Company:
Address:
Phone I Fax:
Design:
Fastening point:
[redacted]

Page:
Specifier:
E-Mail:
Date:
[redacted]

Specifier's comments:

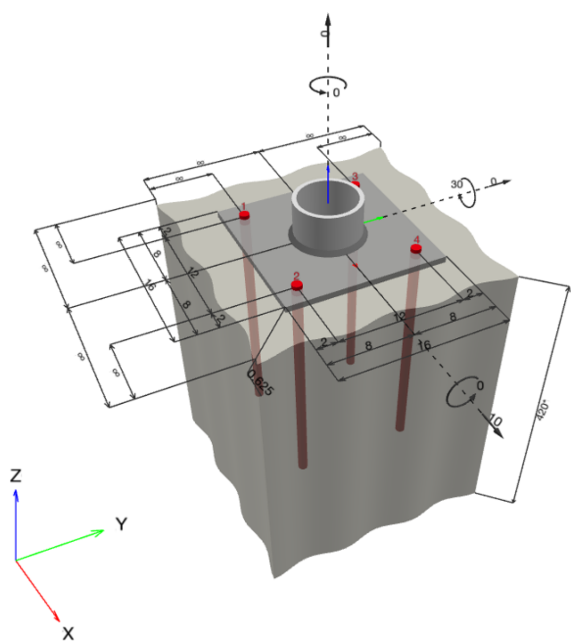
1 Anchor Design

1.1 Input data

Anchor type and diameter:	**Hex Head ASTM F 1554 GR. 36 1**
Item number:	not available
Effective embedment depth:	h_{ef} = 24.000 in.
Material:	ASTM F 1554
Evaluation Service Report:	Hilti Technical Data
Issued I Valid:	- | -
Proof:	Design Method ACI 318-19 / CIP
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.625 in.
Anchor plate^{CBFEM} :	l_x x l_y x t = 16.000 in. x 16.000 in. x 0.625 in.;
Profile:	Steel pipe, PIPE6XS; (L x W x T) = 6.630 in. x 6.630 in. x 0.432 in.
Base material:	cracked concrete, 4000, f_c' = 4,000 psi; h = 420.000 in.
Reinforcement:	tension: not present, shear: not present;
	edge reinforcement: none or < No. 4 bar

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

Geometry [in.] & Loading [kip, ft.kip]



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1.1.1 Design results

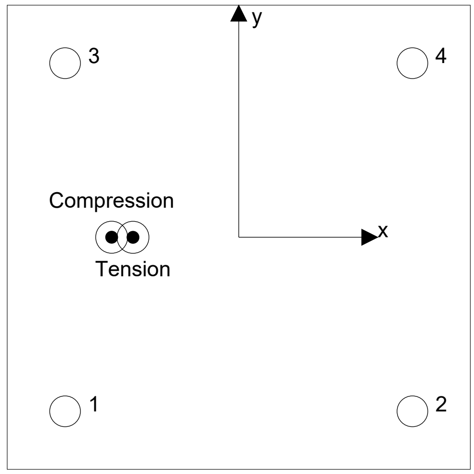
Case	Description	Forces [kip] / Moments [ft.kip]	Seismic	Max. Util. Anchor [%]
1	Combination 1	$N = 0.000$; $V_x = 10.000$; $V_y = 0.000$; $M_x = 0.00000$; $M_y = 30.00000$; $M_z = 0.00000$;	no	327

1.2 Load case/Resulting anchor forces

Anchor reactions [kip]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	85.147	5.450	3.826	3.881
2	20.708	1.174	1.173	-0.034
3	85.106	5.452	3.828	-3.882
4	20.669	1.173	1.173	0.035



resulting tension force in (x/y)=(-3.654/-0.002): 211.630 [kip]
resulting compression force in (x/y)=(-4.390/0.001): 323.802 [kip]

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

1.3 Tension load

	Load N_{ua} [kip]	**Capacity ϕ N_n [kip]**	**Utilization $\beta_N = N_{ua}/\phi$ N_n**	**Status**
Steel Strength*	85.147	26.361	324	not recommended
Pullout Strength*	85.147	26.051	327	not recommended
Concrete Breakout Failure**	211.630	174.777	122	not recommended
Concrete Side-Face Blowout, direction **	N/A	N/A	N/A	N/A

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

1.3.1 Steel Strength

N_{sa} [kip]	ϕ	ϕ N_{sa} [kip]	N_{ua} [kip]
35.148	0.750	26.361	85.147

1.3.2 Pullout Strength

N_p [kip]	$\psi_{c,p}$	λ_a	ϕ	ϕ N_{pn} [kip]	N_{ua} [kip]
37.216	1.000	1	0.700	26.051	85.147

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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[redacted]

1.3.3 Concrete Breakout Failure

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$c_{a,min}$ [in.]	c_{ac} [in.]	$\psi_{c,N}$
7,056.00	5,184.00	∞	-	1.000

$e_{c1,N}$ [in.]	$\psi_{ec1,N}$	$e_{c2,N}$ [in.]	$\psi_{ec2,N}$	$\psi_{ed,N}$	k_{cr}
3.654	0.908	0.002	1.000	1.000	16

λ_a	N_b [kip]	ϕ	$\phi\ N_{cbg}$ [kip]	N_{ua} [kip]
1.000	202.070	0.700	174.777	211.630

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1.4 Shear load

	Load V_{ua} [kip]	Capacity $\phi\ V_n$ [kip]	Utilization $\beta_V = V_{ua}/\phi\ V_n$	Status
Steel Strength*	5.452	13.708	40	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	10.000	385.056	3	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} [kip]	ϕ	$\phi\ V_{sa}$ [kip]	V_{ua} [kip]
21.089	0.650	13.708	5.452

1.4.2 Pryout Strength

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$c_{a,min}$ [in.]	k_{cp}	c_{ac} [in.]	$\psi_{c,N}$
7,056.00	5,184.00	∞	2	∞	1.000

$e_{c1,V}$ [in.]	$\psi_{ec1,V}$	$e_{c2,V}$ [in.]	$\psi_{ec2,V}$	$\psi_{ed,N}$	k_{cr}
0.000	1.000	0.000	1.000	1.000	16

λ_a	N_b [kip]	ϕ	$\phi\ V_{cpg}$ [kip]	V_{ua} [kip]
1.000	202.070	0.700	385.056	10.000

1.5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
3.268	0.398	1.000	306	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.
- For additional information about ACI 318 strength design provisions, please go to https://submittals.us.hilti.com/PROFISAnchorDesignGuide/
- The anchor design methods in PROFIS Engineering require rigid anchor plates, as per current regulations (AS 5216:2018, 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."

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1.7 Installation data

Profile: Steel pipe, PIPE6XS; (L x W x T) = 6.630 in. x 6.630 in. x 0.432 in.

Hole diameter in the fixture: d_f = 1.062 in.

Plate thickness (input): 0.625 in.

Anchor type and diameter: Hex Head ASTM F 1554 GR. 36 1

Item number: not available

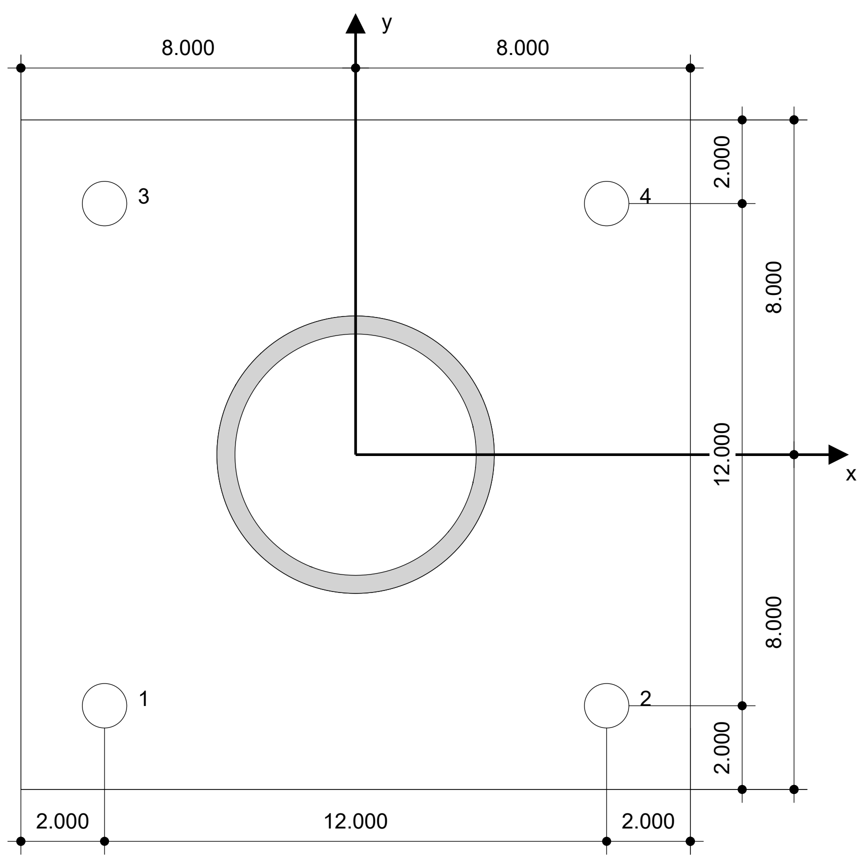
Maximum installation torque: -

Hole diameter in the base material: - in.

Hole depth in the base material: 24.000 in.

Minimum thickness of the base material: 25.172 in.

Hilti Hex Head headed stud anchor with 24 in embedment, 1, Steel galvanized, installation per instruction for use



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-6.000	-6.000	-	-	-	-
2	6.000	-6.000	-	-	-	-
3	-6.000	6.000	-	-	-	-
4	6.000	6.000	-	-	-	-

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2 Anchor plate design

2.1 Input data

Anchor plate:	Shape: Rectangular l_x x l_y x t = 16.000 in x 16.000 in x 0.625 in Calculation: CBFEM Material: ASTM A36; F_y = 36.000 ksi; ε_{lim} = 30.00%
Anchor type and size:	Hex Head ASTM F 1554 GR. 36 1, h_{ef} = 24.000 in
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 = 0.000 in (No stand-off); t = 0.625 in
Profile:	PIPE6XS; (L x W x T x FT) = 6.630 in x 6.630 in x 0.432 in x - Material: ASTM A53 Gr.B; F_y = 35.000 ksi; ε_{lim} = 30.00% Eccentricity x: 0.000 in Eccentricity y: 0.000 in
Base material:	Cracked concrete; 4000; $f_{c,cyl}$ = 4.000 ksi; h = 420.000 in
Welds (profile to anchor plate):	Type of redistribution: Plastic Material: E70xx
Mesh size:	Number of elements on edge: 8 Min. size of element: 0.394 in Max. size of element: 1.969 in

2.2 Summary

	Description	Profile		Anchor plate			Welds [%]	Concrete [%]
		σ_{Ed} [ksi]	ε_{Pl} [%]	σ_{Ed} [ksi]	ε_{Pl} [%]	Hole bearing [%]		
1	Combination 1	47.207	42.05	65.802	102.66	9	156	122

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	15.039 kip	85.147 kip
Anchor 2	-0.001 kip	20.708 kip
Anchor 3	15.039 kip	85.106 kip
Anchor 4	-0.001 kip	20.669 kip

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 [ksi]	ε_{lim} [%]	σ_{Ed} [ksi]	ε_{Pl} [%]	Status
Plate	Combination 1	ASTM A36	36.000	30.00	65.802	102.66	NOT OK
Profile	Combination 1	ASTM A53 Gr.B	35.000	30.00	47.207	42.05	NOT OK

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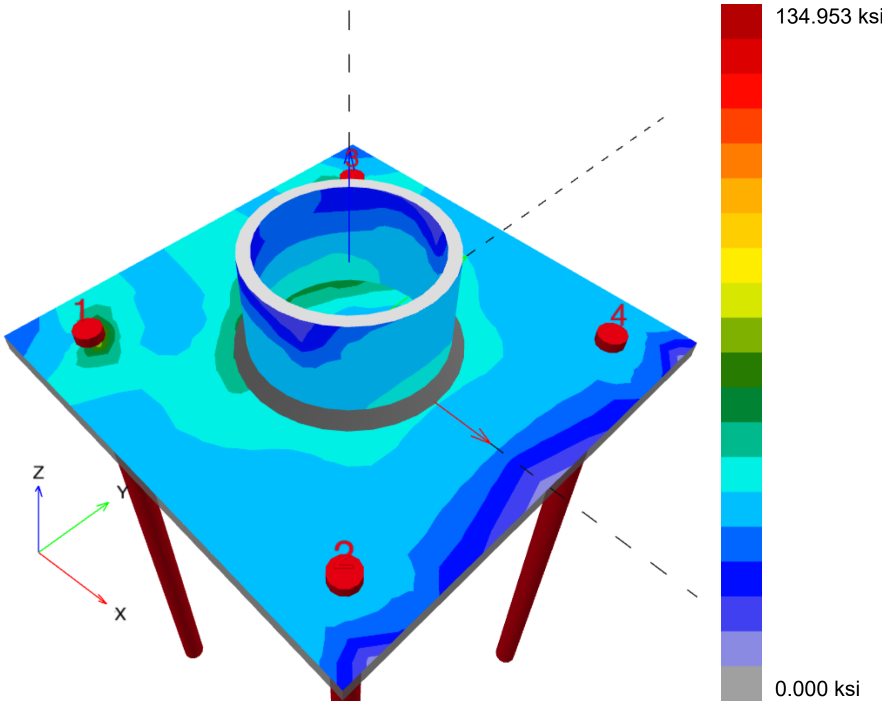
2.4.1.1 Equivalent stress

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



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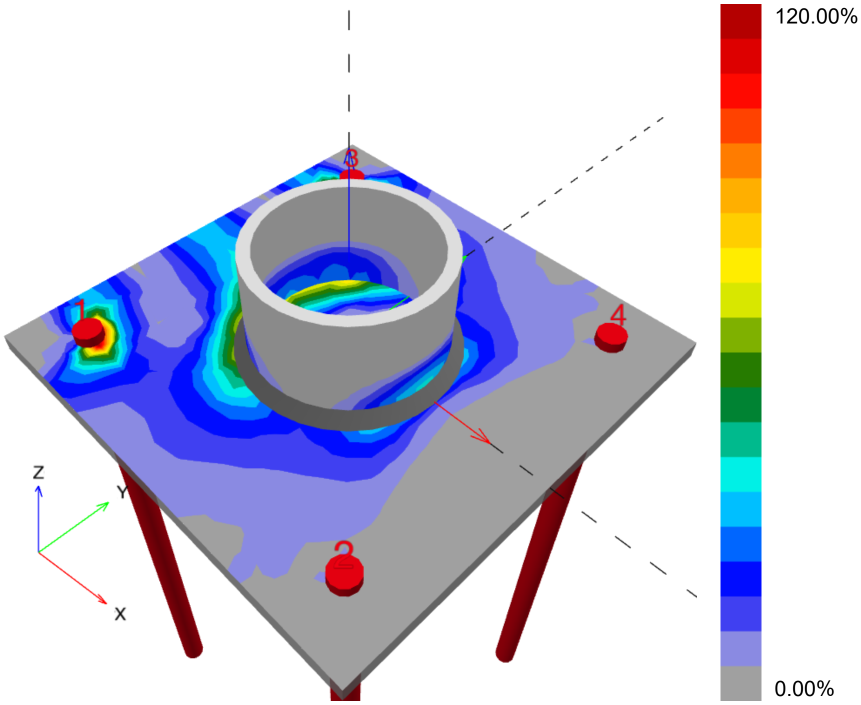
2.4.1.2 Plastic strain

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

Results

	V [kip]	ΦR_n [kip]	Utilization [%]	Status
Anchor 1	5.450	65.271	9	OK
Anchor 2	1.174	65.271	2	OK
Anchor 3	5.451	65.271	9	OK
Anchor 4	1.173	65.271	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

Results

Edge	F_n [kip]	ΦR_n [kip]	Utilization [%]	Status
Member 1	13.933	8.951	156	NOT OK

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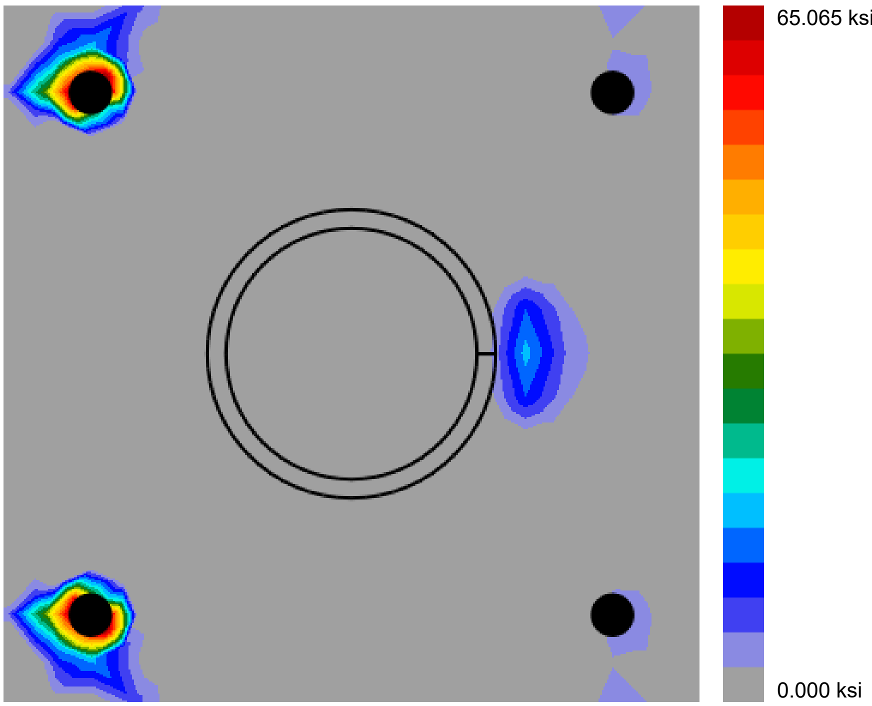
Design:		Date:	
Fastening point:			

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

Results

Load combination	F_p [ksi]	σ [ksi]	Utilization [%]	Status
Combination 1	4.420	5.371	122	NOT OK

2.7 Symbol explanation

ε_{lim}	Limit plastic strain
ε_{Pl}	Plastic strain from CBFEM results
F_n	Force in weld critical element
F_p	Concrete block design bearing strength
f_y	Yield strength
σ	Average stress in concrete
σ_{Ed}	Equivalent stress
ΦR_n	Factored resistance
V	Resultant of shear forces Vy, Vz in bolt.

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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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.

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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Address:
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Date:

3 Summary of results

Design of the anchor plate, anchors, welds and other elements are based on CBFEM (component based finite element method) and AISC.

	Load combination	Max. utilization	Status
Anchors	Combination 1	327%	NOT OK
Anchor plate	Combination 1	183%	NOT OK
Welds	Combination 1	156%	NOT OK
Concrete	Combination 1	122%	NOT OK
Profile	Combination 1	135%	NOT OK

Fastening does not meet the design criteria!

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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