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Specifier's comments:

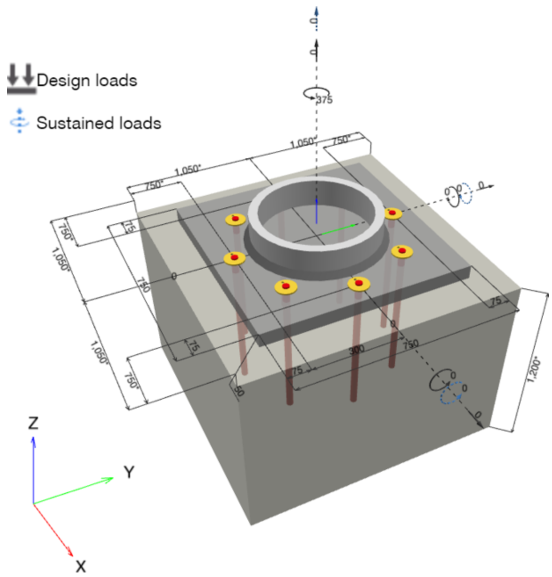
1 Anchor Design

1.1 Input data

Anchor type and size:	**HIT-HY 200-A + HAS-U 8.8 M24**
Return period (service life in years):	50
Item number:	not available (insert) / 2022696 HIT-HY 200-A (mortar)
Gap filling with Hilti Filling Set M24	
Effective embedment depth:	$h_{ef,act}$ = 480.0 mm ($h_{ef,limit}$ = - mm)
Material:	8.8
Approval No.:	ETA 11/0493
Issued I Valid:	10/12/2021 | -
Proof:	SOFA based on EN 1992-4, Chemical
Stand-off installation:	e_b = 0.0 mm (no stand-off); t = 50.0 mm
Baseplate^{CBFEM} :	l_x x l_y x t = 750.0 mm x 750.0 mm x 50.0 mm;
Profile:	Pipe, 457 x 32; (L x W x T) = 457.0 mm x 457.0 mm x 32.0 mm
Base material:	cracked concrete, C40/50, $f_{c,cyl}$ = 40.00 N/mm^2; h = 1,200.0 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)
	with longitudinal edge reinforcement d >= 12.0 [mm]
	Reinforcement to control splitting acc. to EN 1992-4, 7.2.1.7 (2) b) 2) present

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

Geometry [mm] & Loading [kN, kNm]

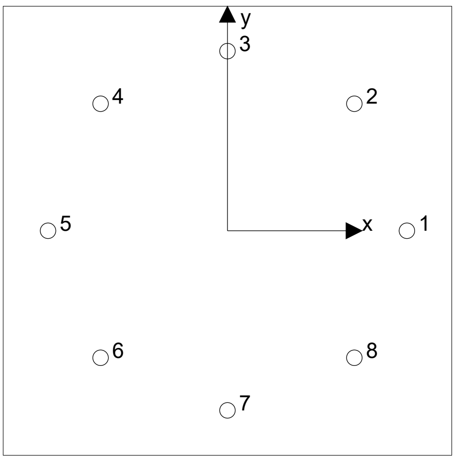


1.1.1 Load combination

Case	Description	Forces [kN] / Moments [kNm]	Seismic	Fire	Max. Util. Anchor [%]
1	Torque - 375kN	$N = 0.000; V_x = 0.000; V_y = 0.000;$ $M_x = 0.000; M_y = 0.000; M_z = 375.000;$ $N_{sus} = 0.000; M_{x,sus} = 0.000; M_{y,sus} = 0.000;$	no	no	233
2	Tension - 250kN	$N = 0.000; V_x = 0.000; V_y = 0.000;$ $M_x = 0.000; M_y = 0.000; M_z = 250.000;$ $N_{sus} = 0.000; M_{x,sus} = 0.000; M_{y,sus} = 0.000;$	no	no	156

1.2 Load case/Resulting anchor forces

Controlling load case: 1 Torque - 375kN



Anchor reactions [kN]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0.197	156.246	0.298	156.245
2	0.264	156.258	-110.308	110.674
3	0.309	156.243	-156.242	0.287
4	0.000	156.254	-110.701	-110.276
5	0.054	156.252	-0.299	-156.251
6	0.588	156.257	110.308	-110.672
7	0.070	156.246	156.246	-0.283
8	0.021	156.254	110.699	110.276

resulting tension force in (x/y)=(0.0/0.0): 0.000 [kN]
resulting compression force in (x/y)=(0.0/0.0): 0.000 [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*	0.588	188.267	1	OK
Combined pullout-concrete cone failure**	1.503	713.612	1	OK
Concrete Breakout failure**	1.503	1,159.232	1	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]
282.400	1.500	188.267	0.588

1.3.2 Combined pullout-concrete cone failure

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

$A_{p,N}$ [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]
1,579,481	552,511	18.00	743.3	371.7	750.0	40.00

ψ_c	$\tau_{Rk,cr}$ [N/mm^2]	k_3	$\tau_{Rk,c}$ [N/mm^2]	$\psi^0_{g,Np}$	$\psi_{g,Np}$
1.072	9.65	7.700	14.15	1.720	1.296

$e_{c1,N}$ [mm]	$\psi_{ec1,Np}$	$e_{c2,N}$ [mm]	$\psi_{ec2,Np}$	$\psi_{s,Np}$	$\psi_{re,Np}$
44.5	0.893	29.4	0.927	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]
349.098	1,070.418	1.500	713.612	1.503

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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)

$\psi_{M,N} = 2.0 - \frac{z}{1.5 \cdot h_{ef}} \geq 1.00$ 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]
3,936,597	2,073,600	720.0	1,440.0	40.00

$e_{c1,N}$ [mm]	$\psi_{ec1,N}$	$e_{c2,N}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$
44.5	0.942	29.4	0.961	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]
16.8	1.977	7.700	512.133	1.500	1,159.232	1.503

Group anchor ID
1-3, 5-8

1.4 Shear load EN 1992-4, Section 7.2.2

	Load [kN]	Capacity [kN]	Utilization β_V [%]	Status
Steel failure (without lever arm)*	156.258	112.960	139	not recommended
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout failure*	156.258	156.118	101	not recommended
Concrete edge failure in direction x-**	533.689	229.141	233	not recommended

* 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]
141.200	1.000	141.200	1.250	112.960	156.258

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)

$A_{c,N}$ [mm²]	$A^0_{c,N}$ [mm²]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	k_8	$f_{c,cyl}$ [N/mm²]
474,085	2,073,600	720.0	1,440.0	2.000	40.00

$e_{c1,V}$ [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	512.133	1.500	156.118	156.258

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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]
288.0	24.00	1.700	0.062	0.050	40.00

c_1 [mm]	$A_{c,V}$ [mm^2]	$A^0_{c,V}$ [mm^2]
750.0	2,362,500	2,531,250

$\psi_{s,V}$	$\psi_{h,V}$	α_V [°]	$\psi_{\alpha,V}$	$e_{c,V}$ [mm]	$\psi_{ec,V}$	$\psi_{re,V}$
0.923	1.000	44.97	1.265	149.9	0.882	1.000

$V^0_{Rk,c}$ [kN]	k_T	$\gamma_{M,c}$	$V_{Rd,c}$ [kN]	V_{Ed} [kN]
357.399	1.0	1.500	229.141	533.689

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
0.001	1.383	2.000	192	not recommended

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

Concrete failure

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0.002	2.329	1.000	195	not recommended

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

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 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 anchor resistances used for this design are ONLY valid if the Seismic set will be installed on the jobsite as per IFU when the Seismic washer was selected.
- 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
- Design is only valid if hole is filled to remove clearance, clearance as per EN 1992-4 Table 6.1
- Load transfer from supplementary reinforcement to the structural member shall be verified by the responsible structural engineer.
- With supplementary reinforcement and post-installed anchors, please ensure that in the jobsite the rebars are not drilled through.
- 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

1.7 Installation data

Baseplate, steel: S 275; E = 210,000.00 N/mm^2; f_{yk} = 275.00 N/mm^2

Profile: Pipe, 457 x 32; (L x W x T) = 457.0 mm x 457.0 mm x 32.0 mm

Hole diameter in the fixture: d_f = 26.0 mm

Plate thickness (input): 50.0 mm

Drilling method: SafeSet - automatic cleaning

Cleaning: Automatically performed while drilling

Anchor type and size: HIT-HY 200-A + HAS-U 8.8 M24

Item number: not available (insert) / 2022696 HIT-HY 200-A (mortar)

Maximum installation torque: 200 Nm

Hole diameter in the base material: 28.0 mm

Hole depth in the base material: 480.0 mm

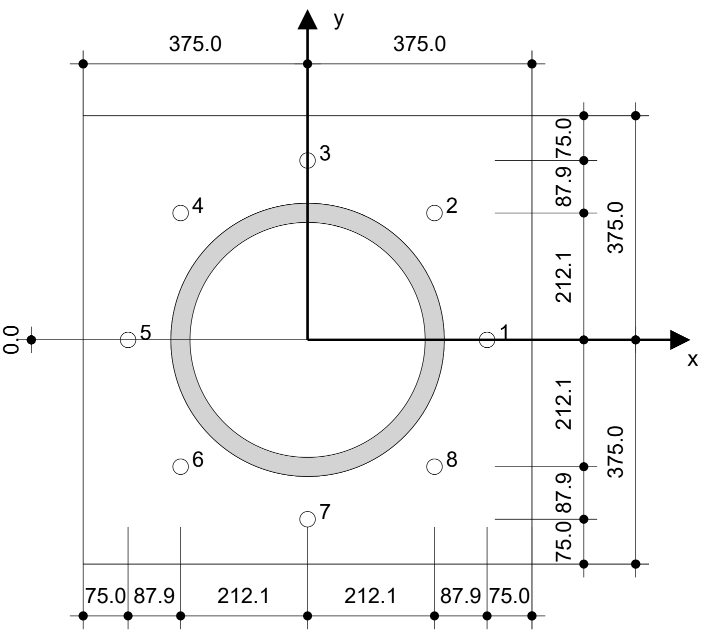
Minimum thickness of the base material: 536.0 mm

Gap filling with Hilti Filling Set M24.0 mm
http://download.hilti.biz/data/techlib/help/IFU_Seismic-Filling-Set.pdf

Hilti HAS-U threaded rod with HIT-HY 200 injection mortar with 480 mm embedment h_ef, M24, Steel galvanized, SAFEset - automatic cleaning installation per ETA 11/0493, with annular gaps filled with Hilti Filling Set or any suitable gap solutions

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 • Hilti Filling Set • Torque wrench



Coordinates Anchor [mm]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	300.0	0.0	1,350.0	750.0	1,050.0	1,050.0
2	212.1	212.1	1,262.1	837.9	1,262.1	837.9
3	0.0	300.0	1,050.0	1,050.0	1,350.0	750.0
4	-212.1	212.1	837.9	1,262.1	1,262.1	837.9

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
5	-300.0	0.0	750.0	1,350.0	1,050.0	1,050.0
6	-212.1	-212.1	837.9	1,262.1	837.9	1,262.1
7	0.0	-300.0	1,050.0	1,050.0	750.0	1,350.0
8	212.1	-212.1	1,262.1	837.9	837.9	1,262.1

2 Baseplate design

2.1 Input data

Baseplate:	Shape: Rectangular l_x x l_y x t = 750.0 mm x 750.0 mm x 50.0 mm Calculation: CBFEM Material: S 275; F_y = 255.00 N/mm²; ε_{lim} = 5.00%
Anchor type and size:	HIT-HY 200-A + HAS-U 8.8 M24, h_{ef} = 480.0 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 = 50.0 mm
Profile:	457 x 32; (L x W x T x FT) = 457.0 mm x 457.0 mm x 32.0 mm x - Material: S 235; F_y = 235.00 N/mm²; ε_{lim} = 5.00% Eccentricity x: 0.0 mm Eccentricity y: 0.0 mm
Base material:	Cracked concrete; C40/50; $f_{c,cyl}$ = 40.00 N/mm²; h = 1,200.0 mm; E = 35,000.00 N/mm²; G = 14,583.33 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	Torque - 375kN	77.12	0.00	110.59	0.00	16	44	1
2	Tension - 250kN	51.42	0.00	73.73	0.00	11	29	1

2.3 Baseplate plate classification

Results below are displayed for the decisive load combinations: Torque - 375kN

Anchor tension forces	Equivalent rigid baseplate (CBFEM)	Component-based Finite Element Method (CBFEM) baseplate
Anchor 1	0.000 kN	0.197 kN
Anchor 2	0.000 kN	0.264 kN
Anchor 3	0.000 kN	0.309 kN
Anchor 4	0.000 kN	0.000 kN
Anchor 5	0.000 kN	0.054 kN
Anchor 6	0.000 kN	0.588 kN
Anchor 7	0.000 kN	0.070 kN
Anchor 8	0.000 kN	0.021 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.

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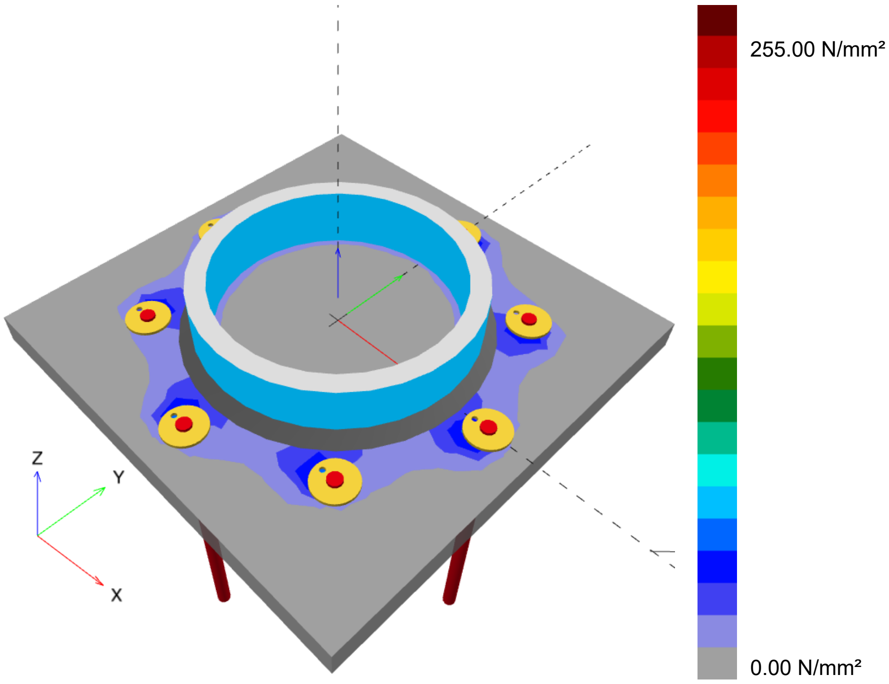
Results

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	Torque - 375kN	S 275	110.59	0.00	255.00	1.00	255.00	5.00	OK
Profile	Torque - 375kN	S 235	77.12	0.00	235.00	1.00	235.00	5.00	OK

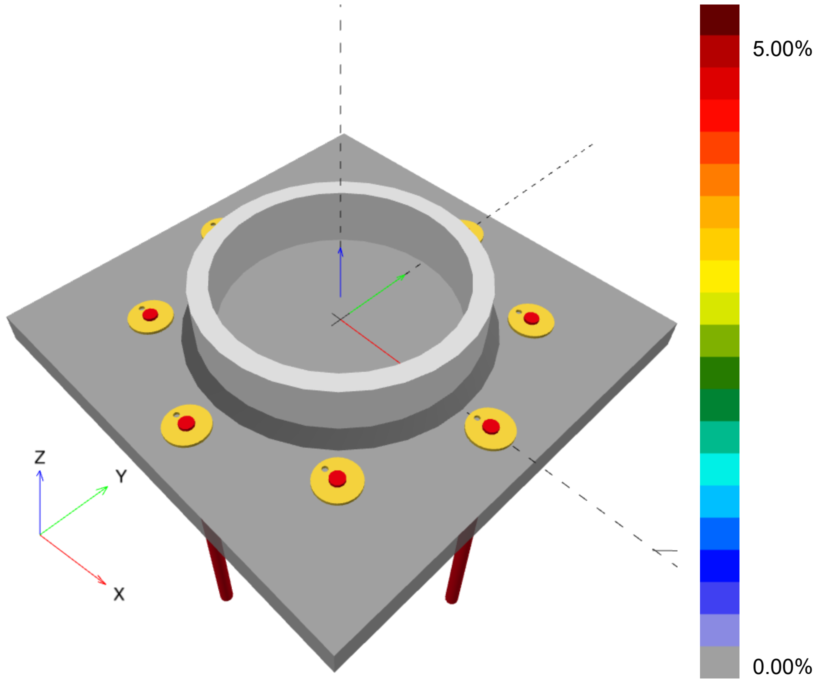
2.4.1.1 Equivalent stress

Results below are displayed for the decisive load combination: 1 - Torque - 375kN



2.4.1.2 Plastic strain

Results below are displayed for the decisive load combination: 1 - Torque - 375kN



2.4.2 Hole bearing

Decisive load combination: 1 - Torque - 375kN

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	410.00	24.0	50.0	1.25
Anchor 2	2.50	1.00	410.00	24.0	50.0	1.25
Anchor 3	2.50	1.00	410.00	24.0	50.0	1.25
Anchor 4	2.50	1.00	410.00	24.0	50.0	1.25
Anchor 5	2.50	1.00	410.00	24.0	50.0	1.25
Anchor 6	2.50	1.00	410.00	24.0	50.0	1.25
Anchor 7	2.50	1.00	410.00	24.0	50.0	1.25
Anchor 8	2.50	1.00	410.00	24.0	50.0	1.25

Results

	V_{Ed} [kN]	$F_{b,Rd}$ [kN]	Utilisation [%]	Status
Anchor 1	156.245	984.000	16	OK
Anchor 2	156.258	984.000	16	OK

	V_{Ed} [kN]	$F_{b,Rd}$ [kN]	Utilisation [%]	Status
Anchor 3	156.242	984.000	16	OK
Anchor 4	156.255	984.000	16	OK
Anchor 5	156.251	984.000	16	OK
Anchor 6	156.257	984.000	16	OK
Anchor 7	156.246	984.000	16	OK
Anchor 8	156.253	984.000	16	OK

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 - Torque - 375kN

Weld design, EN1993-1-8 section 4.5.3.2

Minimum profile to baseplate weld thickness (a_{min}): 6.6 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

Edge	a [mm]	L [mm]	ε_{Pl} [%]	$\sigma_{\perp}$ [N/mm²]	$\tau_{||}$ [N/mm²]	$\tau_{\perp}$ [N/mm²]
Member 1	15.0◣	1,333.0	0.00	1.03	90.40	-0.99

Results

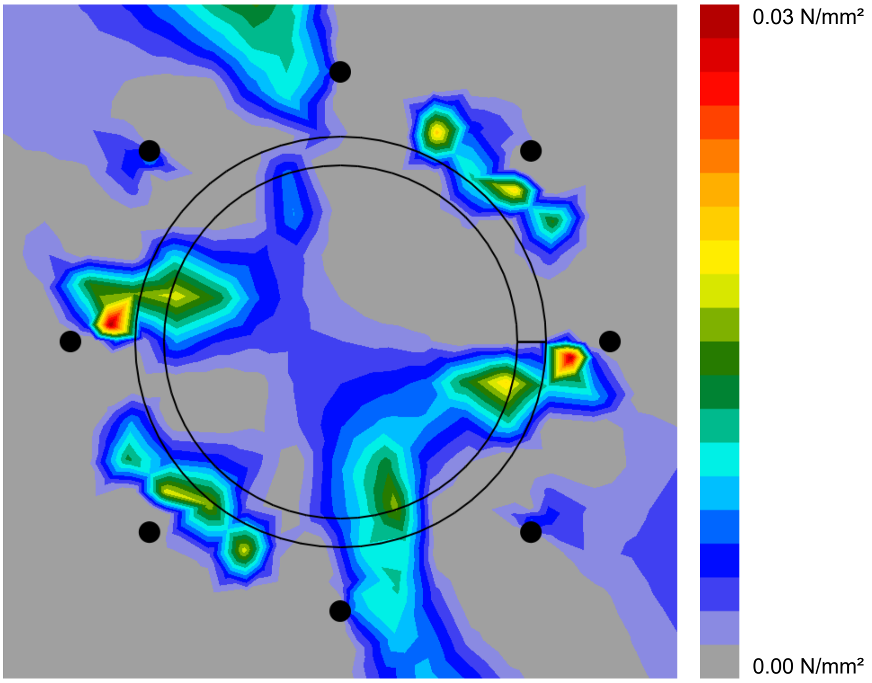
Edge	$\sigma_{w,Ed}$ [N/mm²]	$\sigma_{w,Rd}$ [N/mm²]	$\sigma_{\perp,Rd}$ [N/mm²]	Utilisation [%]	Utilisation_c [%]	Status
Member 1	156.59	360.00	259.20	44	43	OK

2.6 Concrete

Decisive load combination: 1 - Torque - 375kN

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
1.711	106,918	0.67	3.00	0.85	40.00	1.50

Results

σ [N/mm²]	f_{jd} [N/mm²]	Utilisation [%]	Status
0.02	45.56	1	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
$\tau_{\parallel}$	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.

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	Torque - 375kN	233%	NOT OK
Baseplate	Torque - 375kN	44%	OK
Welds	Torque - 375kN	44%	OK
Concrete	Torque - 375kN	1%	OK
Profile	Torque - 375kN	33%	OK

Fastening does not meet the design criteria!

4 Remarks; Your Cooperation Duties

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