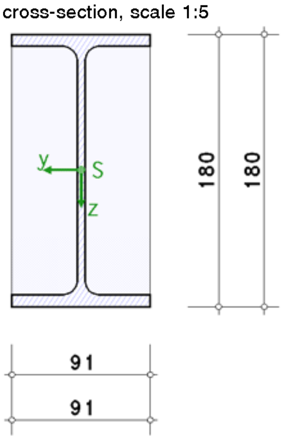
4H-EC3KF version: 4/2024-1d

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: IPE180, of quality S355

base plate
b = 91 mm h = 180 mm t = 10 mm, of quality S235

mortar joint under base plate
h_f = 40 mm

foundation
concrete quality C35/45
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.	0.00	0.00	0.00	12.00	5.00

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 z-axis

coefficient of the contributing width α_m = 1.04
contributing width h_m = 79.7 mm
resulting pressure p = 15.81 kN/cm
perm. plastic shear force $V_{pl,y}$ = 298.42 kN

required clamping depth

LK	D_o kN	D_u kN	$D_u/V_{pl,y}$ -	f_{erf} cm
1	119.43	114.43	0.38	**18.3**

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

maximum required clamping depth for bending around the z-axis $f_{erf,z}$ = 18.3 cm

2.2.2. set clamping depth

required f_{erf} = 18.3 cm (from LK 1, bend. around z-axis)
minimum value f_{min} = 1.5·18.00 = 27.0 > 18.3 cm
maximum value f_{max} = 4.0·18.00 = 72.0 > 18.3 cm
chosen f_{gew} = **28.0** > 27.0 cm

2.3. resistance of cross section

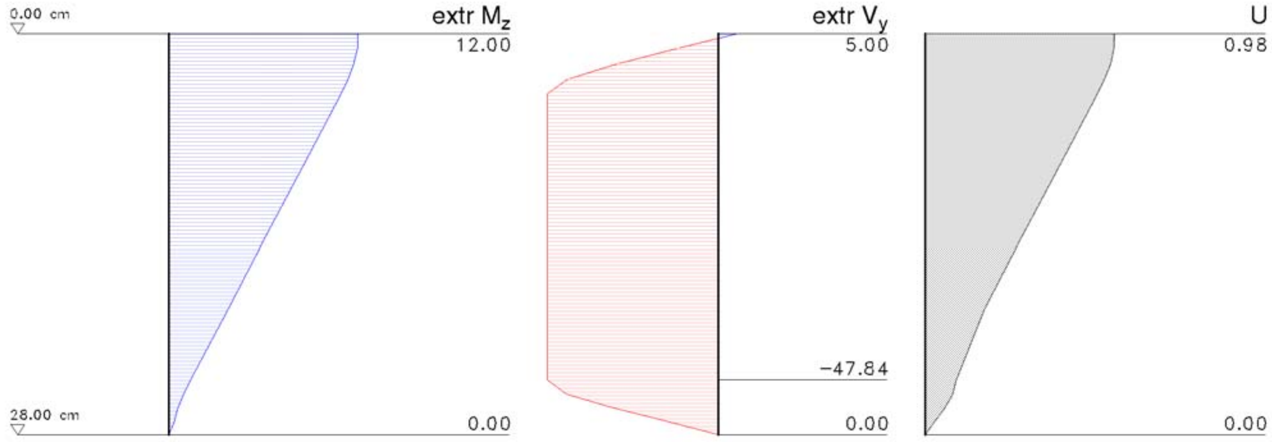
plastic stress analysis is carried out acc. to [2], Abs. 6.2.2 to 6.2.10.

2.3.1. supporting forces

LK	M_z/V_y a_o cm	a_u cm	D_o kN	D_u kN
1	4.2	3.8	54.04	49.04

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} = 0.00 / 0.00 kN

x	extr M_z Min	extr M_z Max	extr V_y Min	extr V_y Max	U
cm	kNm	kNm	kNm	kNm	
0.00	12.00	**12.00**	5.00	**5.00**	**0.98**
1.05	11.96	11.96	-11.68	-11.68	0.97
4.22	10.91	10.91	**-47.84**	-47.84	0.89
28.00	**0.00**	0.00	0.00	0.00	0.00

maximum utilization U = 0.98 < 1.00

from load spectrum 1 at the location x = 0.00 cm
internal forces and moments: N = 0.00 kN, V_y/M_z = 5.00/12.00 kNm
utilization: U_σ = 0.98

2.4. weld between column and base plate

design with direction oriented method acc. to clause 4.5.3.2

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

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

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

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

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

connection designed with a **full-size double fillet weld** (no end craters).
axial force transfer of 100 % by the weld.

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

LK	$a_{w,Fl}$	$a_{w,S}$	$\sigma_\perp$	$\tau_\perp$	τ_{II}	$\sigma_{1,w,Ed}$	$f_{1,w,Rd}$	$\sigma_{2,w,Ed}$	$f_{2,w,Rd}$	U
	mm	mm	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	-
1	**3**	**3**	0.00	0.00	0.00	0.00	0.00	0.00	---	**0.00**

$a_{w,Fl}$ - flange weld thickness $a_{w,S}$ - web weld thickness $\sigma_\perp$ - normal stresses perpendicular to weld
$\tau_\perp$ - shear stresses perpendicular to weld τ_{II} - shear stresses parallel to weld U - utilization

maximum weld thickness flange $a_{w,Fl,max}$ = 3 mm
maximum weld thickness of the web $a_{w,S,max}$ = 3 mm
maximum utilization U = 0.00 < 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 = 18.2 < 40 mm mortar height
⇒ the characteristic strength of the mortar should be greater than 20% of that of the foundation concrete.
alternatively, the connection coefficient is to be set at β_j < 2/3.

2.5.2. load spreading

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

an undisturbed load propagation is assumed.

spreading width	c	= 22.8 mm
loading area	A_{c0}	= 116.26 cm²
distribution area	A_{c1}	= 345.71 cm²

2.5.3. design resistance

$F_{C,Rdr} = f_{jd} \cdot A_{c0}$
$f_{jd} = \beta_j \cdot F_{Rdu}/A_{c0}$
$F_{Rdu} = A_{c0} \cdot f_{cd} \cdot (A_{c1}/A_{c0})^{0.5} \leq 3.0 \cdot f_{cd} \cdot A_{c0}$

joint coefficient	β_j	= 2/3
design value of the mortar strength	f_{jd}	= 22.80 N/mm²
load-bearing capacity under pressure	$F_{C,Rd}$	= 265.08 kN

2.5.4. utilization

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

maximum compressive force (LK 1) N_{Ed} = 0.00 < 265.08 kN

utilization U = 0.00 < 1.00

3. summary

all executed verifications and design calculations successful.

required clamping depth of the column cross section	f_{erf}	= 18.3 cm
chosen clamping depth	f_{gew}	= 28.0 > 18.3 cm
load-bearing cap. column cross-section	μ_{max}	= 0.98
weld between column and base plate	μ_{max}	= 0.00
introd. of normal force	μ_{max}	= 0.00

literature and standards:

[1] Kindmann, Kraus, Laumann, Vette: Verallgem. Berech.methode für in Beton eingesp. Stahlprofile, Stahlbau 92, Heft 1, Ernst & Sohn, 2023
[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