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Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - 1 Mar 2023	Date:	22/03/2023
Fastening Point:			

Specifier's comments:

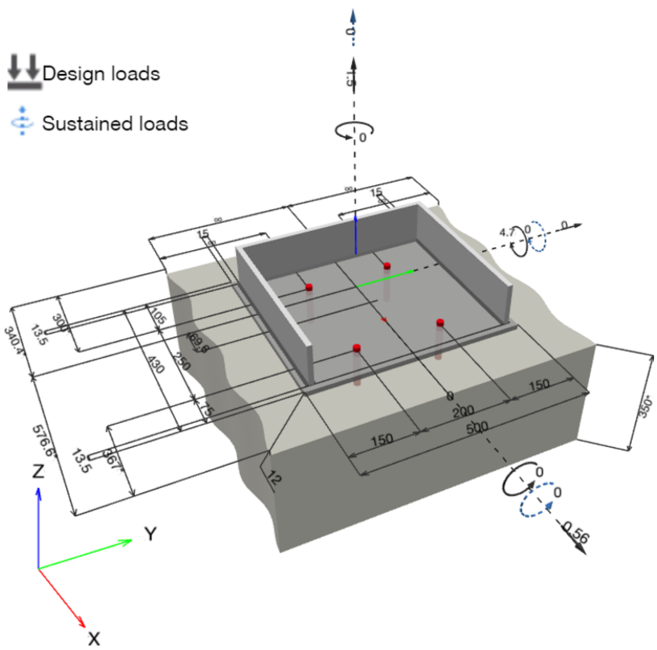
1 Anchor Design

1.1 Input data

Anchor type and size:	**HIT-HY 200-A + HAS-U 5.8 HDG M16**
Return period (service life in years):	50
Item number:	2223943 HAS-U 5.8 HDG M16x150 (insert) / 2022696 HIT-HY 200-A (mortar)
Effective embedment depth:	$h_{ef,opti}$ = 80.0 mm ($h_{ef,limit}$ = 314.0 mm)
Material:	5.8
Approval No.:	ETA 11/0493
Issued I Valid:	10/12/2021 | -
Proof:	Design Method EN 1992-4, 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 = 430.0 mm x 500.0 mm x 12.0 mm;
Profile:	U profile, ; (L x W x T x FT) = 470.0 mm x 403.0 mm x 12.0 mm x 12.0 mm
Base material:	cracked concrete, C30/37, $f_{c,cyl}$ = 30.00 N/mm^2; h = 350.0 mm, Temp. short/long: 0/0 °C, User-defined partial material safety factor γ_c = 1.500
Installation:	**automatic cleaned 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]



1.1.1 Load combination

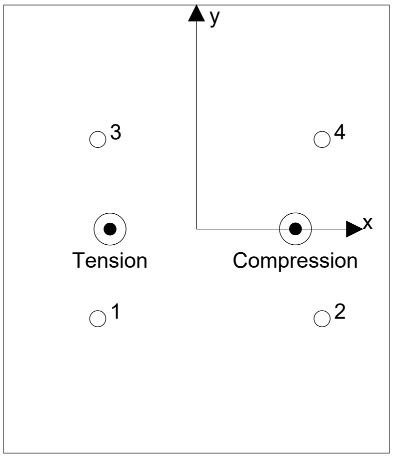
Case	Description	Forces [kN] / Moments [kNm]	Seismic	Fire	Max. Util. Anchor [%]
1	Combination 1	$N = 1.500$; $V_x = 0.560$; $V_y = 0.000$; $M_x = 0.000$; $M_y = 4.700$; $M_z = 0.000$; $N_{sus} = 0.000$; $M_{x,sus} = 0.000$; $M_{y,sus} = 0.000$;	no	no	59

1.2 Load case/Resulting anchor forces

Anchor reactions [kN]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	10.854	0.121	0.119	-0.019
2	0.628	0.161	0.161	0.005
3	10.850	0.121	0.119	0.019
4	0.627	0.161	0.161	-0.005



resulting tension force in (x/y)=(-96.3/-0.0): 22.958 [kN]
resulting compression force in (x/y)=(110.4/0.2): 23.306 [kN]

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

1.3 Tension load (EN 1992-4, Section 7.2.1)

	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel failure*	10.854	52.333	21	OK
Combined pullout-concrete cone failure**	21.704	43.499	50	OK
Concrete Breakout failure**	21.704	36.879	59	OK
Splitting failure**	N/A	N/A	N/A	N/A

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

1.3.1 Steel failure

$$N_{Ed} \leq N_{Rd,s} = \frac{N_{Rk,s}}{\gamma_{M,s}}$$ EN 1992-4, Table 7.1

$N_{Rk,s}$ [kN]	$\gamma_{M,s}$	$N_{Rd,s}$ [kN]	N_{Ed} [kN]
78.500	1.500	52.333	10.854

1.3.2 Combined pullout-concrete cone failure

$N_{Ed} \leq N_{Rd,p} = \dfrac{N_{Rk,p}}{\gamma_{M,p}}$	EN 1992-4, Table 7.1
$N_{Rk,p} = N^0_{Rk,p} \cdot \dfrac{A_{p,N}}{A^0_{p,N}} \cdot \psi_{g,Np} \cdot \psi_{s,Np} \cdot \psi_{re,N} \cdot \psi_{ec1,Np} \cdot \psi_{ec2,Np}$	EN 1992-4, Eq. (7.13)
$N^0_{Rk,p} = \psi_{sus} \cdot \tau_{Rk} \cdot \pi \cdot d \cdot h_{ef}$	EN 1992-4, Eq. (7.14)
$\psi_{sus} = 1$	EN 1992-4, Eq. (7.14a)
$s_{cr,Np} = 7.3 \cdot d \cdot \sqrt{\psi_{sus} \cdot \tau_{Rk}} \leq 3 \cdot h_{ef}$	EN 1992-4, Eq. (7.15)
$\psi_{g,Np} = \psi^0_{g,Np} - \left(\dfrac{s}{s_{cr,Np}}\right)^{0,5} \cdot \left(\psi^0_{g,Np} - 1\right) \geq 1.00$	EN 1992-4, Eq. (7.17)
$\psi^0_{g,Np} = \sqrt{n} - (\sqrt{n} - 1) \cdot \left(\dfrac{\tau_{Rk}}{\tau_{Rk,c}}\right)^{1,5} \geq 1.00$	EN 1992-4, Eq. (7.18)
$\tau_{Rk,c} = \dfrac{k_3}{\pi \cdot d} \cdot \sqrt{h_{ef} \cdot f_{ck}}$	EN 1992-4, Eq. (7.19)
$\psi_{s,Np} = 0.7 + 0.3 \cdot \dfrac{c}{c_{cr,Np}} \leq 1.00$	EN 1992-4, Eq. (7.20)
$\psi_{ec1,Np} = \dfrac{1}{1 + \left(\dfrac{2 \cdot e_{c1,N}}{s_{cr,Np}}\right)} \leq 1.00$	EN 1992-4, Eq. (7.21)
$\psi_{ec2,Np} = \dfrac{1}{1 + \left(\dfrac{2 \cdot e_{c2,N}}{s_{cr,Np}}\right)} \leq 1.00$	EN 1992-4, Eq. (7.21)

$A_{p,N}$ [mm²]	$A^0_{p,N}$ [mm²]	$\tau_{Rk,ucr,20}$ [N/mm²]	$s_{cr,Np}$ [mm]	$c_{cr,Np}$ [mm]	c_{min} [mm]	$f_{c,cyl}$ [N/mm²]
105,600	57,600	18.00	240.0	120.0	300.0	30.00

ψ_c	$\tau_{Rk,cr}$ [N/mm²]	k_3	$\tau_{Rk,c}$ [N/mm²]	$\psi^0_{g,Np}$	$\psi_{g,Np}$
1.041	8.85	7.700	7.50	1.000	1.000

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

ψ^0_{sus}	α_{sus}	ψ_{sus}
0.740	0.000	1.000

$N^0_{Rk,p}$ [kN]	$N_{Rk,p}$ [kN]	$\gamma_{M,p}$	$N_{Rd,p}$ [kN]	N_{Ed} [kN]
35.595	65.248	1.500	43.499	21.704

Group anchor ID
1, 3

1.3.3 Concrete Breakout failure

$N_{Ed} \leq N_{Rd,c} = \frac{N_{Rk,c}}{\gamma_{M,c}}$ EN 1992-4, Table 7.1

$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N}$ EN 1992-4, Eq. (7.1)

$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1,5}$ EN 1992-4, Eq. (7.2)

$A^0_{c,N} = s_{cr,N} \cdot s_{cr,N}$ EN 1992-4, Eq. (7.3)

$\psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leq 1.00$ EN 1992-4, Eq. (7.4)

$\psi_{ec1,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{N,1}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{ec2,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{N,2}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{M,N} = 1$ EN 1992-4, Eq. (7.7)

$A_{c,N}$ [mm²]	$A^0_{c,N}$ [mm²]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	$f_{c,cyl}$ [N/mm²]
105,600	57,600	120.0	240.0	30.00

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

z [mm]	$\psi_{M,N}$	k_1	$N^0_{Rk,c}$ [kN]	$\gamma_{M,c}$	$N_{Rd,c}$ [kN]	N_{Ed} [kN]
206.7	1.000	7.700	30.178	1.500	36.879	21.704

Group anchor ID
1, 3

1.4 Shear load (EN 1992-4, Section 7.2.2)

	Load [kN]	Capacity [kN]	Utilization β_V [%]	Status
Steel failure (without lever arm)*	0.161	37.680	1	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout failure**	0.321	73.766	1	OK
Concrete edge failure in direction x+**	0.560	59.161	1	OK

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

1.4.1 Steel failure (without lever arm)

$V_{Ed} \leq V_{Rd,s} = \frac{V_{Rk,s}}{\gamma_{M,s}}$ EN 1992-4, Table 7.2

$V_{Rk,s} = k_7 \cdot V^0_{Rk,s}$ EN 1992-4, Eq. (7.35)

$V^0_{Rk,s}$ [kN]	k_7	$V_{Rk,s}$ [kN]	$\gamma_{M,s}$	$V_{Rd,s}$ [kN]	V_{Ed} [kN]
47.100	1.000	47.100	1.250	37.680	0.161

1.4.2 Pryout failure (concrete cone relevant)

$V_{Ed} \leq V_{Rd,cp} = \frac{V_{Rk,cp}}{\gamma_{M,c,p}}$ EN 1992-4, Table 7.2

$V_{Rk,cp} = k_8 \cdot \min\{N_{Rk,c}; N_{Rk,p}\}$ EN 1992-4, Eq. (7.39c)

$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N}$ EN 1992-4, Eq. (7.1)

$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1,5}$ EN 1992-4, Eq. (7.2)

$A^0_{c,N} = s_{cr,N} \cdot s_{cr,N}$ EN 1992-4, Eq. (7.3)

$\psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leq 1.00$ EN 1992-4, Eq. (7.4)

$\psi_{ec1,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{V,1}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{ec2,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{V,2}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{M,N} = 1$ EN 1992-4, Eq. (7.7)

$A_{c,N}$ [mm^2]	$A^0_{c,N}$ [mm^2]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	k_8	$f_{c,cyl}$ [N/mm^2]
105,600	57,600	120.0	240.0	2.000	30.00

$e_{c1,V}$ [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]	$\gamma_{M,c,p}$	$V_{Rd,cp}$ [kN]	V_{Ed} [kN]
7.700	30.178	1.500	73.766	0.321

Group anchor ID
2, 4

1.4.3 Concrete edge failure in direction x+

$V_{Ed} \leq V_{Rd,c} = \frac{V_{Rk,c}}{\gamma_{M,c}}$	EN 1992-4, Table 7.2
$V_{Rk,c} = k_T \cdot V^0_{Rk,c} \cdot \frac{A_{c,V}}{A^0_{c,V}} \cdot \psi_{s,V} \cdot \psi_{h,V} \cdot \psi_{\alpha,V} \cdot \psi_{ec,V} \cdot \psi_{re,V}$	EN 1992-4, Eq. (7.40)
$V^0_{Rk,c} = k_9 \cdot d^{\alpha}_{nom} \cdot l^{\beta}_f \cdot \sqrt{f_{ck}} \cdot c_1^{1,5}$	EN 1992-4, Eq. (7.41)
$\alpha = 0.1 \cdot \left(\frac{l_f}{c_1}\right)^{0,5}$	EN 1992-4, Eq. (7.42)
$\beta = 0.1 \cdot \left(\frac{d_{nom}}{c_1}\right)^{0,2}$	EN 1992-4, Eq. (7.43)
$A^0_{c,V} = 4.5 \cdot c_1^2$	EN 1992-4, Eq. (7.44)
$\psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5 \cdot c_1} \leq 1.00$	EN 1992-4, Eq. (7.45)
$\psi_{h,V} = \left(\frac{1.5 \cdot c_1}{h}\right)^{0,5} \geq 1.00$	EN 1992-4, Eq. (7.46)
$\psi_{ec,V} = \frac{1}{1 + \left(\frac{2 \cdot e_V}{3 \cdot c_1}\right)} \leq 1.00$	EN 1992-4, Eq. (7.47)
$\psi_{\alpha,V} = \sqrt{\frac{1}{(\cos \alpha_V)^2 + (0.5 \cdot \sin \alpha_V)^2}} \geq 1.00$	EN 1992-4, Eq. (7.48)

l_f [mm]	d_{nom} [mm]	k_9	α	β	$f_{c,cyl}$ [N/mm^2]
80.0	16.00	1.700	0.047	0.053	30.00

c_1 [mm]	$A_{c,V}$ [mm^2]	$A^0_{c,V}$ [mm^2]
367.0	455,350	606,100

$\psi_{s,V}$	$\psi_{h,V}$	$\psi_{\alpha,V}$	$e_{c,V}$ [mm]	$\psi_{ec,V}$	$\psi_{re,V}$
1.000	1.254	1.000	0.0	1.000	1.000

$V^0_{Rk,c}$ [kN]	k_T	$\gamma_{M,c}$	$V_{Rd,c}$ [kN]	V_{Ed} [kN]
94.175	1.0	1.500	59.161	0.560

1.5 Combined tension and shear loads (EN 1992-4, Section 7.2.3)

Steel failure

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0.207	0.003	2.000	5	OK

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

Concrete failure

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0.589	0.009	1.500	46	OK

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

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 EN 1992-4, Annex A!
- The design is only valid if the clearance hole in the fixture is not larger than the value given in Table 6.1 of EN 1992-4! For larger diameters of the clearance hole see section 6.2.2 of EN 1992-4!
- 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) the minimum concrete cover defined in the design settings is used as the concrete cover of the edge reinforcement.
- 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 5216:2021, 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

www.hilti.co.uk

Company:		Page:	9
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - 1 Mar 2023	Date:	22/03/2023
Fastening Point:			

1.7 Installation data

Baseplate, steel: S 355; E = 210,000.00 N/mm^2; f_{yk} = 355.00 N/mm^2

Profile: U profile, ; (L x W x T x FT) = 470.0 mm x 403.0 mm x 12.0 mm x 12.0 mm

Hole diameter in the fixture: d_f = 18.0 mm

Plate thickness (input): 12.0 mm

Drilling method: SafeSet - automatic cleaning

Cleaning: Automatically performed while drilling

Anchor type and size: HIT-HY 200-A + HAS-U 5.8 HDG M16

Item number: 2223943 HAS-U 5.8 HDG M16x150 (insert) / 2022696 HIT-HY 200-A (mortar)

Maximum installation torque: 80 Nm

Hole diameter in the base material: 18.0 mm

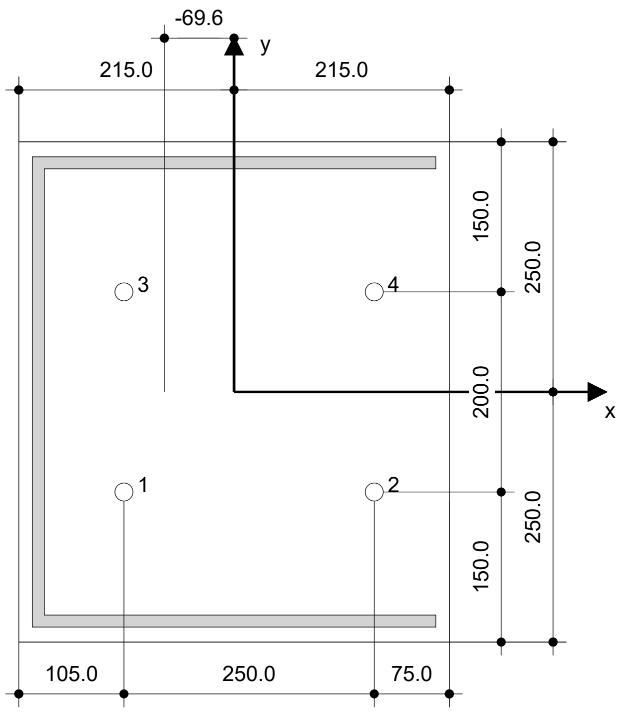
Hole depth in the base material: 80.0 mm

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, Hot dip galvanized, SAFEset - automatic cleaning installation per ETA 11/0493

1.7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit for SAFEset - automatic cleaning (TE-CD / TE-YD) • Vacuum cleaner	• No accessory required	• Dispenser including cassette and mixer • Torque wrench



Coordinates Anchor [mm]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-110.0	-100.0	300.0	617.0	-	-
2	140.0	-100.0	550.0	367.0	-	-
3	-110.0	100.0	300.0	617.0	-	-
4	140.0	100.0	550.0	367.0	-	-

2 Baseplate design

2.1 Input data

Baseplate:	Shape: Rectangular l_x x l_y x t = 430.0 mm x 500.0 mm x 12.0 mm Calculation: CBFEM Material: S 355; F_y = 355.00 N/mm²; ε_{lim} = 5.00%
Anchor type and size:	HIT-HY 200-A + HAS-U 5.8 HDG 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:	EN based design using component-based FEM
Stand-off installation:	e_b = 0.0 mm (No stand-off); t = 12.0 mm
Profile:	Custom; (L x W x T x FT) = 470.0 mm x 403.0 mm x 12.0 mm x 12.0 mm Material: S 235; F_y = 235.00 N/mm²; ε_{lim} = 5.00% Eccentricity x: -69.6 mm Eccentricity y: 0.0 mm
Base material:	Cracked concrete; C30/37; $f_{c,cyl}$ = 30.00 N/mm²; h = 350.0 mm; E = 33,000.00 N/mm²; G = 13,750.00 N/mm²; v = 0.20
Welds (profile to baseplate):	Type of redistribution: Plastic Material: S 235
Mesh size:	Number of elements on edge: 8 Min. size of element: 10.0 mm Max size of element: 50.0 mm

2.2 Summary

	Description	Profile		Baseplate			Welds [%]	Concrete [%]
		σ_{Ed} [N/mm²]	ε_{Pl} [%]	σ_{Ed} [N/mm²]	ε_{Pl} [%]	Hole bearing [%]		
1	Combination 1	29.22	0.00	105.01	0.00	1	17	11

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	9.155 kN	10.854 kN
Anchor 2	0.000 kN	0.628 kN
Anchor 3	9.155 kN	10.850 kN
Anchor 4	0.000 kN	0.627 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

Limit state criteria as per EN1993-1-5 Annex C.8, (1) 2.

Results

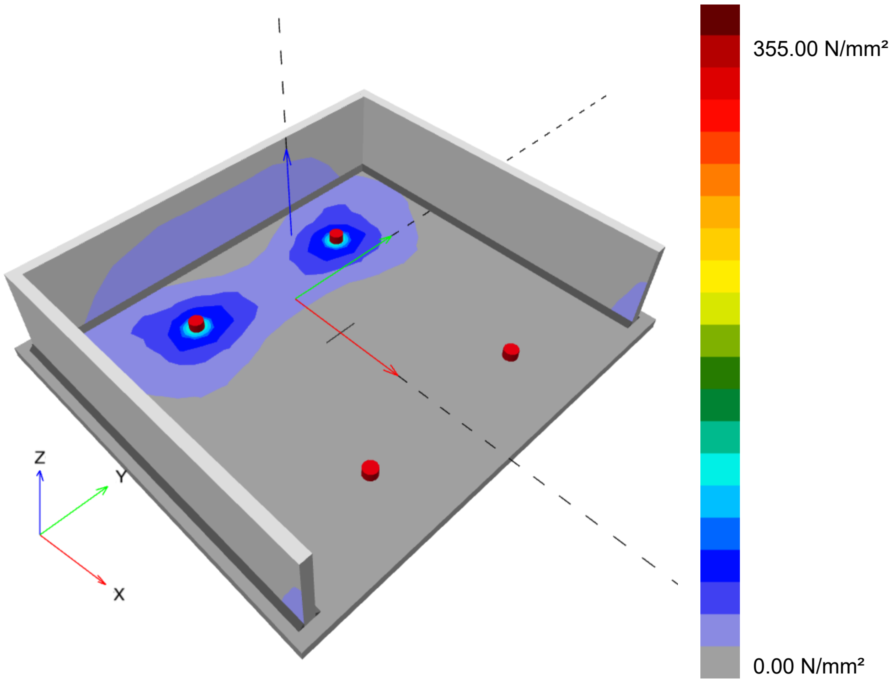
Part	Load combination	Material	σ_{Ed} [N/mm²]	ε_{Pl} [%]	f_y [N/mm²]	γ_{M0}	f_y/γ_{M0} [N/mm²]	ε_{lim} [%]	Status
Plate	Combination 1	S 355	105.01	0.00	355.00	1.00	355.00	5.00	OK

Company:		Page:	11
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - 1 Mar 2023	Date:	22/03/2023
Fastening Point:			

Part	Load combination	Material	σ_{Ed} [N/mm²]	ε_{Pl} [%]	f_y [N/mm²]	γ_{M0}	f_y/γ_{M0} [N/mm²]	ε_{lim} [%]	Status
Profile	Combination 1	S 235	18.64	0.00	235.00	1.00	235.00	5.00	OK
Profile	Combination 1	S 235	18.63	0.00	235.00	1.00	235.00	5.00	OK
Profile	Combination 1	S 235	29.22	0.00	235.00	1.00	235.00	5.00	OK

2.4.1.1 Equivalent stress

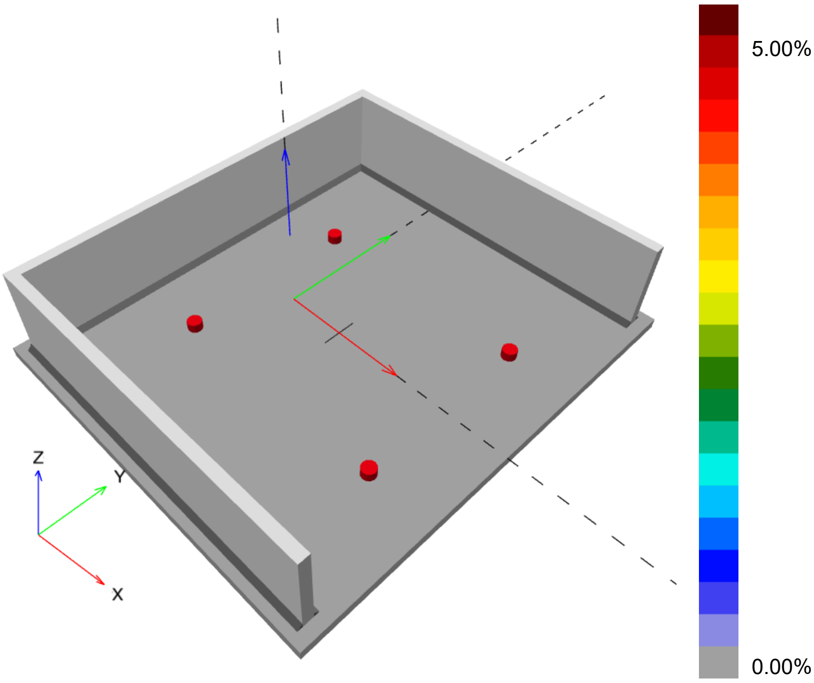
Results below are displayed for the decisive load combination: 1 - Combination 1



Company:		Page:	12
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - 1 Mar 2023	Date:	22/03/2023
Fastening Point:			

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, EN1993-1 - 8 section 3.6.1:

Equations

$$F_{b,Rd} = \frac{k_1 \, a_b \, f_u \, d \, t}{\gamma_{M2}}$$

$$\text{Utilisation} = \frac{V_{Ed}}{F_{b,Rd}}$$

Variables

	k_1	a_b	f_u [N/mm²]	d [mm]	t [mm]	γ_{M2}
Anchor 1	2.50	1.00	490.00	16.0	12.0	1.25
Anchor 2	2.50	1.00	490.00	16.0	12.0	1.25
Anchor 3	2.50	1.00	490.00	16.0	12.0	1.25
Anchor 4	2.50	1.00	490.00	16.0	12.0	1.25

Results

	V_{Ed} [kN]	$F_{b,Rd}$ [kN]	Utilisation [%]	Status
Anchor 1	0.121	188.160	1	OK
Anchor 2	0.161	188.160	1	OK
Anchor 3	0.121	188.160	1	OK
Anchor 4	0.161	188.160	1	OK

www.hilti.co.uk

Company:		Page:	13
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - 1 Mar 2023	Date:	22/03/2023
Fastening Point:			

2.5 Welds

Profiles are modelled without taking the corner radius into account. Special rules for welding (e.g. for cold-formed profiles ...) are not taken into account by the software.

2.5.1 Baseplate to profile

Decisive load combination: 1 - Combination 1

Weld design, EN1993-1-8 section 4.5.3.2

Minimum profile to baseplate weld thickness (a_{min}): 3.0 mm

Minimum baseplate to profile flange thickness (a_{min}): 3.0 mm

Equations

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

$$\sigma_{w,Rd} = \frac{f_u}{\beta_w \gamma_{M2}}$$

$$\sigma_{\perp,Rd} = 0.9 \frac{f_u}{\gamma_{M2}}$$

$$\text{Utilisation} = \max\left(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}\right)$$

Variables

Weld	β_w	f_u [N/mm²]	γ_{M2}
Web	0.80	360.00	1.25
Flange	0.80	360.00	1.25

Edge	a [mm]	L [mm]	ε_{Pl} [%]	$\sigma_\perp$ [N/mm²]	$\tau_{\|\|}$ [N/mm²]	$\tau_\perp$ [N/mm²]
Member 1-bfl 1	◢4.0◣	397.0	0.00	-24.71	-25.05	-18.02
Member 1-bfl	◢4.0◣	397.0	0.00	-11.22	14.70	17.94
Member 1-tfl 1	◢4.0◣	397.0	0.00	-11.21	-14.69	-17.92
Member 1-tfl	◢4.0◣	397.0	0.00	-24.70	25.02	17.99
Member 1-w 1	◢4.0◣	458.0	0.00	11.50	20.06	9.34
Member 1-w	◢4.0◣	458.0	0.00	-7.90	-21.64	5.01

Results

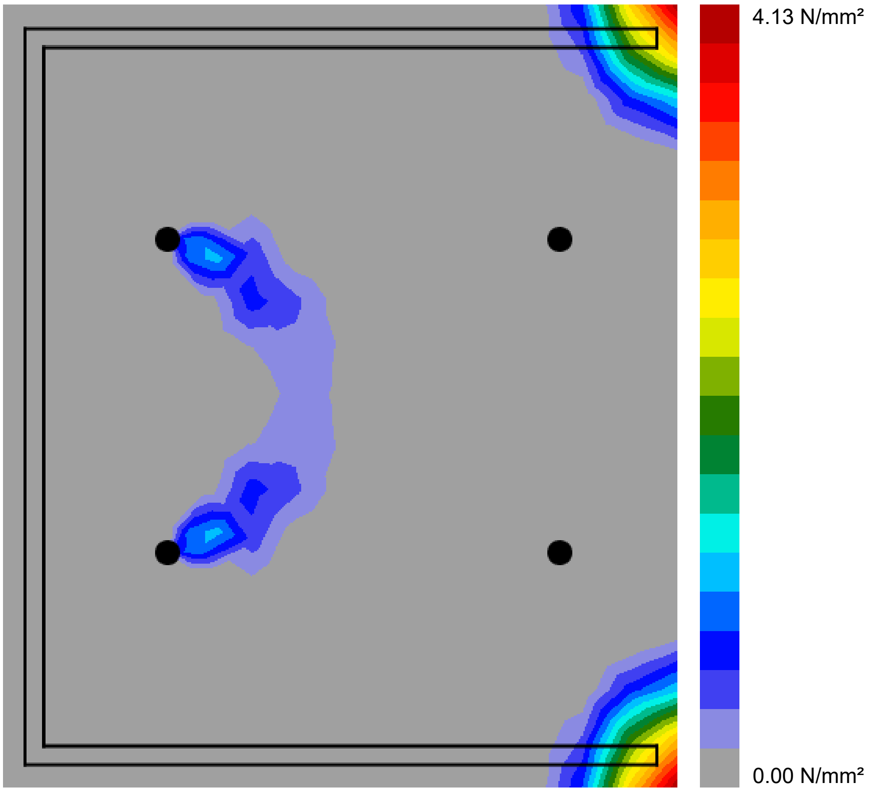
Edge	$\sigma_{w,Ed}$ [N/mm²]	$\sigma_{w,Rd}$ [N/mm²]	$\sigma_{\perp,Rd}$ [N/mm²]	Utilisation [%]	Utilisation_c [%]	Status
Member 1-bfl 1	58.89	360.00	259.20	17	5	OK
Member 1-bfl	41.71	360.00	259.20	12	5	OK
Member 1-tfl 1	41.67	360.00	259.20	12	5	OK
Member 1-tfl	58.82	360.00	259.20	17	5	OK
Member 1-w 1	40.02	360.00	259.20	12	8	OK
Member 1-w	39.28	360.00	259.20	11	6	OK

2.6 Concrete

Decisive load combination: 1 - Combination 1

According to EN1992-1-1 section 6.7(4), 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.

2.6.1 Compression in concrete under the baseplate



2.6.2 Verification of compression in concrete under the baseplate around the profile as per EN1992-1 section 6.7 and EN1993-1-8, section 6.2.5

Equations

$$f_{jd} = \frac{\beta_j \, k_j \, \alpha_{cc} \, f_{ck}}{\gamma_c}$$

$$\sigma = \frac{N}{A_{eff}}$$

$$\text{Utilisation} = \frac{\sigma}{f_{jd}}$$

Variables

N [kN]	A_{eff} [mm²]	β_j	k_j	α_{cc}	f_{ck} [N/mm²]	γ_c
23.306	6,582	0.67	3.00	0.85	30.00	1.50

Results

σ [N/mm²]	f_{jd} [N/mm²]	Utilisation [%]	Status
3.54	34.17	11	OK

2.7 Symbol explanation

a	Throat thickness of weld
a_b	Factor
α_{cc}	Long-term effects on maximum strength of concrete
A_{eff}	Effective area
a_{min}	Minimum weld thickness
β_j	Joint coefficient β_j
β_w	Corelation factor EN 1993-1-8 tab. 4.1
d	Nominal diameter of the bolt
ε_{lim}	Limit plastic strain
ε_{Pl}	Plastic strain from CBFEM results
$F_{b,Rd}$	Plate bearing resistance EN 1993-1-8 tab. 3.4
f_{ck}	Characteristic compressive concrete strength
f_{jd}	The ultimate bearing strength of the concrete block
f_u	Ultimate strength
f_y	Yield strength
γ_c	Service factor - SP 16, Table 41
γ_{M0}	Steel safety factor gamma M0
γ_{M2}	Steel safety factor gamma M2
k_1	Factor for edge distance and bolt spacing perpendicular to the direction of load transfer - EN 1993-1-8 - Table 3.4
k_j	Concentration factor
L	Length of weld
N	Resulting compression force
σ	Average stress in concrete
$\sigma_\perp$	Perpendicular stress
$\sigma_{\perp,Rd}$	Perpendicular stress resistance
σ_{Ed}	Equivalent stress
$\sigma_{w,Ed}$	Equivalent stress
$\sigma_{w,Rd}$	Equivalent stress resistance
t	Thickness of the baseplate
$\tau_\perp$	Shear stress perpendicular to weld axis
$\tau_{\|\|}$	Shear stress parallel to weld axis
$Utilisation_c$	Weld capacity utilisation
V_{Ed}	Anchor shear force

2.8 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.

Company:		Page:	16
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - 1 Mar 2023	Date:	22/03/2023
Fastening Point:			

3 Summary of results

Design of the baseplate, anchor, welds and other elements are based on CBFEM (component based finite element method) and Eurocode regulations.

	Load combination	**Max. utilisation**	**Status**
Anchors	Combination 1	59%	OK
Baseplate	Combination 1	30%	OK
Welds	Combination 1	17%	OK
Concrete	Combination 1	11%	OK
Profile	Combination 1	13%	OK

Fastening meets the design criteria!

4 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
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