o.th)	fulfilled	1	0.40