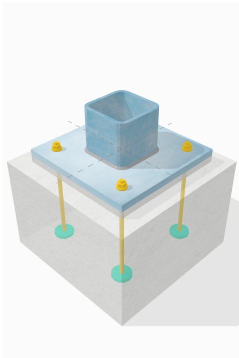
REFERENCES	CALCULATIONS	RESULTS

SkyCiv Base Plate and Anchor Rod Design

c - as

Project Information:
Design Code: AS 4100:2020 and AS 3600:2018
Anchoring Code: AS 5216:2021

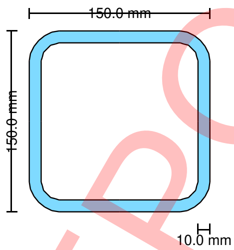


Load Combinations:

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

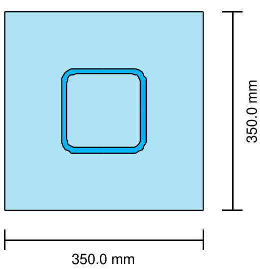
Note: Positive Nx (+) indicates compression; negative Nx (-) indicates tension.

Column Properties:



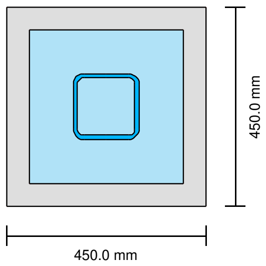
Symbol	Description	Value
$Section$	Column section	150x10 SHS
d_{col}	Column depth	150.0 mm
t_{col}	Column thickness	10.0 mm
b_{col}	Column width	150.0 mm
A_{col}	Column area	5260.0 mm^2
r_{col}	Column root radius	15.0 mm
F_{y_col}	Column yield stress (AS/NZS 1163 Gr. C350)	350.0 MPa
F_{u_col}	Column tensile stress (AS/NZS 1163 Gr. C350)	430.0 MPa

Base Plate Properties:



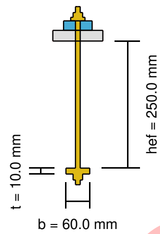
Symbol	Description	Value
B_{bp}	Base plate width	350.0 mm
L_{bp}	Base plate length	350.0 mm
t_{bp}	Base plate thickness	20.0 mm
A_{bp}	Base plate plan area	122500.0 mm^2
f_{y_bp}	Base plate yield stress (AS/NZS 3678 Gr. 250)	250.0 MPa
f_{u_bp}	Base plate tensile stress (AS/NZS 3678 Gr. 250)	410.0 MPa
t_{grout}	Grout thickness	20.0 mm

Concrete Properties:



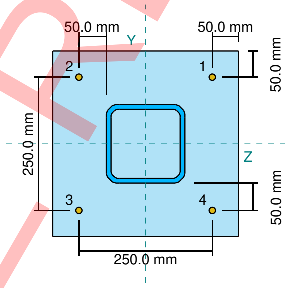
Symbol	Description	Value
B_{conc}	Concrete width	450.0 mm
L_{conc}	Concrete length	450.0 mm
t_{conc}	Concrete thickness	300.0 mm
A_{conc}	Concrete plan area	202500.0 mm^2
$f_c^{'}$	Concrete compressive strength (N28)	28.0 MPa
—	Concrete assumption: cracked or uncracked	Cracked

Anchor Information:



Symbol	Description	Value
d_a	Anchor rod diameter	12.0 mm
h_{ef}	Anchor rod effective embedment length	250.0 mm
b_{embed_plate}	Anchor embed plate dimension	60.0 mm
t_{embed_plate}	Anchor embed plate thickness	10.0 mm
F_{y_anc}	Anchor rod yield stress (8.8)	640.0 MPa
F_{u_anc}	Anchor rod tensile stress (8.8)	800.0 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	-	-	-	-
2	-125	125	-	-	-	-
3	-125	-125	-	-	-	-
4	125	-125	-	-	-	-

Weld Properties:
Weld Type: Fillet Weld

Symbol	Description	Value
$Type$	Weld Type	CFW
W	Fillet weld size	6.000 mm
E_w	Weld throat	4.243 mm
f_{uw}	Filler metal classification strength (430)	430.000 MPa

Summary of Detailing Checks

Check Name	Dimensions (Min/Max/Actual)	Status
Weld Size Requirement	Min: 6.00 mm, Max: 19.00 mm, Actual: 6.00 mm	**PASS**
Anchor Clearance	Min: 30.16 mm, Actual: 75.07 mm	**PASS**
Base Plate Edge Distance	Min: 18.00 mm, Actual: 50.00 mm	**PASS**
Minimum Number of Anchors	Min: 4.00, Actual: 4.00	**PASS**
Embedded Plate Dimension	Min: 48.00 mm, Actual: 60.00 mm	**PASS**
Min. Anchor Spacing to Prevent Concrete Splitting	Min: 48.00 mm, Actual: 250.00 mm	**PASS**
Min. Concrete Cover to Prevent Concrete Splitting	Min: 24.00 mm, Actual: 100.00 mm	**PASS**

The design geometry meets requirements!

REFERENCES	CALCULATIONS	RESULTS

Load Combination No. 1: Compression Load Only

Check No. 1: Concrete Bearing Capacity
Calculate bearing load on concrete

$N_x = 100\ \mathrm{kN}$ - Compression load

N_c^* - Design bearing force of concrete

$$N_c^* = N_x = 100\ \mathrm{kN}$$

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

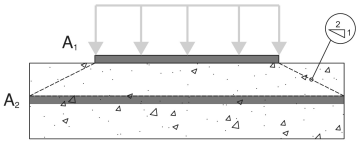


Fig. Bearing area on base plate (A1) and maximum support area on concrete (A2).

Calculate bearing area on base plate

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

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

AS 3600:2018 Clause 12.6 — A_1 - Area of bearing on base plate (assume full area)

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

Calculate maximum bearing area on concrete foundation

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

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

AS 3600:2018 Clause 12.6 — A_2 - Maximum area of bearing on concrete (assume 1:2 slope)

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

Calculate bearing capacity of concrete

$f_c^{'} = 28\ \mathrm{MPa}$ - Concrete compressive strength (N28)

AS 3600:2018 Clause 12.6 — $A_1 = 122500\ \mathrm{mm}^2$

AS 3600:2018 Clause 12.6 — $A_2 = 202500\ \mathrm{mm}^2$

$\phi = 0.6$ - Concrete compression capacity reduction factor

AS 3600:2018 Eq.12.6, taken as equivalent force. ASI Design Guide 07 1st Ed. Section 9.1 — ϕN_c - Design bearing capacity at concrete surface

$$\phi N_c = \min\left(\phi 0.9\,(f_c^{'})\,A_1\sqrt{\frac{A_2}{A_1}},\ \phi 1.8\,(f_c^{'})\,A_1\right)$$

$$\phi N_c = \min\left(0.6 \times 0.9 \times (28\ \mathrm{MPa}) \times 122500\ \mathrm{mm}^2 \times \sqrt{\frac{202500\ \mathrm{mm}^2}{122500\ \mathrm{mm}^2}},\ 0.6 \times 1.8 \times (28\ \mathrm{MPa}) \times 122500\ \mathrm{mm}^2\right)$$

$$\phi N_c = 2381.4\ \mathrm{kN}$$

Result:

DCR - Demand over capacity ratio:

$$DCR = \frac{N_c^*}{\phi N_c} = \frac{100\ \mathrm{kN}}{2381.4\ \mathrm{kN}} = 0.041992$$

PASS = 0.04

Check No. 2: Weld Capacity

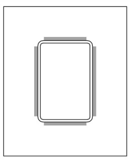


Fig. Effective welds on column to base plate.

Calculate total weld length on four sides of HSS

$d_{col} = 150\ \mathrm{mm}$ - Column depth

$b_{col} = 150\ \mathrm{mm}$ - Column width

$r_{col} = 15\ \mathrm{mm}$ - Column root radius

$t_{col} = 10\ \mathrm{mm}$ - Column thickness

L_{weld} - Total length of weld

$$L_{weld} = 2\,(b_{col} - 2r_{col} - 2t_{col}) + 2\,(d_{col} - 2r_{col} - 2t_{col})$$

$$L_{weld} = 2 \times (150\ \mathrm{mm} - 2 \times 15\ \mathrm{mm} - 2 \times 10\ \mathrm{mm}) + 2 \times (150\ \mathrm{mm} - 2 \times 15\ \mathrm{mm} - 2 \times 10\ \mathrm{mm}) = 400\ \mathrm{mm}$$

Calculate load per unit length of weld

$N_x = 100\ \mathrm{kN}$ - Compression load

$L_{weld} = 400\ \mathrm{mm}$

v_w^* - Required weld resistance per unit length

$$v_w^* = \frac{N_x}{L_{weld}} = \frac{100\ \mathrm{kN}}{400\ \mathrm{mm}} = 0.25\ \mathrm{kN/mm}$$

Calculate fillet weld capacity

$f_{uw} = 430\ \mathrm{MPa}$ - Filler metal classification strength (430)

$E_w = 4.243\ \mathrm{mm}$ - Design weld throat

$k_r = 1$ - Weld reduction factor

$\phi = 0.8$ - Fillet weld capacity reduction factor

AS 4100:2020 Clause 9.6.3.10

ϕv_w - Design capacity of fillet weld per length

$$\phi v_w = \phi 0.6 f_{uw} E_w k_r = 0.8 \times 0.6 \times 430\ \mathrm{MPa} \times 4.243\ \mathrm{mm} \times 1 = 0.87576\ \mathrm{kN/mm}$$

Result:

PASS = 0.29

DCR - Demand over capacity ratio:

$$DCR = \frac{v_w^*}{\phi v_w} = \frac{0.25\ \mathrm{kN/mm}}{0.87576\ \mathrm{kN/mm}} = 0.28547$$

Check No. 3: Base Plate Yield Capacity (Compression Load)

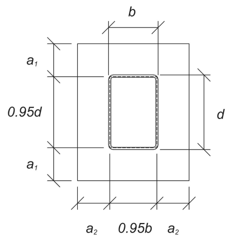


Fig. Cantilever lengths of base plate.

Calculate required factors for critical cantilever length

ASI Design Guide 07 1st Ed. Table 7

k_x - kx factor

$$k_x = 1.65\left(\frac{\sqrt{L_{bp}B_{bp}}}{b_{col}}\right) = 1.65 \times \left(\frac{\sqrt{350\ \mathrm{mm} \times 350\ \mathrm{mm}}}{150\ \mathrm{mm}}\right) = 3.85$$

ϕf_b - Concrete bearing strength

$$\phi f_b = \frac{\phi N_c}{L_{bp}B_{bp}} = \frac{2381.4\ \mathrm{kN}}{350\ \mathrm{mm} \times 350\ \mathrm{mm}} = 19.44\ \mathrm{MPa}$$

ASI Design Guide 07 1st Ed. Table 7

X - X factor

$$X = \frac{4N_c^*}{\phi f_b (2b_{col})^2} = \frac{4 \times 100\ \mathrm{kN}}{19.44\ \mathrm{MPa} \times (2 \times 150\ \mathrm{mm})^2} = 0.22862$$

ASI Design Guide 07 1st Ed. Section 6.1 and Section 9.1 & 9.2

λ - Lambda factor

$$\lambda = \min\left(\frac{\mathrm{k_x}\sqrt{\mathrm{X}}}{1+\sqrt{1-\mathrm{X}}}, 1.0\right) = \min\left(\frac{3.85 \times \sqrt{0.22862}}{1+\sqrt{1-0.22862}}, 1\right) = 0.98008$$

Calculate critical cantilever length for RHS/SHS column

$d_{col} = 150\ \mathrm{mm}$ - Column depth

$b_{col} = 150\ \mathrm{mm}$ - Column width

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

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

ASI Design Guide 07 1st Ed. Section 6.1 and Section 9.1 & 9.2

$\lambda = 0.98008$

ASI Design Guide 07 1st Ed. Section 6.1 and Section 9.1 & 9.2

l - Critical cantilever length of base plate

$$l = \max\left(\frac{\mathrm{L_{bp}} - 0.95\mathrm{d_{col}}}{2}, \frac{\mathrm{B_{bp}} - 0.95\mathrm{b_{col}}}{2}, \lambda 0.306\sqrt{\mathrm{d_{col}b_{col}}}\right)$$

$$l = \max\left(\frac{350\ \mathrm{mm} - 0.95 \times 150\ \mathrm{mm}}{2}, \frac{350\ \mathrm{mm} - 0.95 \times 150\ \mathrm{mm}}{2}, 0.98008 \times 0.306 \times \sqrt{150\ \mathrm{mm} \times 150\ \mathrm{mm}}\right)$$

$$l = 103.75\ \mathrm{mm}$$

Calculate bending stress on critical section of base plate due to compression from concrete

$N_x = 100\ \mathrm{kN}$ - Compression load

ASI Design Guide 07 1st Ed. Section 6.1 and Section 9.1 & 9.2

$l = 103.75\ \mathrm{mm}$

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

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

$t_{bp} = 20\ \mathrm{mm}$ - Base plate thickness

ASI Design Guide 07 1st Ed. Section 6.1, and rearranged equation from Section 9.2

f^* - Design bending stress

AS 4100:2020 Clause 5.2.1	$$f^* = \frac{2N_x l^2}{B_{bp} L_{bp} (t_{bp})^2}$$ $$f^* = \frac{2 \times 100\ \mathrm{kN} \times 103.75\ \mathrm{mm}^2}{350\ \mathrm{mm} \times 350\ \mathrm{mm} \times (20\ \mathrm{mm})^2} = 43.935\ \mathrm{MPa}$$ **Calculate yielding capacity of base plate** $f_{y\_bp} = 250\ \mathrm{MPa}$ - Base plate yield stress (AS/NZS 3678 Gr. 250) $\phi = 0.9$ - Bending capacity reduction factor ϕf_y - Design yield capacity $$\phi f_y = \phi f_{y\_bp} = 0.9 \times 250\ \mathrm{MPa} = 225\ \mathrm{MPa}$$ **Result:** DCR - Demand over capacity ratio: $$DCR = \frac{f^*}{\phi f_y} = \frac{43.935\ \mathrm{MPa}}{225\ \mathrm{MPa}} = 0.19527$$	PASS = 0.20

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

Load Combination	Design Check	Demand	Capacity	DCR	Result
1	Concrete Bearing Capacity	100.00	2381.40	0.04	**PASS**
1	Weld Capacity	0.25	0.88	0.29	**PASS**
1	Base Plate Yield Capacity (Compression Load)	43.93	225.00	0.20	**PASS**

The design is adequate!