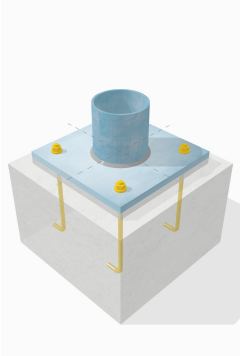
REFERENCES	CALCULATIONS	RESULTS

SkyCiv Base Plate and Anchor Rod Design

New Project File

Project Information:
Design Code: CSA S16:19 and CSA A23.3:19

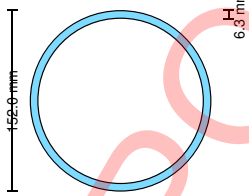


Load Combinations:

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

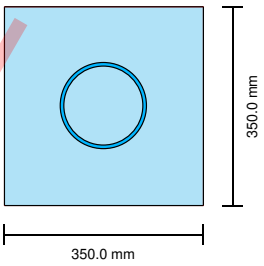
Note: Positive Nx (+) indicates compression; negative Nx (-) indicates tension.

Column Properties:



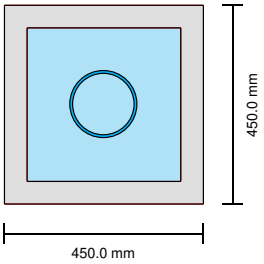
Symbol	Description	Value
$Section$	Column section	HS152x6.4
d_{col}	Column outside diameter	152.0 mm
t_{col}	Column thickness	6.3 mm
A_{col}	Column area	2910.0 mm^2
F_{y_col}	Column yield stress (230G)	230.0 MPa
F_{u_col}	Column tensile stress (230G)	380.0 MPa

Base Plate Properties:



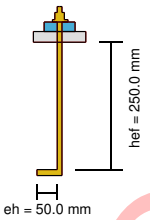
Symbol	Description	Value
B_{bp}	Base plate width	350.0 mm
L_{bp}	Base plate length	350.0 mm
t_{bp}	Base plate thickness	20.0 mm
A_{bp}	Base plate plan area	122500.0 mm^2
F_{y_bp}	Base plate yield stress	230.0 MPa
F_{u_bp}	Base plate tensile stress (230G)	380.0 MPa
t_{grout}	Grout thickness	20.0 mm

Concrete Properties:



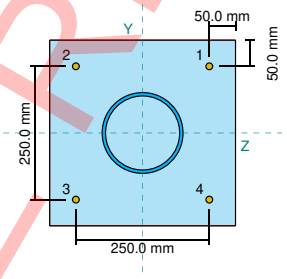
Symbol	Description	Value
B_{conc}	Concrete width	450.0 mm
L_{conc}	Concrete length	450.0 mm
t_{conc}	Concrete thickness	300.0 mm
A_{conc}	Concrete plan area	202500.0 mm^2
f_c'	Concrete compressive strength (20.68)	20.7 MPa
λ	Factor for normal-weight concrete	1.0
–	Concrete assumption: cracked or uncracked	Cracked

Anchor Information:



Symbol	Description	Value
d_a	Anchor rod diameter	12.7 mm
h_{ef}	Anchor rod effective embedment length	250.0 mm
e_h	Anchor hook length	50.0 mm
F_{y_anc}	Anchor rod yield stress (ASTM F1554 G36)	248.2 MPa
F_{u_anc}	Anchor rod tensile stress (ASTM F1554 G36)	399.9 MPa

Anchor Layout:



Symbol	Description	Value
n_a	Total number of anchor rods	4.0
s_z	Spacing of anchor rods along Z-axis	250.0 mm
s_y	Spacing of anchor rods along Y-axis	250.0 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	125	125	✓	BO Group 1	N/A	N/A
2	-125	125	✓	BO Group 1	N/A	N/A
3	-125	-125	✓	BO Group 1	N/A	N/A
4	125	-125	✓	BO Group 1	N/A	N/A

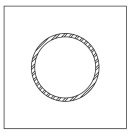
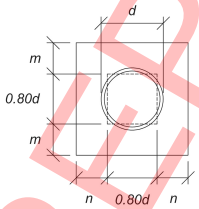
Weld Properties:

Symbol	Description	Value
$Type$	Weld Type	Fillet
D	Fillet weld size	8.000 mm
t_w	Weld throat	5.657 mm
X_u	Filler metal classification strength (E43XX)	490.000 MPa

Summary of Detailing Checks

Check Name	Dimensions (Min/Max/Actual)	Status
Weld Size Requirement	Min: 8.00 mm, Max: 19.00 mm, Actual: 8.00 mm	PASS
Anchor Clearance	Min: 30.16 mm, Actual: 93.00 mm	PASS
Base Plate Edge Distance	Min: 20.00 mm, Actual: 50.00 mm	PASS
Minimum Number of Anchors	Min: 4.00, Actual: 4.00	PASS
Min. Anchor Spacing to Prevent Concrete Splitting	Min: 50.80 mm, Actual: 250.00 mm	PASS
Min. Concrete Cover to Prevent Concrete Splitting	Min: 75.00 mm, Actual: 100.00 mm	PASS

The design geometry meets requirements!

REFERENCES	CALCULATIONS	RESULTS
	Load Combination No. 1: Compression Load Only	
	Check No. 1: Column Bearing Capacity **Calculate bearing load on column member** $N_x = 100$ kN - Compression load	
	B_f - Factored bearing load on steel $$B_f = N_x = 100 \text{ kN}$$	
	 Fig. Bearing area of column.	
	Calculate bearing capacity of column member $F_{y\_col} = 230$ MPa - Column yield stress (230G) $A_{col} = 2910$ mm^2 - Column area $\phi = 0.9$ - Structural steel resistance factor	
CSA S16:19 Clause 13.10, Finished bearing plate per CSA S16.19 Clause 28.5	B_r - Factored bearing resistance of steel $$B_r = 1.50\phi F_{y\_col} A_{col} = 1.5 \times 0.9 \times 230 \text{ MPa} \times 2910 \text{ mm}^2 = 903.55 \text{ kN}$$	
	Result: DCR - Demand over capacity ratio: $$DCR = \frac{B_f}{B_r} = \frac{100 \text{ kN}}{903.55 \text{ kN}} = 0.11067$$	**PASS = 0.11**
	Check No. 2: Weld Capacity **Calculation Note:** Calculation of strength is not required since load is transferred via direct bearing. Refer to code for minimum weld size requirements.	**N/A = 0.00** Ensure column is FIT-TO-BEAR on the base plate. Refer to CSA S16.19 Clause 28.5.
	Check No. 3: Base Plate Yield Capacity (Compression Load)	
	 Fig. Cantilever lengths of base plate.	
	Calculate critical cantilever length for Round HSS column $d_{col} = 152$ mm - Column outside diameter $L_{bp} = 350$ mm - Base plate length $B_{bp} = 350$ mm - Base plate width	
AISC Design Guide 01 3rd Ed. Section 4.3.1	l - Critical cantilever length of base plate $$l = \max\left(\frac{\text{L}_{\text{bp}} - 0.8\text{d}_{\text{col}}}{2}, \frac{\text{B}_{\text{bp}} - 0.8\text{d}_{\text{col}}}{2}\right)$$ $$l = \max\left(\frac{350 \text{ mm} - 0.8 \times 152 \text{ mm}}{2}, \frac{350 \text{ mm} - 0.8 \times 152 \text{ mm}}{2}\right) = 114.2 \text{ mm}$$	
	Calculate applied moment load per unit length on critical section of base plate due to compression from concrete $N_x = 100$ kN - Compression load $B_{bp} = 350$ mm - Base plate width $L_{bp} = 350$ mm - Base plate length	
AISC Design Guide 01 3rd Ed. Section 4.3.1	$l = 114.2$ mm	
AISC Design Guide 01 3rd Ed. Section 4.3.1	m_f - Factored bending load per unit length of base plate $$m_f = \left(\frac{N_x}{B_{bp}L_{bp}}\right)\left(\frac{l^2}{2}\right)$$ $$m_f = \left(\frac{100 \text{ kN}}{350 \text{ mm} \times 350 \text{ mm}}\right) \times \left(\frac{114.2 \text{ mm}^2}{2}\right) = 5.3231 \text{ kN·mm/mm}$$	
	Calculate flexural yielding capacity of base plate per unit length due to compression from concrete $F_{y\_bp} = 230$ MPa - Base plate yield stress $t_{bp} = 20$ mm - Base plate thickness $\phi = 0.9$ - Structural steel resistance factor	
CSA S16:19 Clause 13.5	m_r - Factored bending resistance of base plate per unit length	

$$m_r = \phi \left(\frac{(t_{bp})^2}{4} \right) F_{y\_bp} = 0.9 \times \left(\frac{(20\ \text{mm})^2}{4} \right) \times 230\ \text{MPa} = 20.7\ \text{kN·mm/mm}$$

Result:

PASS = 0.26

DCR - Demand over capacity ratio:

$$DCR = \frac{m_f}{m_r} = \frac{5.3231\ \text{kN·mm/mm}}{20.7\ \text{kN·mm/mm}} = 0.25716$$

Check No. 4: Concrete Bearing Capacity

Calculate bearing load on concrete

$N_x = 100$ kN - Compression load

P_f - Factored bearing load on concrete

$$P_f = N_x = 100\ \text{kN}$$

The restraining side is equal along the concrete width and concrete length.

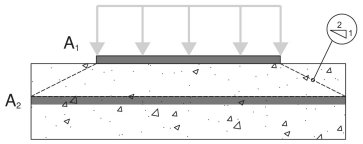


Fig. Bearing area on base plate (A1) and maximum support area on concrete (A2).

Calculate bearing area on base plate

$L_{bp} = 350$ mm - Base plate length

$B_{bp} = 350$ mm - Base plate width

AISC 360-22 Chapter J8, ACI 318-19 Sect. 22.8.3.2 and Fig. R22.8.3.2

A_1 - Area of bearing on base plate (assume full area)

$$A_1 = L_{bp} B_{bp} = 350\ \text{mm} \times 350\ \text{mm} = 122500\ \text{mm}^2$$

Calculate maximum bearing area on concrete foundation

$N_{A2} = 450$ mm - Length of max bearing area on support (A2)

$B_{A2} = 450$ mm - Width of max bearing area on support (A2)

AISC 360-22 Chapter J8, ACI 318-19 Sect. 22.8.3.2 and Fig. R22.8.3.2

A_2 - Maximum area of bearing on concrete (assume 1:2 slope)

$$A_2 = N_{A2} B_{A2} = 450\ \text{mm} \times 450\ \text{mm} = 202500\ \text{mm}^2$$

Calculate bearing capacity of concrete

$f_c^{'} = 20.68$ MPa - Concrete compressive strength (20.68)

AISC 360-22 Chapter J8, ACI 318-19 Sect. 22.8.3.2 and Fig. R22.8.3.2

$A_1 = 122500\ \text{mm}^2$

AISC 360-22 Chapter J8, ACI 318-19 Sect. 22.8.3.2 and Fig. R22.8.3.2

$A_2 = 202500\ \text{mm}^2$

$\phi = 0.65$ - Concrete resistance factor

CSA A23.3:19 Clause 28.5

P_r - Factored bearing resistance of concrete

$$P_r = 0.85 \phi \left(f_c^{'}\right) A_1 \left(\min \left(\sqrt{\frac{A_2}{A_1}},\ 2 \right) \right)$$

$$P_r = 0.85 \times 0.65 \times (20.68\ \text{MPa}) \times 122500\ \text{mm}^2 \times \left(\min \left(\sqrt{\frac{202500\ \text{mm}^2}{122500\ \text{mm}^2}},\ 2 \right) \right) = 1799.5\ \text{kN}$$

Result:

PASS = 0.06

DCR - Demand over capacity ratio:

$$DCR = \frac{P_f}{P_r} = \frac{100\ \text{kN}}{1799.5\ \text{kN}} = 0.05557$$

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

Load Combination	Design Check	Demand	Capacity	DCR	Result
1	Column Bearing Capacity	100.00	903.55	0.11	**PASS**
1	Weld Capacity	0.00	0.00	0.00	**N/A**
1	Base Plate Yield Capacity (Compression Load)	5.32	20.70	0.26	**PASS**
1	Concrete Bearing Capacity	100.00	1799.55	0.06	**PASS**

The design is adequate!