Submittal Documents

Seismic Analysis of the Boiler SVF 725/850

MAY 31, 2022

For:
WEIL-McLAIN

Prepared By:
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Summary

The scope of this report is the seismic qualification, based on the structural analysis, of the boiler model SVF 725/850, under the seismic loads for the seismic zone 4 in the United States. The analyses are limited to the load path from the COG of the assembly to the floor and the interior parts of the boiler are not within the scope of this work.

The qualification is in accordance with the seismic design requirements of IBC 2018, ASCE 7-22 and AISC 14th standards for the seismic zone 4, as the non-structural components, and based on the seismic parameters used in this report.

The structural analyses carried out on the base frame assembly and based on the safety factors reported in section **5.4**, the design requirements of AISC, is met in all the analyses performed in this report.

It is concluded that the design of the main frame and the seismic lugs meets the design requirements of IBC 2018, ASCE 7-22 and ASME BPVC and AISC standards. This conclusion is contingence to the accuracy of the SolidWorks model and other input data provided by WEIL-McLAIN (WM) and used to build the FE models and set up the analyses (material, COG,...) appended in Appendix 1.

Revision History

Rev	Date	Scope of the revision	Created by
A	05/31/2022	First Issue	Sam Salissen

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1 Introduction

1.1 Scope

The scope of this report is the seismic qualification, based on the structural analysis, of the boiler, model SVF 725/850, under the seismic loads (the seismic zone 4 in the states). The analyses are limited to the load path from the COG of the assembly to the floor and the interior parts of the boiler are not within the scope of this work. The qualification is in accordance with the design requirements of IBC 2018, ASCE 7-22 and AISC.

2 Assumptions and open issues

In this chapter, assumptions and open issues are presented in two categories. The definition of each is presented below.

Open issues- Is defined as issues that must be solved, otherwise the analysis cannot be completed.

Key assumption- Is defined as assumptions that may have noticeable impact on the analysis results.

2.1 Open Issues

- No open issues exist.

2.2 Key Assumptions

No fabrication drawing of the parts and assembly were provided and the analyses are based on the SolidWorks model that is provided by WM and no responsibility of the accuracy of the model with respect to the actual assembly will be taken by the author of this report.

- The weight and the location of the center of the gravity of the boiler assembly are estimated and provided by WM, Appendix 1.
- It is assumed that the material of the base frame and the top plate are S235JR.
- It is assumed that the welds have at least the same strength as the base material (Weld strength FEXX=70ksi>54ksi for base material) based on ASME allowable stress in welds under shear and tension is 0.3 *tensile strength =21000psi. In this case the allowable stresses of the structural members, based on (AISC), is less than the allowable stress in the welds. So, no weld analysis will be performed in this work.

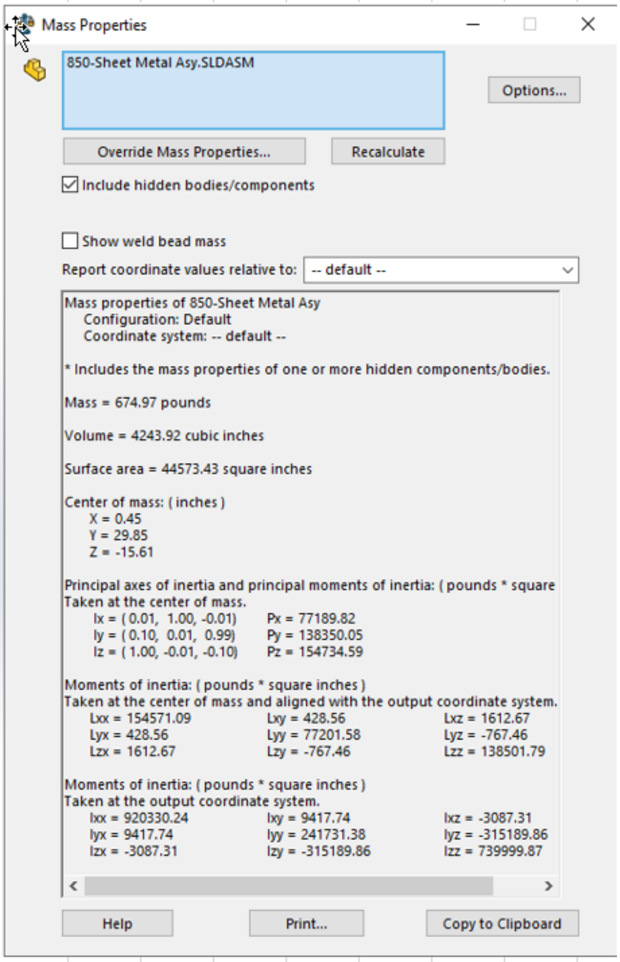
3 Requirements and Prerequisites

3.1 Stress criteria

The seismic loads are calculated based on the IBC 2018 code. The detail of the used parameters and the calculations are as follows. Seismic analyses are performed (using FEM) based on ASD approach of the AISC 14 & ASCE 7-22 for the steel parts and LRFD for the anchorage calculations.

3.2 Loads

The following inputs are used for the weight of the boilers.



Cad model Overall Weight with water

Three load cases are considered in this report, the analyses are based on the worst load combinations specified in ASCE 7-22. The following parameters are used in calculation of the seismic loads as follows:

1- Load case 1: Used for the analyses of the steel parts

CAEP
14271 Jeffery Rd.,
Irvine, CA 90032
PH (949) 923 9073 FX (949) 264 7184
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"CALL US - TO SET THINGS RIGHT"

JOB NAME: **SVF 850**
CUSTOMER: **WEIL-McLAIN**

DATE:	PRP. BY.:	CAE PIPING JOB #:
5/29/2022		

SEISMIC CALCULATION WORKSHEET
BUILDING CODE: **IBC-2018**
SEISMIC DESIGN: S_{ds} = 2; I_p = 1; a_p = 1; R_p = 2.5; Ω_o = 2.0
BLDG. ELEVATION / EQUIP. LOCATION: h = 40 ft; **z = 40 ft
** Assume worst case location.
a_p, R_p, Ω_o per ASCE 7-10
[X] 40 ft. RF
[ ] 0 ft. GF or below ground

EQUIPMENT TAG: SVF 850

LOAD COMBINATION: **LRFD-1**
(0.9 DL + 1.20 E)

EQUIPMENT Information:
W_p = max. operating weight = **510 lbs.**

APPLIED SEISMIC FORCE/ CALCULATIONS:
F_p / W_p = (0.4 x a_p x S_{ds} x (1 + (2 x (z / h))) / (R_p / I_p) = 0.96
F_p / W_p = **0.96g** ; $F_{p,min} / W_p$ = 0.3 x S_{ds} x I_p = 0.60 ; $F_{p,max} / W_p$ = 1.6 x S_{ds} x I_p = 3.20
F_{ph} = Applied Lateral Seismic Force = 1.2 x 0.96g x W_p = **588 lbs.** *WORST CASE
F_{pv} = Vertical component of seismic force = 1.0 x 0.2 x S_{ds} x W_p = **204 lbs.** *WORST CASE
F_v = Vertical total load = F_{pv} - .9*Wp = **-255 lbs.**

ANCHORAGE TO CONCRETE
SHT. NUMBER: 1 OF 1

2- Load case 2: Used for the analyses of the steel parts

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JOB NAME: **SVF 850**
CUSTOMER: **WEIL-McLAIN**

DATE:	PRP. BY.:	CAE PIPING JOB #:
5/29/2022		

SEISMIC CALCULATION WORKSHEET
BUILDING CODE: **IBC-2018**
SEISMIC DESIGN: S_{ds} = 2; I_p = 1; a_p = 1; R_p = 2.5; Ω_o = 2.0
BLDG. ELEVATION / EQUIP. LOCATION: h = 40 ft; **z = 40 ft
** Assume worst case location.
a_p, R_p, Ω_o per ASCE 7-10
[X] 40 ft. RF
[ ] 0 ft. GF or below ground

EQUIPMENT TAG: SVF 850

LOAD COMBINATION: **LRFD -2**
(1 DL + 1.20 E)

EQUIPMENT Information:
W_p = max. operating weight = **510 lbs.**

APPLIED SEISMIC FORCE/ CALCULATIONS:
F_p / W_p = (0.4 x a_p x S_{ds} x (1 + (2 x (z / h))) / (R_p / I_p) = 0.96
F_p / W_p = **0.96g** ; $F_{p,min} / W_p$ = 0.3 x S_{ds} x I_p = 0.60 ; $F_{p,max} / W_p$ = 1.6 x S_{ds} x I_p = 3.20
F_{ph} = Applied Lateral Seismic Force = 1.2 x 0.96g x W_p = **588 lbs.** *WORST CASE
F_{pv} = Vertical component of seismic force = 1.0 x 0.2 x S_{ds} x W_p = **204 lbs.** *WORST CASE
F_v = Vertical total load = F_{pv} - Wp = **-306 lbs.**

ANCHORAGE TO CONCRETE
SHT. NUMBER: 1 OF 1

3- Load case 3: Used in the analyses of the anchorage

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JOB NAME: **SVF 850**
CUSTOMER: **WEIL-McLAIN**

DATE:	PRP. BY.:	CAE PIPING JOB #:
5/29/2022		

SEISMIC CALCULATION WORKSHEET
BUILDING CODE: **IBC-2018**
SEISMIC DESIGN: S_{ds} = 2; I_p = 1; a_p = 1; R_p = 2.5; Ω_o = 2.0
BLDG. ELEVATION / EQUIP. LOCATION: h = 40 ft; **z = 40 ft
** Assume worst case location.
a_p, R_p, Ω_o per ASCE 7-10
[X] 40 ft. RF
[ ] 0 ft. GF or below ground

EQUIPMENT TAG: SVF 850

LOAD COMBINATION: **LRFD -3**
(0.9 DL + 2.00 E)

EQUIPMENT Information:
W_p = max. operating weight = **510 lbs.**

APPLIED SEISMIC FORCE/ CALCULATIONS:
F_p / W_p = (0.4 x a_p x S_{ds} x (1 + (2 x (z / h))) / (R_p / I_p) = 0.96
F_p / W_p = **0.96g** ; $F_{p,min} / W_p$ = 0.3 x S_{ds} x I_p = 0.60 ; $F_{p,max} / W_p$ = 1.6 x S_{ds} x I_p = 3.20
F_{ph} = Applied Lateral Seismic Force = 2.0 x 0.96g x W_p = **980 lbs.** *WORST CASE
F_{pv} = Vertical component of seismic force = 1.0 x 0.2 x S_{ds} x W_p = **204 lbs.** *WORST CASE
F_v = Vertical total load = F_{pv} - .9*Wp = **-255 lbs.**

ANCHORAGE TO CONCRETE
SHT. NUMBER: 1 OF 1

The seismic load and acceleration and the weight loads are applied at the location of the center of the gravity of boiler's assembly, using rigid elements, see Fig. 1.

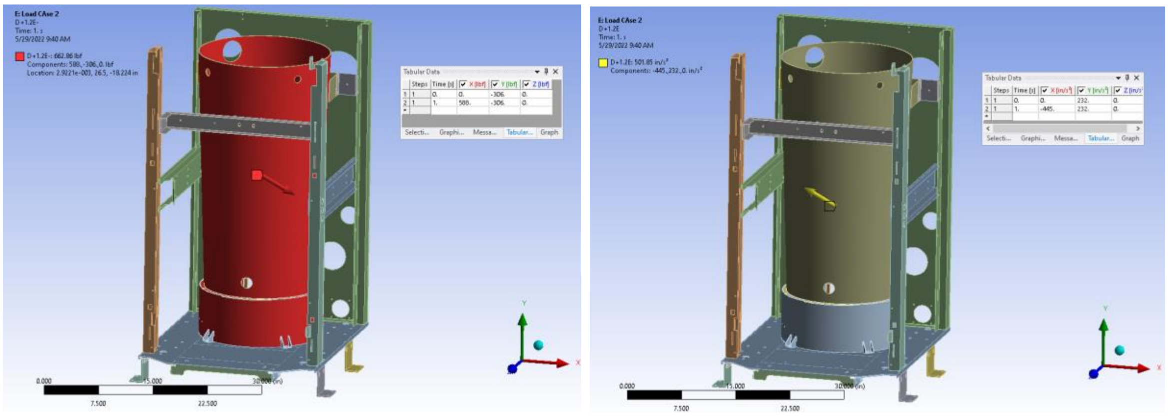


Figure **1-** Loads acting on the boiler structure

Table 1- Load Summary

load Case #	Horizontal Seismic Force FP [lbf]		Vertical Seismic Force FPV [lbf]	Total vertical Force FV [lbf]	Horizontal Seismic Acceleration [g]	
	FZ	FX			AY	AX-AZ
1	588	0	204	-255	0.5	1.152
2	588	0	204	-306	0.6	1.152
3	980	0	204	-255	0.5	1.92

4 FE model

4.1 The extent of the model

A FE model is built based on the SoildWorks model provided by WM. The loads bearing parts , corresponding to the load path from the COG to the base plates, are included in the FE- model. Flexible joints and contact elements are used to assemble the parts, simulating the bolts and welds, see Fig. 2.

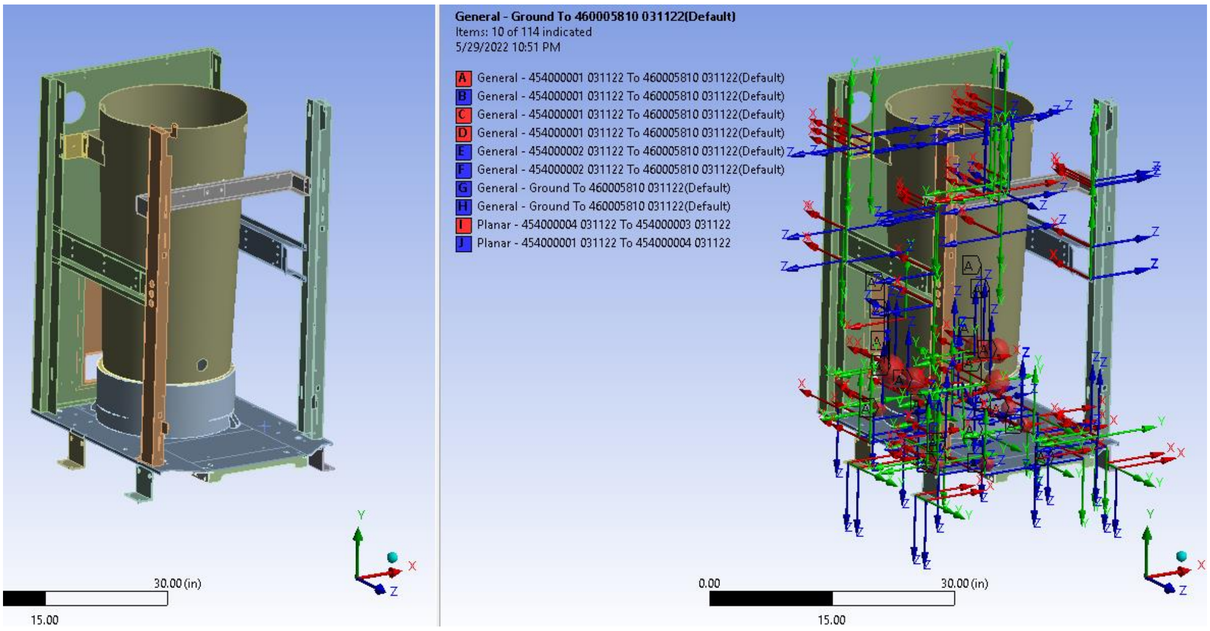


Figure **2-** FE model of the boiler and joint/contact definitions

4.2 Material data

The material properties used in the construction of the boiler is governed under the internationally recognized ANSI, ASTM standards for the solid shapes and the AWS standards for welding wire. The specific alloys of steel bar, tube, plate, round and channel used in the construction include **S235JR** Carbon Steel and listed below.

S235JR Carbon Steel: E=2.9E+7 psi, S_Y=34,000 psi

5 *Stress Analyses*

5.1 *Analysis of assembly: Load Case 1*

In this load case, the lateral seismic load and acceleration, calculated in Section 3.2, is applied in the direction of X-Axis(lateral), as shown in Fig. 3. All dimensions, loads and stresses are in inch, lbf and psi, respectively.

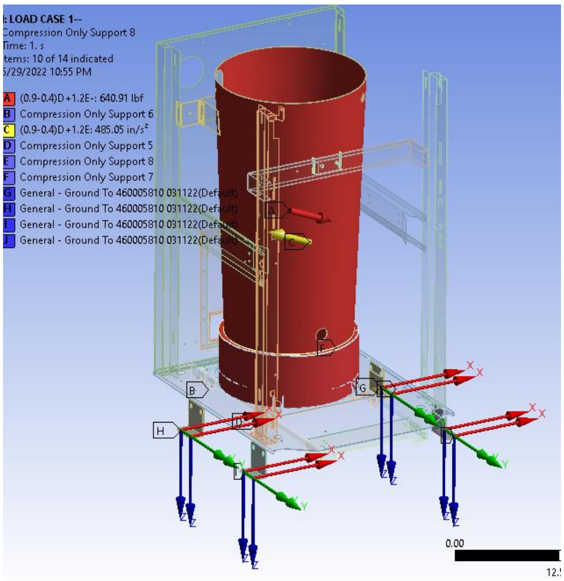
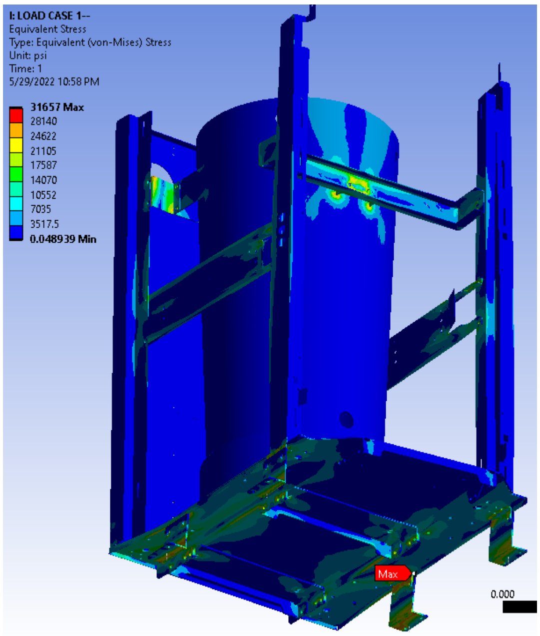


Fig. **3** – Loading case 1- Loading and boundary conditions

Maximum peak stress (Bending+ membrane+ stress concentration stresses) and shear stress of 31,657psi and 17,492psi are computed in the FE analysis, Fig.4, which meets the requirements of AISC. The peak stresses in the parts, Fig.4, are local stresses and the linearized stresses through the thickness of the part at the location where the highest stress is occurred, is much less than the values reported here.



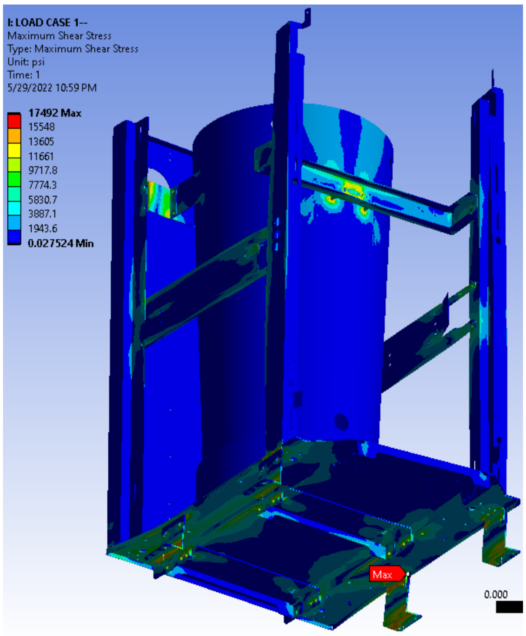


Fig. **4** – Maximum peak and shear stresses in load case 1

5.2 Analysis of assembly: Load Case 2

In this load case, the lateral seismic load and acceleration, calculated in Section 3.2, is applied in the direction of X-Axis (lateral), as shown in Fig. 5. All dimensions, loads and stresses are in inch, lbf and psi, respectively.

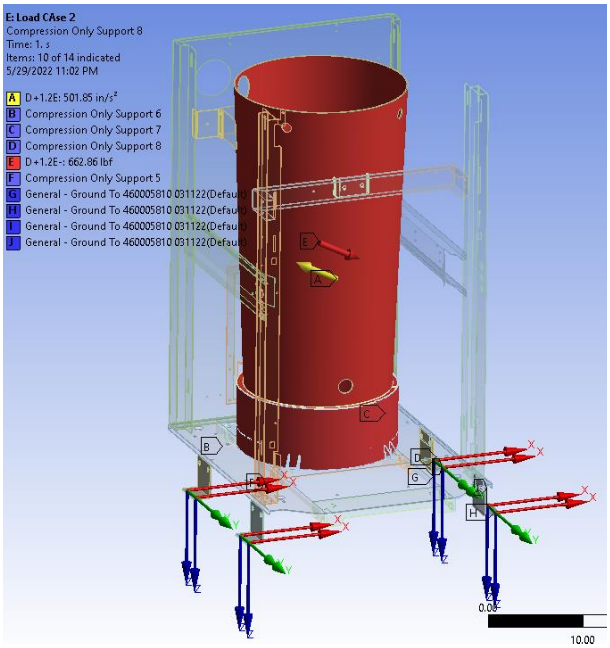


Fig. **5** – Load case 2- Loading and boundary conditions

Maximum peak stress (Bending+ membrane+ stress concentration stresses) and shear stress of 33,535psi and 18,006psi are computed in the FE analysis Fig.6, which meets the requirements of AISC. The peak stresses in the parts, Fig. 6, are local stresses and the linearized stresses through the thickness of the part at the location where the highest stress is occurred, is much less than the values reported here.

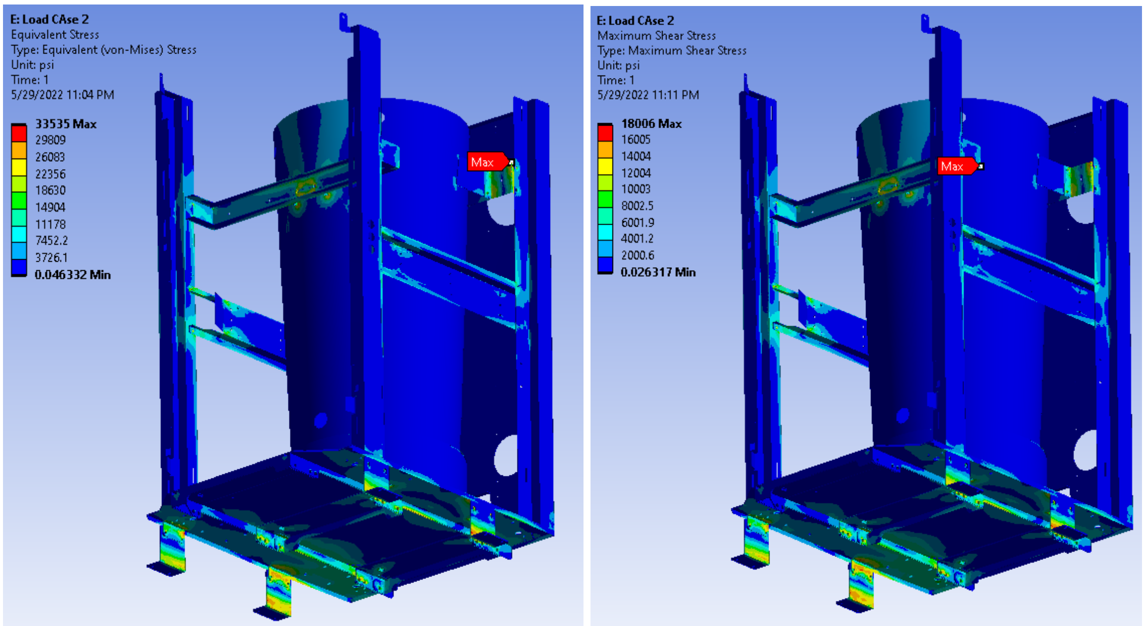


Fig. **6** – Maximum peak and shear stresses in load case 2

5.3 Analysis of assembly: Load Case 3

In this load case, the lateral seismic load, calculated in Section 3.2, is applied in the direction of X-Axis, as shown in Fig. 8. All dimensions, loads and stresses are in inch, lbf and psi, respectively.

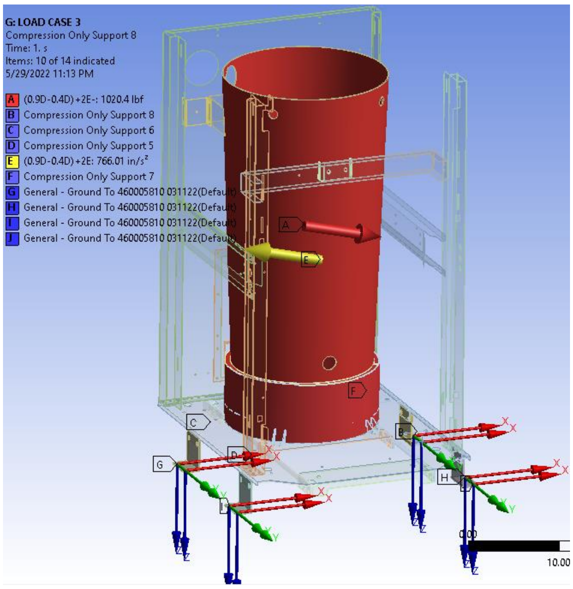


Fig. **8** – Load case 3- Loading and boundary conditions

The maximum reaction loads at the base plates are extracted from the analyses and shown in Figure 10. These loads are used in the analysis of the anchor bolts.

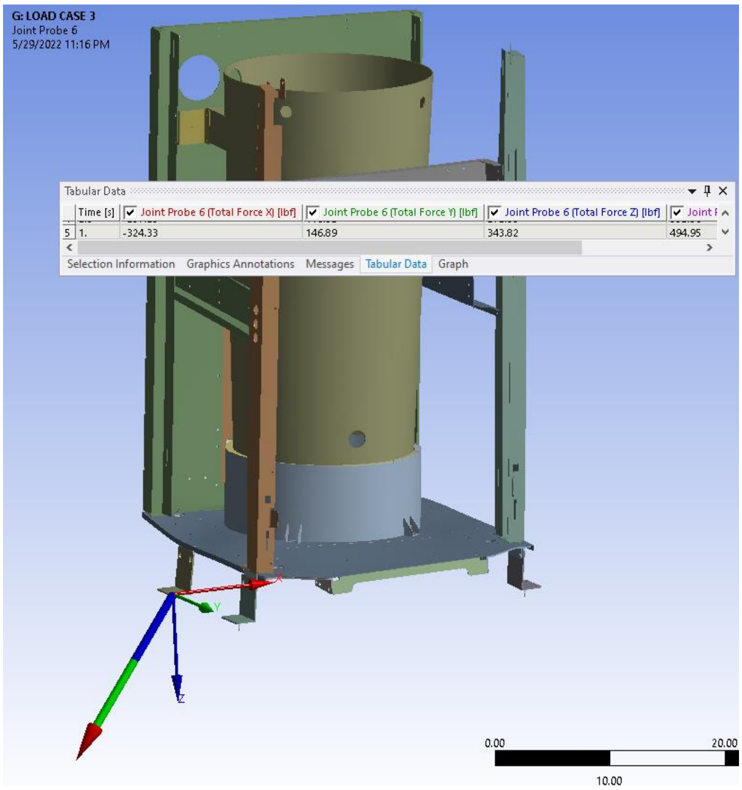


Fig. **10** – Maximum reaction force in the base plates

5.4 Anchor Bolts

Hilti KBZ anchor bolts, 3/8" (2 3/4" embedment), are used to anchor the base plates to the floor. The maximum reaction loads at the location of the anchor bolts are extracted from the FE-analyses (load case 3). The detail of the anchor bolt calcs are provided in Appendix 3. The minimum concrete thickness of 5" and PSI rating of 3.000 psi are considered in the analyses).

Table-3: Reaction loads in the base plate, Fig. 10

Reaction forces [lbf]		
FX	FY	FZ
325	150	350

5.5 Results Evaluation

Minimum required strength specified in ASCE (LRFD design approach) is obtained in the analyses of the assembly carried out in sections 5.1 to 5.4, (minimum safety factor of 1 for LRFD load). The stresses reported in section 5 are the local stresses and the average stress through the thickness of the members are much lower and that can be shown by stress linearization through the thickness. However, since even the maximum local peak stresses don't exceed the allowable values, the stress linearization work is skipped here.

6 Conclusion

Seismic analysis of the boiler, model SVF 725/850, is carried out in this report and based on the safety factors reported in section **5.4**, minimum required strength factor is obtained in all the analyses performed in this report.

It is concluded that the design of the structure of the boiler SVF 725/850 meets the design requirements of AISC, ASCE7-10 and IBC 2018 standards.

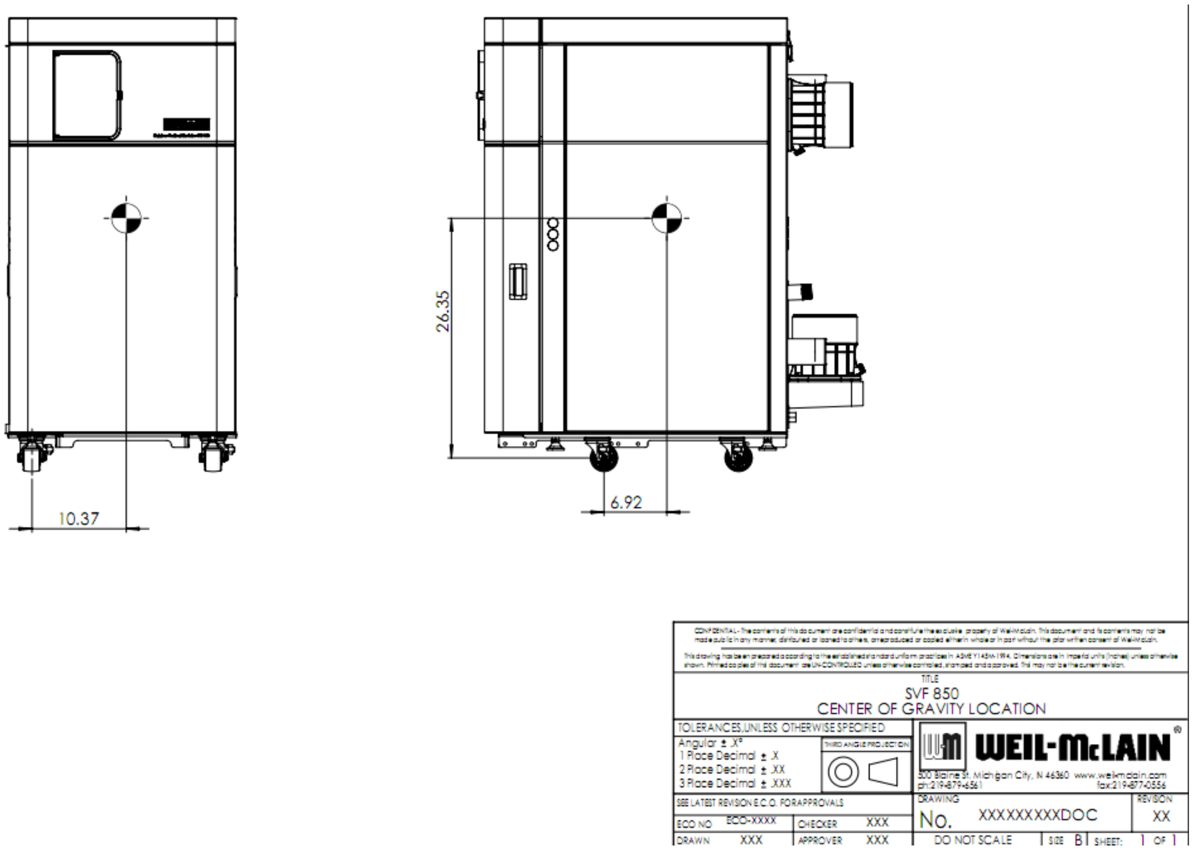
7 *References*

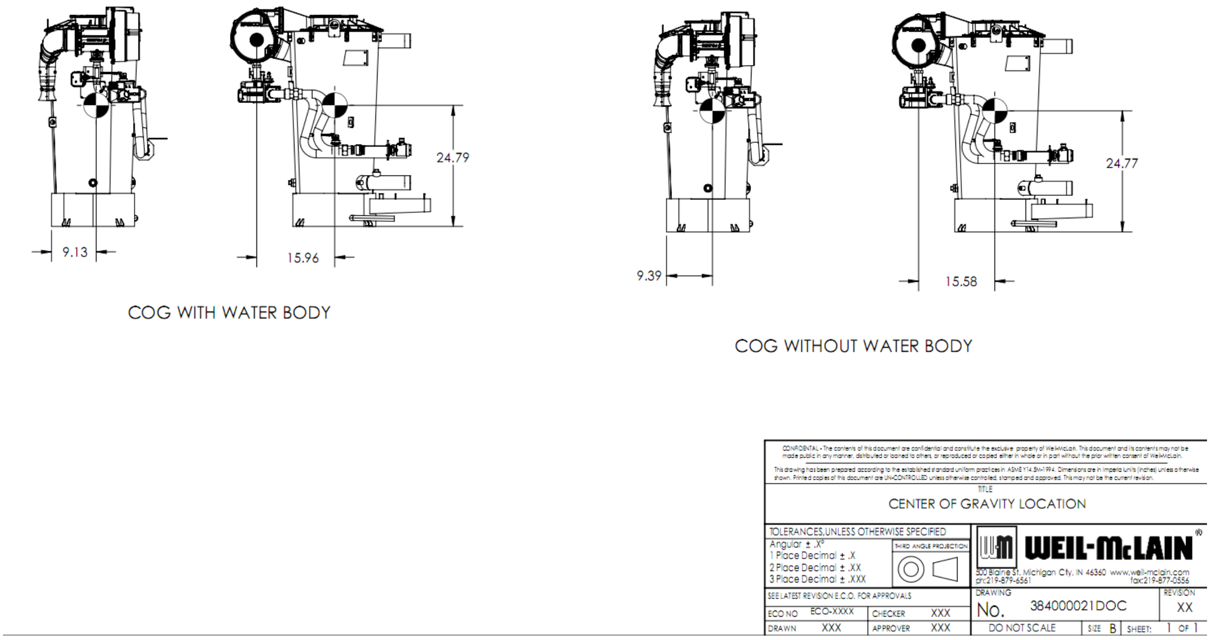
[1]- IBC 2012.

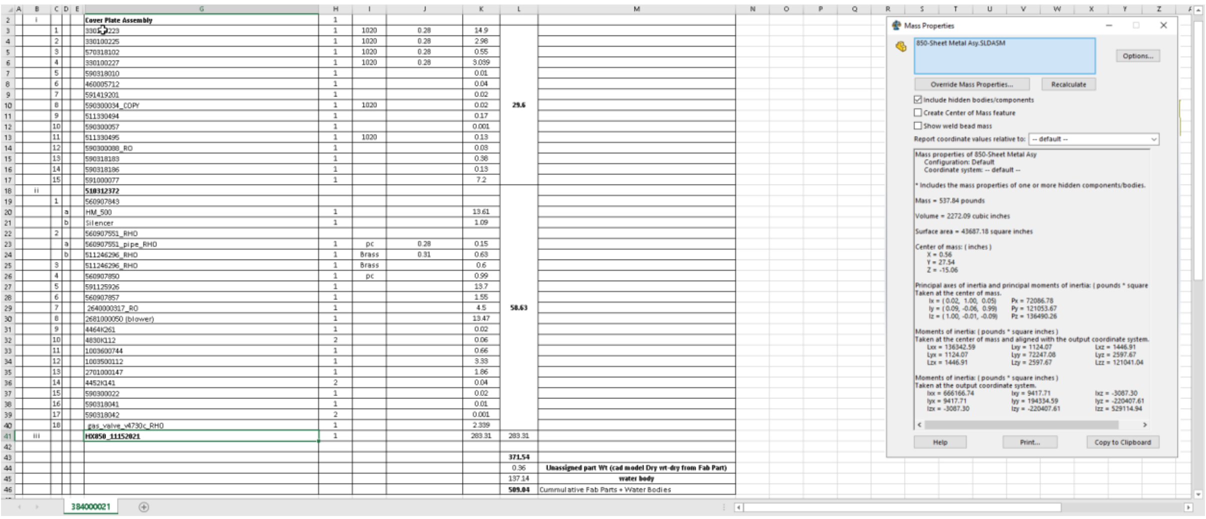
[2]- AISC 14th Edition.

[3]- ASCE 7-10.

APPENDIX ***1***- Drawing with COG markup







	B	C	D	G	H	I	J	K	L	M
2	i			**Cover Plate Assembly**	1					
3		1		3301[illegible]223	1	1020	0.28	14.9		
4		2		330100225	1	1020	0.28	2.98		
5		3		570318102	1	1020	0.28	0.55		
6		4		330100227	1	1020	0.28	3.039		
7		5		590318010	1			0.01		
8		6		460005712	1			0.04		
9		7		591419201	1			0.02		
10		8		590300034_COPY	1	1020		0.02	**29.6**	
11		9		511330494	1			0.17		
12		10		590300057	1			0.001		
13		11		511330495	1	1020		0.13		
14		12		590300088_RO	1			0.03		
15		13		590318183	1			0.38		
16		14		590318186	1			0.13		
17		15		591000077	1			7.2		
18	ii			**510312372**						
19		1		560907843						
20			a	HM_500	1			13.61		
21			b	Silencer	1			1.09		
22		2		560907551_RHO						
23			a	560907551_pipe_RHO	1	pc	0.28	0.15		
24			b	511246296_RHO	1	Brass	0.31	0.63		
25		3		511246296_RHO	1	Brass		0.6		
26		4		560907850	1	pc		0.99		
27		5		591125926	1			13.7		
28		6		560907857	1			1.55		
29		7		2640000317_RO	1			4.5	**58.63**	
30		8		2681000050 (blower)	1			13.47		
31		9		4464K261	1			0.02		
32		10		4830K112	2			0.06		
33		11		1003600744	1			0.66		
34		12		1003500112	1			3.33		
35		13		2701000147	1			1.86		
36		14		4452K141	2			0.04		
37		15		590300022	1			0.02		
38		16		590318041	1			0.01		
39		17		590318042	2			0.001		
40		18		gas_valve_v4730c_RHO	1			2.339		
41	iii			**HX850_11152021**	1			283.31	283.31	
42										
43									**371.54**	
44									0.36	**Unassigned part Wt (cad model Dry wt-dry from Fab Part)**
45									137.14	**water body**
46									**509.04**	Cummulative Fab Parts + Water Bodies

Appendix ***2***- Anchor Bolt Calculation

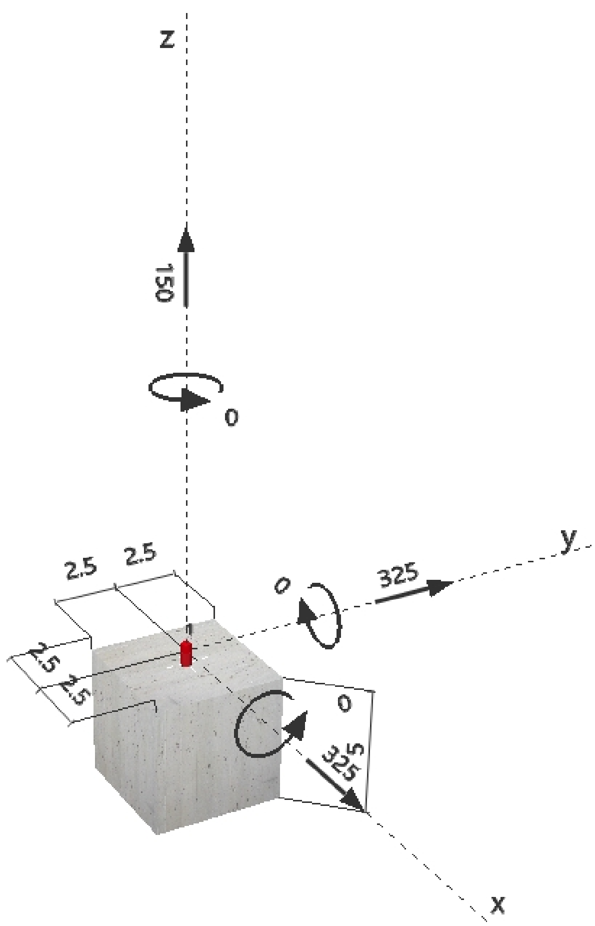
Company:		Page:	1
Specifier:		Project:	SVF 825
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	5/29/2022
E-Mail:			

Specifier's comments:

1 Input data

Anchor type and diameter:	**Kwik Bolt TZ - CS 3/8 (2 3/4)**
Effective embedment depth:	$h_{ef,act}$ = 2.750 in., h_{nom} = 3.063 in.
Material:	Carbon Steel
Evaluation Service Report:	ESR-1917
Issued I Valid:	6/1/2016 | 5/1/2017
Proof:	Design method ACI 318-14 / Mech.
Stand-off installation:	- (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 5.000 in.
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present
	edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.2.3.4.3 (d))
	Shear load: yes (17.2.3.5.3 (c))

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



2 Load case/Resulting anchor forces

Load case: Design loads

Anchor reactions [lb]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	150	460	325	325

max. concrete compressive strain: - [‰]
max. concrete compressive stress: - [psi]
resulting tension force in (x/y)=(0.000/0.000): 0 [lb]
resulting compression force in (x/y)=(0.000/0.000): 0 [lb]

3 Tension load

	Load N_{ua} [lb]	Capacity ϕ N_n [lb]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	150	4875	4	OK
Pullout Strength*	150	1685	9	OK
Concrete Breakout Strength**	150	977	16	OK

* anchor having the highest loading **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-1917
$\phi\ N_{sa} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.05	125000

Calculations

N_{sa} [lb]
6500

Results

N_{sa} [lb]	ϕ_{steel}	$\phi_{nonductile}$	$\phi\ N_{sa}$ [lb]	N_{ua} [lb]
6500	0.750	1.000	4875	150

3.2 Pullout Strength

$N_{pn,f'_c} = N_{p,2500}\ \lambda_a \sqrt{\frac{f'_c}{2500}}$ refer to ICC-ES ESR-1917

$\phi\ N_{pn,f'_c} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

f'_c [psi]	λ_a	$N_{p,2500}$ [lb]
3000	1.000	3155

Calculations

$\sqrt{\frac{f'_c}{2500}}$
1.095

Results

N_{pn,f'_c} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\ N_{pn,f'_c}$ [lb]	N_{ua} [lb]
3456	0.650	0.750	1.000	1685	150

3.3 Concrete Breakout Strength

$N_{cb} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ ACI 318-14 Eq. (17.4.2.1a)

$\phi\ N_{cb} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = k_c\ \lambda_a \sqrt{f'_c}\ h_{ef}^{1.5}$ ACI 318-14 Eq. (17.4.2.2a)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
1.667	0.000	0.000	2.500	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
4.125	17	1.000	3000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
25.00	25.00	1.000	1.000	1.000	1.000	2003

Results

N_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\ N_{cb}$ [lb]	N_{ua} [lb]
2003	0.650	0.750	1.000	977	150

4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_V = V_{ua}/\phi V_n$	Status
Steel Strength*	460	1466	32	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	460	2805	17	OK
Concrete edge failure in direction x+**	460	581	80	OK

* anchor having the highest loading **anchor group (relevant anchors)

4.1 Steel Strength

$V_{sa,eq}$ = ESR value refer to ICC-ES ESR-1917

$\phi \ V_{steel} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.05	125000

Calculations

$V_{sa,eq}$ [lb]
2255

Results

$V_{sa,eq}$ [lb]	ϕ_{steel}	$\phi_{nonductile}$	$\phi \ V_{sa}$ [lb]	V_{ua} [lb]
2255	0.650	1.000	1466	460

4.2 Pryout Strength

$V_{cp} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ed,N} \ \psi_{c,N} \ \psi_{cp,N} \ N_b\right]$ ACI 318-14 Eq. (17.5.3.1a)

$\phi \ V_{cp} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9 \ h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 \ e_N'}{3 \ h_{ef}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = k_c \ \lambda_a \sqrt{f_c'} \ h_{ef}^{1.5}$ ACI 318-14 Eq. (17.4.2.2a)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	1.667	0.000	0.000	2.500

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f_c' [psi]
1.000	4.125	17	1.000	3000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
25.00	25.00	1.000	1.000	1.000	1.000	2003

Results

V_{cp} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi \ V_{cp}$ [lb]	V_{ua} [lb]
4007	0.700	1.000	1.000	2805	460

4.3 Concrete edge failure in direction x+

$V_{cb} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ed,V}\, \psi_{c,V}\, \psi_{h,V}\, \psi_{parallel,V}\, V_b$ ACI 318-14 Eq. (17.5.2.1a)

$\phi\ V_{cb} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Vc} see ACI 318-14, Section 17.5.2.1, Fig. R 17.5.2.1(b)

$A_{Vc0} = 4.5\ c_{a1}^2$ ACI 318-14 Eq. (17.5.2.1c)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{2e_V'}{3c_{a1}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.5.2.5)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ ACI 318-14 Eq. (17.5.2.6b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ ACI 318-14 Eq. (17.5.2.8)

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2} \sqrt{d_a}\right) \lambda_a \sqrt{f_c'}\ c_{a1}^{1.5}$ ACI 318-14 Eq. (17.5.2.2a)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
2.500	2.500	0.000	1.000	5.000

l_e [in.]	λ_a	d_a [in.]	f_c' [psi]	$\psi_{parallel,V}$
2.750	1.000	0.375	3000	1.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
18.75	28.13	1.000	0.900	1.000	1382

Results

V_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\ V_{cb}$ [lb]	V_{ua} [lb]
829	0.700	1.000	1.000	581	460

5 Combined tension and shear loads

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.154	0.792	5/3	73	OK

$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} <= 1$

6 Warnings

- Load re-distributions 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 loading! Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies when supplementary reinforcement is used. The Φ factor is increased for non-steel Design Strengths except Pullout Strength and Pryout strength. Condition B applies when supplementary reinforcement is not used and for Pullout Strength and Pryout Strength. Refer to your local standard.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI 318 or the relevant standard!
- An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-14, Chapter 17, Section 17.2.3.4.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Section 17.2.3.4.3 (b), Section 17.2.3.4.3 (c), or Section 17.2.3.4.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.2.3.5.3 (a), Section 17.2.3.5.3 (b), or Section 17.2.3.5.3 (c).
-
- Hilti post-installed anchors shall be installed in accordance with the Hilti Manufacturer's Printed Installation Instructions (MPII). Reference ACI 318-14, Section 17.8.1.

Company:		Page:	6
Specifier:		Project:	SVF 825
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	5/29/2022
E-Mail:			

Fastening meets the design criteria!

Company:
Specifier:
Address:
Phone I Fax: |
E-Mail:

7 Installation data

Anchor plate, steel: -
Profile: -
Hole diameter in the fixture: -
Plate thickness (input): -
Recommended plate thickness: -
Drilling method: Hammer drilled
Cleaning: Manual cleaning of the drilled hole according to instructions for use is required.

Anchor type and diameter: Kwik Bolt TZ - CS 3/8 (2 3/4)
Installation torque: 25.000 ft.lb
Hole diameter in the base material: 0.375 in.
Hole depth in the base material: 3.375 in.
Minimum thickness of the base material: 5.000 in.

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer	• Manual blow-out pump	• Torque wrench
• Properly sized drill bit		• Hammer

Coordinates Anchor in.

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0.000	0.000	2.500	2.500	2.500	2.500

8 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.