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Specifier's comments:

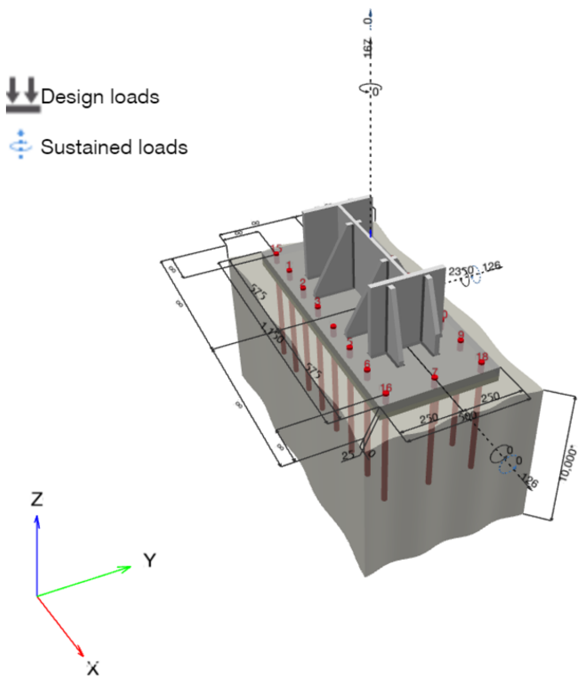
1 Anchor Design

1.1 Input data

Anchor type and diameter:	**HIT-RE 500 V3 + HAS-U 5.8 M24**
Item number:	not available (element) / 2123406 HIT-RE 500 V3 (adhesive)
Effective embedment depth:	$h_{ef,act}$ = 480.0 mm ($h_{ef,limit}$ = - mm)
Material:	5.8
Evaluation Service Report:	ESR-3814
Issued I Valid:	1/3/2021 | 1/1/2023
Proof:	Design Method ACI 318-11 / Chem
Stand-off installation:	without clamping (anchor); restraint level (anchor plate): 2.00; e_b = 25.0 mm; t = 40.0 mm
	Hilti Grout: , precision, $f_{c,Grout}$ = 30.00 N/mm^2
Anchor plate[CBFEM] :	l_x x l_y x t = 1,150.0 mm x 500.0 mm x 40.0 mm;
Profile:	Advance UKB, 610 x 305 x 179; (L x W x T x FT) = 620.2 mm x 307.1 mm x 14.1 mm x 23.6 mm
Base material:	cracked concrete, C45/55, f_c' = 6,527 psi; h = 10,000.0 mm, Temp. short/long: 30/30 °C
Installation:	**automatic cleaned drilled hole, Installation condition: Dry**
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present
	edge reinforcement: none or < No. 4 bar

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 Design results

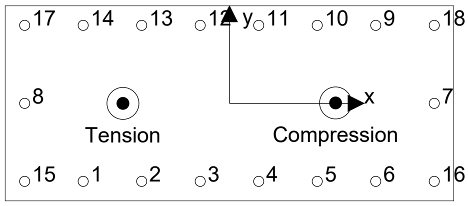
Case	Description	Forces [kN] / Moments [kNm]	Seismic	Max. Util. Anchor [%]
1	Combination 1	$N = 167.000$; $V_x = 126.000$; $V_y = 126.000$; $M_x = 0.000$; $M_y = 235.000$; $M_z = 0.000$; $N_{sus} = 0.000$; $M_{x,sus} = 0.000$; $M_{y,sus} = 0.000$;	no	272

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	67.209	10.453	7.294	7.487
2	72.644	10.600	7.001	7.959
3	40.143	10.241	6.828	7.632
4	14.403	10.022	6.857	7.309
5	-0.003	9.977	6.857	7.247
6	-0.004	9.725	6.819	6.934
7	-0.003	9.973	7.422	6.662
8	60.712	9.704	7.040	6.679
9	-0.004	10.339	7.386	7.234
10	-0.003	10.145	7.094	7.252
11	14.015	9.888	6.927	7.056
12	39.511	9.543	6.760	6.737
13	72.211	9.430	6.740	6.595
14	67.830	9.457	6.717	6.657
15	15.875	10.008	7.346	6.797
16	2.744	9.351	6.774	6.446
17	16.298	9.272	6.636	6.475
18	2.911	10.153	7.501	6.843



resulting tension force in (x/y)=(-273.1/-0.1): 486.490 [kN]
resulting compression force in (x/y)=(272.0/1.1): 322.757 [kN]

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

1.3 Tension load

	Load N_{ua} [kN]	Capacity ϕ N_n [kN]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	72.644	114.725	64	OK
Bond Strength**	486.506	631.152	78	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	486.506	603.060	81	OK

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

1.3.1 Steel Strength

N_{sa} = ESR value — refer to ICC-ES ESR-3814

$\phi\ N_{sa} \geq N_{ua}$ — ACI 318-11 Table D.4.1.1

Variables

$A_{se,N}$ [mm^2]	f_{uta} [N/mm^2]
353	500.00

Calculations

N_{sa} [kN]
176.500

Results

N_{sa} [kN]	ϕ_{steel}	$\phi\ N_{sa}$ [kN]	N_{ua} [kN]
176.500	0.650	114.725	72.644

1.3.2 Bond Strength

$N_{ag} = \left(\frac{A_{Na}}{A_{Na0}}\right) \psi_{ec1,Na}\ \psi_{ec2,Na}\ \psi_{ed,Na}\ \psi_{cp,Na}\ N_{ba}$ — ACI 318-11 Eq. (D-19)

$\phi\ N_{ag} \geq N_{ua}$ — ACI 318-11 Table D.4.1.1

A_{Na} see ACI 318-11, Part D.5.5.1, Fig. RD.5.5.1(b)

$A_{Na0} = (2\ c_{Na})^2$ — ACI 318-11 Eq. (D-20)

$c_{Na} = 10\ d_a \sqrt{\frac{\tau_{uncr}}{1100}}$ — ACI 318-11 Eq. (D-21)

$\psi_{ec,Na} = \left(\frac{1}{1 + \frac{e_N}{c_{Na}}}\right) \leq 1.0$ — ACI 318-11 Eq. (D-23)

$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}}\right) \leq 1.0$ — ACI 318-11 Eq. (D-25)

$\psi_{cp,Na} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}}\right) \leq 1.0$ — ACI 318-11 Eq. (D-27)

$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \pi \cdot d_a \cdot h_{ef}$ — ACI 318-11 Eq. (D-22)

Variables

$\tau_{k,c,uncr}$ [N/mm^2]	d_a [mm]	h_{ef} [mm]	$c_{a,min}$ [mm]	$\alpha_{overhead}$	$\tau_{k,c}$ [N/mm^2]
17.54	24.0	480.0	∞	1.000	9.82

$e_{c1,N}$ [mm]	$e_{c2,N}$ [mm]	c_{ac} [mm]	λ_a
140.4	0.1	920.0	1.000

Calculations

c_{Na} [mm]	A_{Na} [mm^2]	A_{Na0} [mm^2]	$\psi_{ed,Na}$
363.3	2,001,803	528,090	1.000

$\psi_{ec1,Na}$	$\psi_{ec2,Na}$	$\psi_{cp,Na}$	N_{ba} [kN]
0.721	1.000	1.000	355.250

Results

N_{ag} [kN]	ϕ_{bond}	$\phi\ N_{ag}$ [kN]	N_{ua} [kN]
971.002	0.650	631.152	486.506

1.3.3 Concrete Breakout Failure

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$	ACI 318-11 Eq. (D-4)
$\phi\ N_{cbg} \geq N_{ua}$	ACI 318-11 Table D.4.1.1
$A_{Nc0} = 9\ h_{ef}^2$	ACI 318-11 Eq. (D-5)
$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$	ACI 318-11 Eq. (D-8)
$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$	ACI 318-11 Eq. (D-10)
$\psi_{cp,N} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$	ACI 318-11 Eq. (D-12)
$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$	ACI 318-11 Eq. (D-6)

Variables

h_{ef} [mm]	$e_{c1,N}$ [mm]	$e_{c2,N}$ [mm]	$c_{a,min}$ [mm]	$\psi_{c,N}$
480.0	140.4	0.1	∞	1.000

c_{ac} [mm]	k_c	λ_a	f'_c [psi]
920.0	17	1.000	6,527

Calculations

A_{Nc} [mm^2]	A_{Nc0} [mm^2]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [kN]
4,581,600	2,073,600	0.837	1.000	1.000	1.000	501.872

Results

N_{cbg} [kN]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [kN]	N_{ua} [kN]
927.784	0.650	603.060	486.506

1.4 Shear load

	Load V_{ua} [kN]	Capacity ϕ V_n [kN]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	10.600	50.880	21	OK
Steel failure (with lever arm)*	10.600	4.332	245	not recommended
Pryout Strength (Concrete Breakout Strength controls)**	178.191	1,552.435	12	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 Strength

V_{sa} = ESR value refer to ICC-ES ESR-3814

ϕ $V_{steel} \geq V_{ua}$ ACI 318-11 Table D.4.1.1

Variables

$A_{se,V}$ [mm^2]	f_{uta} [N/mm^2]
353	500.00

Calculations

V_{sa} [kN]
106.000

Results

V_{sa} [kN]	ϕ $_{steel}$	ϕ_{eb}	ϕ V_{sa} [kN]	V_{ua} [kN]
106.000	0.600	0.800	50.880	10.600

1.4.2 Steel failure (with lever arm)

V_s^M	$= \frac{\alpha_M \cdot M_s}{L_b}$	bending equation for stand-off
M_s	$= M_s^0 \left(1 - \frac{N_{ua}}{\phi N_{sa}}\right)$	resultant flexural resistance of anchor
M_s^0	$= (1.2)\,(S)\,(f_{u,min})$	characteristic flexural resistance of anchor
$\left(1 - \frac{N_{ua}}{\phi N_{sa}}\right)$		reduction for tensile force acting simultaneously with a shear force on the anchor
S	$= \frac{\pi(d)^3}{32}$	elastic section modulus of anchor bolt at concrete surface
L_b	$= z + (n)(d_0)$	internal lever arm adjusted for spalling of the surface concrete
ϕV_s^M	$\geq V_{ua}$	ACI 318-11 Table D.4.1.1

Variables

α_M	$f_{u,min}$ [N/mm^2]	N_{ua} [kN]	ϕN_{sa} [kN]	z [mm]	n	d_0 [mm]
2.00	500.00	72.644	114.725	45.0	0.500	24.0

Calculations

M_s^0 [kNm]	$\left(1 - \frac{N_{ua}}{\phi N_{sa}}\right)$	M_s [kNm]	L_b [mm]
0.561	0.367	0.206	57.0

Results

V_s^M [kN]	ϕ_{steel}	ϕV_s^M [kN]	V_{ua} [kN]
7.220	0.600	4.332	10.600

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1.4.3 Pryout Strength (Concrete Breakout Strength controls)

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b \right]$ ACI 318-11 Eq. (D-41)

$\phi\ V_{cpg} \geq V_{ua}$ ACI 318-11 Table D.4.1.1

A_{Nc} see ACI 318-11, Part D.5.2.1, Fig. RD.5.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ ACI 318-11 Eq. (D-5)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e_N'}{3\ h_{ef}}} \right) \leq 1.0$ ACI 318-11 Eq. (D-8)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ ACI 318-11 Eq. (D-10)

$\psi_{cp,N} = \mathrm{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-11 Eq. (D-12)

$N_b = k_c\ \lambda_a \sqrt{f_c'}\ h_{ef}^{1.5}$ ACI 318-11 Eq. (D-6)

Variables

k_{cp}	h_{ef} [mm]	$e_{c1,N}$ [mm]	$e_{c2,N}$ [mm]	$c_{a,min}$ [mm]
2	480.0	0.0	0.0	∞

$\psi_{c,N}$	c_{ac} [mm]	k_c	λ_a	f_c' [psi]
1.000	920.0	17	1.000	6,527

Calculations

A_{Nc} [mm^2]	A_{Nc0} [mm^2]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [kN]
4,581,600	2,073,600	1.000	1.000	1.000	1.000	501.872

Results

V_{cpg} [kN]	$\phi_{concrete}$	$\phi\ V_{cpg}$ [kN]	V_{ua} [kN]
2,217.765	0.700	1,552.435	178.191

1.5 Combined tension and shear loads

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.807	2.447	1.000	272	not recommended

$\beta_{NV} = (\beta_N + \beta_V) / 1.2 <= 1$

1.6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates 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 anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate 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!
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- ACI 318 does not specifically address anchor bending when a stand-off condition exists. PROFIS Engineering calculates a shear load corresponding to anchor bending when stand-off exists and includes the results as a shear Design Strength!
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://submittals.us.hilti.com/PROFISAnchorDesignGuide/
- Attention! In case of compressive anchor forces a buckling check as well as the proof of the local load transfer into and within the base material (incl. punching) has to be done separately.
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-11, Part D.9.1
- The anchor design methods in PROFIS Engineering require rigid anchor plates, as per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means that the anchor plate should be sufficiently rigid to prevent load re-distribution to the anchors due to elastic/plastic displacements. The user accepts that the anchor plate is considered close to rigid by engineering judgment."

1.7 Installation data

Profile: Advance UKB, 610 x 305 x 179; (L x W x T x FT) = 620.2 mm x 307.1 mm x 14.1 mm x 23.6 mm

Hole diameter in the fixture: d_f = 26.0 mm

Plate thickness (input): 40.0 mm

Drilling method: SafeSet - automatic cleaning

Cleaning: Automatically performed while drilling

Anchor type and diameter: HIT-RE 500 V3 + HAS-U 5.8 M24

Item number: not available (element) / 2123406 HIT-RE 500 V3 (adhesive)

Maximum installation torque: 200 Nm

Hole diameter in the base material: 28.0 mm

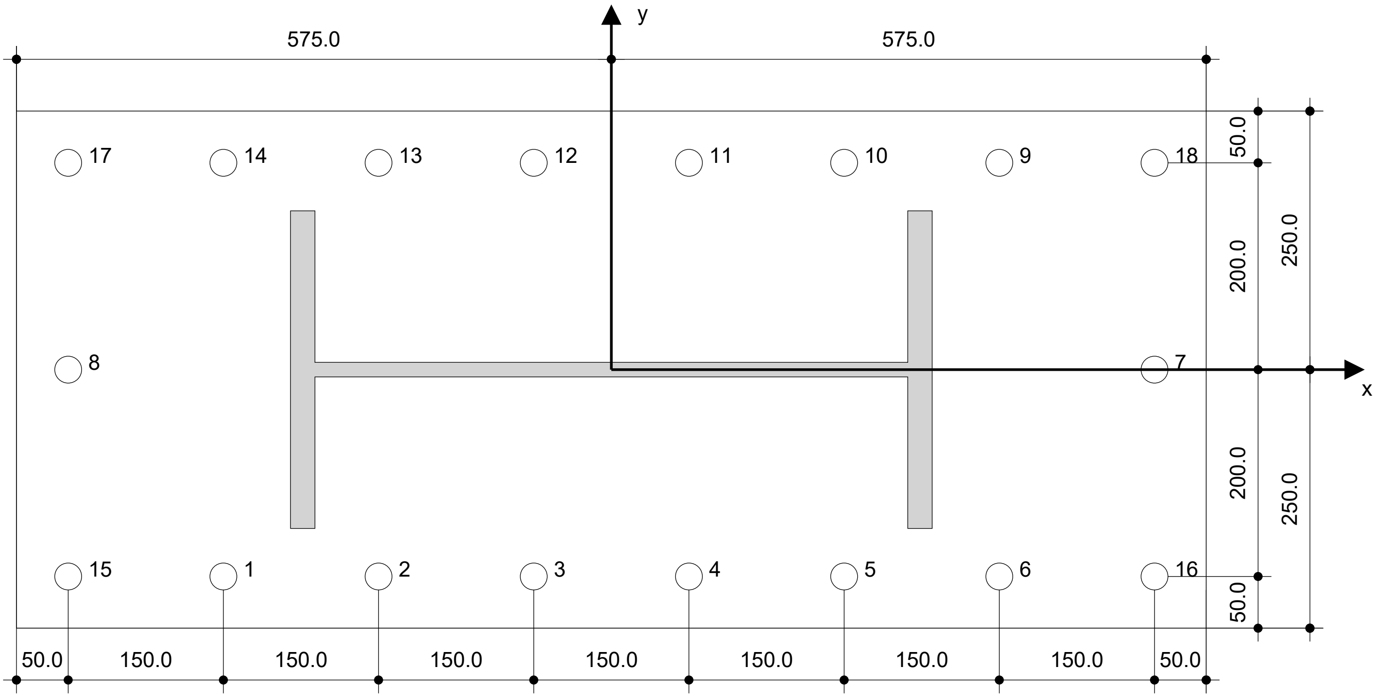
Hole depth in the base material: 480.0 mm

Minimum thickness of the base material: 536.0 mm

Hilti HAS-U threaded rod with HIT-RE 500 V3 injection mortar with 480 mm embedment h_ef, M24, Steel galvanized, SAFEset - automatic cleaning installation per ESR-3814

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	-375.0	-200.0	-	-	-	-
2	-225.0	-200.0	-	-	-	-
3	-75.0	-200.0	-	-	-	-
4	75.0	-200.0	-	-	-	-
5	225.0	-200.0	-	-	-	-
6	375.0	-200.0	-	-	-	-
7	525.0	0.0	-	-	-	-
8	-525.0	0.0	-	-	-	-
9	375.0	200.0	-	-	-	-
10	225.0	200.0	-	-	-	-
11	75.0	200.0	-	-	-	-
12	-75.0	200.0	-	-	-	-
13	-225.0	200.0	-	-	-	-
14	-375.0	200.0	-	-	-	-
15	-525.0	-200.0	-	-	-	-
16	525.0	-200.0	-	-	-	-
17	-525.0	200.0	-	-	-	-
18	525.0	200.0	-	-	-	-

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2 Anchor plate design

2.1 Input data

Anchor plate:	Shape: Rectangular l_x x l_y x t = 1,150.0 mm x 500.0 mm x 40.0 mm Calculation: CBFEM Material: ASTM A36; F_y = 248.21 N/mm²; ε_{lim} = 5.00%
Anchor type and size:	HIT-RE 500 V3 + HAS-U 5.8 M24, h_{ef} = 480.0 mm
Anchor stiffness:	The anchor is modeled 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:	AISC and LRFD-based design using component-based FEM
Stand-off installation:	e_b = 25.0 mm (Stand-off with grouting); t = 40.0 mm
Profile:	610 x 305 x 179; (L x W x T x FT) = 620.2 mm x 307.1 mm x 14.1 mm x 23.6 mm Material: ASTM A36; F_y = 248.21 N/mm²; ε_{lim} = 5.00% Eccentricity x: 0.0 mm Eccentricity y: 0.0 mm
Base material:	Cracked concrete; C45/55; $f_{c,cyl}$ = 45.00 N/mm²; h = 10,000.0 mm
Welds (profile to anchor plate):	Type of redistribution: Plastic Material: E70xx
Stiffeners:	Material: ASTM A36; F_y = 248.21 N/mm²; ε_{lim} = 5.00%
Welds (stiffeners to profile/anchor plate):	Type of redistribution: Plastic Material: E70xx
Mesh size:	Number of elements on edge: 8 Min. size of element: 10.0 mm Max. size of element: 50.0 mm

2.1.1 Custom stiffeners

	Profile side	Position [mm]	Height [mm]	Thickness [mm]	Width [mm]	Horizontal edge length [mm]	Vertical edge length [mm]
Stiffener 1	Flange - outer (F1)	80.0	300.0	20.0	100.0	25.0	100.0
Stiffener 2	Flange - outer (F7)	80.0	300.0	20.0	100.0	25.0	100.0
Stiffener 3	Flange - outer (F1)	230.0	300.0	20.0	100.0	25.0	25.0
Stiffener 4	Flange - outer (F7)	230.0	300.0	20.0	100.0	25.0	25.0
Stiffener 5	Web - side (W1)	135.0	300.0	20.0	175.0	25.0	25.0
Stiffener 6	Web - side (W1)	435.0	300.0	20.0	175.0	25.0	25.0
Stiffener 7	Web - side (W2)	135.0	300.0	20.0	175.0	25.0	25.0
Stiffener 8	Web - side (W2)	435.0	300.0	20.0	175.0	25.0	25.0

2.2 Summary

	Description	Profile		Stiffeners		Anchor plate			Welds [%]	Concrete [%]
		σ_{Ed} [N/mm²]	ε_{Pl} [%]	σ_{Ed} [N/mm²]	ε_{Pl} [%]	σ_{Ed} [N/mm²]	ε_{Pl} [%]	Hole bearing [%]		
1	Combination 1	198.34	0.00	144.19	0.00	95.42	0.00	2	78	3

2.3 Anchor plate classification

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

Anchor tension forces	Equivalent rigid anchor plate (CBFEM)	Component-based Finite Element Method (CBFEM) anchor plate design
Anchor 1	43.252 kN	67.209 kN
Anchor 2	34.912 kN	72.644 kN
Anchor 3	26.570 kN	40.143 kN
Anchor 4	18.228 kN	14.403 kN
Anchor 5	0.000 kN	-0.003 kN
Anchor 6	-0.003 kN	-0.004 kN
Anchor 7	-0.006 kN	-0.003 kN
Anchor 8	51.606 kN	60.712 kN
Anchor 9	-0.003 kN	-0.004 kN
Anchor 10	0.000 kN	-0.003 kN
Anchor 11	18.258 kN	14.015 kN
Anchor 12	26.600 kN	39.511 kN
Anchor 13	34.942 kN	72.211 kN
Anchor 14	43.282 kN	67.830 kN
Anchor 15	51.589 kN	15.875 kN
Anchor 16	-0.006 kN	2.744 kN
Anchor 17	51.619 kN	16.298 kN
Anchor 18	-0.006 kN	2.911 kN

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

2.4 Profile/Stiffeners/Plate

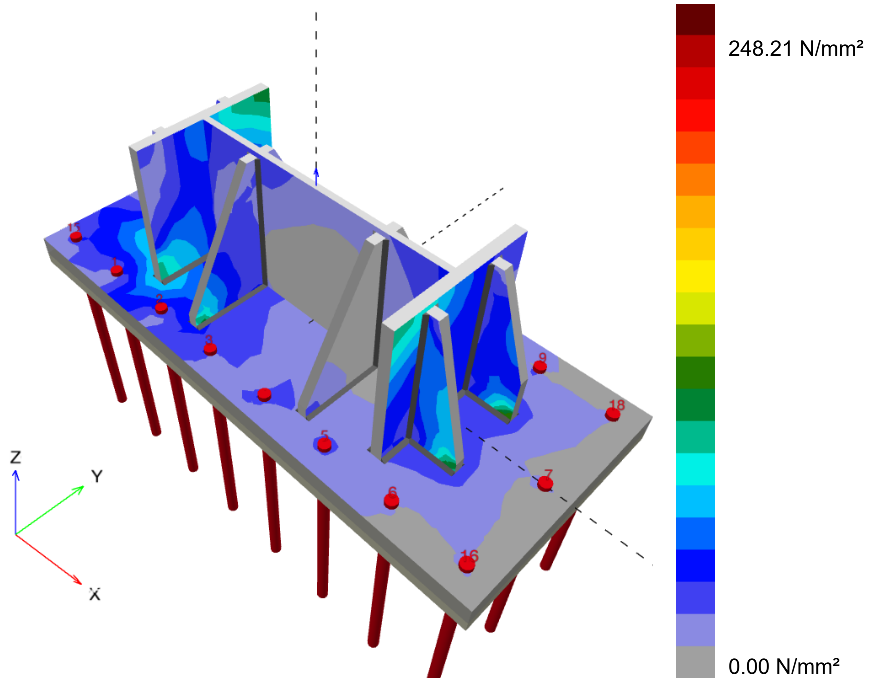
Profile and stiffeners are verified at the level of the steel to concrete connection. The connection design does not replace the steel design for critical cross sections, which should be performed outside of PROFIS Engineering.

2.4.1 Equivalent stress and plastic strain

Part	Load combination	Material	f_y [N/mm²]	ε_{lim} [%]	σ_{Ed} [N/mm²]	ε_{Pl} [%]	Status
Plate	Combination 1	ASTM A36	248.21	5.00	95.42	0.00	OK
Profile	Combination 1	ASTM A36	248.21	5.00	184.68	0.00	OK
Profile	Combination 1	ASTM A36	248.21	5.00	198.34	0.00	OK
Profile	Combination 1	ASTM A36	248.21	5.00	45.76	0.00	OK
Stiffener	Combination 1	ASTM A36	248.21	5.00	144.19	0.00	OK

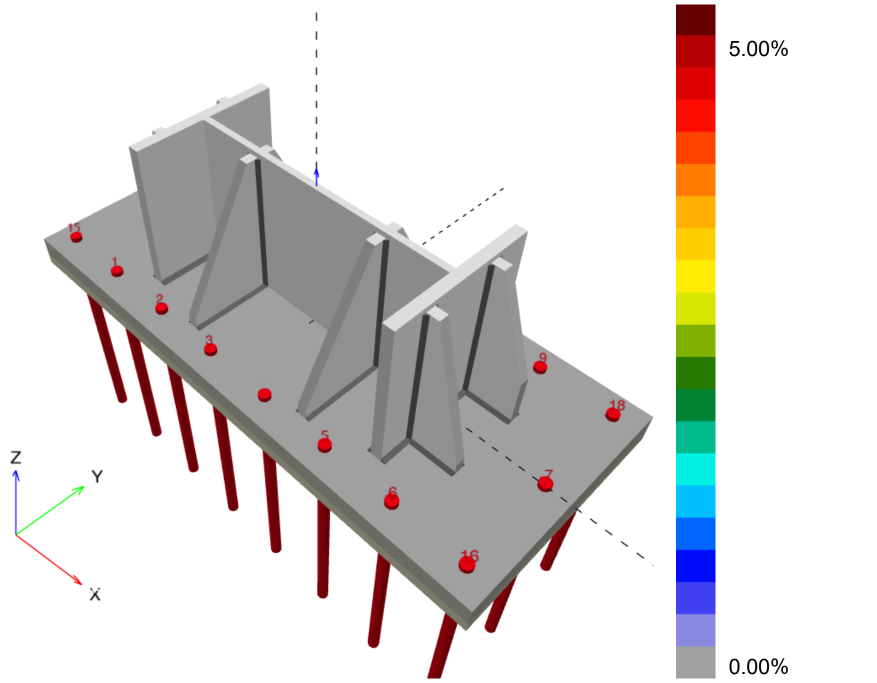
2.4.1.1 Equivalent stress

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



2.4.1.2 Plastic strain

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



2.4.2 Plate hole bearing resistance, AISC 360-16 Section J3

Decisive load combination: 1 - Combination 1

Equations

R_n = $\min(1.2\, l_c\, t\, F_u\, ,\, 2.4\, d\, t\, F_u)$ (AISC 360-16 J3-6a, c)

ΦR_n = $0.75\, R_n$

$V \leq \Phi R_n$

Variables

	l_c [mm]	t [mm]	F_u [N/mm²]	d [mm]	R_n [kN]
Anchor 1	56.8	40.0	399.90	24.0	921.360
Anchor 2	53.6	40.0	399.90	24.0	921.360
Anchor 3	54.1	40.0	399.90	24.0	921.360
Anchor 4	55.6	40.0	399.90	24.0	921.360
Anchor 5	55.8	40.0	399.90	24.0	921.360
Anchor 6	57.1	40.0	399.90	24.0	921.360
Anchor 7	361.2	40.0	399.90	24.0	921.360
Anchor 8	55.9	40.0	399.90	24.0	921.360
Anchor 9	630.1	40.0	399.90	24.0	921.360
Anchor 10	616.5	40.0	399.90	24.0	921.360
Anchor 11	617.6	40.0	399.90	24.0	921.360
Anchor 12	624.5	40.0	399.90	24.0	921.360
Anchor 13	476.7	40.0	399.90	24.0	921.360
Anchor 14	268.6	40.0	399.90	24.0	921.360
Anchor 15	55.1	40.0	399.90	24.0	921.360
Anchor 16	59.5	40.0	399.90	24.0	921.360
Anchor 17	56.9	40.0	399.90	24.0	921.360
Anchor 18	576.1	40.0	399.90	24.0	921.360

Results

	V [kN]	ΦR_n [kN]	Utilization [%]	Status
Anchor 1	10.453	691.020	2	OK
Anchor 2	10.600	691.020	2	OK
Anchor 3	10.241	691.020	2	OK
Anchor 4	10.022	691.020	2	OK
Anchor 5	9.977	691.020	2	OK
Anchor 6	9.725	691.020	2	OK
Anchor 7	9.973	691.020	2	OK
Anchor 8	9.704	691.020	2	OK
Anchor 9	10.338	691.020	2	OK
Anchor 10	10.145	691.020	2	OK
Anchor 11	9.888	691.020	2	OK
Anchor 12	9.544	691.020	2	OK
Anchor 13	9.430	691.020	2	OK
Anchor 14	9.457	691.020	2	OK
Anchor 15	10.008	691.020	2	OK
Anchor 16	9.351	691.020	2	OK
Anchor 17	9.272	691.020	2	OK
Anchor 18	10.153	691.020	2	OK

2.5 Welds

Profiles are modeled 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 Anchor plate to profile

Decisive load combination: 1 - Combination 1

Equations

$F_{nw} = 0.6\, F_{EXX}\, (1.0 + 0.5\sin^{1.5}\Theta)$

$\Phi R_n = \Phi\, F_{nw}\, A_w$

$\text{Utilization} = \dfrac{F_n}{\Phi\, R_n}$

Variables

Edge	X_u	T_h [mm]	L_s [mm]	L [mm]	L_c [mm]	F_{EXX} [N/mm²]	Θ [°]	A_w [mm²]
Member 1-bfl 1	E70xx	◢6.0◣	8.5	306.8	51.1	482.63	76.5	307
Member 1-bfl	E70xx	◢6.0◣	8.5	306.8	51.1	482.63	48.4	307
Member 1-tfl 1	E70xx	◢6.0◣	8.5	306.8	51.1	482.63	54.3	307
Member 1-tfl	E70xx	◢6.0◣	8.5	306.8	51.1	482.63	58.3	307

Results

Edge	F_n [kN]	ΦR_n [kN]	Utilization [%]	Status
Member 1-bfl 1	24.305	98.577	25	OK
Member 1-bfl	26.136	88.189	30	OK
Member 1-tfl 1	68.368	91.034	76	OK
Member 1-tfl	68.075	92.788	74	OK

2.5.2 Stiffeners to profile/anchor plate

Decisive load combination: 1 - Combination 1

Equations

$F_{nw} = 0.6\, F_{EXX}\, (1.0 + 0.5\sin^{1.5}\Theta)$

$\Phi R_n = \Phi\, F_{nw}\, A_w$

$\text{Utilization} = \dfrac{F_n}{\Phi\, R_n}$

Variables

Edge	X_u	T_h [mm]	L_s [mm]	L [mm]	L_c [mm]	F_{EXX} [N/mm²]	Θ [°]	A_w [mm²]
Stiffener0 (Anchor plate)	E70xx	◢5.0◣	7.1	99.8	20.0	482.63	68.9	100
Stiffener0 (Anchor plate) 1	E70xx	◢5.0◣	7.1	99.8	20.0	482.63	64.7	100
Stiffener1 (Anchor plate)	E70xx	◢5.0◣	7.1	99.8	20.0	482.63	64.5	100
Stiffener1 (Anchor plate) 1	E70xx	◢5.0◣	7.1	99.8	20.0	482.63	67.9	100
Stiffener2 (Anchor plate)	E70xx	◢5.0◣	7.1	99.8	20.0	482.63	62.4	100
Stiffener2 (Anchor plate) 1	E70xx	◢5.0◣	7.1	99.8	20.0	482.63	68.0	100
Stiffener3 (Anchor plate)	E70xx	◢5.0◣	7.1	99.8	20.0	482.63	64.2	100

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Edge	X_u	T_h [mm]	L_s [mm]	L [mm]	L_c [mm]	F_{EXX} [N/mm²]	Θ [°]	A_w [mm²]
Stiffener3 (Anchor plate) 1	E70xx	◢5.0◣	7.1	99.8	20.0	482.63	61.4	100
Stiffener4 (Anchor plate)	E70xx	◢5.0◣	7.1	174.1	19.3	482.63	25.5	97
Stiffener4 (Anchor plate) 1	E70xx	◢5.0◣	7.1	174.6	19.4	482.63	78.5	97
Stiffener5 (Anchor plate)	E70xx	◢5.0◣	7.1	174.6	19.4	482.63	62.5	97
Stiffener5 (Anchor plate) 1	E70xx	◢5.0◣	7.1	174.6	19.4	482.63	67.8	97
Stiffener6 (Anchor plate)	E70xx	◢5.0◣	7.1	174.6	19.4	482.63	73.7	97
Stiffener6 (Anchor plate) 1	E70xx	◢5.0◣	7.1	174.1	19.3	482.63	24.7	97
Stiffener7 (Anchor plate)	E70xx	◢5.0◣	7.1	174.6	19.4	482.63	68.3	97
Stiffener7 (Anchor plate) 1	E70xx	◢5.0◣	7.1	174.6	19.4	482.63	62.8	97
Stiffener0 (Member 1-tfl 1)	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	34.8	94
Stiffener0 (Member 1-tfl 1) 1	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	34.2	94
Stiffener1 (Member 1-bfl 1)	E70xx	◢5.0◣	7.1	298.4	18.7	482.63	19.7	93
Stiffener1 (Member 1-bfl 1) 1	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	44.8	94
Stiffener2 (Member 1-tfl 1)	E70xx	◢5.0◣	7.1	298.4	18.7	482.63	27.4	93
Stiffener2 (Member 1-tfl 1) 1	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	38.5	94
Stiffener3 (Member 1-bfl 1)	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	32.7	94
Stiffener3 (Member 1-bfl 1) 1	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	32.5	94
Stiffener4 (Member 1-w 1)	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	24.5	94
Stiffener4 (Member 1-w 1) 1	E70xx	◢5.0◣	7.1	298.4	18.7	482.63	44.2	93
Stiffener5 (Member 1-w 1)	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	32.7	94
Stiffener5 (Member 1-w 1) 1	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	34.0	94

Edge	X_u	T_h [mm]	L_s [mm]	L [mm]	L_c [mm]	F_{EXX} [N/mm²]	Θ [°]	A_w [mm²]
Stiffener6 (Member 1-w 1)	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	82.2	94
Stiffener6 (Member 1-w 1) 1	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	23.7	94
Stiffener7 (Member 1-w 1)	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	33.8	94
Stiffener7 (Member 1-w 1) 1	E70xx	◢5.0◣	7.1	299.2	18.7	482.63	32.4	94

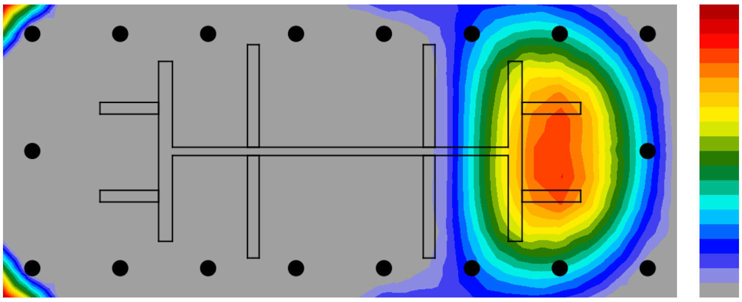
Results

Edge	F_n [kN]	ΦR_n [kN]	Utilization [%]	Status
Stiffener0 (Anchor plate)	24.432	31.423	78	OK
Stiffener0 (Anchor plate) 1	23.781	30.971	77	OK
Stiffener1 (Anchor plate)	23.152	30.950	75	OK
Stiffener1 (Anchor plate) 1	23.555	31.322	76	OK
Stiffener2 (Anchor plate)	23.385	30.704	77	OK
Stiffener2 (Anchor plate) 1	24.198	31.332	78	OK
Stiffener3 (Anchor plate)	23.273	30.922	76	OK
Stiffener3 (Anchor plate) 1	22.953	30.570	76	OK
Stiffener4 (Anchor plate)	5.877	23.971	25	OK
Stiffener4 (Anchor plate) 1	3.337	31.274	11	OK
Stiffener5 (Anchor plate)	22.441	29.863	76	OK
Stiffener5 (Anchor plate) 1	22.840	30.447	76	OK
Stiffener6 (Anchor plate)	3.327	30.966	11	OK
Stiffener6 (Anchor plate) 1	5.796	23.849	25	OK
Stiffener7 (Anchor plate)	22.867	30.488	76	OK
Stiffener7 (Anchor plate) 1	22.467	29.897	76	OK
Stiffener0 (Member 1-tfl 1)	13.325	24.678	54	OK
Stiffener0 (Member 1-tfl 1) 1	14.361	24.581	59	OK
Stiffener1 (Member 1-bfl 1)	6.769	22.238	31	OK
Stiffener1 (Member 1-bfl 1) 1	6.277	26.312	24	OK
Stiffener2 (Member 1-tfl 1)	9.054	23.406	39	OK
Stiffener2 (Member 1-tfl 1) 1	7.281	25.292	29	OK
Stiffener3 (Member 1-bfl 1)	11.312	24.331	47	OK
Stiffener3 (Member 1-bfl 1) 1	11.840	24.307	49	OK
Stiffener4 (Member 1-w 1)	2.441	23.011	11	OK
Stiffener4 (Member 1-w 1) 1	1.251	26.153	5	OK
Stiffener5 (Member 1-w 1)	6.464	24.343	27	OK
Stiffener5 (Member 1-w 1) 1	6.452	24.552	27	OK
Stiffener6 (Member 1-w 1)	1.191	30.320	4	OK
Stiffener6 (Member 1-w 1) 1	2.461	22.893	11	OK
Stiffener7 (Member 1-w 1)	6.563	24.520	27	OK
Stiffener7 (Member 1-w 1) 1	6.396	24.291	27	OK

2.6 Concrete

Decisive load combination: 1 - Combination 1

2.6.1 Compression in concrete under the anchor plate



2.6.2 Concrete block compressive strength resistance check, AISC 360-16 Section J8

Equations

$$F_p = \Phi f_{p,max}$$

$$f_{p,max} = 0.85 f_c' \sqrt{\left(\frac{A_2}{A_1}\right)} \leq 1.7 f_c; \quad \sqrt{\left(\frac{A_2}{A_1}\right)} \leq 2$$

$$\sigma = \frac{N}{A_1}$$

$$\text{Utilization} = \frac{\sigma}{F_p}$$

Variables

N [kN]	f_c' [N/mm²]	Φ	A_1 [mm²]	A_2 [mm²]
322.757	45.00	0.65	239,734	361,591,872

Results

Load combination	F_p [N/mm²]	σ [N/mm²]	Utilization [%]	Status
Combination 1	49.73	1.35	3	OK

2.7 Symbol explanation

A_1	Loaded area of concrete
A_2	Supporting area
A_w	Effective area of weld critical element
d	Nominal diameter of the bolt
ε_{lim}	Limit plastic strain
ε_{Pl}	Plastic strain from CBFEM results
f_c	Concrete compressive strength
f_c'	Concrete compressive strength
F_{EXX}	Electrode classification number, i.e. minimum specified tensile strength
F_u	Specified minimum tensile strength of the connected material
F_n	Force in weld critical element
F_{nw}	Nominal stress of the weld material
F_p	Concrete block design bearing strength
$f_{p,max}$	Concrete block design bearing strength maximum
f_y	Yield strength
l_c	Clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material
L	Length of weld
L_c	Length of weld critical element
L_s	Leg size of weld
N	Resulting compression force
σ	Average stress in concrete
σ_{Ed}	Equivalent stress
Φ	Resistance factor
ΦR_n	Factored resistance
R_n	Resistance
t	Thickness of the anchor plate
Θ	Angle of loading measured from the weld longitudinal axis
T_h	Throat thickness of weld
V	Resultant of shear forces Vy, Vz in bolt.
X_u	Filler metal tensile strength

2.8 Warnings

- By using the CBFEM calculation functionality of PROFIS Engineering you may act outside the applicable design codes and your specified anchor plate may not behave rigid. Please, validate the results with a professional designer and/or structural engineer to ensure suitability and adequacy for your specific jurisdiction and project requirements.
- The anchor is modeled 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.