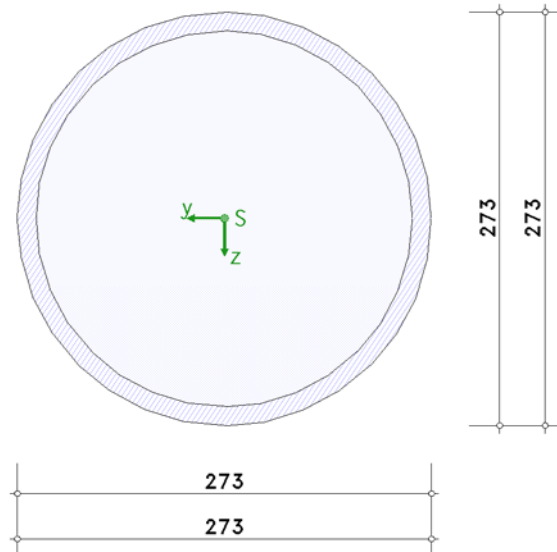


clamped steel support foot

steel code verifications acc. to DIN EN 1993-1:2010-12 with NA-Germany

cross-section, scale 1:5



column cross section

standardized profile: R 273.0 x 12.5(w), of quality S235

base plate

b = 273 mm h = 273 mm t = 10 mm, of quality S235

mortar joint under base plate

h_f = 40 mm

foundation

concrete quality C25/30

height = 100.0 cm

splitting tensile reinforcement is provided

1. loading

1.1. design values of column load

point of application in column centroid

LK	notation	design situat.	N _{St,d} kN	M _{y,St,Ed} kNm	H _{z,St,Ed} kN	M _{z,St,Ed} kNm	H _{y,St,Ed} kN
1	new design load c.	perman. a.v.	98.00	164.00	63.00	0.00	0.00

2. verification

2.1. partial safety factors for material

design situat.	γ _{M0}	γ _{M2}	γ _c
perman.	1.00	1.25	1.50

2.2. clamping depth

determination of the required clamping depth acc. to [1]

2.2.1. required clamping depth for bending around the y-axis

coefficient of the contributing width	α _m	= 1.00
contributing width	b _m	= 273.0 mm
resulting pressure	p	= 38.67 kN/cm
perm. plastic shear force	V _{p1,z}	= 883.60 kN

required clamping depth

LK	D ₀ kN	D _u kN	D _u /V _{p1,z} -	f _{erf} cm
1	620.46	557.46	0.63	47.8

D₀/D_u - res. compressive force top/bottom f_{erf} - req. clamping depth

maximum required clamping depth for bending around the y-axis f_{erf,y} = 47.8 cm

2.2.2. set clamping depth

required	f _{erf}	= 47.8 cm	(from LK 1, Bieg. um y-Achse)
minimum value	f _{min} = 2.0 · 27.30	= 54.6 > 47.8 cm	
maximum value	f _{max} = 4.0 · 27.30	= 109.2 > 47.8 cm	
chosen	f _{gew}	= 55.0 > 54.6 cm	

2.3. resistance of cross section

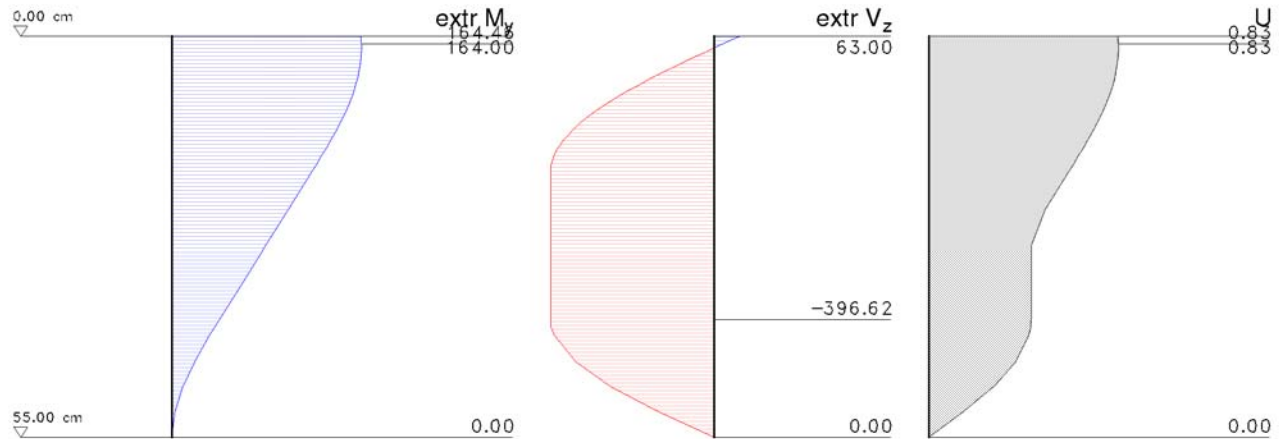
plastic stress analysis is carried out acc. to [2], Abs. 6.2.2 to 6.2.10.

2.3.1. supporting forces

LK	M_y/V_z			
	a_o cm	a_u cm	D_o kN	D_u kN
1	18.7	16.1	460.22	397.22

a_o/a_u - pressure area top/bottom D_o/D_u - res. compressive force top/bottom

2.3.2. extreme internal forces and moments



extreme values of axial force: $N_{Min} / N_{Max} = 98.00 / 98.00$ kN

x cm	extr M_y		extr V_z		U
	Min kNm	Max kNm	Min kNm	Max kNm	
0.00	164.00	164.00	63.00	63.00	0.83
1.10	164.46	164.46	20.59	20.59	0.83
2.20	164.45	164.45	-21.45	-21.45	0.83
18.68	121.15	121.15	-396.62	-396.62	0.61
55.00	0.00	0.00	0.00	0.00	0.00

maximum utilization $U = 0.83 < 1.00$

from load spectrum 1 at the location $x = 1.10$ cm

internal forces and moments: $N = 98.00$ kN, $V_z/M_y = 20.59/164.46$ kNm

utilization: $U_\sigma = 0.83$

2.4. weld between column and base plate

design with direction oriented method acc. to clause 4.5.3.2

$$\sigma_{1,w,Ed} = (\sigma_{\perp}^2 + 3\tau_{\perp}^2 + 3\tau_{\parallel}^2)^{0.5}$$

$$\sigma_{2,w,Ed} = \sigma_{\perp}$$

$$f_{1,w,Rd} = f_u / (\beta_w \gamma M2)$$

$$f_{2,w,Rd} = 0.9 f_u / \gamma M2$$

$$U = \max\{ \sigma_{1,w,Ed}/f_{1,w,Rd}, \sigma_{2,w,Ed}/f_{2,w,Rd} \}$$

connection designed with a **circumferential fillet weld**.

axial force transfer of 100 % by the weld.

minimum value of the weld thickness $a_{min} = 3$ mm

LK	a_w mm	$\sigma_{\perp}$ N/mm ²	$\tau_{\perp}$ N/mm ²	$\tau_{\parallel}$ N/mm ²	$\sigma_{1,w,Ed}$ N/mm ²	$f_{1,w,Rd}$ N/mm ²	$\sigma_{2,w,Ed}$ N/mm ²	$f_{2,w,Rd}$ N/mm ²	U
1	3	-26.93	-26.93	0.00	53.87	360.00	26.93	259.20	0.15

a_w - weld thickness $\sigma_{\perp}$ - normal stresses perpendicular to weld $\tau_{\perp}$ - shear stresses perpendicular to weld

$\tau_{\parallel}$ - shear stresses parallel to weld U - utilization

maximum weld thickness $a_{w,max} = 3$ mm

maximum utilization $U = 0.15 < 1.00$

2.5. introduction of the normal force into the foundation

verification acc. to [4], parag. 6.2.5 and load-bearing capacity of the subareas acc. to [3], parag.6.7

2.5.1. requirements for the mortar under the base plate

0.2-fold of the smallest panel dimension = 54.6 > 40 mm mortar height

⇒ the characteristic strength of the mortar should be at least 20% of the foundation concrete.

2.5.2. load spreading

$$c = t \{ [f_y / (3 f_{jd} \gamma_{M0})]^{0.5} \leq 0.5 (h - 2t) \}$$

an undisturbed load propagation is assumed.

spreading width	c	= 16.6 mm
loading area	A _{c0}	= 133.92 cm ²
distribution area	A _{c1}	= 3557.30 cm ²

2.5.3. design resistance

$$F_{C,Rd} = f_{jd} A_{c0}$$

$$f_{jd} = \beta_j F_{Rdu} / A_{c0}$$

$$F_{Rdu} = A_{c0} f_{cd} (A_{c1} / A_{c0})^{0.5} \leq 3.0 f_{cd} A_{c0}$$

joint coefficient	β_j	= 2/3
design value of the mortar strength	f_{jd}	= 28.33 N/mm ²
load-bearing capacity under pressure	$F_{C,Rd}$	= 379.44 kN

2.5.4. utilization

$$U = N_{Ed} / F_{C,Rd}$$

maximum compressive force (LK 1) $N_{Ed} = 98.00 < 379.44$ kN

utilization $U = 0.26 < 1.00$

3. summary

all executed verifications and design calculations successful.

required clamping depth of the column cross section	$f_{erf} = 47.8$ cm
chosen clamping depth	$f_{gew} = 55.0 > 47.8$ cm
load-bearing cap. column cross-section	$\mu_{max} = 0.83$
weld between column and base plate	$\mu_{max} = 0.15$
introd. of normal force	$\mu_{max} = 0.26$

literature and standards:

- [1] R. Kindmann, J. Vette: Tragf. von Stahrohren im Einspannbereich, Stahlbau 90, Heft 1, Ernst & Sohn, 2021
- [2] DIN EN 1993-1-1: Eurocode 3: Bem. und Konstr. von Stahlbauten - Teil 1-1: Allg. Bem.regeln u. Regeln für den Hochbau, Dez. 2010
- [3] DIN EN 1992-1-1: Eurocode 2: Bemessung und Konstruktion von Stahlbeton- und Spannbetontragwerken, Teil 1-1, Januar 2011
- [4] DIN EN 1993-1-8: Eurocode 3: Bemessung und Konstruktion von Stahlbauten - Teil 1-8: Bemessung von Anschlüssen, Dez. 2010