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Address:	1a Old Toll Bar Rd., Toowoomba Qld 4350	Specifier:	Denis Brown
Phone I Fax:	07 4632 0126 | 07 4639 4177	E-Mail:	denis@dessolqld.com.au
Design:	Concrete - 8 May 2020 (1)	Date:	9/05/2020
Fastening Point:	Direct to Reinforced Core Filled Wall		

Specifier's comments: Check the core filling is in place before creating the connection.

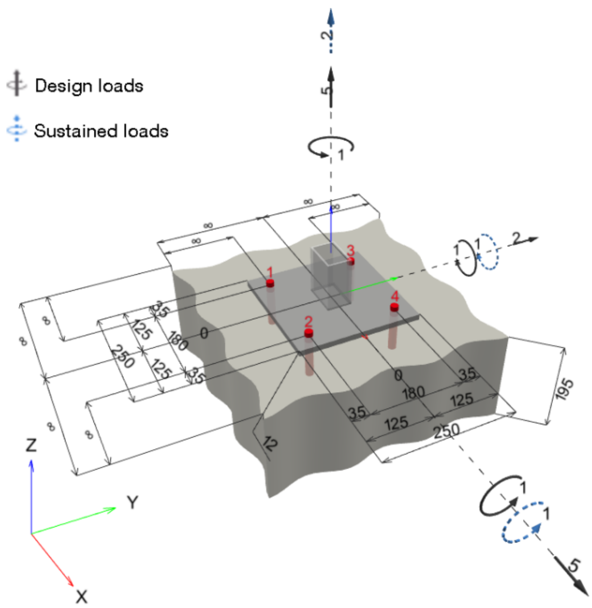
1 Anchor Design

1.1 Input data

Anchor type and size:	**HIT-HY 200-R + HAS-U 5.8 M16**
Return period (service life in years):	50
Item number:	2223828 HAS-U 5.8 M16x150 (insert) / 2045036 HIT-HY 200-R (mortar)
Effective embedment depth:	$h_{ef,opti}$ = 80.0 mm ($h_{ef,limit}$ = 159.0 mm)
Material:	5.8
Approval No.:	Hilti Technical Data
Issued I Valid:	- | -
Proof:	Design Method AS 5216:2018, Chemical
Stand-off installation:	e_b = 0.0 mm (no stand-off); t = 12.0 mm
Baseplate^{CBFEM} :	l_x x l_y x t = 250.0 mm x 250.0 mm x 12.0 mm;
Profile:	Rectangular hollow section, 75x50x4RHS; (L x W x T) = 75.0 mm x 50.0 mm x 4.0 mm
Base material:	cracked concrete, 12MPa, f'_c = 12.00 N/mm^2; h = 195.0 mm, Temp. short/long: 0/0 °C
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	No reinforcement or Reinforcement spacing >= 150 mm (any Ø) or >= 100 mm (Ø <= 10 mm)
	no longitudinal edge reinforcement

^{CBFEM} - The anchor calculation is based on a component-based Finite Element Method (CBFEM)

Geometry [mm] & Loading [kN, kNm]



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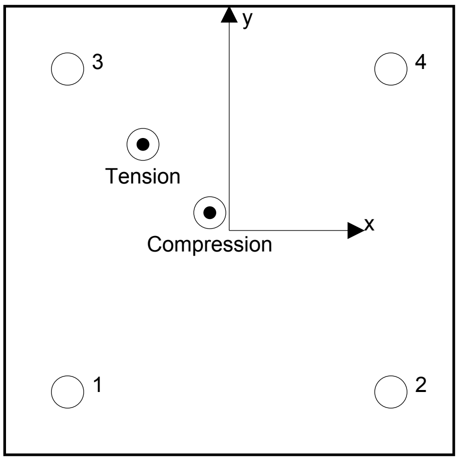
1.1.1 Load combination

Case	Description	Forces [kN] / Moments [kNm]	Seismic	Fire	Max. Util. Anchor [%]
1	Combination 1	$N = 5.000; V_x = 5.000; V_y = 2.000;$ $M_x = 1.000; M_y = 1.000; M_z = 1.000;$ $N_{sus} = 3.000; M_{x,sus} = 1.000; M_{y,sus} = 1.000;$	no	no	86
2	Servicability	$N = 2.500; V_x = 2.500; V_y = 1.500;$ $M_x = 1.000; M_y = 1.000; M_z = 1.000;$ $N_{sus} = 2.000; M_{x,sus} = 1.000; M_{y,sus} = 1.000;$	no	no	79

1.2 Load case/Resulting anchor forces

Controlling load case: 1 Combination 1



Anchor reactions [kN]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	4.802	2.764	2.631	-0.847
2	0.000	3.238	2.642	1.872
3	10.974	0.941	-0.109	-0.935
4	4.800	1.917	-0.164	1.910

resulting tension force in (x/y)=(-48.0/48.0): 20.577 [kN]
resulting compression force in (x/y)=(-10.8/9.9): 16.136 [kN]

Anchor forces are calculated based on a component-based Finite Element Method (CBFEM)

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1.3 Tension load (AS 5216:2018, Section 6.2)

	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel failure*	10.974	52.333	21	OK
Combined pullout-concrete cone failure**	20.577	32.786	63	OK
Concrete Breakout failure**	20.577	24.053	86	OK
Splitting failure**	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (anchors in tension)

1.3.1 Steel failure

$N^* \leq N_{Rd,s} = \phi_{Ms,N} \cdot N_{Rk,s}$ AS 5216:2018, Table 3.4.2.1

$N_{Rk,s}$ [kN]	$\phi_{Ms,N}$	$N_{Rd,s}$ [kN]	N^* [kN]
78.500	0.667	52.333	10.974

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1.3.2 Combined pullout-concrete cone failure

$N^* \leq N_{Rd,p} = \phi_{Mp} \cdot N_{Rk,p}$ — AS 5216:2018, Table 3.4.2.1

$N_{Rk,p} = N^0_{Rk,p} \cdot \frac{A_{p,N}}{A^0_{p,N}} \cdot \psi_{g,Np} \cdot \psi_{s,Np} \cdot \psi_{re,N} \cdot \psi_{ec1,Np} \cdot \psi_{ec2,Np}$ — AS 5216:2018, Eq. 6.2.5.1

$N^0_{Rk,p} = \psi_{sus} \cdot \tau_{Rk} \cdot \pi \cdot d \cdot h_{ef}$ — AS 5216:2018, Eq. 6.2.5.2

$\psi_{sus} = \psi^0_{sus} + 1 - \alpha_{sus}$

$s_{cr,Np} = 7.3 \cdot d \cdot \sqrt{\psi_{sus} \cdot \tau_{Rk}} \leq 3 \cdot h_{ef}$ — AS 5216:2018, Eq. 6.2.5.3(2)

$\psi_{g,Np} = \psi^0_{g,Np} - \left(\frac{s}{s_{cr,Np}}\right)^{0,5} \cdot \left(\psi^0_{g,Np} - 1\right) \geq 1.00$ — AS 5216:2018, Eq. 6.2.5.5(1)

$\psi^0_{g,Np} = \sqrt{n} - (\sqrt{n} - 1) \cdot \left(\frac{\tau_{Rk}}{\tau_{Rk,c}}\right)^{1,5} \geq 1.00$ — AS 5216:2018, Eq. 6.2.5.5(2)

$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d} \cdot \sqrt{h_{ef} \cdot f'_c}$ — AS 5216:2018, Eq. 6.2.5.5(3)

$\psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} \leq 1.00$ — AS 5216:2018, Eq. 6.2.3.4

$\psi_{ec1,Np} = \frac{1}{1 + \left(\frac{2 \cdot e_{c1,N}}{s_{cr,Np}}\right)} \leq 1.00$ — AS 5216:2018, Eq. 6.2.3.6

$\psi_{ec2,Np} = \frac{1}{1 + \left(\frac{2 \cdot e_{c2,N}}{s_{cr,Np}}\right)} \leq 1.00$ — AS 5216:2018, Eq. 6.2.3.6

$A_{p,N}$ [mm^2]	$A^0_{p,N}$ [mm^2]	$\tau_{Rk,ucr,20}$ [N/mm^2]	$s_{cr,Np}$ [mm]	$c_{cr,Np}$ [mm]	c_{min} [mm]	$f_{c,cyl}$ [N/mm^2]
144,000	57,600	18.00	240.0	120.0	∞	12.00

ψ_c	$\tau_{Rk,cr}$ [N/mm^2]	k_3	$\tau_{Rk,c}$ [N/mm^2]	$\psi^0_{g,Np}$	$\psi_{g,Np}$
0.945	8.04	7.700	4.75	1.000	1.000

$e_{c1,N}$ [mm]	$\psi_{ec1,Np}$	$e_{c2,N}$ [mm]	$\psi_{ec2,Np}$	$\psi_{s,Np}$	$\psi_{re,Np}$
18.0	0.870	18.0	0.870	1.000	1.000

ψ^0_{sus}	α_{sus}	ψ_{sus}
0.740	0.935	0.805

$N^0_{Rk,p}$ [kN]	$N_{Rk,p}$ [kN]	ϕ_{Mp}	$N_{Rd,p}$ [kN]	N^* [kN]
26.016	49.178	0.667	32.786	20.577

Group anchor ID
1, 3, 4

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1.3.3 Concrete Breakout failure

$N^* \leq N_{Rd,c} = \phi_{Mc} \cdot N_{Rk,c}$	AS 5216:2018, Table 3.4.2.1
$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N}$	AS 5216:2018, Eq. 6.2.3.1
$N^0_{Rk,c} = k_1 \cdot \sqrt{f'_c} \cdot h_{ef}^{1,5}$	AS 5216:2018, Eq. 6.2.3.2
$A^0_{c,N} = s_{cr,N} \cdot s_{cr,N}$	AS 5216:2018, Eq. 6.2.3.3
$\psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leq 1.00$	AS 5216:2018, Eq. 6.2.3.4
$\psi_{ec1,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{N,1}}{s_{cr,N}}\right)} \leq 1.00$	AS 5216:2018, Eq. 6.2.3.6
$\psi_{ec2,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{N,2}}{s_{cr,N}}\right)} \leq 1.00$	AS 5216:2018, Eq. 6.2.3.6
$\psi_{M,N} = 1$	AS 5216:2018, Clause 6.2.3.7

$A_{c,N}$ [mm^2]	$A^0_{c,N}$ [mm^2]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	$f_{c,cyl}$ [N/mm^2]
144,000	57,600	120.0	240.0	12.00

$e_{c1,N}$ [mm]	$\psi_{ec1,N}$	$e_{c2,N}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$
18.0	0.870	18.0	0.870	1.000	1.000

z [mm]	$\psi_{M,N}$	k_1	$N^0_{Rk,c}$ [kN]	ϕ_{Mc}	$N_{Rd,c}$ [kN]	N* [kN]
53.2	1.000	7.700	19.086	0.667	24.053	20.577

Group anchor ID
1, 3, 4

1.4 Shear load (AS 5216:2018, Section 7.2)

	Load [kN]	Capacity [kN]	Utilization β_V [%]	Status
Steel failure (without lever arm)*	3.238	31.440	11	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout failure*	3.238	19.484	17	OK
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (relevant anchors)

1.4.1 Steel failure (without lever arm)

$V^* \leq V_{Rd,s} = \phi_{Ms,V} \cdot V_{Rk,s}$ AS 5216:2018, Table 3.4.3.1

$V_{Rk,s} = k_7 \cdot V^0_{Rk,s}$ AS 5216:2018, Eq. 7.2.2.2(1)

$V^0_{Rk,s}$ [kN]	k_7	$V_{Rk,s}$ [kN]	$\phi_{Ms,V}$	$V_{Rd,s}$ [kN]	V* [kN]
39.300	1.000	39.300	0.800	31.440	3.238

1.4.2 Pryout failure (concrete cone relevant)

$V^* \leq V_{Rd,cp} = \phi_{Mc} \cdot V_{Rk,cp}$ AS 5216:2018, Table 3.4.3.1

$V_{Rk,cp} = k_8 \cdot \min\{N_{Rk,c}; N_{Rk,p}\}$ AS 5216:2018, Eq. 7.2.4.1(3)

$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N}$ AS 5216:2018, Eq. 6.2.3.1

$N^0_{Rk,c} = k_1 \cdot \sqrt{f_c} \cdot h_{ef}^{1,5}$ AS 5216:2018, Eq. 6.2.3.2

$A^0_{c,N} = s_{cr,N} \cdot s_{cr,N}$ AS 5216:2018, Eq. 6.2.3.3

$\psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leq 1.00$ AS 5216:2018, Eq. 6.2.3.4

$\psi_{ec1,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{V,1}}{s_{cr,N}}\right)} \leq 1.00$ AS 5216:2018, Eq. 6.2.3.6

$\psi_{ec2,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{V,2}}{s_{cr,N}}\right)} \leq 1.00$ AS 5216:2018, Eq. 6.2.3.6

$\psi_{M,N} = 1$ AS 5216:2018, Clause 6.2.3.7

$A_{c,N}$ [mm^2]	$A^0_{c,N}$ [mm^2]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	k_8	$f_{c,cyl}$ [N/mm^2]
44,100	57,600	120.0	240.0	2.000	12.00

$e_{c1,V}$ [mm]	$\psi_{ec1,N}$	$e_{c2,V}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$	$\psi_{M,N}$
0.0	1.000	0.0	1.000	1.000	1.000	1.000

k_1	$N^0_{Rk,c}$ [kN]	ϕ_{Mc}	$V_{Rd,cp}$ [kN]	V* [kN]
7.700	19.086	0.667	19.484	3.238

Group anchor ID
1-4

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1.5 Combined tension and shear loads (AS 5216:2018, Section 8.1.1, 8.2.1)

Steel failure

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0.210	0.103	2.000	6	OK

$\beta_N^\alpha + \beta_V^\alpha \leq 1.0$

Concrete failure

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0.855	0.166	1.000	86	OK

$(\beta_N + \beta_V) / 1.2 \leq 1.0$

1.6 Warnings

- The anchor design methods in PROFIS Engineering require rigid baseplates as per current regulations (ETAG 001/Annex C, EOTA TR029, etc.). This means load re-distribution on the anchors due to elastic deformations of the baseplate are not considered - the baseplate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required baseplate thickness with CBFEM to limit the stress of the baseplate based on the assumptions explained above. The proof if the rigid base plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Checking the transfer of loads into the base material is required in accordance with AS 5216:2018, Appendix C!
- The design is only valid if the clearance hole in the fixture is not larger than the value given in Table 4.2.2.1 of AS 5216:2018 ! For larger diameters of the clearance hole see section 2.2 of AS 5216:2018!
- The accessory list in this report is for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.
- For the determination of the $\psi_{re,v}$ (concrete edge failure) a concrete cover of the edge reinforcement c = 30 mm is assumed
- Drilled hole cleaning must be performed according to instructions for use (blow twice with oil-free compressed air (min. 6 bar), brush twice, blow twice with oil-free compressed air (min. 6 bar)).
- Characteristic bond resistances depend on short- and long-term temperatures.
- Edge reinforcement is not required to avoid splitting failure
- The anchor design methods in PROFIS Engineering require rigid baseplates, as per current regulations (AS 5216:2018, ETAG 001/Annex C, EOTA TR029 etc.). This means that the baseplate should be sufficiently rigid to prevent load re-distribution to the anchors due to elastic/plastic displacements. The user accepts that the baseplate is considered close to rigid by engineering judgment."
- The characteristic bond resistances depend on the return period (service life in years): 50

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1.7 Installation data

Baseplate, steel: Grade 300; E = 200,000.00 N/mm^2; f_{yk} = 310.00 N/mm^2
Profile: Rectangular hollow section, 75x50x4RHS; (L x W x T) = 75.0 mm x 50.0 mm x 4.0 mm
Hole diameter in the fixture: d_f = 18.0 mm
Plate thickness (input): 12.0 mm

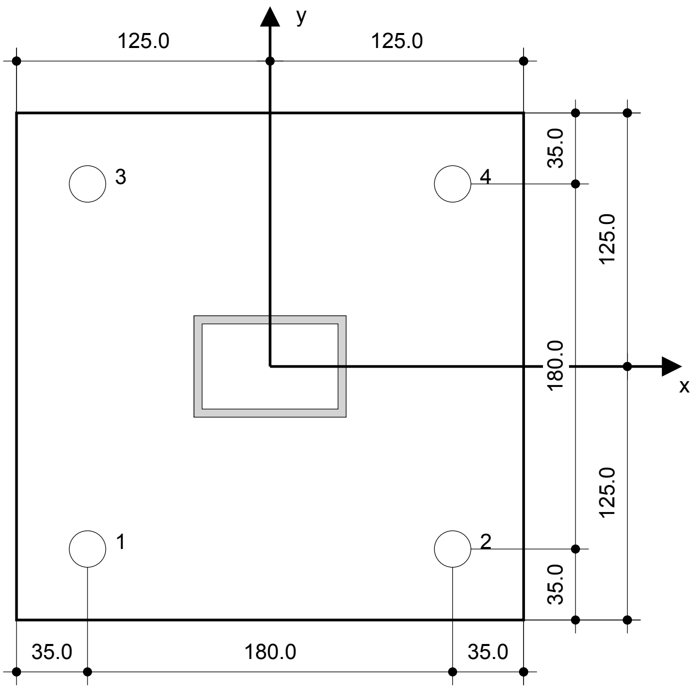
Drilling method: Hammer drilled
Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and size: HIT-HY 200-R + HAS-U 5.8 M16
Item number: 2223828 HAS-U 5.8 M16x150 (insert) / 2045036 HIT-HY 200-R (mortar)
Installation torque: 80 Nm
Hole diameter in the base material: 18.0 mm
Hole depth in the base material: 80.0 mm
Minimum thickness of the base material: 116.0 mm

Hilti HAS-U threaded rod with HIT-HY 200 injection mortar with 80 mm embedment h_ef, M16, Steel galvanized, SAFEset Auto cleaning
Hammer drilling installation per instruction for use

1.7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• Dispenser including cassette and mixer • Torque wrench



Coordinates Anchor mm

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-90.0	-90.0	-	-	-	-
2	90.0	-90.0	-	-	-	-
3	-90.0	90.0	-	-	-	-
4	90.0	90.0	-	-	-	-

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2 Baseplate design

2.1 Input data

Baseplate:	Shape: Rectangular l_x x l_y x t = 250.0 mm x 250.0 mm x 12.0 mm Calculation: CBFEM Material: Grade 300; F_y = 310.00 N/mm²; ε_{lim} = 5.00%
Anchor type and size:	HIT-HY 200-R + HAS-U 5.8 M16, h_{ef} = 80.0 mm
Anchor stiffness:	The anchor is modelled considering stiffness values determined from load displacement curves tested in an independent laboratory. Please note that no simple replacement of the anchor is possible as the anchor stiffness has a major impact on the load distribution results.
Design method:	AS 4100:1998 -based design using component-based FEM
Stand-off installation:	e_b = 0.0 mm (No stand-off); t = 12.0 mm
Profile:	75x50x4RHS; (L x W x T x FT) = 75.0 mm x 50.0 mm x 4.0 mm x - Material: Grade C250; F_y = 250.00 N/mm²; ε_{lim} = 5.00% Eccentricity x: 0.0 mm Eccentricity y: 0.0 mm
Base material:	Cracked concrete; 12MPa; $f_{c,cyl}$ = 12.00 N/mm²; h = 195.0 mm; E = 27,000.00 N/mm²; G = 11,250.00 N/mm²; v = 0.20
Welds (profile to baseplate):	Type of redistribution: Plastic Material: Grade B-E43XX Web weld thickness: 2.8 mm; f_{uw} = 430.00 N/mm² Flange weld thickness: 2.8 mm; f_{uw} = 430.00 N/mm²
Mesh size:	Number of elements on edge: 8 Min. size of element: 10.0 mm Max size of element: 50.0 mm

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2.2 Summary

	Description	Profile		Baseplate			Concrete [%]
		σ_{Eq} [N/mm²]	ε_{Pl} [%]	σ_{Eq} [N/mm²]	ε_{Pl} [%]	Hole bearing [%]	
1	Combination 1	225.16	0.08	159.37	0.00	2	5
2	Servicability	223.09	0.07	149.05	0.00	2	5

2.3 Baseplate plate classification

Results below are displayed for the decisive load combinations: Combination 1

Anchor tension forces	Equivalent rigid baseplate (CBFEM)	Component-based Finite Element Method (CBFEM) baseplate
Anchor 1	0.010 kN	4.802 kN
Anchor 2	0.000 kN	0.000 kN
Anchor 3	8.594 kN	10.974 kN
Anchor 4	0.028 kN	4.800 kN

User accepted to consider the selected baseplate as rigid by his/her engineering judgement. This means the anchor design guidelines can be applied.

2.4 Profile/Stiffeners/Plate

Profile and stiffeners are verified at the level of the steel to concrete connection. The connection design does not replace the steel design for critical cross sections, which should be performed outside of PROFIS Engineering.

2.4.1 Equivalent stress and plastic strain

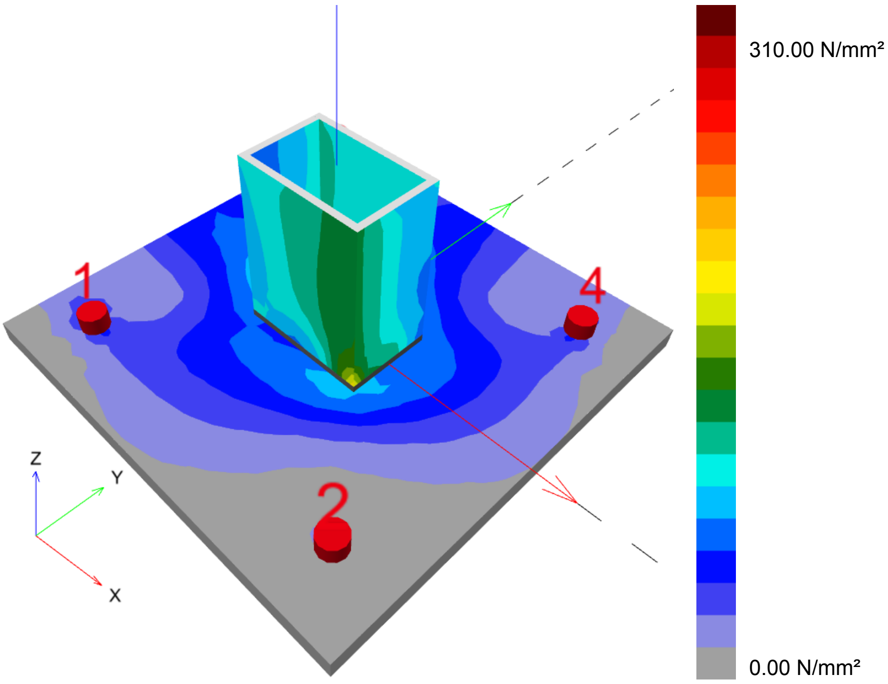
$\varepsilon_{Pl} \leq \varepsilon_{lim}$

Results

Part	Load combination	Material	σ_{Eq} [N/mm²]	ε_{Pl} [%]	f_y [N/mm²]	Φ_{steel}	$f_y\ \Phi_{steel}$ [N/mm²]	ε_{lim} [%]	Status
Plate	Combination 1	Grade 300	159.37	0.00	310.00	0.90	279.00	5.00	OK
Profile	Combination 1	Grade C250	225.16	0.08	250.00	0.90	225.00	5.00	OK
Profile	Combination 1	Grade C250	160.79	0.00	250.00	0.90	225.00	5.00	OK
Profile	Combination 1	Grade C250	181.26	0.00	250.00	0.90	225.00	5.00	OK
Profile	Combination 1	Grade C250	202.14	0.02	250.00	0.90	225.00	5.00	OK

2.4.1.1 Equivalent stress

Results below are displayed for the decisive load combination: 1 - Combination 1



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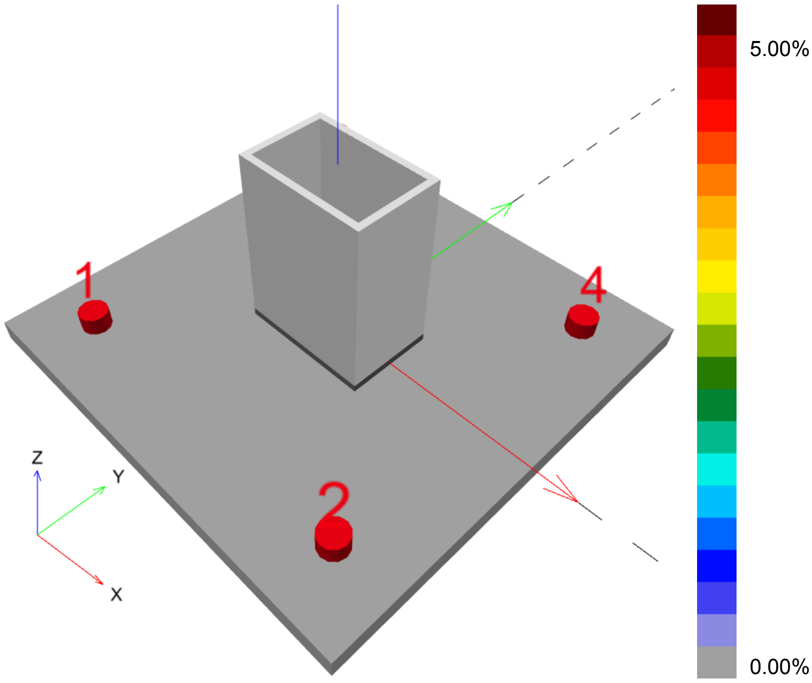
2.4.1.2 Plastic strain

Results below are displayed for the decisive load combination: 1 - Combination 1



2.4.2 Hole bearing

Decisive load combination: 1 - Combination 1

Plate hole bearing resistance, AS 4100:1998 section 9.3.2.4:

Results

	ΦV_b [kN]	V_b^* [kN]	Utilisation [%]	Status
Anchor 1	166.120	2.764	2	OK
Anchor 2	237.773	3.238	2	OK
Anchor 3	158.998	0.941	1	OK
Anchor 4	237.773	1.917	1	OK

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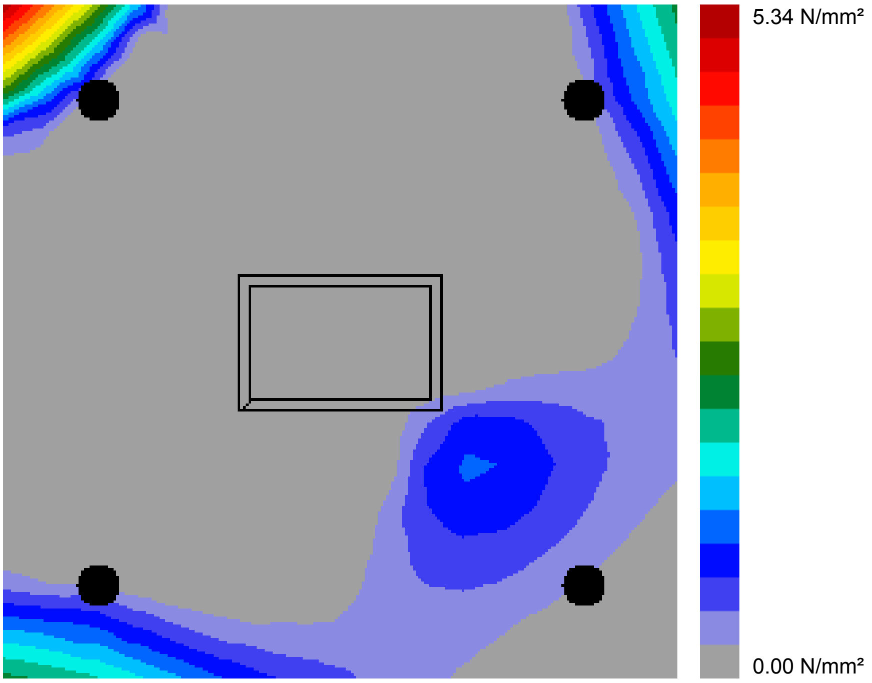
Design:	Concrete - 8 May 2020 (1)	Date:	9/05/2020
Fastening Point:	Direct to Reinforced Core Filled Wall		

2.5 Concrete

Decisive load combination: 1 - Combination 1

According to AS 3600:2018 section 12.6, the concrete should have sufficient reinforcement to take into account the tensile forces that develop due to the fixture attachment. The definition of the reinforcement in the concrete is not within the scope of PROFIS Engineering.

2.5.1 Compression in concrete under the baseplate



2.5.2 Verification of compression in concrete under the baseplate around the profile as per AS 3600:2018 12.6

Results

σ_c [N/mm²]	f_b [N/mm²]	Utilisation [%]	Status
0.63	12.96	5	OK

2.6 Symbol explanation

ε_{lim}	Limit plastic strain
ε_{Pl}	Plastic strain from CBFEM results
f_b	Concrete block bearing resistance
f_y	Yield strength
σ_c	Average stress in concrete
σ_{Eq}	Equivalent stress
Φ_{steel}	Steel capacity factor
V_b^*	Resultant of anchor shear forces Vy and Vz in shear planes

2.7 Warnings

- By using the CBFEM calculation functionality of PROFIS Engineering you may act outside the applicable design codes and your specified baseplate may not behave rigidly. Please, have the results validated by a professional designer and/or structural engineer to ensure suitability and adequacy for your specific jurisdiction and project requirements.
- The anchor is modelled considering stiffness values determined from load displacement curves tested in an independent laboratory. Please note that no simple replacement of the anchor is possible as the anchor stiffness has a major impact on the load distribution results.

3 Summary of results

Design of the baseplate, anchors, welds and other elements are based on CBFEM (component-based finite element method) and AS.

	Load combination	Max. utilisation	Status
Anchors	Combination 1	86%	OK
Baseplate	Combination 1	52%	OK
Concrete	Combination 1	5%	OK
Profile	Combination 1	91%	OK

Fastening meets the design criteria!

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4 Remarks; Your Cooperation Duties

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