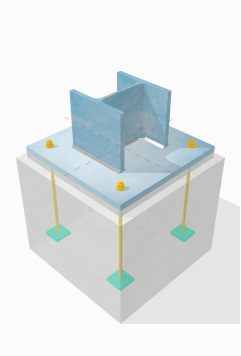
REFERENCES	CALCULATIONS	RESULTS

SkyCiv Base Plate and Anchor Rod Design

c - en

Project Information:
Design Code: EN 1993-1-8-2005, EN 1993-1-1-2005 and EN 1992-1-1-2004
Anchoring Code: EN 1992-4:2018

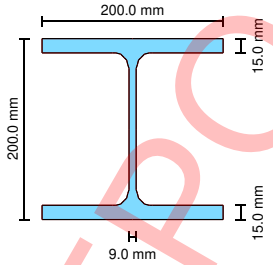


Load Combinations:

Load Combination	Axial Load, Nx (kN)	Strong-axis Shear, Vy (kN)	Weak-axis Shear, Vz (kN)
1	100.00	0.00	0.00

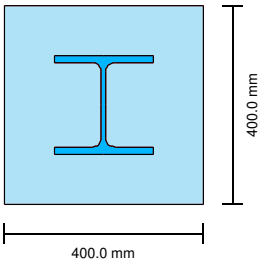
Note: Positive Nx (+) indicates compression; negative Nx (-) indicates tension.

Column Properties:



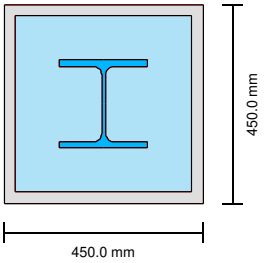
Symbol	Description	Value
$Section$	Column section	HE 200 B
d_{col}	Column depth	200.0 mm
t_w	Column web thickness	9.0 mm
b_f	Column flange width	200.0 mm
t_f	Column flange thickness	15.0 mm
A_{col}	Column area	7808.0 mm^2
r_{col}	Column root radius	18.0 mm
f_{y_col}	Column yield strength (S235)	235.0 MPa
f_{u_col}	Column ultimate tensile strength (S235)	360.0 MPa

Base Plate Properties:



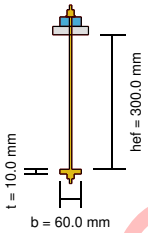
Symbol	Description	Value
B_{bp}	Base plate width	400.0 mm
L_{bp}	Base plate length	400.0 mm
t_{bp}	Base plate thickness	20.0 mm
A_{bp}	Base plate plan area	160000.0 mm^2
f_{y_bp}	Base plate yield strength (S235)	225.0 MPa
f_{u_bp}	Base plate ultimate tensile strength (S235)	360.0 MPa
t_{grout}	Grout thickness	20.0 mm

Concrete Properties:



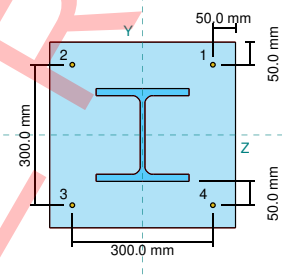
Symbol	Description	Value
B_{conc}	Concrete width	450.0 mm
L_{conc}	Concrete length	450.0 mm
t_{conc}	Concrete thickness	380.0 mm
A_{conc}	Concrete plan area	202500.0 mm^2
f_{ck}	Concrete compressive strength (C20/25)	20.0 MPa
–	Concrete assumption: cracked or uncracked	Cracked

Anchor Information:



Symbol	Description	Value
d_{anc}	Anchor rod diameter	10.0 mm
h_{ef}	Anchor rod embedment length	300.0 mm
b_{embed_plate}	Anchor embed plate side dimension	60.0 mm
t_{embed_plate}	Anchor embed plate thickness	10.0 mm
F_{y_anc}	Anchor rod yield strength (8.8)	640.0 MPa
F_{u_anc}	Anchor rod ultimate tensile strength (8.8)	800.0 MPa

Anchor Layout:



Symbol	Description	Value
n_{anc}	Total number of anchor rods	4.0
s_z	Spacing of anchor rods along Z-axis	300.0 mm
s_y	Spacing of anchor rods along Y-axis	300.0 mm
$l_{edge,z}$	Base Plate edge distance along Z-axis	50.0 mm
$l_{edge,y}$	Base Plate edge distance along Y-axis	50.0 mm

Anchor Data Summary:

ID	Z (mm)	Y (mm)	Anchor in Tension Zone	Breakout (Tension)	Side-Face Blowout (Y-direction)	Side-Face Blowout (Z-direction)
1	150	150	✓	BO Group 1	Single	Single
2	-150	150	✓	BO Group 1	Single	Single
3	-150	-150	✓	BO Group 1	Single	Single
4	150	-150	✓	BO Group 1	Single	Single

Weld Properties:

Symbol	Description	Value
$Type$	Weld Type	Fillet
s_{top_flange}	Fillet weld size at Top Flange	7.000 mm
s_{bottom_flange}	Fillet weld size at Bottom Flange	7.000 mm
s_{web}	Fillet weld size at Web	7.000 mm
a_{top_flange}	Weld throat at Top Flange	4.950 mm
a_{bottom_flange}	Weld throat at Bottom Flange	4.950 mm
a_{web}	Weld throat at Web	4.950 mm
f_{uw}	Filler metal ultimate tensile strength (E35)	440.000 MPa

Summary of Detailing Checks

Check Name	Dimensions (Min/Max/Actual)	Status
Weld Size Requirement (Flange)	Min: 4.24 mm, Max: 19.00 mm, Actual: 7.00 mm	PASS
Weld Size Requirement (Web)	Min: 4.24 mm, Max: 19.00 mm, Actual: 7.00 mm	PASS
Anchor Clearance	Min: 30.16 mm, Actual: 65.95 mm	PASS
Base Plate Edge Distance	Min: 15.00 mm, Actual: 50.00 mm	PASS
Minimum Number of Anchors	Min: 4.00, Actual: 4.00	PASS
Embedded Plate Dimension	Min: 40.00 mm, Actual: 60.00 mm	PASS
Min. Anchor Spacing to Prevent Concrete Splitting	Min: 20.00 mm, Actual: 300.00 mm	PASS
Min. Concrete Cover to Prevent Concrete Splitting	Min: 40.00 mm, Actual: 75.00 mm	PASS

The design geometry meets requirements!

REFERENCES	CALCULATIONS	RESULTS
	Load Combination No. 1: Compression Load Only	
	Check No. 1: Weld Capacity	
	Calculation Note:	N/A = 0.00
	Calculation of strength is not required since load is transferred via direct bearing. Refer to code for minimum weld size requirements.	Ensure column is FIT-TO-BEAR on the base plate. Refer to BS EN 1090-2:2018 Clause 6.8.
	Check No. 2: Concrete Bearing Capacity and Base Plate Yield Capacity (Compression Load)	
	Calculate bearing load on concrete	
	$N_x = 100$ kN - Compression load	
	N_{Ed} - Design bearing force	
	$$N_{Ed} = N_x = 100 \text{ kN}$$	
	Calculate base plate area	
	$L_{bp} = 400$ mm - Base plate length	
	$B_{bp} = 400$ mm - Base plate width	
	A_{c0} - Loaded area of base plate	
	$$A_{c0} = B_{bp}L_{bp} = 400 \text{ mm} \times 400 \text{ mm} = 160000 \text{ mm}^2$$	
	Calculate alpha coefficient	
	$L_{conc} = 450$ mm - Concrete length	
	$B_{conc} = 450$ mm - Concrete width	
	$t_{conc} = 380$ mm - Concrete thickness	
	e_h - Additional length outside of base plate in calculating alpha coefficient	
	$$e_h = \frac{L_{conc} - L_{bp}}{2} = \frac{450 \text{ mm} - 400 \text{ mm}}{2} = 25 \text{ mm}$$	
	e_b - Additional width outside of base plate in calculating alpha coefficient	
	$$e_b = \frac{B_{conc} - B_{bp}}{2} = \frac{450 \text{ mm} - 400 \text{ mm}}{2} = 25 \text{ mm}$$	
Design Guide "Multi-Storey Steel Buildings" by Arcelor Mittal, Peiner Trager and Corus, Part 5, Section 6.1	α - Alpha coefficient which accounts for diffusion of the concentrated force within the foundation	
	$$\alpha = \min\left(1 + \frac{\mathrm{t_{conc}}}{\max\left(\mathrm{L_{bp}},\ \mathrm{B_{bp}}\right)},\ 1 + 2\left(\frac{\mathrm{e_h}}{\mathrm{L_{bp}}}\right),\ 1 + 2\left(\frac{\mathrm{e_b}}{\mathrm{B_{bp}}}\right),\ 3\right)$$	
	$$\alpha = \min\left(1 + \frac{380 \text{ mm}}{\max\left(400 \text{ mm},\ 400 \text{ mm}\right)},\ 1 + 2 \times \left(\frac{25 \text{ mm}}{400 \text{ mm}}\right),\ 1 + 2 \times \left(\frac{25 \text{ mm}}{400 \text{ mm}}\right),\ 3\right)$$	
	$$\alpha = 1.125$$	
	Calculate design compressive strength of concrete	
EN 1992-1-1:2004 Clause 3.1.6	$a_{cc} = 1$ - Coefficient for compressive strength long term effects	
	$f_{ck} = 20$ MPa - Concrete compressive strength (C20/25)	
EN 1992-1-1:2004 Table 2.1N	$\gamma_C = 1.5$ - Partial safety factor for resistance of concrete	
EN 1992-1-1:2004 Eq. 3.15	f_{cd} - Design compressive strength of concrete	
	$$f_{cd} = \frac{a_{cc}f_{ck}}{\gamma_C} = \frac{1 \times 20 \text{ MPa}}{1.5} = 13.333 \text{ MPa}$$	
	Calculate design bearing strength of the joint	
Design Guide "Multi-Storey Steel Buildings" by Arcelor Mittal, Peiner Trager and Corus, Part 5, Section 6.1	$\alpha = 1.125$	
	$\beta = 0.66667$ - Foundation joint material coefficient	
EN 1992-1-1:2004 Eq. 3.15	$f_{cd} = 13.333$ MPa	
EN 1993-1-8:2005 Eq 6.6 and EN 1992-1-1:2004 Eq. 6.63	f_{jd} - Design bearing strength of the joint	
	$$f_{jd} = \beta\alpha f_{cd} = 0.66667 \times 1.125 \times 13.333 \text{ MPa} = 10 \text{ MPa}$$	
	Calculate cantilever 'c' dimension on base plate effective area	
EN 1993-1-8:2005 Eq 6.6 and EN 1992-1-1:2004 Eq. 6.63	$f_{jd} = 10$ MPa	
	$f_{y\_bp} = 225$ MPa - Base plate yield strength (S235)	
	$t_{bp} = 20$ mm - Base plate thickness	
EN 1993-1-1:2005 Clause 6.1	$\gamma_{M0} = 1$ - Partial safety factor for resistance of steel cross-sections	
SCI P358 pg. 243, EN 1993-1-1:2005 Clause 6.2.5	c - Cantilever length from base plate bending resistance	
	$$c = t_{bp}\sqrt{\frac{f_{y\_bp}}{3f_{jd}\gamma_{M0}}} = 20 \text{ mm} \times \sqrt{\frac{225 \text{ MPa}}{3 \times 10 \text{ MPa} \times 1}} = 54.772 \text{ mm}$$	
	Calculate effective area	
	$b_f = 200$ mm - Column flange width	

$d_{col} = 200$ mm - Column depth

$t_w = 9$ mm - Column web thickness

$A_{col} = 7808$ mm^2 - Column area

SCI P358 pg. 243, EN 1993-1-1:2005 Clause 6.2.5

$c = 54.772$ mm

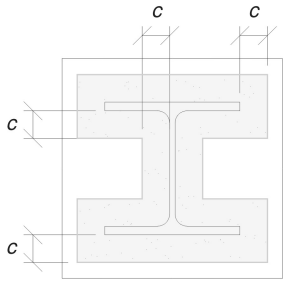


Fig. Effective area on base plate.

The dimension 'c' is not overlapping within the column profile

SCI P358 pg. 242

P_{col} - Perimeter of column

$$P_{col} = 2b_f + 2d_{col} + 2\left(b_f - t_w\right) = 2 \times 200 \text{ mm} + 2 \times 200 \text{ mm} + 2 \times (200 \text{ mm} - 9 \text{ mm}) = 1182 \text{ mm}$$

SCI P358 pg. 242

A_e - Effective area of base plate

$$A_e = 4c^2 + P_{col}c + A_{col} = 4 \times 54.772 \text{ mm}^2 + 1182 \text{ mm} \times 54.772 \text{ mm} + 7808 \text{ mm}^2 = 84549 \text{ mm}^2$$

Calculate design bearing resistance

EN 1993-1-8:2005 Eq 6.6 and EN 1992-1-1:2004 Eq. 6.63

$f_{jd} = 10$ MPa

SCI P358 pg. 242

$A_e = 84549$ mm^2

$A_{c0} = 160000$ mm^2

EN 1993-1-8:2005 Eq 6.6 and EN 1992-1-1:2004 Eq. 6.63

N_{Rd} - Design concrete bearing resistance on base plate effective area

$$N_{Rd} = \left(\min\left(\mathrm{A_e},\ \mathrm{A_{c0}}\right)\right) f_{jd} = \left(\min\left(84549 \text{ mm}^2,\ 160000 \text{ mm}^2\right)\right) \times 10 \text{ MPa} = 845.49 \text{ kN}$$

Result:

PASS = 0.12

DCR - Demand over capacity ratio:

$$DCR = \frac{N_{Ed}}{N_{Rd}} = \frac{100 \text{ kN}}{845.49 \text{ kN}} = 0.11827$$

REFERENCES	CALCULATIONS	RESULTS
	Summary of Design Checks	The governing combination is Load Combination 1.

Load Combination	Design Check	Demand	Capacity	DCR	Result
1	Weld Capacity	0.00	0.00	0.00	N/A
1	Concrete Bearing Capacity and Base Plate Yield Capacity (Compression Load)	100.00	845.49	0.12	PASS

The design is adequate!