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Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - 9 Aug 2023	Date:	09/08/2023
Fastening Point:			

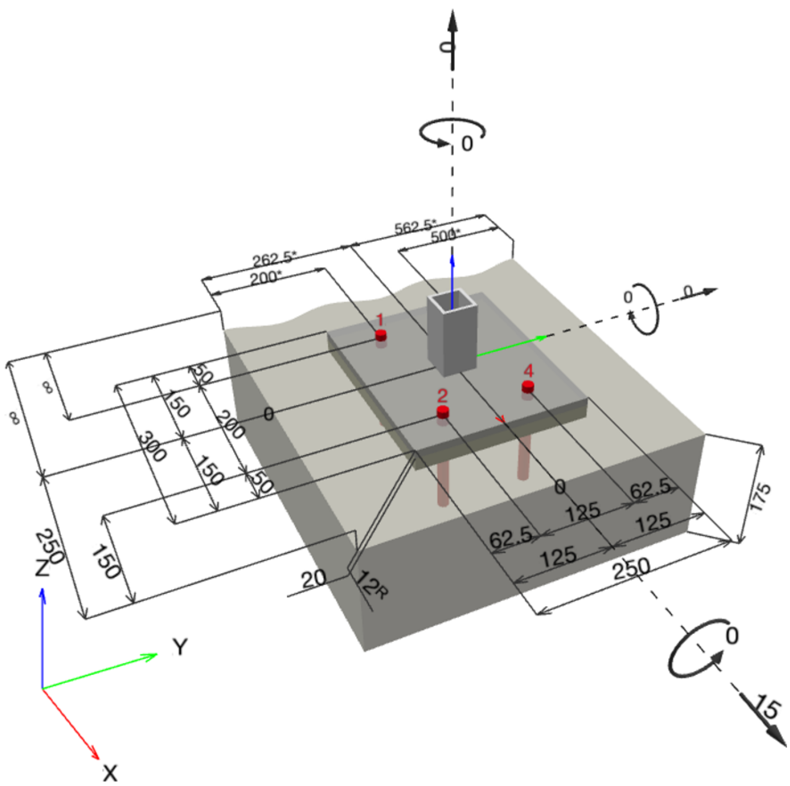
Specifier's comments:

1 Input data

Anchor type and size:	**Headed fastener 5.8 M16**
Effective embedment depth:	h_{ef} = 120.0 mm
Material:	5.8
Approval No.:	-
Issued I Valid:	- | -
Proof:	Design Method EN 1992-4, CastInPlace
Stand-off installation:	without clamping (anchor); restraint level (baseplate): 2.00; e_b = 20.0 mm; t = 12.0 mm
	Hilti Grout: CB-G EG, epoxy, $f_{c,Grout}$ = 120.00 N/mm^2
Baseplate[R] :	l_x x l_y x t = 200.0 mm x 125.0 mm x 12.0 mm; (Recommended plate thickness: not calculated)
Profile:	Square hollow, 50 x 50 x 5,0; (L x W x T) = 50.0 mm x 50.0 mm x 5.0 mm
Base material:	cracked concrete, C20/25, $f_{c,cyl}$ = 20.00 N/mm^2; h = 175.0 mm, User-defined partial material safety factor γ_c = 1.500
Reinforcement:	No reinforcement or Reinforcement spacing >= 150 mm (any Ø) or >= 100 mm (Ø <= 10 mm)
	no longitudinal edge reinforcement

[R] - The anchor calculation is based on a rigid baseplate assumption.

Geometry [mm] & Loading [kN, kNm]



1.1 Load combination

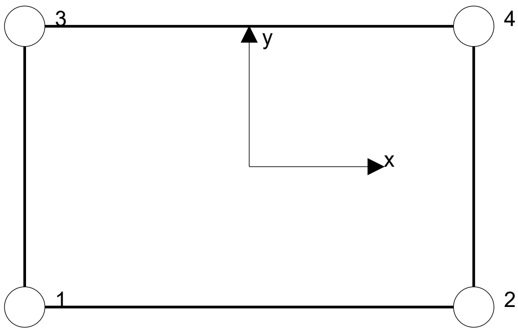
Case	Description	Forces [kN] / Moments [kNm]	Seismic	Fire	Max. Util. Anchor [%]
1	Combination 1	N = 0.000; V_x = 15.000; V_y = 0.000; M_x = 0.000; M_y = 0.000; M_z = 0.000;	no	no	99

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	0.000	3.750	3.750	0.000
2	0.000	3.750	3.750	0.000
3	0.000	3.750	3.750	0.000
4	0.000	3.750	3.750	0.000



max. concrete compressive strain: - [‰]
max. concrete compressive stress: - [N/mm^2]
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 the assumption of a rigid baseplate.
Concrete compression area reduced by the thickness of the grout, per SOFA (Hilti method for anchor design in grouted connections)

3 Tension load EN 1992-4, Section 7.2.1

	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel failure*	N/A	N/A	N/A	N/A
Pull-out failure*	N/A	N/A	N/A	N/A
Concrete Blowout Failure in direction **	N/A	N/A	N/A	N/A
Concrete Breakout failure**	N/A	N/A	N/A	N/A
Splitting failure**	N/A	N/A	N/A	N/A

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

4 Shear load EN 1992-4, Section 7.2.2

	Load [kN]	Capacity [kN]	Utilization β_V [%]	Status
Steel failure (without lever arm)*	3.750	41.821	9	OK
Steel failure (with lever arm)*	3.750	33.457	12	OK
Pryout failure**	15.000	131.447	12	OK
Concrete edge failure in direction x+**	15.000	15.244	99	OK

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

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]
52.276	1.000	52.276	1.250	41.821	3.750

4.2 Steel failure (with lever arm)

$V_{Ed} \leq V^M_{Rd,s} = \frac{V^M_{Rk,s}}{\gamma_{M,s}}$ Hilti Method for anchor design in grouted stand-off connections, Hilti, 2023

$V^M_{Rk,s} = 0.8 \cdot k_7 \cdot V^0_{Rk,s}$

k_7	$V^0_{Rk,s}$ [kN]	$V^M_{Rk,s}$ [kN]	$\gamma_{M,s}$	$V^M_{Rd,s}$ [kN]	V_{Ed} [kN]
1.000	52.276	41.821	1.250	33.457	3.750

4.3 Pryout failure

$V_{Ed} \leq V_{Rd,cp} = \frac{V_{Rk,cp}}{\gamma_{M,c,p}}$	EN 1992-4, Table 7.2
$V_{Rk,cp} = k_8 \cdot N_{Rk,c}$	EN 1992-4, Eq. (7.39a)
$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N}$	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]
257,050	129,600	180.0	360.0	2.000	20.00

$e_{c1,V}$ [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	0.950	1.000	1.000

k_1	$N^0_{Rk,c}$ [kN]	$\gamma_{M,c,p}$	$V_{Rd,cp}$ [kN]	V_{Ed} [kN]
8.900	52.321	1.500	131.447	15.000

Group anchor ID
1-4

4.4 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

$$V_{Rk,c} = k_T \cdot \psi_{b,g} \cdot V^0_{Rk,c} \cdot \frac{A_{c,V}}{A^0_{c,V}} \cdot \psi_{s,V} \cdot \psi_{h,V} \cdot \psi_{\alpha,V} \cdot \psi_{ec,V} \cdot \psi_{re,V}$$ EN 1992-4, Eq. (7.40)

$$\psi_{b,g} = \frac{1}{\alpha_{b,g}} = \frac{1}{1+\frac{C\, t_g}{d^{\frac{3}{4}}}}$$ Hilti Method for anchor design in grouted stand-off connections, Hilti, 2023

$$V^0_{Rk,c} = k_9 \cdot d_{nom}^{\alpha} \cdot l_f^{\beta} \cdot \sqrt{f_{ck}} \cdot c_1^{1,5}$$ 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]
120.0	16.00	1.700	0.089	0.064	20.00

$\psi_{b,g}$	C [$\frac{1}{mm^4}$]	d [mm]	t_g [mm]
0.903	0.043	16.0	20.0

c_1 [mm]	$A_{c,V}$ [mm^2]	$A^0_{c,V}$ [mm^2]
150.0	96,250	101,250

$\psi_{s,V}$	$\psi_{h,V}$	α_V [°]	$\psi_{\alpha,V}$	$e_{c,V}$ [mm]	$\psi_{ec,V}$	$\psi_{re,V}$
0.967	1.134	0.00	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]
24.305	1.0	1.500	15.244	15.000

5 Displacements (highest loaded anchor)

Short term loading:

N_{Sk}	=	0.000 [kN]	δ_N	=	- [mm]
V_{Sk}	=	2.778 [kN]	δ_V	=	- [mm]
			δ_{NV}	=	- [mm]

Long term loading:

N_{Sk}	=	0.000 [kN]	δ_N	=	- [mm]
V_{Sk}	=	2.778 [kN]	δ_V	=	- [mm]
			δ_{NV}	=	- [mm]

Comments: Tension displacements are valid with half of the required installation torque moment for uncracked concrete! Shear displacements are valid without friction between the concrete and the baseplate! The gap due to the drilled hole and clearance hole tolerances are not included in this calculation!

The acceptable anchor displacements depend on the fastened construction and must be defined by the designer!

6 Warnings

- The anchor design methods in PROFIS Engineering require rigid baseplates per current regulations (AS 5216:2021, 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 baseplate 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.
- The steel failure (with lever arm) verification is performed according to EN 1992-4, section 7.2.2.3.1 (3)
- The grout has to be applied on roughened concrete surface according to EN 1992-1-1, section 6.2.5
- The grout cylinder compression strength has to be larger than or equal to the maximum of the concrete cylinder compression strength and 30 N/mm²
- The designed fasteners should respect the product design conditions and recommendations by the manufacturer and in EN 1992-4, section F.3, such as welding procedures, installation, max. size of fixing, etc.
- Please ensure that the fastening system is statically indetermined
- The characteristic bond resistances depend on the return period (service life in years): 50

Fastening meets the design criteria!

7 Installation data

Baseplate, steel: S 235; E = 210,000.00 N/mm^2; f_{yk} = 235.00 N/mm^2
Profile: Square hollow, 50 x 50 x 5,0; (L x W x T) = 50.0 mm x 50.0 mm x 5.0 mm
Hole diameter in the fixture: d_f = 18.0 mm
Plate thickness (input): 12.0 mm
Recommended plate thickness: not calculated

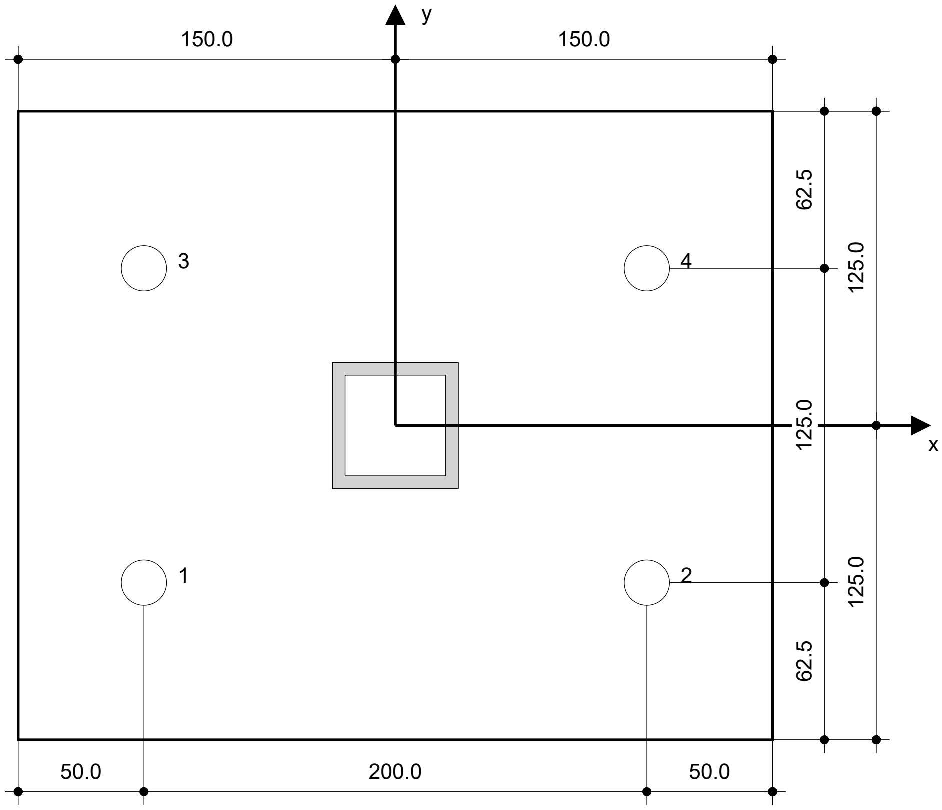
Anchor type and size: Headed fastener 5.8 M16
Item number: not available

Minimum thickness of the base material: 0.0 mm

Hilti Headed fastener headed stud anchor with 120 mm embedment, M16, Steel galvanized, installation per -

7.1 Recommended accessories

Drilling	Cleaning	Setting
• -	• No accessory required	• -



Coordinates Anchor [mm]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-100.0	-62.5	-	350.0	200.0	625.0
2	100.0	-62.5	-	150.0	200.0	625.0
3	-100.0	62.5	-	350.0	325.0	500.0
4	100.0	62.5	-	150.0	325.0	500.0

8 Remarks; Your Cooperation Duties

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