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Specifier's comments:

1 Input data

Channel type	**HAC-V-50 106/300 F**
bolt	**HBC-C-N 8.8F, M16 x 50 mm**
Channel filled w/ HIT-HY 100	no
Effective embedment depth	h_{ef} = 106 mm
Channel specification	Length: 300 mm, anchor spacing: 250 mm, projection: 25 mm, width: b_{ch} = 42 mm, height: h_{ch} = 31 mm
Material	Anchor & Channel: hot-dip galvanized Bolt: hot-dip galvanized
ICC Approval	ESR-3520
Issued I Valid	1. 08. 2022 | 1. 08. 2024
Standard	ESR-3520, AC232, ACI 318-14
Base material	Normal weight concrete, cracked, f_c' = 45.0 N/mm^2, h = 300 mm
Special inspection	Periodic
Reinforcement	Exist. Reinf.: Straight edge reinf. present
	tension: condition B, shear: condition B
Tolerance data	tolerance interval: -250 mm/250 mm most unfavorable tolerance: -45 mm

2 Overall Result

Design ok! (Maximum utilization: 87%)

IMPORTANT! Failure analysis modes evaluated by PROFIS follow ACI 318-14, chapter 17. This DOES NOT include evaluating the base material (e.g. edge-of-slab) capacity to resist compressive forces generated by the fixture. The engineer must ALWAYS verify the base material (e.g. edge-of-slab) design is capable of resisting the applied loading.
Compressive forces generated by the fixture = 23.399 kN

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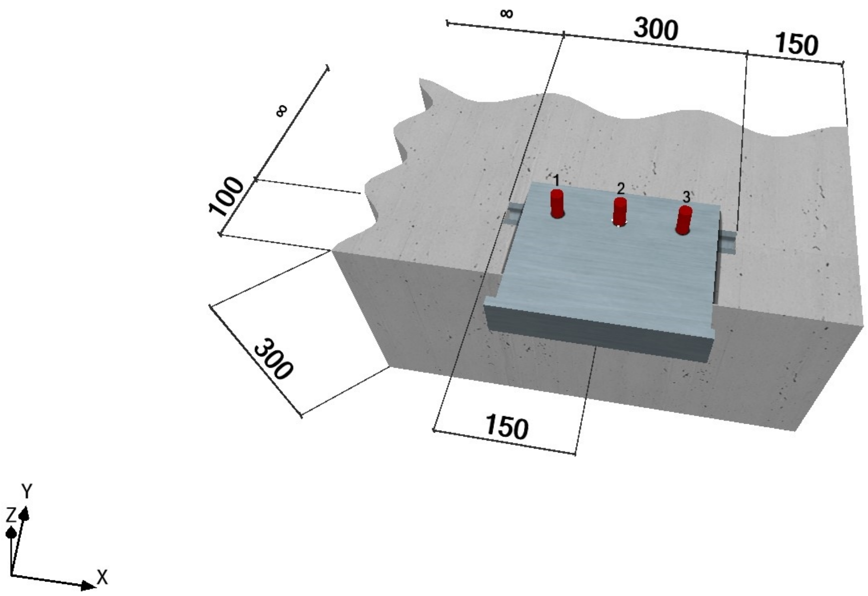
3 Geometry



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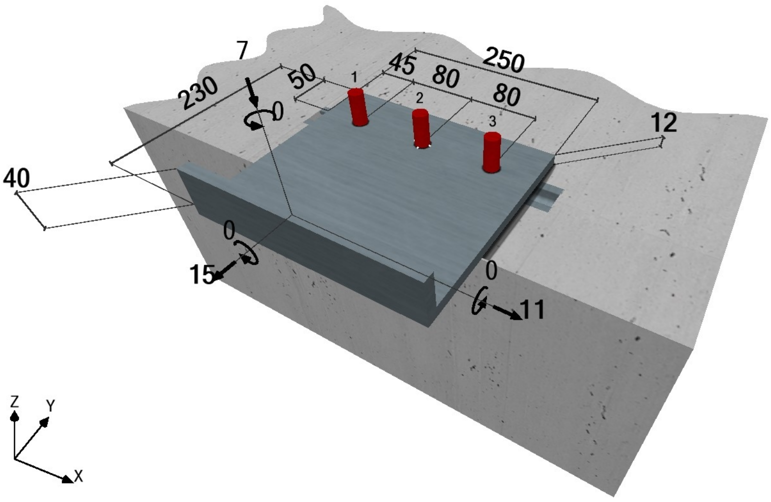
3.1 Fixtures / Bolt groups / Loads

Fixture 1



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4 Load case / Resulting bolt forces

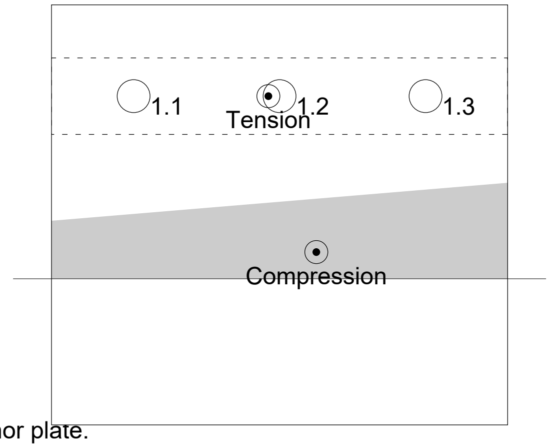
Load case: Design load

4.1 Load distribution

4.1.1 Fixture 1: bolt: HBC-C-N 8.8F, M16 x 50 mm

Profile: ; L x W x T = 250 x 12 x 0 mm
Standoff: No standoff
Plate dimensions: 250 mm x 230 mm x 12 mm
Anchorplate design calculated: no

Bolt	N [kN]	V [kN]	V_x [kN]	V_y [kN]
1.1	6.096	17.354	3.667	-16.963
1.2	5.466	6.200	3.667	-5.000
1.3	4.837	7.869	3.667	6.963



max. concrete compressive strain: 0.15 [‰]
max. concrete compressive stress: 5.4 [N/mm^2]
resulting tension force in (x/y)=(118.9/180.0): 16.399 [kN]
resulting compression force in (x/y)=(145.1/94.6): 23.399 [kN]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

4.2 Derivation of forces acting on anchor channels

$N^a_{ua,i} = k \cdot A'_i \cdot N_{ua}$

A'_i Ordinate at the position of the anchor *i* of the loadtriangle with load *N* and the base length *2l$_i$*

$k = \frac{1}{\sum_1^n A'_i}$

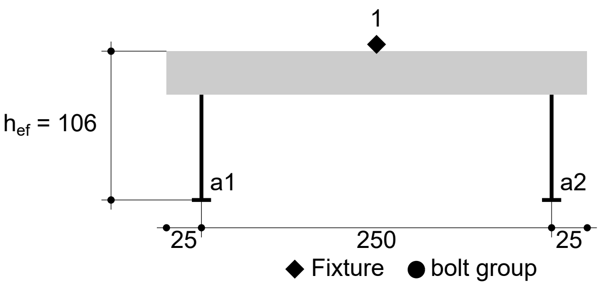
$l_{in} = 4.93 \cdot I_y^{0.05} \cdot s^{0.5} \approx 346$ [mm] $\geq s$

$I_y = 33125$ [mm^4]

$s = 250$ [mm]

$V^a_{ua,i} = k \cdot A'_i \cdot V_{ua}$

$M_{u,flex} = 0.437$ [kNm]



Anchor forces [kN]

Anchor	N	V_y
a1	10.098	-13.361
a2	6.301	-1.639

Anchor longitudinal shear forces [kN]

Anchor	V_x
a1	5.500
a2	5.500

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5 Verifications

5.1 Verifications for anchor channels under tension loading

	Load [kN], [kNm]	Resistance [kN], [kNm]	Utilization [%]	Status
Anchor	10.098	41.250	25	ok
Connection anchor-channel	10.098	31.500	33	ok
Local flexure of channel lip	6.096	30.693	20	ok
Channel bolt	6.096	81.637	8	ok
Flexure	0.437	1.327	33	ok
Pull-out	10.098	65.016	16	ok
Concrete breakout	10.098	27.660	37	ok
Concrete splitting in tension	N/A	N/A	N/A	N/A
Concrete side-face blowout	N/A	N/A	N/A	N/A
Anchor reinf. - steel	N/A	N/A	N/A	N/A
Anchor reinf. - anchorage	N/A	N/A	N/A	N/A

5.1.1 Steel strength (acc. to ESR-3520 section 4.1.3.2.2)

5.1.1.1 Anchor strength (Anchor a1, Channel a)

$\phi\ N_{sa} \geq N_{ua}^{a}$

N_{sa} [kN]	ϕ	$\phi\ N_{sa}$ [kN]	N_{ua}^{a} [kN]
55.000	0.750	41.250	10.098

5.1.1.2 Strength of connection between anchor and channel (Anchor a1, Channel a)

$\phi\ N_{sc} \geq N_{ua}^{a}$

N_{sc} [kN]	ϕ	$\phi\ N_{sc}$ [kN]	N_{ua}^{a} [kN]
42.000	0.750	31.500	10.098

5.1.1.3 Strength for local flexure of channel lip (Fixture 1, bolt 1.1, Channel a)

$\phi\ N_{sl} \geq N_{ua}^{s}$

b_{ch} = 42 [mm]

$$\psi_{sl,red} = \frac{1}{1 + \sum_{i=2}^{n+1}\left[\left(1 - \frac{s_{chb,i}}{2 \cdot b_{ch}}\right)^{2.0} \cdot \frac{N_{ua,i}^{b}}{N_{ua,1}^{b}}\right]} = 0.998$$

$N_{sl,red} = \psi_{sl,red} \cdot N_{sl} = 40.925$ [kN]

$N_{sl,red}$ [kN]	ϕ	$\phi\ N_{sl}$ [kN]	N_{ua}^{s} [kN]
40.925	0.750	30.693	6.096

5.1.1.4 Channel bolt strength (Fixture 1, bolt 1.1, Channel a)

$\phi\ N_{ss} \geq N_{ua}^{s}$

N_{ss} [kN]	ϕ	$\phi\ N_{ss}$ [kN]	N_{ua}^{s} [kN]
125.596	0.650	81.637	6.096

5.1.1.5 Flexure of channel (Channel a)

$\phi\ M_{s,flex} \geq M_{u,flex}$

$M_{s,flex}$ [kNm]	ϕ	$\phi\ M_{s,flex}$ [kNm]	$M_{u,flex}$ [kNm]
1.561	0.850	1.327	0.437

5.1.2 Pull-out strength (Anchor a1, Channel a) (acc. to ESR-3520 section 4.1.3.2.4)

$\phi\ N_{pn} \geq N^{a}_{ua}$

$N_{pn} = \psi_{cp} \cdot \lambda \cdot N_p$

$N_p = 8 \cdot A_{brg} \cdot f'_c$

A_{brg} [mm²]	f'_c [N/mm²]	N_p [kN]	$\psi_{c,p}$	λ
258	45.0	92.880	1.000	1.000

N_{pn} [kN]	ϕ	$\phi\ N_{pn}$ [kN]	N^{a}_{ua} [kN]
92.880	0.700	65.016	10.098

5.1.3 Concrete breakout strength (Anchor a1, Channel a) (acc. to ESR-3520 section 4.1.3.2.3)

$\phi\ N_{cb} \geq N^{a}_{ua}$

$N_{cb} = N_b \cdot \psi_{s,N} \cdot \psi_{ed,N} \cdot \psi_{co1,N} \cdot \psi_{co2,N} \cdot \psi_{c,N} \cdot \psi_{cp,N}$

$N_b = 24 \cdot \lambda \cdot \alpha_{ch,N} \sqrt{f'_c} \cdot h_{ef}^{1.5}$

$$\alpha_{ch,N} = \left(\frac{h_{ef}}{7.1}\right)^{0.15} \leq 1.0$$

$$\psi_{s,N} = \frac{1}{1 + \sum_{i=2}^{n+1}\left[\left(1 - \frac{s_i}{s_{cr,N}}\right)^{1.5} \cdot \frac{N^{a}_{ua,i}}{N^{a}_{ua,1}}\right]} \leq 1.0$$

$s_{cr,N} = 2 \cdot (2.8 - 1.3 \cdot h_{ef} / 7.1) \cdot h_{ef} \geq 3 \cdot h_{ef}$

$$\psi_{ed,N} = \left(\frac{c_{a1}}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

$c_{cr,N} = 0.5 \cdot s_{cr,N} \geq 1.5 \cdot h_{ef}$

$$\psi_{co1,N} = \left(\frac{c_{a2,1}}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

$$\psi_{co2,N} = \left(\frac{c_{a2,2}}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

λ	$\alpha_{ch,N}$	f'_c [N/mm²]	h_{ef} [mm]	N_b [kN]
1.000	0.923	45.0	106	67.894

s [mm]	$s_{cr,N}$ [mm]	$\psi_{s,N}$	c_{a1} [mm]	$c_{cr,N}$ [mm]	$\psi_{ed,N}$
250	431	0.855	100	216	0.681

$c_{a2,1}$ [mm]	$c_{a2,2}$ [mm]	$\psi_{co1,N}$	$\psi_{co2,N}$
425	-	1.000	1.000

$\psi_{c,N}$	$\psi_{cp,N}$
1.000	1.000

N_{cb} [kN]	ϕ	$\phi\ N_{cb}$ [kN]	N^{a}_{ua} [kN]
39.514	0.700	27.660	10.098

5.2 Verifications for anchor channels under shear loading

	Load [kN], [kNm]	Resistance [kN], [kNm]	Utilization [%]	Status
Channel bolt w/o lever arm	17.354	45.212	39	ok
Channel lip w/o lever arm - perpendicular shear	16.963	30.693	56	ok
Channel lip w/o lever arm - longitudinal shear	3.667	10.814	34	ok
Channel bolt with lever arm	N/A	N/A	N/A	N/A
Anchor - perpendicular shear	13.361	31.500	43	ok
Anchor - longitudinal shear	5.500	24.750	23	ok
Connection anchor/channel - perpendicular shear	13.361	31.500	43	ok
Connection anchor/channel - longitudinal shear	5.500	18.900	30	ok
Concrete pryout, perpendicular shear	13.361	62.633	22	ok
Concrete pryout, longitudinal shear	5.500	45.820	13	ok
Concrete edge breakout - perpendicular	13.361	18.924	71	ok
Concrete edge breakout - longitudinal	11.000	38.745	29	ok
Anchor reinf. - steel, perpendicular shear	N/A	N/A	N/A	N/A
Anchor reinf. - anchorage, perpendicular shear	N/A	N/A	N/A	N/A
Anchor reinf. - steel, longitudinal shear	N/A	N/A	N/A	N/A
Anchor reinf. - anchorage, longitudinal shear	N/A	N/A	N/A	N/A

5.2.1 Steel strength (acc. to ESR-3520 section 4.1.3.3.2, 4.1.3.4.2)

5.2.1.1 Channel bolt strength - without lever arm, longitudinal shear included (Fixture 1, bolt 1.1, Channel a)

$\phi \ V_{ss} \geq V^{s}_{ua}$

$V^{s}_{ua} \ = \sqrt{V^{s\ 2}_{ua,x} + V^{s\ 2}_{ua,y}}$

V_{ss} [kN]	ϕ	$\phi \ V_{ss}$ [kN]	$V^{s}_{ua,x}$ [kN]	$V^{s}_{ua,y}$ [kN]	V^{s}_{ua} [kN]
75.353	0.600	45.212	3.667	16.963	17.354

5.2.1.2 Strength for local flexure of channel lip - perpendicular shear load w/o lever arm (Fixture 1, bolt 1.1, Channel a)

$\phi \ V_{sl,y} \geq V^{s}_{ua,y}$

$V_{sl,y} \ = \min(V_{sl,y,ESR}, N_{sl})$

$V_{sl,y}$ [kN]	$V_{sl,y,ESR}$ [kN]	ϕ	$\phi \ V_{sl,y}$ [kN]	$V^{s}_{ua,y}$ [kN]
40.925	55.000	0.750	30.693	16.963

5.2.1.3 Strength for local flexure of channel lip - longitudinal shear load w/o lever arm (Fixture 1, bolt 1.1, Channel a)

$\phi \; V_{sl,x} \geq V^{s}_{ua,x}$

$V_{sl,x}$ [kN]	ϕ	$\phi \; V_{sl,x}$ [kN]	$V^{s}_{ua,x}$ [kN]
19.661	0.550	10.814	3.667

5.2.1.4 Anchor strength - perpendicular shear (Anchor a1, Channel a)

$\phi \; V_{sa,y} \geq V^{a}_{ua,y}$

$V_{sa,y} \quad = \min(V_{sa,y,ESR}, N_{sa}, N_{sc})$

$V_{sa,y}$ [kN]	$V_{sa,y,ESR}$ [kN]	ϕ	$\phi \; V_{sa,y}$ [kN]	$V^{a}_{ua,y}$ [kN]
42.000	57.500	0.750	31.500	13.361

5.2.1.5 Anchor strength - longitudinal shear (Anchor a1, Channel a)

$\phi \; V_{sa,x} \geq V^{a}_{ua,x}$

$V_{sa,x}$ [kN]	ϕ	$\phi \; V_{sa,x}$ [kN]	$V^{a}_{ua,x}$ [kN]
33.000	0.750	24.750	5.500

5.2.1.6 Strength of connection between anchor and channel - perpendicular shear (Anchor a1, Channel a)

$\phi \; V_{sc,y} \geq V^{a}_{ua,y}$

$V_{sc,y} \quad = \min(V_{sc,y,ESR}, N_{sa}, N_{sc})$

$V_{sc,y}$ [kN]	$V_{sc,y,ESR}$ [kN]	ϕ	$\phi \; V_{sc,y}$ [kN]	$V^{a}_{ua,y}$ [kN]
42.000	57.500	0.750	31.500	13.361

5.2.1.7 Strength of connection between anchor and channel - longitudinal shear (Anchor a1, Channel a)

$\phi \; V_{sc,x} \geq V^{a}_{ua,x}$

$V_{sc,x}$ [kN]	ϕ	$\phi \; V_{sc,x}$ [kN]	$V^{a}_{ua,x}$ [kN]
25.200	0.750	18.900	5.500

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5.2.2 Concrete pryout strength - perpendicular shear (Anchor a1, Channel a) (acc. to ESR-3520 section 4.1.3.3.4)

$\phi \ V^{a}_{cp,y} \geq V^{a}_{ua,y}$

$V_{cp,y} = k_{cp} \cdot N_{cb}$

$N_{cb} = N_b \cdot \psi_{s,N} \cdot \psi_{ed,N} \cdot \psi_{co1,N} \cdot \psi_{co2,N} \cdot \psi_{c,N} \cdot \psi_{cp,N}$

$N_b = 24 \cdot \lambda \cdot \alpha_{ch,N} \sqrt{f'_c} \cdot h_{ef}^{1.5}$

$$\alpha_{ch,N} = \left(\frac{h_{ef}}{7.1}\right)^{0.15} \leq 1.0$$

$$\psi_{s,N} = \frac{1}{1 + \sum_{i=2}^{n+1}\left[\left(1 - \frac{s_i}{s_{cr,N}}\right)^{1.5} \cdot \frac{V^{a}_{ua,i}}{V^{a}_{ua,1}}\right]} \leq 1.0$$

$s_{cr,N} = 2 \cdot (2.8 - 1.3 \cdot h_{ef} / 7.1) \cdot h_{ef} \geq 3 \cdot h_{ef}$

$$\psi_{ed,N} = \left(\frac{c_{a1}}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

$c_{cr,N} = 0.5 \cdot s_{cr,N} \geq 1.5 \cdot h_{ef}$

$$\psi_{co1,N} = \left(\frac{c_{a2,1}}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

$$\psi_{co2,N} = \left(\frac{c_{a2,2}}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

λ	$\alpha_{ch,N}$	f'_c [N/mm^2]	h_{ef} [mm]	N_b [kN]
1.000	0.923	45.0	106	67.894

s [mm]	$s_{cr,N}$ [mm]	$\psi_{s,N}$	c_{a1} [mm]	$c_{cr,N}$ [mm]	$\psi_{ed,N}$
250	431	0.968	100	216	0.681

$c_{a2,1}$ [mm]	$c_{a2,2}$ [mm]	$\psi_{co1,N}$	$\psi_{co2,N}$
425	-	1.000	1.000

$\psi_{c,N}$	k_{cp}
1.000	2.0

N_{cb} [kN]	$V_{cp,y}$ [kN]	ϕ	$\phi \ V_{cp,y}$ [kN]	$V^{a}_{ua,y}$ [kN]
44.738	89.475	0.700	62.633	13.361

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5.2.3 Concrete pryout strength - longitudinal shear (Anchor a2, Channel a) (acc. to ESR-3520 section 4.1.3.4.4)

$$\phi \; V^{a}_{cp,x} \geq V^{a}_{ua,x}$$

$$V_{cp,x} = k_{cp} \cdot N_{cb}$$

$$N_{cb} = N_b \cdot \psi_{s,N} \cdot \psi_{ed,N} \cdot \psi_{co1,N} \cdot \psi_{co2,N} \cdot \psi_{c,N} \cdot \psi_{cp,N}$$

$$N_b = 24 \cdot \lambda \cdot \alpha_{ch,N} \sqrt{f'_c} \cdot h_{ef}^{1.5}$$

$$\alpha_{ch,N} = \left(\frac{h_{ef}}{7.1}\right)^{0.15} \leq 1.0$$

$$\psi_{s,N} = \frac{1}{1 + \sum_{i=2}^{n+1}\left[\left(1 - \frac{s_i}{s_{cr,N}}\right)^{1.5} \cdot \frac{V^{a}_{ua,i}}{V^{a}_{ua,1}}\right]} \leq 1.0$$

$$s_{cr,N} = 2 \cdot (2.8 - 1.3 \cdot h_{ef} / 7.1) \cdot h_{ef} \geq 3 \cdot h_{ef}$$

$$\psi_{ed,N} = \left(\frac{c_{a1}}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

$$c_{cr,N} = 0.5 \cdot s_{cr,N} \geq 1.5 \cdot h_{ef}$$

$$\psi_{co1,N} = \left(\frac{c_{a2,1}}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

$$\psi_{co2,N} = \left(\frac{c_{a2,2}}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

λ	$\alpha_{ch,N}$	f'_c [N/mm²]	h_{ef} [mm]	N_b [kN]
1.000	0.923	45.0	106	67.894

s [mm]	$s_{cr,N}$ [mm]	$\psi_{s,N}$	c_{a1} [mm]	$c_{cr,N}$ [mm]	$\psi_{ed,N}$
250	431	0.786	175	216	0.901

$c_{a2,1}$ [mm]	$c_{a2,2}$ [mm]	$\psi_{co1,N}$	$\psi_{co2,N}$
-	100	1.000	0.681

$\psi_{c,N}$	$\psi_{cp,N}$	k_{cp}
1.000	1.000	2.0

N_{cb} [kN]	$V_{cp,x}$ [kN]	ϕ	$\phi \; V_{cp,x}$ [kN]	$V^{a}_{ua,x}$ [kN]
32.729	65.458	0.700	45.820	5.500

5.2.4 Concrete edge breakout strength - perpendicular shear, direction, y- (Anchor a1, Channel a) (acc. to ESR-3520 section 4.1.3.3.3)

$\phi \ V_{cb,y} \geq V^{a}_{ua,y}$

$V_{cb} = V_b \cdot \psi_{s,V} \cdot \psi_{co1,V} \cdot \psi_{co2,V} \cdot \psi_{c,V} \cdot \psi_{h,V} \cdot \psi_{parallel,V}$

$V_b = \lambda \cdot \alpha_{ch,V} \cdot \sqrt{f'_c} \cdot c_{a1}^{4/3}$

$$\psi_{s,V} = \frac{1}{1 + \sum_{i=2}^{n+1}\left[\left(1 - \frac{s_i}{s_{cr,V}}\right)^{1.5} \cdot \frac{V^{a}_{ua,i}}{V^{a}_{ua,1}}\right]} \leq 1.0$$

$s_{cr,V} = 4 \cdot c_{a1} + 2 \cdot b_{ch}$

$$\psi_{co1,V} = \left(\frac{c_{a2,1}}{c_{cr,V}}\right)^{0.5} \leq 1.0$$

$$\psi_{co2,V} = \left(\frac{c_{a2,2}}{c_{cr,V}}\right)^{0.5} \leq 1.0$$

$c_{cr,V} = 0.5 \cdot s_{cr,V} = 2 \cdot c_{a1} + b_{ch}$

$$\psi_{h,V} = \left(\frac{h}{h_{cr,V}}\right)^{\beta_1} \leq 1.0$$

$h_{cr,V} = 2 \cdot c_{a1} + 2 \cdot h_{ch}$

$\alpha_{ch,V}$	f'_c [N/mm²]	c_{a1} [mm]	V_b [kN]
10.500	45.0	100	23.457

s [mm]	$s_{cr,V}$ [mm]	$\psi_{s,V}$	$c_{a2,1}$ [mm]	$c_{a2,2}$ [mm]	$c_{cr,V}$ [mm]
250	484	0.960	425	-	242

$\psi_{co1,V}$	$\psi_{co2,V}$	λ	$\psi_{c,V}$
1.000	1.000	1.000	1.200

h [mm]	$h_{cr,V}$ [mm]	$\psi_{h,V}$	β_1	$\psi_{parallel,V}$
300	262	1.000	0.500	1.000

$V_{cb,y}$ [kN]	ϕ	$\phi \ V_{cb,y}$ [kN]	$V^{a}_{ua,y}$ [kN]
27.034	0.700	18.924	13.361

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5.2.5 Concrete edge breakout strength - longitudinal shear, direction, x+ (Anchor a1, Channel a) (acc. to ESR-3520 section 4.1.3.4.3)

$\phi \; V_{cb,x} \geq V^{a}_{ua,x}$

$V_{cb} = \frac{A_{Vc}}{A_{Vc0}} \cdot \psi_{ed,V} \cdot \psi_{c,V} \cdot \psi_{h,V} \cdot \psi_{parallel,V} \cdot V_b$

$V_b = 7 \cdot \left(\frac{l_e}{d_a}\right)^{0.2} \cdot \sqrt{d_a} \cdot \lambda \cdot \sqrt{f'_c} \cdot c_{a1}^{1.5}$

A_{Vc} see ACI 318-14, Chapter 17.5.2.1, Fig. R17.5.2.1

$A_{Vc0} = 4.5 \cdot c_{a1}^2$

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$

$\psi_{h,V} = \sqrt{\frac{1.5 \cdot c_{a1}}{h_a}} \geq 1.0$

A_{Vc} [mm²]	A_{Vc0} [mm²]	c_{a1} [mm]	l_e [mm]	d_a [mm]
221250	812813	425	72	9

f'_c [N/mm²]	λ	V_b [kN]
45.0	1.000	155.600

c_{a2} [mm]	$\psi_{ed,V}$	$\psi_{c,V}$	h_a [mm]	$\psi_{h,V}$	$\psi_{parallel,V}$
100	0.747	1.200	300	1.458	1.000

$V_{cb,x}$ [kN]	ϕ	$\phi \; V_{cb,x}$ [kN]	$V^{a}_{ua,x}$ [kN]
55.350	0.700	38.745	11.000

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5.3 Combined tension and shear loads (acc. to ESR-3520, section 4.1.3.6)

Proof of interaction performed independently for steel strength of channel bolt, steel strength of the channel and concrete strength

5.3.1 Channel bolt (Fixture 1, bolt 1.1)

$$\beta_{N+V,s} = \left(\frac{N^s_{ua}}{\phi\ N_{ss}}\right)^2 + \left(\frac{\sqrt{{V^s_{ua,y}}^2 + {V^s_{ua,x}}^2}}{\phi\ V_{ss}}\right)^2 \leq 1.0$$

$$\beta_{N,s} = \left(\frac{N^s_{ua}}{\phi\ N_{ss}}\right)^2 = 0.00557$$

$$\beta_{V,s} = \left(\frac{\sqrt{{V^s_{ua,y}}^2 + {V^s_{ua,x}}^2}}{\phi\ V_{ss}}\right)^2 = 0.14734$$

$$\beta_{N+V,s} = (0.00557) + (0.14734) = 0.15291 \leq 1.0$$

(Utilization : 16%)

5.3.2 Anchor and connection between anchor and channel (Anchor a1)

$$\beta_{N+V,ac} = \max\left(\frac{N^a_{ua}}{\phi\ N_{sa}}, \frac{N^a_{ua}}{\phi\ N_{sc}}\right)^\alpha + \max\left(\frac{V^a_{ua,y}}{\phi\ V_{sa,y}}, \frac{V^a_{ua,y}}{\phi\ V_{sc,y}}\right)^\alpha + \max\left(\frac{V^a_{ua,x}}{\phi\ V_{sa,x}}, \frac{V^a_{ua,x}}{\phi\ V_{sc,x}}\right)^2 \leq 1.0$$

$$\beta_{N,ac} = \max\left(\frac{N^a_{ua}}{\phi\ N_{sa}}, \frac{N^a_{ua}}{\phi\ N_{sc}}\right)^{2.0} = 0.10277$$

$$\beta_{V,ac,y} = \max\left(\frac{V^a_{ua,y}}{\phi\ V_{sa,y}}, \frac{V^a_{ua,y}}{\phi\ V_{sc,y}}\right)^{2.0} = 0.17990$$

$$\beta_{V,ac,x} = \max\left(\frac{V^a_{ua,x}}{\phi\ V_{sa,x}}, \frac{V^a_{ua,x}}{\phi\ V_{sc,x}}\right)^2 = 0.08468$$

$$\beta_{N+V,ac} = 0.10277 + 0.17990 + 0.08468 \leq 1.0$$

(Utilization : 37%)

$\beta_{N,ac}$, governing failure mode: Connection anchor-channel
$\beta_{V,ac,y}$, governing failure mode: Anchor - perpendicular shear
$\beta_{V,ac,x}$, governing failure mode: Connection anchor/channel - longitudinal shear

5.3.3 Point of load application - channel lip (Fixture 1, bolt 1.1)

$$\beta_{N+V,la,c} = \left(\frac{N^s_{ua}}{\phi\ N_{sl}}\right)^\alpha + \left(\frac{V^s_{ua,y}}{\phi\ V_{sl,y}}\right)^\alpha + \left(\frac{V^s_{ua,x}}{\phi\ V_{sl,x}}\right)^2 \leq 1.0$$

$$\beta_{N,la,c} = \left(\frac{N^s_{ua}}{\phi\ N_{sl}}\right)^{2.0} = 0.03944$$

$$\beta_{V,la,c,y} = \left(\frac{V^s_{ua,y}}{\phi\ V_{sl,y}}\right)^{2.0} = 0.30541$$

$$\beta_{V,la,c,x} = \left(\frac{V^s_{ua,x}}{\phi\ V_{sl,x}}\right)^2 = 0.11497$$

$$\beta_{N+V,la,c} = 0.03944 + 0.30541 + 0.11497 \leq 1.0$$

(Utilization : 46%)

$\beta_{N,la,c}$, governing failure mode: Local flexure of channel lip
$\beta_{V,la,c,y}$, governing failure mode: Channel lip w/o lever arm - perpendicular shear
$\beta_{V,la,c,x}$, governing failure mode: Channel lip w/o lever arm - longitudinal shear

5.3.4 Point of load application - flexural moment and channel lip (Fixture 1, bolt 1.1)

$$\beta_{N+V,la,m-c} = \left(\frac{M_{u,flex}}{\phi \ M_{s,flex}}\right)^{\alpha} + \left(\frac{V^{s}_{ua,y}}{\phi \ V_{sl,y}}\right)^{\alpha} + \left(\frac{V^{s}_{ua,x}}{\phi \ V_{sl,x}}\right)^{2} \leq 1.0$$

$$\beta_{N,la,m-c} = \left(\frac{M_{u,flex}}{\phi \ M_{s,flex}}\right)^{2.0} = 0.00000$$

$$\beta_{V,la,m-c,y} = \left(\frac{V^{s}_{ua,y}}{\phi \ V_{sl,y}}\right)^{2.0} = 0.30541$$

$$\beta_{V,la,m-c,x} = \left(\frac{V^{s}_{ua,x}}{\phi \ V_{sl,x}}\right)^{2} = 0.11497$$

$$\beta_{N+V,la,m-c} = 0.00000 + 0.30541 + 0.11497 \leq 1.0$$

(Utilization : 43%)

$\beta_{N,la,m-c}$, governing failure mode: N/A
$\beta_{V,la,m-c,y}$, governing failure mode: Channel lip w/o lever arm - perpendicular shear
$\beta_{V,la,m-c,x}$, governing failure mode: Channel lip w/o lever arm - longitudinal shear

5.3.5 Concrete strength (anchor) (Anchor a1)

$$\beta_{V,c,y} + \beta_{V,c,x} = \left(\frac{V^{a}_{ua,y}}{\phi \ V_{nc,y}}\right) + \left(\frac{V^{a}_{ua,x}}{\phi \ V_{nc,x}}\right) > 0.2$$

$$\beta_{N,c} = \left(\frac{N^{a}_{ua}}{\phi \ N_{nc}}\right) > 0.2$$

$$\beta_{N+V,c} = \left(\frac{N^{a}_{ua}}{\phi \ N_{nc}}\right) + \left(\frac{V^{a}_{ua,y}}{\phi \ V_{nc,y}}\right) + \left(\frac{V^{a}_{ua,x}}{\phi \ V_{nc,x}}\right) \leq 1.2$$

$$\beta_{N,c} = \left(\frac{N^{a}_{ua}}{\phi \ N_{nc}}\right)^{\frac{5}{3}} = 0.18649$$

$$\beta_{V,c,y} = \left(\frac{V^{a}_{ua,y}}{\phi \ V_{nc,y}}\right)^{\frac{5}{3}} = 0.55979$$

$$\beta_{V,c,x} = \left(\frac{V^{a}_{ua,x}}{\phi \ V_{nc,x}}\right)^{\frac{5}{3}} = 0.12264$$

$$\beta_{N+V,c} = 0.18649 + 0.55979 + 0.12264 = 0.86892 \leq 1.0$$

(Utilization : 87%)

$\beta_{N,c}$, governing failure mode: Concrete breakout
$\beta_{V,c,y}$, governing failure mode: Concrete edge breakout - perpendicular
$\beta_{V,c,x}$, governing failure mode: Concrete edge breakout - longitudinal

Remarks and warnings

- The anchor plate overlaps the basematerial edges. A local concrete spalling due to compression close to the edges has to be checked separately!
- The calculations performed by PROFIS are in accordance with ICC-ES AC 232, and utilize the methodologies, data, and limitations contained in ICC-ESR-3520.
- It is the responsibility of the Engineer of Record (EOR) to verify that the associated shear resistance and transfer of loads into the structure meets local building code requirements and is otherwise suitable for the specific project/application.
- “Supplementary reinforcement” (existing reinforcement, anchor reinforcement) input should only be selected if the EOR has verified the design of the concrete substructure complies with the associated reinforcement requirements contained in ACI 318-11 or ACI 318-14. Condition A applies when supplementary reinforcement is selected. The Φ factor is increased for non-steel Design Strengths except Pullout Strength and Pry-out strength. Condition B applies when supplementary reinforcement is not selected, and for Pullout Strength and Pry-out Strength. Refer to your local codes.
- The PROFIS calculation is based on the simplified assumption of a rigid anchor plate/bracket. The anchor plate must be designed separately outside the PROFIS software.
- PROFIS calculations assume proper installation of the anchor channel system and surrounding structure – deviations will affect the Design Strength of anchor channel systems. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for installation of the anchor channel, bolt and, if required HIT-HY100 adhesive.
- Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Any as-built conditions which vary from the PROFIS inputs (e.g., use of alternative product, variations in supplementary reinforcement or base material, changes in the loading conditions…), renders the PROFIS design invalid, and requires recalculation.

Design ok! (Maximum utilization: 87%)

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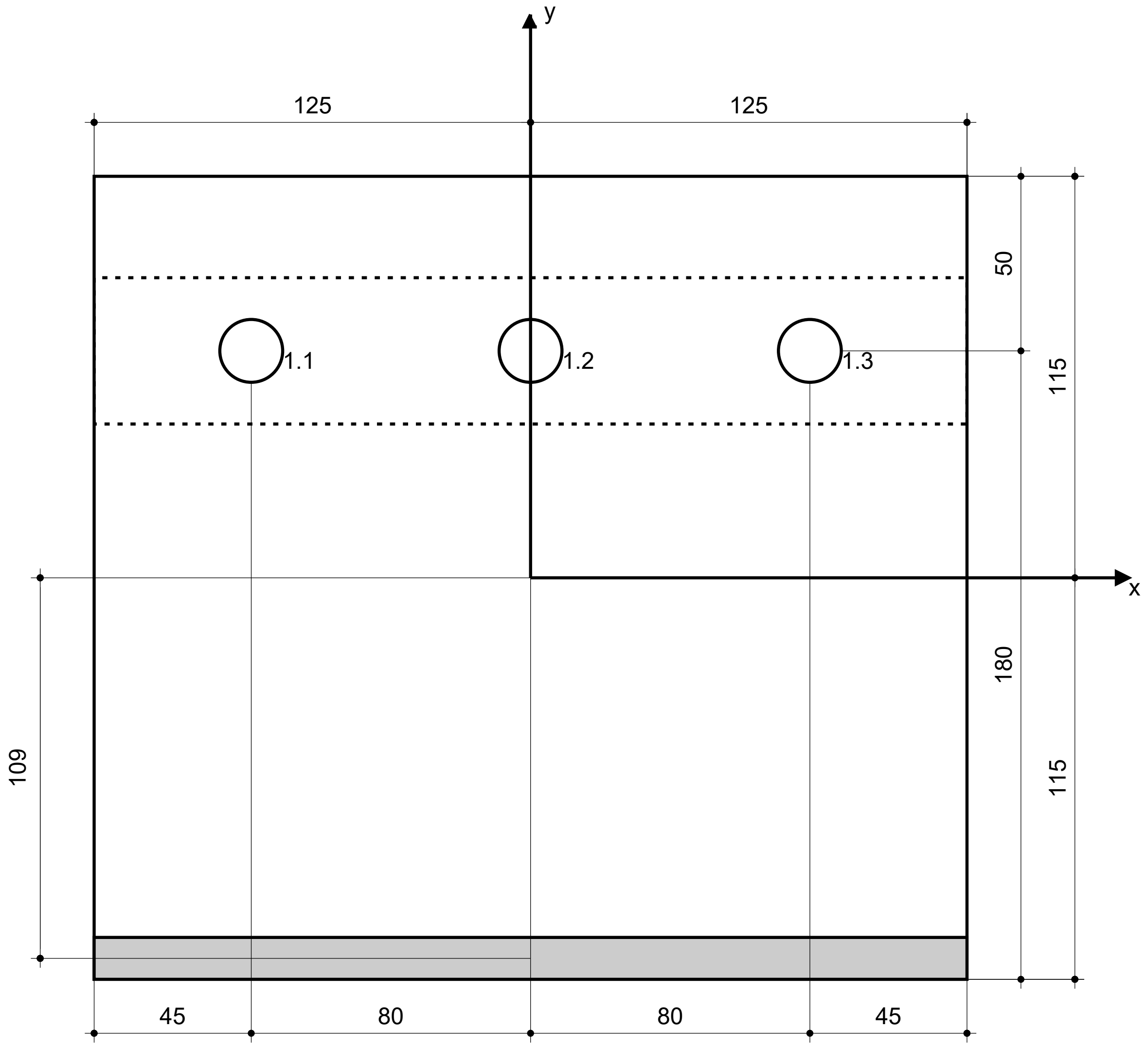
6 Installation data

6.1 Fixture 1

Plate type:	-	Bolt type:	HBC-C-N 8.8F, M16 x 50 mm
Plate dimensions:	250 mm x 230 mm x 12 mm	Bolt length:	50 mm
Profile:	; L x W x T = 250 x 12 x 0 mm	Bolt diameter:	16 mm
Anchorplate design calculated:	no	Diameter hole:	18 mm
		Installation torque:	0.185 kNm



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7 Remarks; Your Cooperation Duties

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