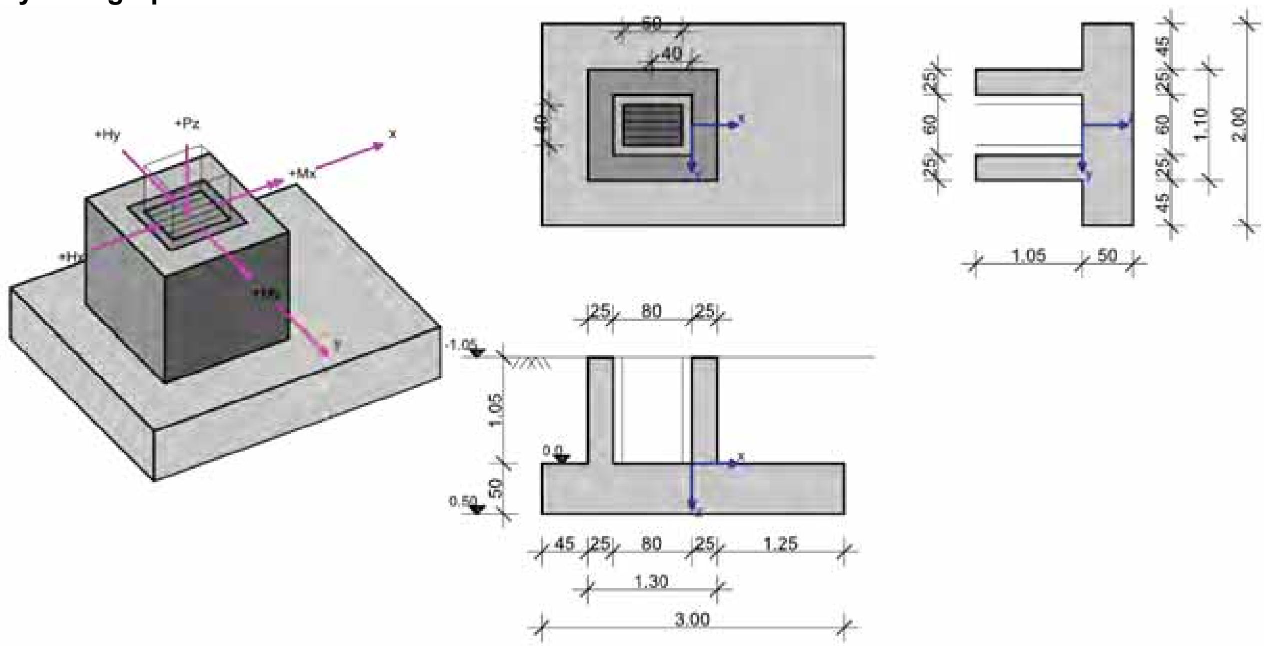
RIB Software SE	Funda V18.0 Build-No. 31102018	Type: Sleeve foundation
File: Köcherfundament_DBV-Bsp12.RTfun		

Project information

Task	DBV Beispiel 12
Description	DBV Beispiel 12
Position	
Component	

System information

System graph



Standards

Soil engineering: DIN EN 1997-1	Design:DIN EN 1992-1-1
Design situation: permanent	

Geometry and material

b_x, b_y	Foundation width in x/y-direction	γ_S, $\gamma_{S,accid.}$	Partial safety factor, reinforcement, permanent / accidental
h	Foundation height	f_{yk}	Yield point, reinforcement
b_{sx}, b_{sy}	Column width in x/y-direction	f_{tk}	Tensile strength, reinforcement
a_x, a_y	Eccentricity of column in x/y-direction	φ	Friction angle of the soil
h_e	Earth covering	c	Cohesion
t	Embedment depth, foundation	tan $\delta_{s,f}$	Angle of base friction
γ_1	Unit weight of soil, above base	γ_2	Unit weight of soil, below base
t_w	Ground water level, distance to UE foundation	γ_c, $\gamma_{c,accid.}$	Partial safety factor, concrete, permanent / accidental
γ_B	Unit weight, concrete	σ_{Rd}	Base resistance
f_{ck}	Cylinder compressive strength, concrete, char.	f_{cd}	Cylinder compressive strength, concrete, design
f_{yd}	Yield point, reinforcement, design value	α_{cc}	Creep coefficient, concrete

Foundation and column

Foundation type	b_x [m]	b_y [m]	h [m]	Column type	b_{sx} [m]	b_{sy} [m]	α_x [m]	α_y [m]
Sleeve foundation	3.000	2.000	0.500	Rectangle	0.600	0.400	-0.400	0.000

Sleeve geometry

Depth in foundation	hp:	0.000 m	Base height	hs:	1.050 m
Base height, top, x-direction	bxt:	1.300 m	Base height, top, y-direction	byt:	1.100 m
Base width, bottom, x-direction	bxb:	1.300 m	Base width, bottom, y-direction	byb:	1.100 m
x wall thickness, base, top	dx:	0.250 m	y wall thickness, top	dy:	0.250 m

Material coefficient, reinforced concrete (C25/30, B500S)

Concrete	γ_c	$\gamma_{c,accid.}$	α_{cc}	γ_B [kN/m³]	f_{ck} [MN/m²]	f_{cd} [MN/m²]
C25/30	1.50	1.30	0.85	25.00	25.00	14.17

Reinforcement	γ_s	$\gamma_{s,accid.}$	f_{yd} [MN/m²]	f_{yk} [MN/m²]	f_{tk} [MN/m²]
B500S	1.15	1.00	434.78	500.00	540.00

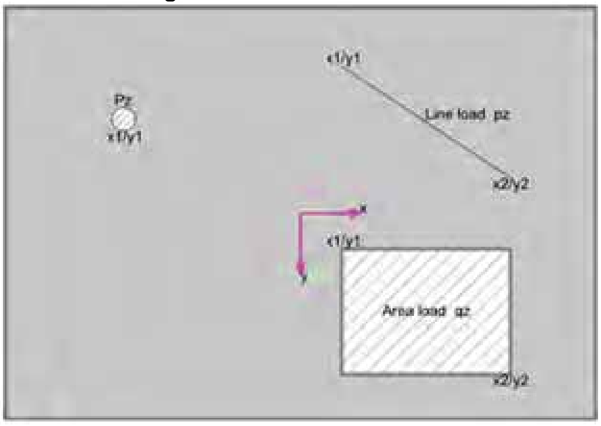
Subsoil geometry and material

h_e [m]	t_w [m]	φ [°]	c [kN/m²]	tan $\delta_{s,f}$	γ_1 [kN/m³]	γ_2 [kN/m³]
1.050	0.500	30.00	0.00	0.577	20.00	20.00
σ_{Rd}= 200.00 kN/m², User-defined						

Loading

P_z [kN]	vertical single load
p_z [kN/m]	Line load
q_z [kN/m²]	Area load
$H_{x,y}$ [kN]	Horizontal force
ΔM_{II} [kNm]	Additional moment due to 2nd order theory
x_1/y_1 [m]	Position of the single load (left boundary for line and area loads)
x_2/y_2 [m]	right boundary for line and area loads
res.M_x [kNm]	resulting moment Mx due to load
res.M_y [kNm]	resulting moment My due to load
I	imported column loads
LC_I	Load case number from imported column load
A_L	Foundation area for the calculation of the dead load

Schema drawing



Combination coefficients

Type of action	γ_{sup}	γ_{inf}	ψ_0	ψ_1	ψ_2
Permanent load	1.35	1.00	1.00	1.00	1.00
Storage rooms (Live load E)	1.50	0.00	1.00	0.90	0.80
Wind	1.50	0.00	0.60	0.20	0.00

Load cases

LC	I	LC_I	Source	Type of action	Name
0				Dead load	
1				Permanent load	
2				Storage rooms (Live load E)	
3				Wind	

Dead load

Position x/y; Resultant P_z, Earth with subtraction of the sleeve and column area

Component	P_z [kN]	x [m]	y [m]
Slab	75.00	0.000	0.000
Soil	95.97	0.000	0.000
Sleeve (with column)	37.54	-0.400	0.000

Dead load sum - Load case 0

LC	P_z [kN]
0	208.5

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	257.0	0.0	0.0	0.0	-96.0	0.0	-48.0	-0.400	0.000
2	S.c	573.0	20.0	0.0	0.0	-180.0	0.0	-106.0	-0.400	0.000
3	S.c	0.0	35.0	0.0	0.0	-90.0	0.0	0.0	-0.400	0.000

Load case combinations

LCC	Load case combination	Crit.	Combination criterion: GK=BasicComb., A=Accidental, LS=SafetyDisplacement, AP=Impact
Type: G	LCC only with permanent loads for core width analysis	Type: G +Q	LCC from permanent and variable loads for core width analysis

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

LCC	decis.	Type	Crit.	Combination
1	yes	G	GK	1.35*LC1+1.50*LC2+1.50*LC3
2	yes	G	GK	1.00*LC1+1.50*LC3

Stress resultants

Stress resultants in the base joint, 1st order theory

LCC	N_c	N_d	$H_{x,c}$	$H_{x,d}$	$H_{y,c}$	$H_{y,d}$	$M_{x,c}$	$M_{x,d}$	$M_{y,c}$	$M_{y,d}$
1	1038.5	1487.9	55.0	82.5	0.0	0.0	0.0	0.0	-116.2	-175.8
2	465.5	538.5	35.0	52.5	0.0	0.0	0.0	0.0	-134.4	-205.5

Stress resultants in the base joint, 2nd order theory

LCC	N_c	N_d	$H_{x,c}$	$H_{x,d}$	$H_{y,c}$	$H_{y,d}$	$M_{x,c}$	$M_{x,d}$	$M_{y,c}$	$M_{y,d}$
1	1038.5	1487.9	55.0	82.5	0.0	0.0	0.0	0.0	-270.2	-399.6
2	465.5	538.5	35.0	52.5	0.0	0.0	0.0	0.0	-182.4	-253.5

Stress resultants in design sections (detail)

Section No. 1, Position in y Direction: y=0.55 m

LCC	M_d [kNm]	V_d [kN]
1	61.6	273.7
2	13.5	60.1

Section No. 2, Position in x Direction: x=-1.05 m

LCC	M_d [kNm]	V_d [kN]
1	16.8	80.6
2	-6.4	24.6

Section No. 3, Position in x Direction: x=0.25 m

LCC	M_d [kNm]	V_d [kN]
1	467.1	701.2
2	164.9	234.5

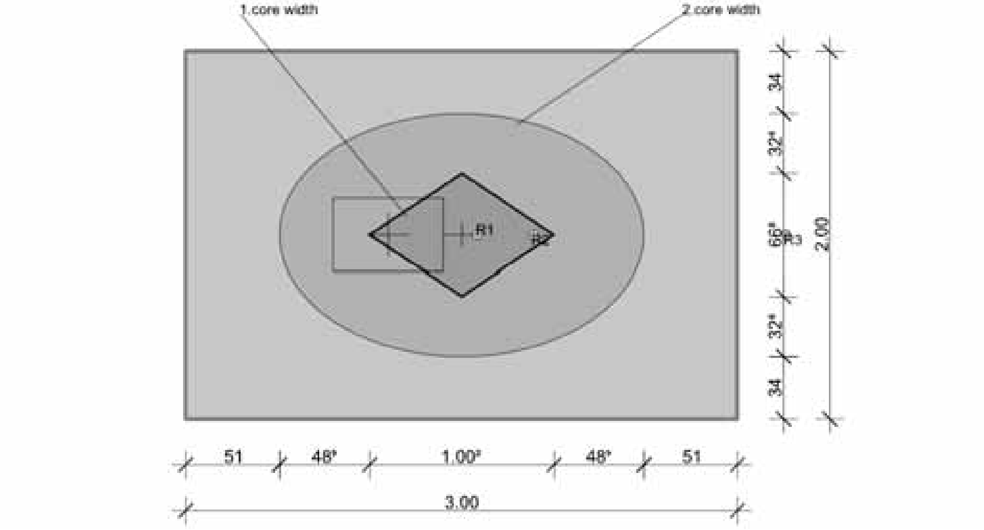
Section No. 4, Position in x Direction: x=0.70 m

LCC	M_d [kNm]	V_d [kN]
1	199.9	480.7
2	73.0	170.4

Geotechnical analyses

Analyses in the limit state of serviceability (SLS)

Gaping joint



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

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

Analysis format: $e_x/b_x \leq 1/6$; $e_y/b_y \leq 1/6$; $(e_x/b_x)^2+(e_y/b_y)^2 \leq 1/9$

It has to be proven, that the resultant from permanent loads is within the 1st core width and the resultant from permanent and variable loads is within the 2nd core width.
$e_x / b_x \leq 1/6$ 1. core width in x direction
$e_y / b_y \leq 1/6$ 1. core width in y direction
$(e_x / b_x)^2 + (e_y / b_y)^2 \leq 1/9$ 2. core width

b_x	Foundation width in x-direction	$CW1_x$	related eccentricity= $e_{x,G} / b_x$
b_y	Foundation width in y-direction	$CW1_y$	related eccentricity= $e_{y,G} / b_y$
$e_{x,y,G}$	Eccentricity in x-/y-direction due to permanent loads	CW2	related eccentricity= $(e_{x,P} / b_x)^2 + (e_{y,P} / b_y)^2$
$e_{x,y,P}$	Eccentricity in x-/y-direction due to permanent + variable loads	1. CW	Utilization level, 1st core width$CW_1 \leq 1/6$
$P_{res,G,c}$	Resultant due to permanent loads	2. CW	Utilization level, 2nd core width$CW_2 \leq 1/9$
$P_{res,P,c}$	Resultant due to permanent + variable loads	**	No 1st CW analysis, since LCC attribute = 'non-permanent'

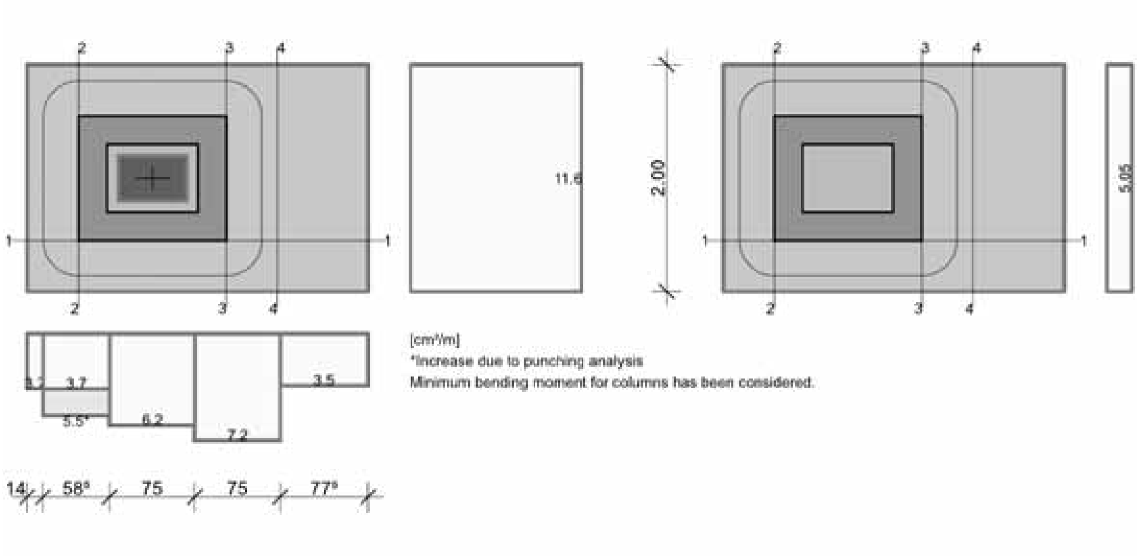
Analysis - Design values based on 2nd order theory, characteristic

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	466	0.08	0.00	1039	0.26	0.00	0.03	0.00	**	16.4	0.0	16.4	**
2	466	0.08	0.00	466	0.39	0.00	0.03	0.00	**	16.4	0.0	16.4	**

1.core width (2.o.th) Decisive LCC1, η=0.16 **Analysis fulfilled**

Reinforced concrete design

Reinforcement distribution, bottom/top [cm²/m]



Increase due to the punching analysis

Design sections

Section	As-direction	Design section [m]			Design for
		Pos.	Width	Height	
1	y	0.550	3.000	0.500	Bending+Shear
2	x	-1.050	2.000	0.500	Bending+Shear
3	x	0.250	2.000	0.500	Bending+Shear
4	x	0.700	2.000	0.500	Shear

Bending design

Legend

M_{max}	max. design moment	$A_{s,b}$	Required longitudinal reinforcement, bottom
M_{min}	min. design moment	$A_{s,o}$	Required longitudinal reinforcement, top
h	Component height in the design section	ε_b	Concrete compression
b	Component width in the design section	ε_s	Steel strain
$z_{i,B}$	inner lever arm for bending design	d	Ductility reinforcement decisive
d_1	Reinforcement distance top (t) and bottom (b)	c_{vl}	Laying dimension for calculation of the z_{iS}

Reinforcement layer [cm]

$d_{1,b,x}$	$d_{1,b,y}$	$d_{1,t,x}$	$d_{1,t,y}$	$c_{vl,b,x}$	$c_{vl,b,y}$	$c_{vl,t,x}$	$c_{vl,t,y}$
5.0	4.0	3.0	3.0	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	1	2	61.6	13.5	0.500	3.000	0.00	0.00	0.414	15.5d	0.0
2	1	2	16.8	-6.4	0.500	2.000	-2.09	25.00	0.335	10.6d	10.1d
3	1	2	467.1	164.9	0.500	2.000	0.00	0.00	0.405	23.1	0.0

distribute bottom x reinforcement as follows (ya=-1.000 m)

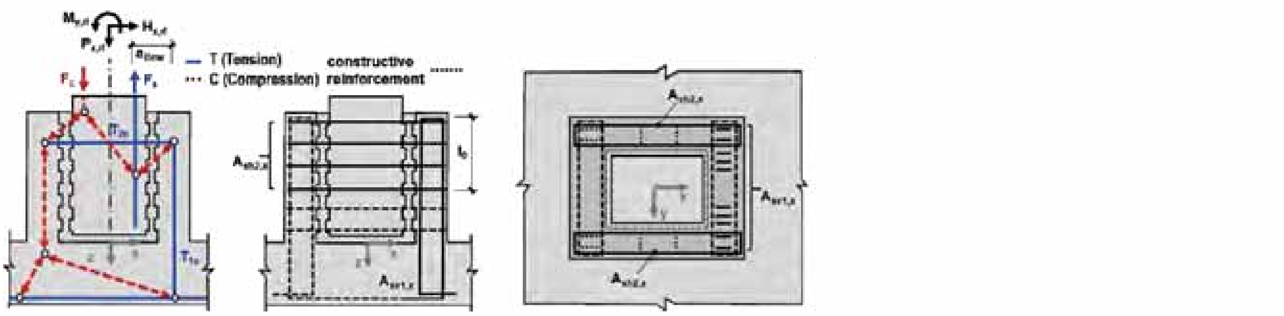
sb_y [m]	2.000									
A_{su} [cm²]	23.12									
A_{su} [cm²/m]	11.56									

distribute bottom y reinforcement as follows (xa=-1.500 m)

sb_x [m]	0.140	0.585	0.750	0.750	0.775					
A_{su} [cm²]	0.52	3.24	4.64	5.42	2.71					
A_{su} [cm²/m]	3.74	5.54	6.19	7.22	3.50					

Sleeve design with profiled joint according to Schlaich/Schäfer

Schema drawing



Legend

l_0	required lap length	t_{reco}	suggested embedment depth of the column = 1.50·b_s
a_n	clearance column / sleeve reinforcement - min(4*d_s,50mm)	t_{req}	required embedment depth of the column = l_0 +a_n
l_{bd}	required anchorage length	t_{exis}	existing embedment depth of the column
A_{sh}	Horizontal sleeve reinforcement (total)	A_{sv}	Column / sleeve reinforcement vertical (per side)
T_v,T_h	Tensile force of load application column - foundation	a_{Rein}	Distance column / sleeve reinforcement

Composite condition

Increase of bond stress fbd by 50 %

	f_{ck} [N/mm²]	f_{bd} [N/mm²]	f_{yd} [N/mm²]	Composite
Column	45	5.98	435	Composite conditionwell
Sleeve	25	4.09	435	Composite condition good

Specifications for the sleeve design

Formwork:	profiled	Thickness of mortar d_t:	0.050 m
$A_{sx,exis}$ of the vertical reinforcement:	18.10 cm²	$A_{sy,exis}$ of the vertical reinforcement:	2.26 cm²
Vertical reinforcement, sleeve d_s:	12 mm	Vertical reinforcement, column d_s:	25 mm

Design

As-direction	LC C	$M_{x,d}$ [kNm]	$M_{y,d}$ [kNm]	$P_{z,d}$ [kN]	$H_{x,d}$ [kN]	$H_{y,d}$ [kN]
x A_{sv}	1	-	758.4	1206.5	82.5	-
y A_{sv}	0	0.0	-	0.0	-	0.0
x A_{sh}	1	-	758.4	1206.5	82.5	-
y A_{sh}	0	0.0	-	0.0	-	0.0

Column

t_{exis} [m]	t_{req} [m]	t_{sugg} [m]	$a_{reinf,x}$ [m]	$a_{reinf,y}$ [m]
1.000	0.684	0.900	0.275	0.275

As-direct.	d_s [mm]	T_{1v} [kN]	$A_{sv1,req}$[cm²]	$A_{sv1,exis}$ [cm²]	a_n [m]	l_{bd} [m]	l_0 [m]
x	25	919.13	21.1	29.4	0.206	0.272	0.477
y	25	0.00	0.0	9.8	0.000	0.272	0.000

Sleeve

As-direct.	d_s [mm]	T_{1v} [kN]	$A_{sv1,req}$[cm²]	$A_{sv1,exis}$ [cm²]	a_n [m]	l_{bd} [m]	l_0 [m]	T_{2h} [kN]	A_{sh2} [cm²]
x	12	671.56	15.4	18.1	0.208	0.190	0.266	675.49	15.5
y	12	0.00	0.0	2.3	0.000	0.000	0.000	0.00	0.0

Shear design

Analysis of the shear bearing capacityCalculation asBeam

Angle of the stirrup reinforcement: 90.00 °

Legend

V_{Ed}	existing shear force	$V_{Rd,ct}$	Concrete resistance for minimum reinforcement
$V_{Rd,max}$	max. bearable strut force	$V_{Rd,sy}$	with reinforcement bearable shear force
$z_{i,S}$	inner lever arm for shear design	ρ_l	existing longitudinal reinforcement degree
[cm²/m]	cm² reinforcement in the cross-section per m longitudinal direction	θ	Strut inclination angle
a_{sb}	req. stirrup reinforcement - always with 90° to the	$a_{sb,min}$	Minimum shear reinforcement - stirrups

	longitudinal direction		
a_{ss}	req. inclined reinforcement with angle alpha to the longitudinal direction	$a_{ss,min}$	Minimum shear reinforcement - inclined bars

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	273.7	516.2	5896.9	0.0	0.370	0.11	45.0	0.00	0.00	0.00	0.00
2	2	80.6	338.9	3559.4	242.4	0.335	0.12	45.0	16.64	0.00	16.64	0.00
3	1	701.2	338.9	2497.1	701.2	0.360	0.12	20.4	16.64	0.00	16.64	0.00
4	1	480.7	338.9	3204.2	480.7	0.360	0.12	28.4	16.64	0.00	16.64	0.00

Decisive design results:

Req. shear reinforcement, stirrups 16.64 cm²/m in section: 2, Distribution:Evenly

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

Punching analysis

Legend

V_{Ed}	shear force to bear	$V_{Ed,red}$	reduced shear force
$\sigma_{0,d}$	Base pressure inside A_{crit}	ß	Load increase factor for eccentric loads
A_{crit}	Reduction area within the critical perimeter	a_{crit}	Distance of the critical perimeter to the column edge
u_{crit}	Effective circumference of the critical perimeter	u_{out}	Circumference of the area reinforced for punching
u_0	Effective circumference of the load application area	d_m	mean statically effective depth
a_{crit}/d_m	Inclination of the punching cone$a_{crit}/d_m = \cot_\theta$	v_{Ed}	related shear force(ß·V_{Ed})/(u_{crit}·d_m)
$v_{Rd,c}$	Punching resistance without punching reinforcement	$v_{Rd,max}$	maximum punching resistance
L_w	Distance of the outmost reinforcement layer to the column edge	as_x/as_y	exis./req. longitudinal reinforcement bottom/top
ρ_l	mean reinforcement ratio	$As_{w,j}$	Sum of the punching reinforcement per layer
a_j	Distance of the reinforcement layer to the column edge	u_j	effective circumference of the reinforcement row

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 0.163	1206.5 3.21	201.1 6.73	560.9 7.58	1.57 4.80	0.31 0.14	0.45 0.68	0.00 11.56	0.00 4.69	0.289 1.098	1.538 0.263

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]
1	1206.5	918.9	114.9	114.9	5.54	5.54

No punching reinforcement required.

The longitudinal reinforcement has been increased for the punching analysis.

Analysis overview

Analysis	Status	LCC	Utilization
1.core width (2.o.th)	fulfilled	1	0.16