

WILCO – HAY SHED, WATER TREATMENT & PROPANE TANK (FOUNDATION CALCULATIONS)

W11TH & WILLOW CREEK
EUGENE, OR 97402

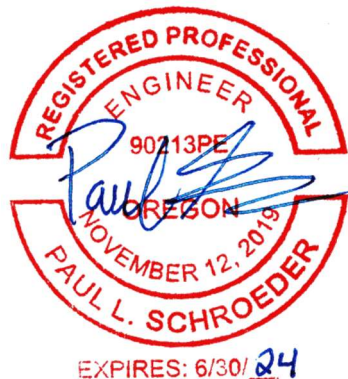
MAY 24, 2023
JOB# 22-0690

STRUCTURAL CALCULATIONS
BY



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05/24/2023



HAY SHED FOUNDATION
WATER TREATMENT RETAINING WALLS
PROPANE TANK ANCHORAGE

1-23
24-58
59-67

A This is a beta release of the new ATC Hazards by Location website. Please [contact us](#) with feedback.

i The ATC Hazards by Location website will not be updated to support ASCE 7-22. [Find out why.](#)

ATC Hazards by Location

Search Information

Address: W 11th Ave & Willow Creek Rd, Eugene, OR 97402, USA

Coordinates: 44.0482492, -123.1781955

Elevation: 393 ft

Timestamp: 2022-11-30T21:23:18.969Z

Hazard Type: Seismic

Reference Document: ASCE7-16

Risk Category: II

Site Class: D-default



Basic Parameters

Name	Value	Description
S_S	0.748	MCE_R ground motion (period=0.2s)
S_1	0.424	MCE_R ground motion (period=1.0s)
S_{MS}	0.899	Site-modified spectral acceleration value
S_{M1}	* null	Site-modified spectral acceleration value
S_{DS}	0.599	Numeric seismic design value at 0.2s SA
S_{D1}	* null	Numeric seismic design value at 1.0s SA

* See Section 11.4.8

▼Additional Information

Name	Value	Description
SDC	* null	Seismic design category
F_a	1.201	Site amplification factor at 0.2s
F_v	* null	Site amplification factor at 1.0s
CR_S	0.872	Coefficient of risk (0.2s)
CR_1	0.86	Coefficient of risk (1.0s)
PGA	0.357	MCE_G peak ground acceleration
F_{PGA}	1.243	Site amplification factor at PGA

PGA _M	0.444	Site modified peak ground acceleration
T _L	16	Long-period transition period (s)
SsRT	0.748	Probabilistic risk-targeted ground motion (0.2s)
SsUH	0.858	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.424	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.493	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.706	Factored deterministic acceleration value (1.0s)
PGAd	0.591	Factored deterministic acceleration value (PGA)

* See Section 11.4.8

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Please note that the ATC Hazards by Location website will not be updated to support ASCE 7-22. [Find out why.](#)

Disclaimer

Hazard loads are provided by the U.S. Geological Survey [Seismic Design Web Services](#).

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STRUCTURAL DESIGN

TABLE 1609.3
BASIC DESIGN WIND SPEED, V, FOR RISK CATEGORY I, II, III AND IV BUILDINGS AND OTHER STRUCTURES

COUNTY	RISK CATEGORY I BASIC DESIGN WIND SPEED (MPH)	RISK CATEGORY II BASIC DESIGN WIND SPEED (MPH)	RISK CATEGORY III BASIC DESIGN WIND SPEED (MPH)	RISK CATEGORY IV BASIC DESIGN WIND SPEED (MPH)
Baker	97	103	110	114
Benton	90	96	102	107
Clackamas	92	98	105	109
Clackamas special wind region ^a	115	120	130	130
Clatsop	91	96	102	107
Clatsop special wind region ^a	125	135	145	145
Columbia	91	97	103	107
Columbia special wind region ^a	115	120	130	130
Coos	89	95	101	106
Coos special wind region ^{a, b}	115 ^b	120 ^b	130 ^b	130 ^b
Crook	93	100	106	111
Crook special wind region ^a	100	110	115	115
Curry	88	94	101	105
Curry special wind region ^a	125	135	145	145
Deschutes	93	99	106	110
Deschutes special wind region ^a	100	110	115	115
Douglas	91	97	103	108
Douglas special wind region ^{a, b}	115 ^b	120 ^b	130 ^b	130 ^b
Gilliam ^d	94 ^d	100 ^d	107 ^d	111 ^d
Grant	95	101	108	113
Harney	94	101	108	112
Hood River ^c	92 ^c	98 ^c	105 ^c	109 ^c
Hood River N.45.5° special wind region ^{a, c}	115 ^c	120 ^c	130 ^c	130 ^c
Hood River S.45.5° special wind region ^a	100	110	115	115
Jackson	90	96	103	107
Jefferson	93	99	106	110
Jefferson special wind region ^a	100	110	115	115
Josephine	89	95	102	106
Klamath	91	98	104	108
Klamath special wind region ^a	100	110	115	115
Lake	93	99	106	111
Lane	91	98	105	110
Lane special wind region ^{a, b}	115 ^b	120 ^b	130 ^b	130 ^b
Lincoln	90	96	102	106
Lincoln special wind region ^a	125	135	145	145
Linn	92	98	104	108
Malheur	96	102	109	113
Marion	92	98	104	108
Morrow ^d	94 ^d	101 ^d	108 ^d	112 ^d
Multnomah ^c	92 ^c	98 ^c	105 ^c	110 ^c
Multnomah special wind region ^{a, c}	115 ^c	120 ^c	130 ^c	130 ^c
Polk	90	97	103	107

(continued)

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Project: 22-0690 Wilco Hay Storage


**STABILITY
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By: Paul Schroeder

STEEL COLUMN: LINE A COLUMNS 1 & 4

LOADS (lbs)	HORIZ TRANS.	HORIZ LONG.	VERT. (+)	VERT. (-)
DIRECTION:				
DEAD:	200	0	2600	---
LIVE:	0	0	0	---
LIVE ROOF:	400	0	4600	---
SNOW:	500	0	5700	---
RAIN:	0	0	0	---
WIND:	4600	2000	7400	-7400
SEISMIC:	1200	1700	2000	-2000

ASD LOAD COMB	TRANS.	LONG.	VERT. (+)	VERT. (-)	Strength	TRANS.	LONG.	VERT. (+)	VERT. (-)
LOAD COMB 1	200	0	2600	---	LOAD COMB 1	280	0	3640	---
LOAD COMB 2	200	0	2600	---	LOAD COMB 2	490	0	5970	---
LOAD COMB 3	700	0	8300	---	LOAD COMB 3	3340	1000	15940	---
LOAD COMB 4	575	0	6875	---	LOAD COMB 4	5090	2000	13370	---
LOAD COMB 5	2960	1200	7040	1200	LOAD COMB 5	1540	1700	6260	---
LOAD COMB 6a	2645	900	10205	3545	LOAD COMB 6	4780	2000	9740	-5060
LOAD COMB 6b	1205	892.5	7925	5825	LOAD COMB 7	1380	1700	4340	340
LOAD COMB 7	2880	1200	6000	-2880	MAX	5090	2000	15940	-5060
LOAD COMB 8	960	1190	2960	160					

ASD DESIGN LOADS	TRANS.	LONG.	VERT.
MINIMUM:	200	0	-2880
MAXIMUM:	2960	1200	10205

DESIGN SQUARE FOOTING FOR GRAVITY LOADS

MINIMUM (Ft)	
WIDTH:	2.6
LENGTH:	2.6

*ASSUMED BEARING CAPACITY: 1500 PSF

DESIGN SQUARE FOOTING FOR UPLIFT LOADS

DEAD LOAD (lbs):	2600	CONCRETE WEIGHT:	150 PCF	SLAB AREA USED:	29 FT ²
UPLIFT (lbs):	-7400	SLAB THICKNESS:	6 "	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	-2880	FTG DEPTH:	12 "	LOAD FACTOR:	0.6

MINIMUM (Ft)		USE
WIDTH:	3.1	3.25
LENGTH:	3.1	3.25

 END WALL SLAB AREA: 29 FT²
 SIDE WALL SLAB AREA: 58 FT²
DESIGN SQUARE FOOTING FOR SLIDING

LAT LOAD (lbs):	2960	CONCRETE WEIGHT:	150 PCF
FRICTION (lbs):	1544	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	1416	REBAR SIZE (#)	4

MINIMUM REBAR REQ'TS	
180° HOOK (in):	12.0
DEVELOP. (in):	18.0
LAP SPLICE (in)	23.40
CAPACITY (K):	5.89

Fy:	60 KSI
ψt:	1
ψe:	1
ψs:	1
λ:	1

5/15/2023

Project: 22-0690 Wilco Hay Storage



By: Paul Schroeder

STEEL COLUMN: LINE A COLUMNS 2 & 3

LOADS (lbs)	HORIZ TRANS.	HORIZ LONG.	VERT. (+)	VERT. (-)
DIRECTION:				
DEAD:	300	0	3900	---
LIVE:	0	0	0	---
LIVE ROOF:	600	0	7900	---
SNOW:	900	0	10900	---
RAIN:	0	0	0	---
WIND:	7300	2900	12400	-12400
SEISMIC:	1800	600	2200	-2200

ASD LOAD COMB	TRANS.	LONG.	VERT. (+)	VERT. (-)	Strength	TRANS.	LONG.	VERT. (+)	VERT. (-)
LOAD COMB 1	300	0	3900	---	LOAD COMB 1	420	0	5460	---
LOAD COMB 2	300	0	3900	---	LOAD COMB 2	810	0	10130	---
LOAD COMB 3	1200	0	14800	---	LOAD COMB 3	5450	1450	28320	---
LOAD COMB 4	975	0	12075	---	LOAD COMB 4	8110	2900	22530	---
LOAD COMB 5	4680	1740	11340	2360	LOAD COMB 5	2340	600	9060	---
LOAD COMB 6a	4260	1305	17655	6495	LOAD COMB 6	7570	2900	15910	-8890
LOAD COMB 6b	1920	315	13230	10920	LOAD COMB 7	2070	600	5710	1310
LOAD COMB 7	4560	1740	9780	-5100	MAX	8110	2900	28320	-8890
LOAD COMB 8	1440	420	3880	800					

ASD DESIGN LOADS	TRANS.	LONG.	VERT.
MINIMUM:	300	0	-5100
MAXIMUM:	4680	1740	17655

DESIGN SQUARE FOOTING FOR GRAVITY LOADS

MINIMUM (Ft)	
WIDTH:	3.4
LENGTH:	3.4

*ASSUMED BEARING CAPACITY: 1500 PSF

DESIGN SQUARE FOOTING FOR UPLIFT LOADS

DEAD LOAD (lbs):	3900	CONCRETE WEIGHT:	150 PCF	SLAB AREA USED:	64 FT ²
UPLIFT (lbs):	-12400	SLAB THICKNESS:	6 "	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	-5100	FTG DEPTH:	12 "	LOAD FACTOR:	0.6

MINIMUM (Ft)		USE
WIDTH:	3.7	4.00
LENGTH:	3.7	4.00

END WALL SLAB AREA: 32 FT²
 SIDE WALL SLAB AREA: 64 FT²

DESIGN SQUARE FOOTING FOR SLIDING

LAT LOAD (lbs):	4680	CONCRETE WEIGHT:	150 PCF
FRICTION (lbs):	2331	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	2349	REBAR SIZE (#)	4

MINIMUM REBAR REQ'TS	
180° HOOK (in):	12.0
DEVELOP. (in):	18.0
LAP SPLICE (in)	23.40
CAPACITY (K):	5.89

Fy:	60 KSI
ψ _t :	1
ψ _e :	1
ψ _s :	1
λ:	1

5/15/2023

Project: 22-0690 Wilco Hay Storage



By: Paul Schroeder

STEEL COLUMN: LINE C COLUMNS 1 & 4

LOADS (lbs)	HORIZ TRANS.	HORIZ LONG.	VERT. (+)	VERT. (-)
DIRECTION:				
DEAD:	200	0	1600	---
LIVE:	0	0	0	---
LIVE ROOF:	400	0	3200	---
SNOW:	500	0	4000	---
RAIN:	0	0	0	---
WIND:	3300	2100	5800	-5800
SEISMIC:	600	900	2000	-2000

ASD LOAD COMB	TRANS.	LONG.	VERT. (+)	VERT. (-)	Strength	TRANS.	LONG.	VERT. (+)	VERT. (-)
LOAD COMB 1	200	0	1600	---	LOAD COMB 1	280	0	2240	---
LOAD COMB 2	200	0	1600	---	LOAD COMB 2	490	0	3920	---
LOAD COMB 3	700	0	5600	---	LOAD COMB 3	2690	1050	11220	---
LOAD COMB 4	575	0	4600	---	LOAD COMB 4	3790	2100	9720	---
LOAD COMB 5	2180	1260	5080	200	LOAD COMB 5	940	900	4720	---
LOAD COMB 6a	2060	945	7210	1990	LOAD COMB 6	3480	2100	7240	-4360
LOAD COMB 6b	890	472.5	5650	3550	LOAD COMB 7	780	900	3440	-560
LOAD COMB 7	2100	1260	4440	-2520	MAX	3790	2100	11220	-4360
LOAD COMB 8	540	630	2360	-440					

ASD DESIGN LOADS	TRANS.	LONG.	VERT.
MINIMUM:	200	0	-2520
MAXIMUM:	2180	1260	7210

DESIGN SQUARE FOOTING FOR GRAVITY LOADS

MINIMUM (Ft)	
WIDTH:	2.2
LENGTH:	2.2

*ASSUMED BEARING CAPACITY: 1500 PSF

DESIGN SQUARE FOOTING FOR UPLIFT LOADS

DEAD LOAD (lbs):	1600	CONCRETE WEIGHT:	150 PCF	SLAB AREA USED:	29 FT ²
UPLIFT (lbs):	-5800	SLAB THICKNESS:	6 "	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	-2520	FTG DEPTH:	12 "	LOAD FACTOR:	0.6

MINIMUM (Ft)		USE
WIDTH:	2.7	3.25
LENGTH:	2.7	3.25

END WALL SLAB AREA: 29 FT²
 SIDE WALL SLAB AREA: 58 FT²

DESIGN SQUARE FOOTING FOR SLIDING

LAT LOAD (lbs):	2180	CONCRETE WEIGHT:	150 PCF
FRICTION (lbs):	1334	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	846	REBAR SIZE (#)	4

MINIMUM REBAR REQ'TS	
180° HOOK (in):	12.0
DEVELOP. (in):	18.0
LAP SPLICE (in)	23.40
CAPACITY (K):	5.89

Fy:	60 KSI
ψ _t :	1
ψ _e :	1
ψ _s :	1
λ:	1

5/15/2023

Project: 22-0690 Wilco Hay Storage


**STABILITY
ENGINEERING** INC.

By: Paul Schroeder

STEEL COLUMN: LINE C COLUMNS 2 & 3 W/ X-BRACE

LOADS (lbs)	HORIZ TRANS.	HORIZ LONG.	VERT. (+)	VERT. (-)
DIRECTION:				
DEAD:	300	0	2600	---
LIVE:	0	0	0	---
LIVE ROOF:	600	0	5400	---
SNOW:	900	0	7600	---
RAIN:	0	0	0	---
WIND:	6600	8600	11100	-11000
SEISMIC:	1100	8500	6500	-6500

Controls Anchor
Design

For Anchor Design

ASD LOAD COMB	TRANS.	LONG.	VERT. (+)	VERT. (-)	Strength	TRANS.	LONG.	VERT. (+)	VERT. (-)
LOAD COMB 1	300	0	2600	---	LOAD COMB 1	420	0	3640	---
LOAD COMB 2	300	0	2600	---	LOAD COMB 2	810	0	6920	---
LOAD COMB 3	1200	0	10200	---	LOAD COMB 3	5100	4300	20830	---
LOAD COMB 4	975	0	8300	---	LOAD COMB 4	7410	8600	18020	---
LOAD COMB 5	4260	5950	9260	-1950	LOAD COMB 5	1640	8500	11140	---
LOAD COMB 6a	3945	3870	13295	3350	LOAD COMB 6	6870	8600	13440	-8660
LOAD COMB 6b	1552.5	4462.5	11712.5	4887.5	LOAD COMB 7	1370	8500	8840	-4160
LOAD COMB 7	4140	5160	8220	-5040	MAX	7410	8600	20830	-8660
LOAD COMB 8	950	5950	6110	-2990					

Wind
Load
Case

ASD DESIGN LOADS	TRANS.	LONG.	VERT.
MINIMUM:	300	0	-5040
MAXIMUM:	4260	5950	13295

Shear(x) Shear(y) Tension(z)

DESIGN SQUARE FOOTING FOR GRAVITY LOADS

MINIMUM (Ft)	
WIDTH:	3.0
LENGTH:	3.0

*ASSUMED BEARING CAPACITY:

1500 PSF

DESIGN SQUARE FOOTING FOR UPLIFT LOADS

DEAD LOAD (lbs):	2600
UPLIFT (lbs):	-11000
DESIGN LOAD (lbs):	-5040

CONCRETE WEIGHT:	150 PCF
SLAB THICKNESS:	6 "
FTG DEPTH:	12 "

SLAB AREA USED:	64 FT ²
SOIL WEIGHT:	120 PCF
LOAD FACTOR:	0.6

MINIMUM (Ft)		USE
WIDTH:	3.7	4.00
LENGTH:	3.7	4.00

END WALL SLAB AREA:	32 FT ²
SIDE WALL SLAB AREA:	64 FT ²

DESIGN SQUARE FOOTING FOR SLIDING

LAT LOAD (lbs):	5950
FRICTION (lbs):	2058
DESIGN LOAD (lbs):	3892

CONCRETE WEIGHT:	150 PCF
SOIL WEIGHT:	120 PCF
REBAR SIZE (#)	4
Fy:	60 KSI
ψt:	1
ψe:	1
ψs:	1
λ:	1

MINIMUM REBAR REQ'TS	
180° HOOK (in):	12.0
DEVELOP. (in):	18.0
LAP SPLICE (in):	23.40
CAPACITY (K):	5.89



Anchor Designer™
Software
 Version 3.0.7947.0

Company:		Date:	2/17/2023
Engineer:		Page:	1/6
Project:			
Address:			
Phone:			
E-mail:			

1. Project Information

Customer company:
 Customer contact name:
 Customer e-mail:
 Comment:

Project description:
 Location:
 Fastening description:

2. Input Data & Anchor Parameters

General

Design method: ACI 318-14
 Units: Imperial units

Anchor Information:

Anchor type: Cast-in-place
 Material: AB
 Diameter (inch): 0.750
 Effective Embedment depth, h_{ef} (inch): 21.000
 Anchor category: -
 Anchor ductility: Yes
 h_{min} (inch): 23.25
 C_{min} (inch): 1.63
 S_{min} (inch): 3.00

Base Material

Concrete: Normal-weight
 Concrete thickness, h (inch): 24.00
 State: Uncracked
 Compressive strength, f_c (psi): 2500
 $\Psi_{c,v}$: 1.0
 Reinforcement condition: B tension, B shear
 Supplemental reinforcement: Yes
 Reinforcement provided at corners: Yes
 Ignore concrete breakout in tension: No
 Ignore concrete breakout in shear: Yes
 Ignore 6do requirement: Yes
 Build-up grout pad: No

Base Plate

Length x Width x Thickness (inch): 9.50 x 8.00 x 0.50

Recommended Anchor

Anchor Name: PAB Pre-Assembled Anchor Bolt - PAB6 (3/4"Ø)



Input data and results must be checked for agreement with the existing circumstances, the standards and guidelines must be checked for plausibility.

Simpson Strong-Tie Company Inc. 5956 W. Las Positas Boulevard Pleasanton, CA 94588 Phone: 925.560.9000 Fax: 925.847.3871 www.strongtie.com



Anchor Designer™
Software
 Version 3.0.7947.0

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Address:			
Phone:			
E-mail:			

Load and Geometry

Load factor source: ACI 318 Section 5.3

Load combination: not set

Seismic design: No

Anchors subjected to sustained tension: Not applicable

Apply entire shear load at front row: No

Anchors only resisting wind and/or seismic loads: No

Strength level loads:

N_{ua} [lb]: 8660

V_{uax} [lb]: -7410

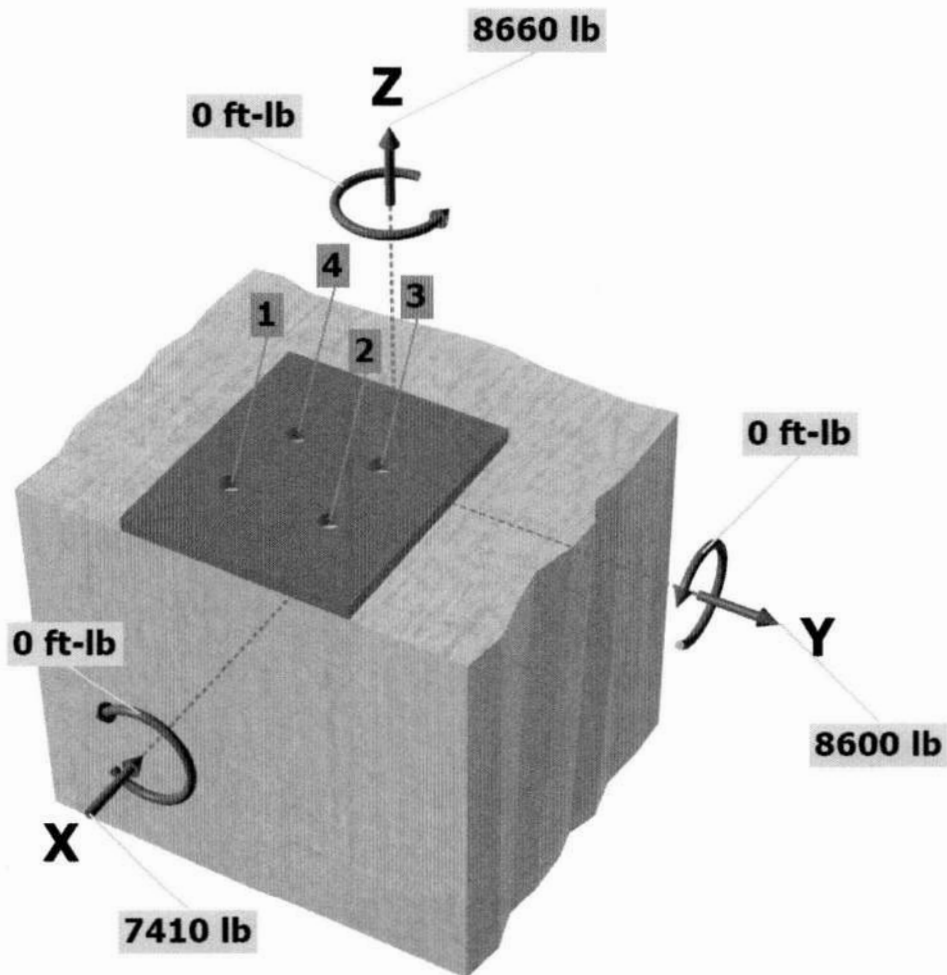
V_{uay} [lb]: 8600

M_{ux} [ft-lb]: 0

M_{uy} [ft-lb]: 0

M_{uz} [ft-lb]: 0

<Figure 1>

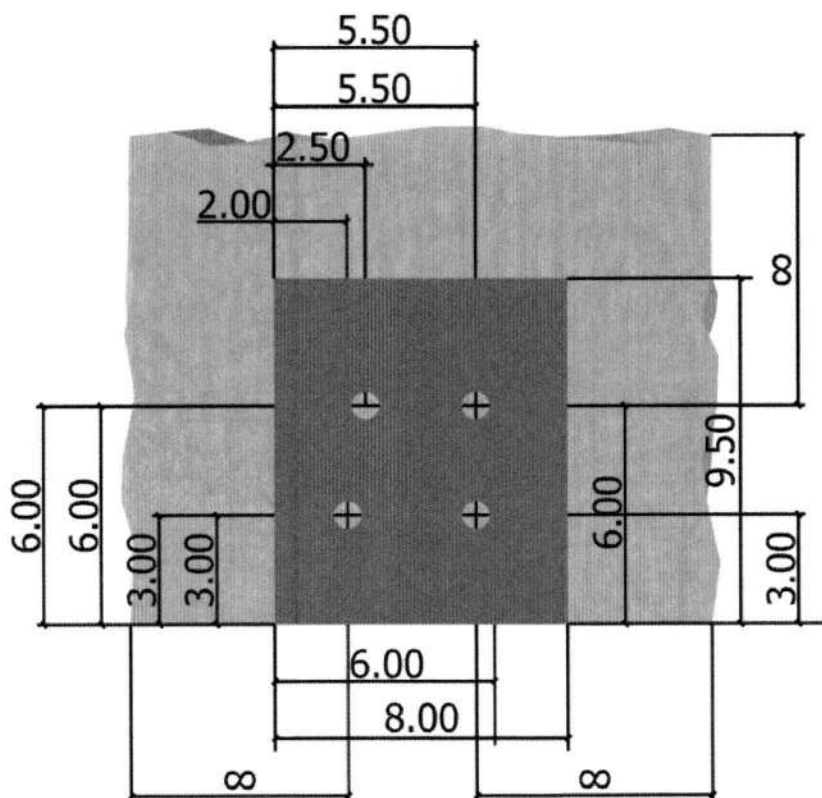


Input data and results must be checked for agreement with the existing circumstances, the standards and guidelines must be checked for plausibility.

Simpson Strong-Tie Company Inc. 5956 W. Las Positas Boulevard Pleasanton, CA 94588 Phone: 925.560.9000 Fax: 925.847.3871 www.strongtie.com

Company:		Date:	2/17/2023
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Phone:			
E-mail:			

<Figure 2>



Company:		Date:	2/17/2023
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Address:			
Phone:			
E-mail:			

3. Resulting Anchor Forces

Anchor	Tension load, N _{ua} (lb)	Shear load x, V _{uax} (lb)	Shear load y, V _{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2 + (V_{uay})^2}$ (lb)
1	392.4	-1581.4	2366.9	2846.6
2	3602.7	-2087.4	2366.9	3155.8
3	5040.4	-2087.4	1933.1	2845.1
4	2288.7	-1653.7	1933.1	2544.0
Sum	11324.3	-7410.0	8600.0	11391.5

Maximum concrete compression strain (‰): 0.19

Maximum concrete compression stress (psi): 847

Resultant tension force (lb): 11324

Resultant compression force (lb): 2664

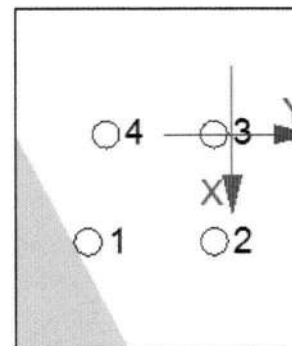
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.90

Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.44

Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.16

Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.19

<Figure 3>



4. Steel Strength of Anchor in Tension (Sec. 17.4.1)

N _{sa} (lb)	φ	φN _{sa} (lb)
19370	0.75	14528

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.4.2)

$$N_b = 16\lambda_a \sqrt{f_c} h_{ef}^{5/3} \text{ (Eq. 17.4.2.2b)}$$

λ _a	f _c (psi)	h _{ef} (in)	N _b (lb)
1.00	2500	21.000	127876

$$\phi N_{cbg} = \phi (A_{Nc} / A_{Nco}) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \text{ (Sec. 17.3.1 & Eq. 17.4.2.1b)}$$

A _{Nc} (in ²)	A _{Nco} (in ²)	C _{a,min} (in)	ψ _{ec,N}	ψ _{ed,N}	ψ _{c,N}	ψ _{cp,N}	N _b (lb)	φ	φN _{cbg} (lb)
2653.97	3969.00	3.00	0.959	0.729	1.25	1.000	127876	0.70	52268

6. Pullout Strength of Anchor in Tension (Sec. 17.4.3)

$$\phi N_{pn} = \phi \psi_{c,P} N_p = \phi \psi_{c,P} 8 A_{brg} f_c \text{ (Sec. 17.3.1, Eq. 17.4.3.1 & 17.4.3.4)}$$

ψ _{c,P}	A _{brg} (in ²)	f _c (psi)	φ	φN _{pn} (lb)
1.4	3.53	2500	0.70	69266



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E-mail:			

7. Side-Face Blowout Strength of Anchor in Tension (Sec. 17.4.4)

$$\phi N_{sb} = \phi \left\{ (1 + C_{a2}/C_{a1})/4 \right\} (1 + s/6C_{a1}) N_{sb} = \phi \left\{ (1 + C_{a2}/C_{a1})/4 \right\} (1 + s/6C_{a1}) (160 C_{a1} \sqrt{A_{brg}}) \lambda \sqrt{f'_c} \quad (\text{Sec. 17.3.1, Eq. 17.4.4.1 \& 17.4.4.2})$$

s (in)	C _{a1} (in)	C _{a2} (in)	A _{brg} (in ²)	λ _a	f' _c (psi)	φ	φN _{sb} (lb)
3.50	3.00	99999.00	3.53	1.00	2500	0.70	37723

8. Steel Strength of Anchor in Shear (Sec. 17.5.1)

V _{sa} (lb)	φ _{grout}	φ	φ _{grout} φ V _{sa} (lb)
11625	1.0	0.65	7556

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.5.3)

$$\phi V_{cp} = \phi K_{cp} N_{cb} = \phi K_{cp} (A_{Nc} / A_{Nco}) \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b \quad (\text{Sec. 17.3.1 \& Eq. 17.5.3.1b})$$

K _{cp}	A _{Nc} (in ²)	A _{Nco} (in ²)	Ψ _{ec,N}	Ψ _{ed,N}	Ψ _{c,N}	Ψ _{cp,N}	N _b (lb)	φ	φV _{cp} (lb)
2.0	2653.97	3969.00	0.989	0.729	1.250	1.000	127876	0.70	107808

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.6.)

Tension	Factored Load, N_{ua} (lb)	Design Strength, ϕN_n (lb)	Ratio	Status	
Steel	5040	14528	0.35	Pass (Governs)	
Concrete breakout	11324	52268	0.22	Pass	
Pullout	5040	69266	0.07	Pass	
Side-face blowout	3995	37723	0.11	Pass	
Shear	Factored Load, V_{ua} (lb)	Design Strength, ϕV_n (lb)	Ratio	Status	
Steel	3156	7556	0.42	Pass (Governs)	
Pryout	11352	107808	0.11	Pass	
Interaction check	$N_{ua}/\phi N_n$	$V_{ua}/\phi V_n$	Combined Ratio	Permissible	Status
Sec. 17.6.2	0.00	0.42	41.8%	1.0	Pass

PAB6 (3/4"Ø) with hef = 21.000 inch meets the selected design criteria.



Company:		Date:	2/17/2023
Engineer:		Page:	6/6
Project:			
Address:			
Phone:			
E-mail:			

12. Warnings

- For irregular anchor patterns, the designer must consider sizing of base plate holes to ensure shear loads are distributed to anchors as designed.
- Minimum spacing and edge distance requirement of 6da per ACI 318 Sections 17.7.1 and 17.7.2 for torqued cast-in-place anchor is waived per designer option.
- Concrete breakout strength in shear has not been evaluated against applied shear load(s) per designer option. Refer to ACI 318 Section 17.3.2.1 for conditions where calculations of the concrete breakout strength may not be required.
- Designer must exercise own judgement to determine if this design is suitable.

Concrete Column

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: Line A Column 4**Code References**

Calculations per ACI 318-14, IBC 2015, CBC 2016, ASCE 7-10

Load Combinations Used : IBC 2021

General Information

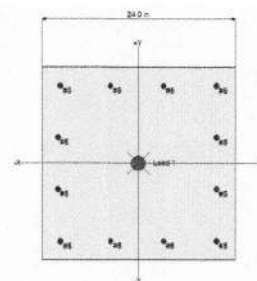
f'_c : Concrete 28 day strength	=	2.50 ksi
E =	=	2,850.0 ksi
Density	=	150.0 pcf
β	=	0.850
f_y - Main Rebar	=	60.0 ksi
E - Main Rebar	=	29,000.0 ksi
Allow. Reinforcing Limits	ASTM A615 Bars Used	
Min. Reinf.	=	0.50 %
Max. Reinf.	=	8.0 %

Overall Column Height	=	8.0 ft
End Fixity	Top Free, Bottom Fixed	
Brace condition for deflection (buckling) along column		
X-X (width) axis :		
Unbraced Length for buckling ABOUT Y-Y Axis = 8.0 ft, K = 2.10		
Y-Y (depth) axis :		
Unbraced Length for buckling ABOUT X-X Axis = 8.0 ft, K = 2.10		

Column Cross Section

Column Dimensions : 24.0in Square Column, Column
Edge to Rebar Edge Cover = 2.0in

Column Reinforcing : 4 - #5 bars @ corners,, 2 - #5 bars
top & bottom between corner bars, 2
- #5 bars left & right between corner

**Applied Loads**

Entered loads are factored per load combinations specified by user.

Column self weight included : 4,800.0 lbs * Dead Load Factor

AXIAL LOADS . . .

Axial Load at 8.0 ft above base, D = 2.60, LR = 4.60, S = 5.70, W = 7.40, E = 2.0 k

BENDING LOADS . . .

Transverse Loading: Lat. Point Load at 8.0 ft creating Mx-x, D = 0.20, LR = 0.40, S = 0.50, W = 4.60, E = 1.20 k

Longitudinal Loads: Lat. Point Load at 8.0 ft creating My-y, W = 2.0, E = 1.70 k

DESIGN SUMMARY

Load Combination	+0.90D+W		Maximum SERVICE Load Reactions .			
Location of max.above base	7.946 ft		Top along Y-Y	0.0 k	Bottom along Y-Y	2.0 k
Maximum Stress Ratio	0.179 : 1		Top along X-X	4.60 k	Bottom along X-X	4.60 k
Ratio = (Pu^2+Mu^2)^.5 / (PhiPn^2+PhiMn^2)^.5						
Pu =	14.060 k	φ * Pn =	78.523 k	Maximum SERVICE Load Deflections . .		
Mu-x =	-38.240 k-ft	φ * Mn-x =	207.462 k-ft	Along Y-Y	0.01713 in at	8.0 ft above base
Mu-y =	-16.0 k-ft	φ * Mn-y =	107.960 k-ft	for load combination : W Only		
Mu Angle =	23.0 deg	φ =	0.90	Along X-X	0.007448 in at	8.0 ft above base
Mu at Angle =	41.452 k-ft	φMn at Angle =	232.148 k-ft	for load combination : W Only		
<i>Pn & Mn values located at Pu-Mu vector intersection with capacity curve</i>						
Column Capacities . .				General Section Informatio		
Pnmax : Nominal Max. Compressive Axial Capac	1,439.30 k			ρ : % Reinforcing	0.6458 %	Rebar % Ok
Pnmin : Nominal Min. Tension Axial Capacity	k			Reinforcing Area	3.720 in^2	
φ Pn, max : Usable Compressive Axial Capacity	748.43 k			Concrete Area	576.0 in^2	
φ Pn, min : Usable Tension Axial Capacity	k					
				β = 0.850 θ = 0.80		

Concrete Column

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: Line A Column 4**Governing Load Combination Results**

Governing Factored Load Combination	Moment		Dist. from base ft	Axial Load k			Bending Analysis k-ft						Utilization	
	X-X	Y-Y		Pu	ϕ	Pn	δx	$\delta x * Mux$	δy	$\delta y * Muy$	Alpha (deg)	δMu	ϕ	Mn Ratio
+1.40D	Actual		7.95	10.36	729.45	1.000	-2.24				180.000	2.24	158.15	0.014
+1.20D+0.50Lr	Actual		7.95	11.18	646.87	1.000	-3.52				180.000	3.52	202.70	0.017
+1.20D+0.50S	Actual		7.95	11.73	629.55	1.000	-3.92				180.000	3.92	210.52	0.019
+1.20D+1.60Lr	Actual		7.95	16.24	551.38	1.000	-7.04				180.000	7.04	239.83	0.029
+1.20D+1.60Lr+0.50W	Actual	Actual	7.95	19.94	213.67	1.000	-25.44	1.000	-8.00	17.000	26.67	287.73	0.093	
+1.20D+1.60S	Actual		7.95	18.00	529.81	1.000	-8.32				180.000	8.32	246.31	0.034
+1.20D+1.60S+0.50W	Actual	Actual	7.95	21.70	225.36	1.000	-26.72	1.000	-8.00	17.000	27.89	288.31	0.097	
+1.20D+0.50Lr+W	Actual	Actual	7.95	18.58	108.67	1.000	-40.32	1.000	-16.00	22.000	43.38	249.32	0.174	
+1.20D+0.50S+W	Actual	Actual	7.95	19.13	108.55	1.000	-40.72	1.000	-16.00	21.000	43.75	249.37	0.175	
+1.20D+0.70S+E	Actual	Actual	7.95	14.87	192.39	1.000	-14.32	1.000	-13.60	44.000	19.75	254.61	0.078	
+0.90D+W	Actual	Actual	7.95	14.06	78.52	1.000	-38.24	1.000	-16.00	23.000	41.45	232.15	0.179	
+0.90D+E	Actual	Actual	7.95	8.66	122.13	1.000	-11.04	1.000	-13.60	51.000	17.52	248.89	0.070	

Maximum Reactions

Note: Only non-zero reactions are listed.

Load Combination	X-X Axis Reaction		k	Y-Y Axis Reaction		Axial Reaction	Mx - End Moments k-ft		My - End Moments	
	@ Base	@ Top		@ Base	@ Top		@ Base	@ Top	@ Base	@ Top
D Only		0.000		0.200	0.200	7.400	-1.600			
+D+Lr		0.000		0.600	0.600	12.000	-4.800			
+D+S		0.000		0.700	0.700	13.100	-5.600			
+D+0.750Lr		0.000		0.500	0.500	10.850	-4.000			
+D+0.750S		0.000		0.575	0.575	11.675	-4.600			
+D+0.60W	1.200	0.000		2.960	2.960	11.840	-23.680		-9.600	
+D+0.70E	1.190	0.000		1.040	1.040	8.800	-8.320		-9.520	
+D+0.750Lr+0.450W	0.900	0.000		2.570	2.570	14.180	-20.560		-7.200	
+D+0.750S+0.450W	0.900	0.000		2.645	2.645	15.005	-21.160		-7.200	
+D+0.750S+0.5250E	0.893	0.000		1.205	1.205	12.725	-9.640		-7.140	
+0.60D+0.60W	1.200	0.000		2.880	2.880	8.880	-23.040		-9.600	
+0.60D+0.70E	1.190	0.000		0.960	0.960	5.840	-7.680		-9.520	
Lr Only		0.000		0.400	0.400	4.600	-3.200			
S Only		0.000		0.500	0.500	5.700	-4.000			
W Only	2.000	0.000		4.600	4.600	7.400	-36.800		-16.000	
E Only	1.700	0.000		1.200	1.200	2.000	-9.600		-13.600	

Maximum Moment Reactions

Note: Only non-zero reactions are listed.

Load Combination	Moment About X-X Axis			Moment About Y-Y Axis		
	@ Base	@ Top		@ Base	@ Top	
D Only	-1.600		k-ft			k-ft
+D+Lr	-4.800		k-ft			k-ft
+D+S	-5.600		k-ft			k-ft
+D+0.750Lr	-4.000		k-ft			k-ft
+D+0.750S	-4.600		k-ft			k-ft
+D+0.60W	-23.680		k-ft	-9.600		k-ft
+D+0.70E	-8.320		k-ft	-9.520		k-ft
+D+0.750Lr+0.450W	-20.560		k-ft	-7.200		k-ft
+D+0.750S+0.450W	-21.160		k-ft	-7.200		k-ft
+D+0.750S+0.5250E	-9.640		k-ft	-7.140		k-ft
+0.60D+0.60W	-23.040		k-ft	-9.600		k-ft
+0.60D+0.70E	-7.680		k-ft	-9.520		k-ft
Lr Only	-3.200		k-ft			k-ft
S Only	-4.000		k-ft			k-ft
W Only	-36.800		k-ft	-16.000		k-ft
E Only	-9.600		k-ft	-13.600		k-ft

Maximum Deflections for Load Combinations

Load Combination	Max. X-X Deflection		Max. Y-Y Deflection	
	Distance		Distance	
D Only	0.0000 in	0.000 ft	0.001 in	8.000 ft
+D+Lr	0.0000 in	0.000 ft	0.002 in	8.000 ft
+D+S	0.0000 in	0.000 ft	0.003 in	8.000 ft
+D+0.750Lr	0.0000 in	0.000 ft	0.002 in	8.000 ft

Concrete Column

Project File: 22-0690.ec6

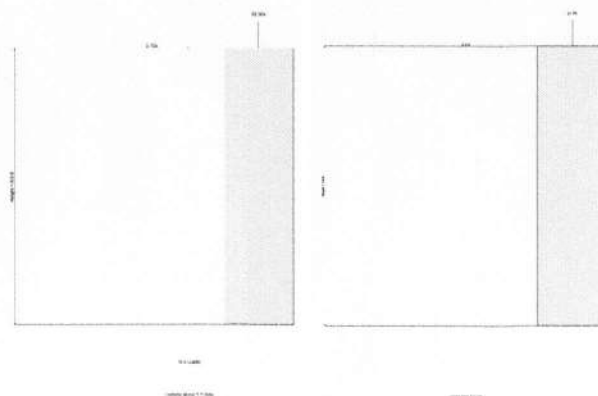
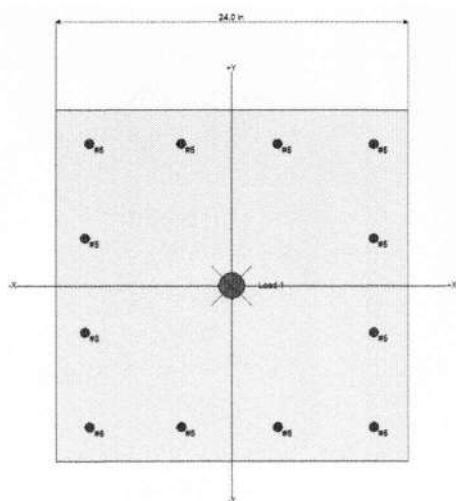
LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: Line A Column 4**Maximum Deflections for Load Combinations**

Load Combination	Max. X-X Deflection	Distance	Max. Y-Y Deflection	Distance
+D+0.750S	0.0000 in	0.000 ft	0.002 in	8.000 ft
+D+0.60W	-0.0045 in	8.000 ft	0.011 in	8.000 ft
+D+0.70E	-0.0044 in	8.000 ft	0.004 in	8.000 ft
+D+0.750Lr+0.450W	-0.0034 in	8.000 ft	0.010 in	8.000 ft
+D+0.750S+0.450W	-0.0034 in	8.000 ft	0.010 in	8.000 ft
+D+0.750S+0.5250E	-0.0033 in	8.000 ft	0.004 in	8.000 ft
+0.60D+0.60W	-0.0045 in	8.000 ft	0.011 in	8.000 ft
+0.60D+0.70E	-0.0044 in	8.000 ft	0.004 in	8.000 ft
Lr Only	0.0000 in	0.000 ft	0.001 in	8.000 ft
S Only	0.0000 in	0.000 ft	0.002 in	8.000 ft
W Only	-0.0074 in	8.000 ft	0.017 in	8.000 ft
E Only	-0.0063 in	7.946 ft	0.004 in	7.946 ft

Sketches

General Footing

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: FTG. @ Line A Column 4

Code References

Calculations per ACI 318-14, IBC 2015, CBC 2016, ASCE 7-10

Load Combinations Used : IBC 2021

General Information

Material Properties

f_c : Concrete 28 day strength	=	2.50 ksi
f_y : Rebar Yield	=	60.0 ksi
E_c : Concrete Elastic Modulus	=	2,850.0 ksi
Concrete Density	=	150.0 pcf
ϕ Values Flexure	=	0.90
Shear	=	0.750

Analysis Settings

Min Steel % Bending Reinf.	=	
Min Allow % Temp Reinf.	=	0.00180
Min. Overturning Safety Factor	=	1.0 : 1

Add Ftg Wt for Soil Pressure	:	Yes
Use ftg wt for stability, moments & shears	:	Yes
Add Pedestal Wt for Soil Pressure	:	No
Use Pedestal wt for stability, mom & shear	:	No

Soil Design Values

Allowable Soil Bearing	=	2.50 ksf
Soil Density	=	110.0 pcf
Increase Bearing By Footing Weight	=	No
Soil Passive Resistance (for Sliding)	=	250.0 pcf
Soil/Concrete Friction Coeff.	=	0.30

Increases based on footing Depth

Footing base depth below soil surface	=	3.50 ft
Allow press. increase per foot of depth when footing base is below	=	ksf ft

Increases based on footing plan dimension

Allowable pressure increase per foot of depth when max. length or width is greater than	=	ksf ft
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Dimensions

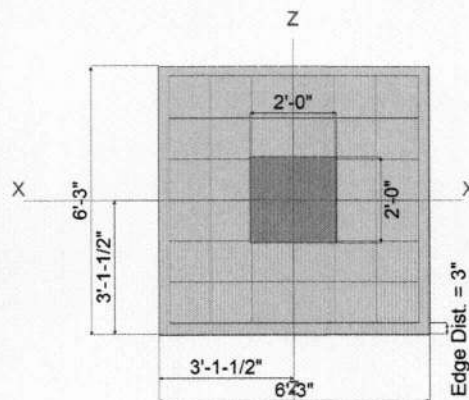
Width parallel to X-X Axis	=	6.250 ft
Length parallel to Z-Z Axis	=	6.250 ft
Footing Thickness	=	14.0 in

Pedestal dimensions...

px : parallel to X-X Axis	=	24.0 in
pz : parallel to Z-Z Axis	=	24.0 in
Height	=	0.0010 in

Rebar Centerline to Edge of Concrete...

at Bottom of footing	=	3.0 in
----------------------	---	--------



Reinforcing

Bars parallel to X-X Axis	=	
Number of Bars	=	7
Reinforcing Bar Size	=	# 5

Bars parallel to Z-Z Axis	=	
Number of Bars	=	7
Reinforcing Bar Size	=	# 5

Bandwidth Distribution Check (ACI 15.4.4.2)

Direction Requiring Closer Separation

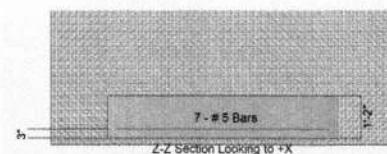
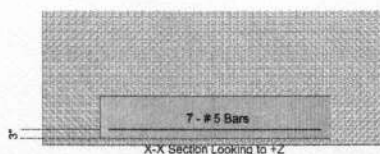
n/a

Bars required within zone

n/a

Bars required on each side of zone

n/a



Applied Loads

	D	Lr	L	S	W	E	H
P : Column Load	=	7.40	4.60		5.70	7.40	2.0 k
OB : Overburden	=						ksf
M-xx	=	1.60		3.20	4.0	36.80	9.60 k-ft
M-zz	=					16.0	13.60 k-ft
V-x	=				2.0	1.70	k
V-z	=	0.20	0.40	0.50	4.60	1.20	k

General Footing

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: FTG. @ Line A Column 4**DESIGN SUMMARY**

Design OK

	Min. Ratio	Item	Applied	Capacity	Governing Load Combination
PASS	0.6888	Soil Bearing	1.722 ksf	2.50 ksf	+0.60D-0.60W about X-X axis
PASS	1.140	Overturing - X-X	39.175 k-ft	44.666 k-ft	+0.60D-0.60W
PASS	1.751	Overturing - Z-Z	24.875 k-ft	43.566 k-ft	+0.60D-0.60W
PASS	3.140	Uplift	4.440 k	13.941 k	+0.60D-0.60W
PASS	0.110	Z Flexure (+X)	1.821 k-ft/ft	16.548 k-ft/ft	+1.20D+0.50L+0.50S+W
PASS	0.07407	Z Flexure (-X)	1.226 k-ft/ft	16.548 k-ft/ft	+1.20D+0.50L+0.70S-E
PASS	0.1899	X Flexure (+Z)	3.142 k-ft/ft	16.548 k-ft/ft	+1.20D+0.50L+0.50S+W
PASS	0.2079	X Flexure (-Z)	3.440 k-ft/ft	16.548 k-ft/ft	+0.90D-W
PASS	0.09874	1-way Shear (+X)	7.405 psi	75.0 psi	+1.20D+0.50L+0.50S+W
PASS	0.06681	1-way Shear (-X)	5.010 psi	75.0 psi	+1.20D+0.50L+0.70S-E
PASS	0.1723	1-way Shear (+Z)	12.924 psi	75.0 psi	+1.20D+0.50L+0.50S+W
PASS	0.1717	1-way Shear (-Z)	12.881 psi	75.0 psi	+0.90D-W
PASS	0.06986	2-way Punching	10.479 psi	150.0 psi	+1.20D+1.60S+0.50W



Top reinforcing mat required (see 'Bending' tab).

Hand check required for anchor pullout.

Concrete Column

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: Line C Column 4**Code References**

Calculations per ACI 318-14, IBC 2015, CBC 2016, ASCE 7-10

Load Combinations Used : IBC 2021

General Information

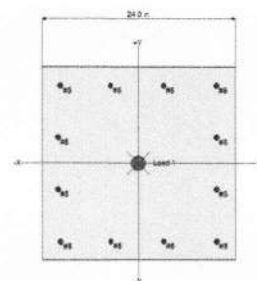
f'_c : Concrete 28 day strength	=	2.50 ksi
E =	=	2,850.0 ksi
Density	=	150.0 pcf
β	=	0.850
f_y - Main Rebar	=	60.0 ksi
E - Main Rebar	=	29,000.0 ksi
Allow. Reinforcing Limits	ASTM A615 Bars Used	
Min. Reinf.	=	0.50 %
Max. Reinf.	=	8.0 %

Overall Column Height	=	8.0 ft
End Fixity	Top Free, Bottom Fixed	
Brace condition for deflection (buckling) along column		
X-X (width) axis :		
Unbraced Length for buckling ABOUT Y-Y Axis = 8.0 ft, K = 2.10		
Y-Y (depth) axis :		
Unbraced Length for buckling ABOUT X-X Axis = 8.0 ft, K = 2.10		

Column Cross Section

Column Dimensions : 24.0in Square Column, Column
Edge to Rebar Edge Cover = 2.0in

Column Reinforcing : 4 - #5 bars @ corners,, 2 - #5 bars
top & bottom between corner bars, 2
- #5 bars left & right between corner

**Applied Loads**

Entered loads are factored per load combinations specified by user.

Column self weight included : 4,800.0 lbs * Dead Load Factor

AXIAL LOADS . . .

Axial Load at 8.0 ft above base, D = 1.60, LR = 3.20, S = 4.0, W = 5.80, E = 2.0 k

BENDING LOADS . . .

Transverse Loading: Lat. Point Load at 8.0 ft creating Mx-x, D = 0.20, LR = 0.40, S = 0.50, W = 3.30, E = 0.60 k

Longitudinal Loads: Lat. Point Load at 8.0 ft creating My-y, W = 2.10, E = 0.90 k

DESIGN SUMMARY

Load Combination	+0.90D+W		Maximum SERVICE Load Reactions .			
Location of max.above base	7.946 ft		Top along Y-Y	0.0 k	Bottom along Y-Y	2.10 k
Maximum Stress Ratio	0.138 : 1		Top along X-X	3.30 k	Bottom along X-X	3.30 k
Ratio = (Pu^2+Mu^2)^.5 / (PhiPn^2+PhiMn^2)^.5						
Pu =	11.560 k	φ * Pn =	Maximum SERVICE Load Deflections . .			
Mu-x =	-27.840 k-ft	φ * Mn-x =	Along Y-Y	0.01229 in	at	8.0 ft above base
Mu-y =	-16.80 k-ft	φ * Mn-y =	for load combination : W Only			
		φ =	Along X-X	0.007820 in	at	8.0 ft above base
Mu Angle =	31.0 deg		for load combination : W Only			
Mu at Angle =	32.516 k-ft	φMn at Angle =				
Pn & Mn values located at Pu-Mu vector intersection with capacity curve						
Column Capacities . .						
Pnmax : Nominal Max. Compressive Axial Capacity	1,439.30 k	General Section Information				
Pnmin : Nominal Min. Tension Axial Capacity	k	β = 0.850 θ = 0.80				
φ Pn, max : Usable Compressive Axial Capacity	748.43 k	ρ : % Reinforcing	0.6458 %	Rebar % Ok		
φ Pn, min : Usable Tension Axial Capacity	k	Reinforcing Area	3.720 in^2			
		Concrete Area	576.0 in^2			

Concrete Column

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: Line C Column 4**Governing Load Combination Results**

Governing Factored Load Combination	Moment		Dist. from base ft	Axial Load k		Bending Analysis k-ft								Utilization	
	X-X	Y-Y		Pu	ϕ * Pn	δx	δx * Mux	δy	δy * Muy	Alpha (deg)	δ Mu	ϕ Mn	Ratio		
+1.40D	Actual		7.95	8.96	699.01	1.000	-2.24			180.000	2.24	176.01	0.013		
+1.20D+0.50Lr	Actual		7.95	9.28	594.93	1.000	-3.52			180.000	3.52	224.66	0.016		
+1.20D+0.50S	Actual		7.95	9.68	573.09	1.000	-3.92			180.000	3.92	232.62	0.017		
+1.20D+1.60Lr	Actual		7.95	12.80	473.34	1.000	-7.04			180.000	7.04	260.46	0.027		
+1.20D+1.60Lr+0.50W	Actual	Actual	7.95	15.70	198.34	1.000	-20.24	1.000	-8.40	23.000	21.91	274.85	0.080		
+1.20D+1.60S	Actual		7.95	14.08	447.29	1.000	-8.32			180.000	8.32	265.76	0.031		
+1.20D+1.60S+0.50W	Actual	Actual	7.95	16.98	204.76	1.000	-21.52	1.000	-8.40	21.000	23.10	279.06	0.083		
+1.20D+0.50Lr+W	Actual	Actual	7.95	15.08	108.64	1.000	-29.92	1.000	-16.80	29.000	34.31	249.45	0.138		
+1.20D+0.50S+W	Actual	Actual	7.95	15.48	114.50	1.000	-30.32	1.000	-16.80	29.000	34.66	252.55	0.137		
+1.20D+0.70S+E	Actual	Actual	7.95	12.48	269.32	1.000	-9.52	1.000	-7.20	37.000	11.94	256.82	0.046		
+0.90D+W	Actual	Actual	7.95	11.56	84.46	1.000	-27.84	1.000	-16.80	31.000	32.52	235.96	0.138		
+0.90D+E	Actual	Actual	7.95	7.76	208.67	1.000	-6.24	1.000	-7.20	49.000	9.53	255.98	0.037		

Maximum Reactions

Note: Only non-zero reactions are listed.

Load Combination	X-X Axis Reaction		k	Y-Y Axis Reaction		Axial Reaction	Mx - End Moments k-ft		My - End Moments
	@ Base	@ Top		@ Base	@ Top		@ Base	@ Top	
D Only		0.000		0.200	0.200	6.400	-1.600		
+D+Lr		0.000		0.600	0.600	9.600	-4.800		
+D+S		0.000		0.700	0.700	10.400	-5.600		
+D+0.750Lr		0.000		0.500	0.500	8.800	-4.000		
+D+0.750S		0.000		0.575	0.575	9.400	-4.600		
+D+0.60W	1.260	0.000		2.180	2.180	9.880	-17.440		-10.080
+D+0.70E	0.630	0.000		0.620	0.620	7.800	-4.960		-5.040
+D+0.750Lr+0.450W	0.945	0.000		1.985	1.985	11.410	-15.880		-7.560
+D+0.750S+0.450W	0.945	0.000		2.060	2.060	12.010	-16.480		-7.560
+D+0.750S+0.5250E	0.473	0.000		0.890	0.890	10.450	-7.120		-3.780
+0.60D+0.60W	1.260	0.000		2.100	2.100	7.320	-16.800		-10.080
+0.60D+0.70E	0.630	0.000		0.540	0.540	5.240	-4.320		-5.040
Lr Only		0.000		0.400	0.400	3.200	-3.200		
S Only		0.000		0.500	0.500	4.000	-4.000		
W Only	2.100	0.000		3.300	3.300	5.800	-26.400		-16.800
E Only	0.900	0.000		0.600	0.600	2.000	-4.800		-7.200

Maximum Moment Reactions

Note: Only non-zero reactions are listed.

Load Combination	Moment About X-X Axis			Moment About Y-Y Axis		
	@ Base	@ Top		@ Base	@ Top	
D Only	-1.600		k-ft			k-ft
+D+Lr	-4.800		k-ft			k-ft
+D+S	-5.600		k-ft			k-ft
+D+0.750Lr	-4.000		k-ft			k-ft
+D+0.750S	-4.600		k-ft			k-ft
+D+0.60W	-17.440		k-ft	-10.080		k-ft
+D+0.70E	-4.960		k-ft	-5.040		k-ft
+D+0.750Lr+0.450W	-15.880		k-ft	-7.560		k-ft
+D+0.750S+0.450W	-16.480		k-ft	-7.560		k-ft
+D+0.750S+0.5250E	-7.120		k-ft	-3.780		k-ft
+0.60D+0.60W	-16.800		k-ft	-10.080		k-ft
+0.60D+0.70E	-4.320		k-ft	-5.040		k-ft
Lr Only	-3.200		k-ft			k-ft
S Only	-4.000		k-ft			k-ft
W Only	-26.400		k-ft	-16.800		k-ft
E Only	-4.800		k-ft	-7.200		k-ft

Maximum Deflections for Load Combinations

Load Combination	Max. X-X Deflection		Max. Y-Y Deflection	
	Distance		Distance	
D Only	0.0000 in	0.000 ft	0.001 in	8.000 ft
+D+Lr	0.0000 in	0.000 ft	0.002 in	8.000 ft
+D+S	0.0000 in	0.000 ft	0.003 in	8.000 ft
+D+0.750Lr	0.0000 in	0.000 ft	0.002 in	8.000 ft

Concrete Column

Project File: 22-0690.ec6

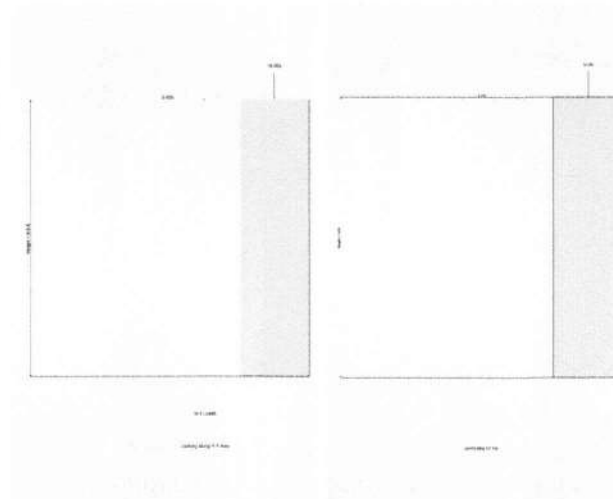
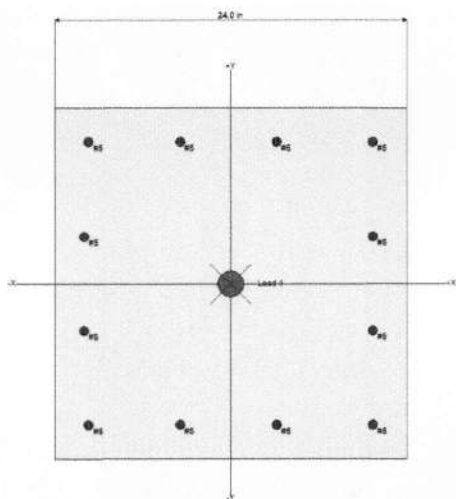
LIC# : KW-06014874, Build:20.23.05.01

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DESCRIPTION: Line C Column 4**Maximum Deflections for Load Combinations**

Load Combination	Max. X-X Deflection	Distance	Max. Y-Y Deflection	Distance
+D+0.750S	0.0000 in	0.000 ft	0.002 in	8.000 ft
+D+0.60W	-0.0047 in	8.000 ft	0.008 in	8.000 ft
+D+0.70E	-0.0023 in	8.000 ft	0.002 in	8.000 ft
+D+0.750Lr+0.450W	-0.0035 in	8.000 ft	0.007 in	8.000 ft
+D+0.750S+0.450W	-0.0035 in	8.000 ft	0.008 in	8.000 ft
+D+0.750S+0.5250E	-0.0018 in	8.000 ft	0.003 in	8.000 ft
+0.60D+0.60W	-0.0047 in	8.000 ft	0.008 in	8.000 ft
+0.60D+0.70E	-0.0023 in	8.000 ft	0.002 in	8.000 ft
Lr Only	0.0000 in	0.000 ft	0.001 in	8.000 ft
S Only	0.0000 in	0.000 ft	0.002 in	8.000 ft
W Only	-0.0078 in	8.000 ft	0.012 in	8.000 ft
E Only	-0.0033 in	7.946 ft	0.002 in	7.946 ft

Sketches

General Footing

Project File: 22-0690.ec6

LIC#: KW-06014874, Build: 20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: FTG. @ Line C Column 4**Code References**

Calculations per ACI 318-14, IBC 2015, CBC 2016, ASCE 7-10

Load Combinations Used : IBC 2021

General Information**Material Properties**

f_c : Concrete 28 day strength	=	2.50 ksi
f_y : Rebar Yield	=	60.0 ksi
E_c : Concrete Elastic Modulus	=	2,850.0 ksi
Concrete Density	=	150.0 pcf
ϕ Values Flexure	=	0.90
Shear	=	0.750

Analysis Settings

Min Steel % Bending Reinf.	=	
Min Allow % Temp Reinf.	=	0.00180
Min. Overturning Safety Factor	=	1.0 : 1

Add Ftg Wt for Soil Pressure	:	Yes
Use ftg wt for stability, moments & shears	:	Yes
Add Pedestal Wt for Soil Pressure	:	No
Use Pedestal wt for stability, mom & shear	:	No

Soil Design Values

Allowable Soil Bearing	=	2.50 ksf
Soil Density	=	110.0 pcf
Increase Bearing By Footing Weight	=	No
Soil Passive Resistance (for Sliding)	=	250.0 pcf
Soil/Concrete Friction Coeff.	=	0.30

Increases based on footing Depth

Footing base depth below soil surface	=	3.50 ft
Allow press. increase per foot of depth when footing base is below	=	ksf ft

Increases based on footing plan dimension

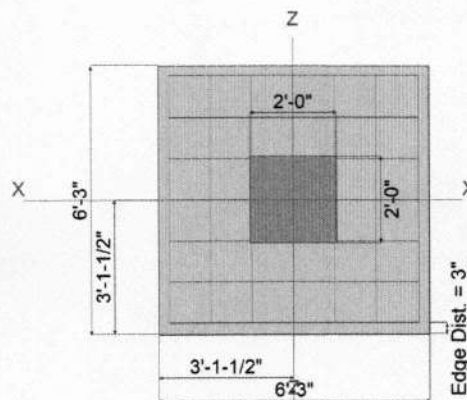
Allowable pressure increase per foot of depth when max. length or width is greater than	=	ksf ft
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Dimensions

Width parallel to X-X Axis	=	6.250 ft
Length parallel to Z-Z Axis	=	6.250 ft
Footing Thickness	=	14.0 in

Pedestal dimensions...

px : parallel to X-X Axis	=	24.0 in
pz : parallel to Z-Z Axis	=	24.0 in
Height	=	0.0010 in
Rebar Centerline to Edge of Concrete... at Bottom of footing	=	3.0 in

**Reinforcing**

Bars parallel to X-X Axis	=	
Number of Bars	=	7
Reinforcing Bar Size	=	# 5

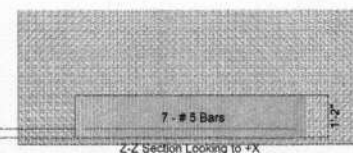
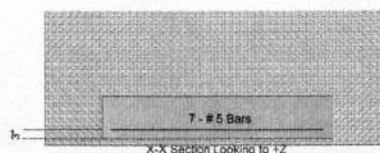
Bars parallel to Z-Z Axis	=	
Number of Bars	=	7
Reinforcing Bar Size	=	# 5

Bandwidth Distribution Check (ACI 15.4.4.2)

Direction Requiring Closer Separation

Bars required within zone

Bars required on each side of zone

n/a
n/a
n/a**Applied Loads**

	D	Lr	L	S	W	E	H
P : Column Load	=	6.40	3.20		4.0	5.80	2.0
OB : Overburden	=						k ksf
M-xx	=	1.60		3.20	4.0	26.40	3.467
M-zz	=					16.80	7.20
V-x	=					2.10	0.90
V-z	=	0.20	0.40		0.50	3.30	0.60

General Footing

Project File: 22-0690.ec6

LIC#: KWW-06014874, Build:20.23.05.01

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DESCRIPTION: FTG. @ Line C Column 4**DESIGN SUMMARY****Design OK**

	Min. Ratio	Item	Applied	Capacity	Governing Load Combination
PASS	0.4924	Soil Bearing	1.231 ksf	2.50 ksf	+D+0.750L+0.750S+0.450W about X-
PASS	1.474	Overturning - X-X	29.025 k-ft	42.791 k-ft	+0.60D-0.60W
PASS	1.859	Overturning - Z-Z	22.425 k-ft	41.691 k-ft	+0.60D-0.60W
PASS	3.834	Uplift	3.480 k	13.341 k	+0.60D-0.60W
PASS	0.09968	Z Flexure (+X)	1.649 k-ft/ft	16.548 k-ft/ft	+1.20D+0.50L+0.50S+W
PASS	0.05970	Z Flexure (-X)	0.9880 k-ft/ft	16.548 k-ft/ft	+1.20D+1.60S-0.50W
PASS	0.1440	X Flexure (+Z)	2.383 k-ft/ft	16.548 k-ft/ft	+1.20D+0.50L+0.50S+W
PASS	0.09343	X Flexure (-Z)	1.546 k-ft/ft	16.548 k-ft/ft	+0.90D-W
PASS	0.08972	1-way Shear (+X)	6.729 psi	75.0 psi	+1.20D+0.50L+0.50S+W
PASS	0.05410	1-way Shear (-X)	4.057 psi	75.0 psi	+1.20D+0.50L+0.50S-W
PASS	0.1305	1-way Shear (+Z)	9.790 psi	75.0 psi	+1.20D+0.50L+0.50S+W
PASS	0.08776	1-way Shear (-Z)	6.582 psi	75.0 psi	+0.90D-W
PASS	0.05375	2-way Punching	8.062 psi	150.0 psi	+1.20D+1.60S+0.50W



Top reinforcing mat required (see 'Bending' tab).

Hand check required for anchor pullout.

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KKW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retaining Wall W/ Seismic**Code Reference:**

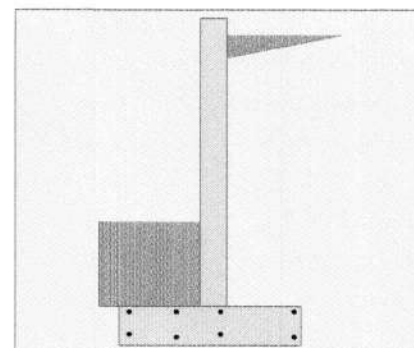
Calculations per IBC 2015 1807.3, CBC 2016, ASCE 7-10

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	30.00 in
Water table above bottom of footing	=	3.5 ft

Soil Data

Allow Soil Bearing	=	2,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	32.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.350
Soil height to ignore for passive pressure	=	30.00 in

**Surcharge Loads**

Surcharge Over Heel	=	175.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0 psf
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Mononobe-Okabe/Seed-Whitman
 Design Kh = 0.148 g

Using Mononobe-Okabe / Seed-Whitman procedure

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem	=	0.0 psf (Strength Level)

K _{ae} for seismic earth pressure	=	0.266
Difference K _{ae} - K _a	=	0.210
K _a for static earth pressure	=	0.055

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type	=	Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Added seismic base force 256.1 lbs

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: 8' Retaining Wall W/ Seismic

Design Summary			Stem Construction			2nd	Bottom		
			Design Height Above Ftg	ft =	Stem OK	Stem OK			
			Wall Material Above "Ht"	=	Concrete	Concrete			
Wall Stability Ratios			Design Method	=	SD	SD		SD	SD
Overturning	=	1.64 OK	Thickness	=	8.00	8.00			
Sliding	=	1.17 Ratio < 1.5!	Rebar Size	=	# 5	# 5			
Global Stability	=	4.04	Rebar Spacing	=	16.00	8.00			
			Rebar Placed at	=	Center	Edge			
Total Bearing Load = 4,834 lbs			Design Data						
...resultant ecc. = 11.91 in			fb/FB + fa/Fa	=	0.998	0.802			
Eccentricity outside middle third			Total Force @ Section						
Soil Pressure @ Toe	=	2,231 psf OK	Service Level	lbs =					
Soil Pressure @ Heel	=	0 psf OK	Strength Level	lbs =	1,414.0	2,749.4			
Allowable	=	2,500 psf	Moment....Actual						
Soil Pressure Less Than Allowable			Service Level	ft-# =					
ACI Factored @ Toe	=	3,059 psf	Strength Level	ft-# =	3,892.2	9,473.9			
ACI Factored @ Heel	=	0 psf	Moment.....Allowable	ft-# =	3,898.0	11,799.2			
Footing Shear @ Toe	=	17.4 psi OK	Shear.....Actual						
Footing Shear @ Heel	=	24.2 psi OK	Service Level	psi =					
Allowable	=	75.0 psi	Strength Level	psi =	29.5	37.0			
Sliding Calcs			Shear.....Allowable	psi =	75.0	75.0			
Lateral Sliding Force	=	2,374.9 lbs	Anet (Masonry)	in2 =					
less 100% Passive Force	=	1,079.2 lbs	Wall Weight	psf =	100.0	100.0			
less 100% Friction Force	=	1,692.0 lbs	Rebar Depth 'd'	in =	4.00	6.19			
Added Force Req'd	=	0.0 lbs OK	Masonry Data						
....for 1.5 Stability	=	1,052.3 lbs NG	f'm	psi =					
Vertical component of active lateral soil pressure IS considered in the calculation of soil bearing pressures.			Fs	psi =					
			Solid Grouting	=					
			Modular Ratio 'n'	=					
			Equiv. Solid Thick.	=					
			Masonry Block Type	=					
			Masonry Design Method	=	ASD				
Load Factors			Concrete Data						
Building Code			f'c	psi =	2,500.0	2,500.0			
Dead Load		1.200	Fy	psi =	60,000.0	60,000.0			
Live Load		1.600							
Earth, H		1.600							
Wind, W		1.600							
Seismic, E		1.000							

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

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DESCRIPTION: 8' Retaining Wall W/ Seismic**Concrete Stem Rebar Area Details**

2nd Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>
As (based on applied moment) :	0.235 in ² /ft	
(4/3) * As :	0.3133 in ² /ft	Min Stem T&S Reinf Area 1.152 in ²
200bd/fy : 200(12)(4)/60000 :	0.16 in ² /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in ² /ft
0.0018bh : 0.0018(12)(8) :	0.1728 in ² /ft	Horizontal Reinforcing Options :
	=====	<u>One layer of :</u> <u>Two layers of :</u>
Required Area :	0.235 in ² /ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.2325 in ² /ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.5419 in ² /ft	#6@ 27.50 in #6@ 55.00 in

Bottom Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>
As (based on applied moment) :	0.3587 in ² /ft	
(4/3) * As :	0.4783 in ² /ft	Min Stem T&S Reinf Area 0.480 in ²
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in ² /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in ² /ft
0.0018bh : 0.0018(12)(8) :	0.1728 in ² /ft	Horizontal Reinforcing Options :
	=====	<u>One layer of :</u> <u>Two layers of :</u>
Required Area :	0.3587 in ² /ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.465 in ² /ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8382 in ² /ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	2.00 ft
Heel Width	=	2.50
Total Footing Width	=	4.50
Footing Thickness	=	14.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	1.83 ft
f _c =	2,500 psi	F _y = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm.= 3.00 in

Footing Design Results

	<u>Toe</u>	<u>Heel</u>
Factored Pressure	= 3,059	0 psf
Mu' : Upward	= 5,036	183 ft-#
Mu' : Downward	= 1,080	4,430 ft-#
Mu : Design	= 3,956 OK	4,247 ft-# OK
phiMn	= 21,219	15,795 ft-#
Actual 1-Way Shear	= 17.43	24.18 psi
Allow 1-Way Shear	= 75.00	75.00 psi
Toe Reinforcing	= # 5 @ 8.00 in	
Heel Reinforcing	= # 5 @ 12.00 in	
Key Reinforcing	= None Spec'd	
Footing Torsion, Tu	=	0.00 ft-lbs
Footing Allow. Torsion, phi Tu	=	0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Heel: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Key: No key defined

Min footing T&S reinf Area 1.36 in²
Min footing T&S reinf Area per foot 0.30 in²/ft

If one layer of horizontal bars:

#4@ 7.94 in
#5@ 12.30 in
#6@ 17.46 in

If two layers of horizontal bars:

#4@ 15.87 in
#5@ 24.60 in
#6@ 34.92 in

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: 8' Retaining Wall W/ Seismic**Summary of Overturning & Resisting Forces & Moments**

Item	.....OVERTURNING.....				.....RESISTING.....		
	Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	513.8	5.39	4,857.5	Soil Over HL (ab. water tbl)	1,142.8	3.58	4,095.0
HL Act Pres (be water tbl)	756.2	1.66	1,252.4	Soil Over HL (bel. water tbl)	291.7	3.58	4,095.0
Hydrostatic Force	382.2	1.17		Water Table	266.9	3.58	1,045.4
Buoyant Force =	327.6	2.25		Sloped Soil Over Heel =			
Surcharge over Heel =	466.7	4.58	2,138.9	Surcharge Over Heel =	320.8	3.58	1,149.7
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	550.0	1.00	550.0
Seismic Earth Load =	256.1	5.50	1,408.3	Surcharge Over Toe =			
=				Stem Weight(s) =	850.0	2.33	1,983.3
				Earth @ Stem Transitions =			
				Footing Weight =	787.5	2.25	1,771.9
				Key Weight =		1.83	
				Vert. Component =	624.5	4.50	2,810.2
Total	= 2,702.5	O.T.M. =	8,751.3				
Resisting/Overturning Ratio		= 1.64					
Vertical Loads used for Soil Pressure =		4,834.3	lbs				
					</		

* If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS considered in the calculation of Overturning Resistance.

Tilt**Horizontal Deflection at Top of Wall due to settlement of soil**

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci

Horizontal Defl @ Top of Wall (approximate only) 0.117 in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC# : KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retaining Wall W/ Seismic**Rebar Lap & Embedment Lengths Information**Stem Design Segment: 2nd

Stem Design Height: 2.50 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.3a) =

23.40 in

Development length for #5 bar specified in this stem design segment =

18.00 in

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.3a) =

23.40 in

Development length for #5 bar specified in this stem design segment =

18.00 in

Hooked embedment length into footing for #5 bar specified in this stem design segment =

10.50 in

As Provided =

0.4650 in²/ft

As Required =

0.3587 in²/ft

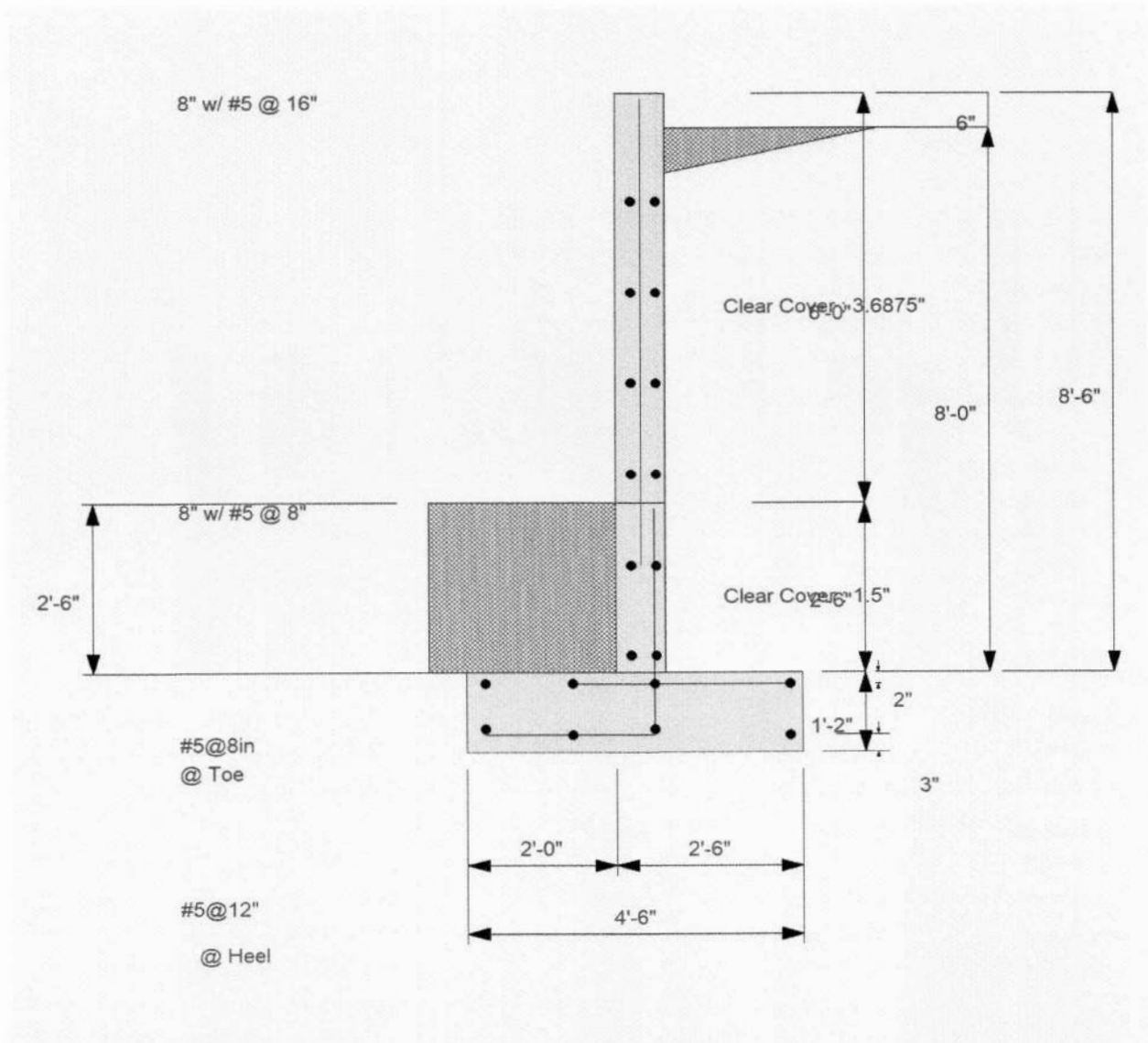
Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: 8' Retaining Wall W/ Seismic


Cantilevered Retaining Wall

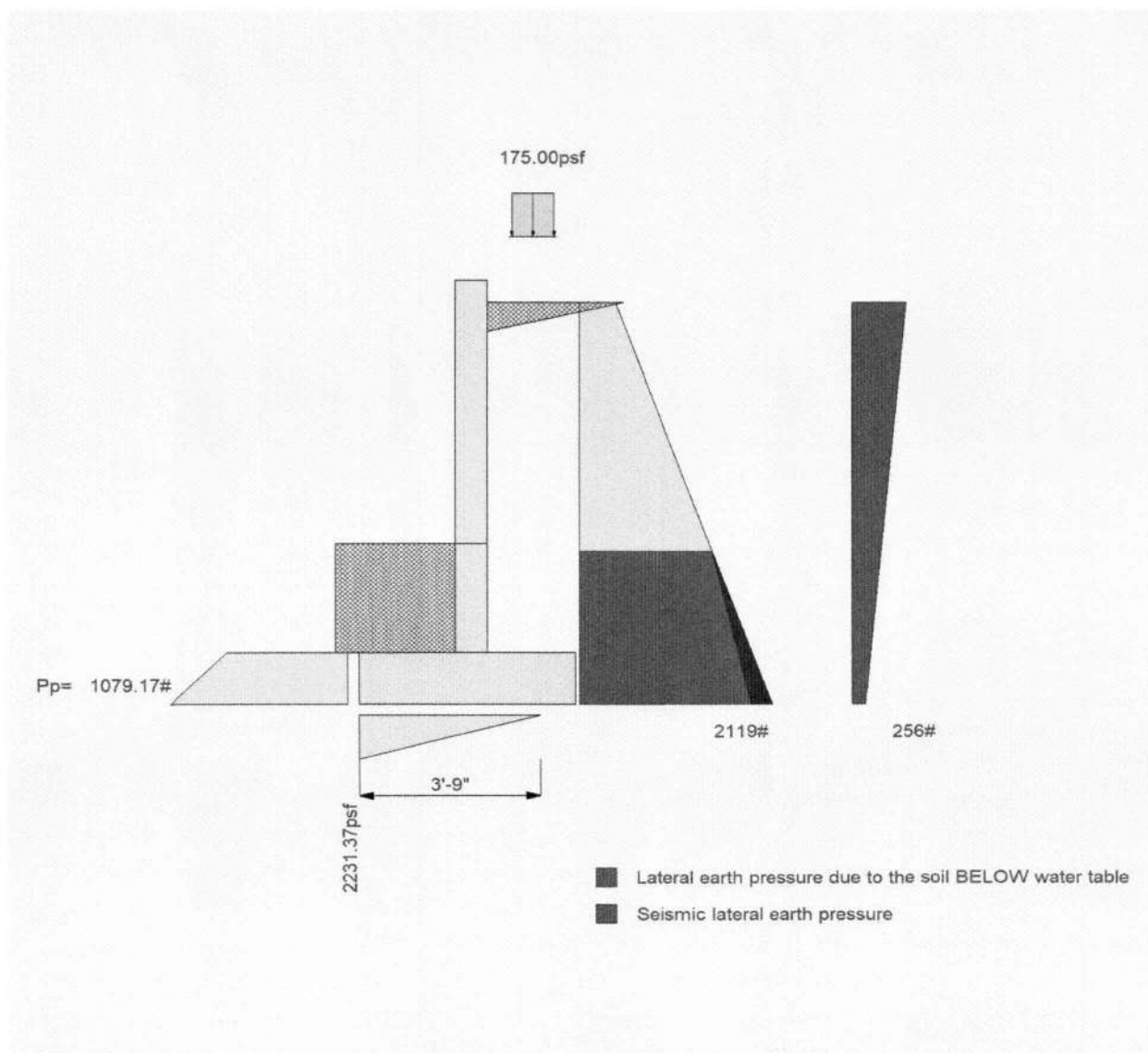
LIC# : KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

Project File: 22-0690.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retaining Wall W/ Seismic



Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: 8' Retaining Wall W/O Seismic**Code Reference:**

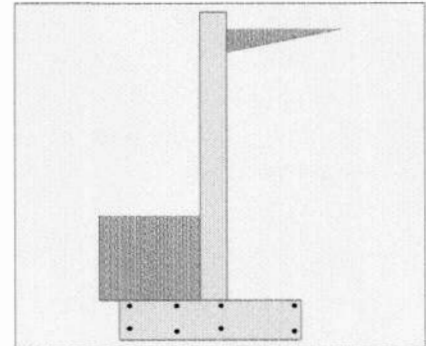
Calculations per IBC 2015 1807.3, CBC 2016, ASCE 7-10

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	30.00 in
Water table above bottom of footing	=	3.5 ft

Soil Data

Allow Soil Bearing	=	2,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	32.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.350
Soil height to ignore for passive pressure	=	12.00 in

**Surcharge Loads**

Surcharge Over Heel	=	175.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0 psf
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W)
		(Service Level)
Wind on Exposed Stem	=	0.0 psf
(Strength Level)		

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retaining Wall W/O Seismic

Design Summary			Stem Construction		2nd	Bottom		
Wall Stability Ratios			Design Height Above Ftg	ft =	Stem OK 2.50	Stem OK 0.00		
Overturning	=	1.96 OK	Wall Material Above "Ht"	=	Concrete	Concrete	SD	SD
Sliding	=	1.68 OK	Design Method	=	SD	SD		
Global Stability	=	4.04	Thickness	=	8.00	8.00		
			Rebar Size	=	# 5	# 5		
			Rebar Spacing	=	16.00	8.00		
			Rebar Placed at	=	Center	Edge		
Total Bearing Load			Design Data					
...resultant ecc.	=	4,834 lbs	fb/FB + fa/Fa	=	0.837	0.705		
	=	7.89 in	Total Force @ Section					
Eccentricity within middle third			Service Level	lbs =				
Soil Pressure @ Toe	=	1,756 psf OK	Strength Level	lbs =	1,223.5	2,508.9		
Soil Pressure @ Heel	=	115 psf OK	Moment....Actual					
Allowable	=	2,500 psf	Service Level	ft-# =				
Soil Pressure Less Than Allowable			Strength Level	ft-# =	3,263.5	8,319.4		
ACI Factored @ Toe	=	2,407 psf	Moment.....Allowable	ft-# =	3,898.0	11,799.2		
ACI Factored @ Heel	=	158 psf	Shear.....Actual					
Footing Shear @ Toe	=	13.2 psi OK	Service Level	psi =				
Footing Shear @ Heel	=	19.6 psi OK	Strength Level	psi =	25.5	33.8		
Allowable	=	75.0 psi	Shear.....Allowable	psi =	75.0	75.0		
Sliding Calcs			Anet (Masonry)	in2 =				
Lateral Sliding Force	=	2,118.8 lbs	Wall Weight	psf =	100.0	100.0		
less 100% Passive Force	=	1,866.7 lbs	Rebar Depth 'd'	in =	4.00	6.19		
less 100% Friction Force	=	1,692.0 lbs	Masonry Data					
Added Force Req'd	=	0.0 lbs OK	f'm	psi =				
....for 1.5 Stability	=	0.0 lbs OK	Fs	psi =				
			Solid Grouting	=				
			Modular Ratio 'n'	=				
			Equiv. Solid Thick.	=				
			Masonry Block Type	=				
			Masonry Design Method	=	ASD			
Load Factors			Concrete Data					
Building Code			f'c	psi =	2,500.0	2,500.0		
Dead Load		1.200	Fy	psi =	60,000.0	60,000.0		
Live Load		1.600						
Earth, H		1.600						
Wind, W		1.600						
Seismic, E		1.000						

Vertical component of active lateral soil pressure IS considered in the calculation of soil bearing pressures.

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retaining Wall W/O Seismic**Concrete Stem Rebar Area Details**

2nd Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>
As (based on applied moment) :	0.197 in ² /ft	
(4/3) * As :	0.2627 in ² /ft	Min Stem T&S Reinf Area 1.152 in ²
200bd/fy : 200(12)(4)/60000 :	0.16 in ² /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in ² /ft
0.0018bh : 0.0018(12)(8) :	0.1728 in ² /ft	Horizontal Reinforcing Options :
	=====	<u>One layer of :</u> <u>Two layers of :</u>
Required Area :	0.197 in ² /ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.2325 in ² /ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.5419 in ² /ft	#6@ 27.50 in #6@ 55.00 in

Bottom Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>
As (based on applied moment) :	0.315 in ² /ft	
(4/3) * As :	0.42 in ² /ft	Min Stem T&S Reinf Area 0.480 in ²
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in ² /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in ² /ft
0.0018bh : 0.0018(12)(8) :	0.1728 in ² /ft	Horizontal Reinforcing Options :
	=====	<u>One layer of :</u> <u>Two layers of :</u>
Required Area :	0.315 in ² /ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.465 in ² /ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8382 in ² /ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	2.00 ft
Heel Width	=	2.50
Total Footing Width	=	4.50
Footing Thickness	=	14.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	1.83 ft
f'c =	2,500 psi	Fy = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm = 3.00 in

Footing Design Results

	<u>Toe</u>	<u>Heel</u>
Factored Pressure	= 2,407	158 psf
Mu' : Upward	= 4,147	778 ft-#
Mu' : Downward	= 1,080	4,430 ft-#
Mu : Design	= 3,067 OK	3,652 ft-# OK
phi Mn	= 21,219	15,795 ft-#
Actual 1-Way Shear	= 13.18	19.60 psi
Allow 1-Way Shear	= 75.00	75.00 psi
Toe Reinforcing	= # 5 @ 8.00 in	
Heel Reinforcing	= # 5 @ 12.00 in	
Key Reinforcing	= None Spec'd	
Footing Torsion, Tu	=	0.00 ft-lbs
Footing Allow. Torsion, phi Tu	=	0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Heel: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Key: No key defined

Min footing T&S reinf Area	1.36 in ²
Min footing T&S reinf Area per foot	0.30 in ² /ft
<u>If one layer of horizontal bars:</u>	<u>If two layers of horizontal bars:</u>
#4@ 7.94 in	#4@ 15.87 in
#5@ 12.30 in	#5@ 24.60 in
#6@ 17.46 in	#6@ 34.92 in

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC# : KWW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retaining Wall W/O Seismic**Summary of Overturning & Resisting Forces & Moments**

Item	.....OVERTURNING.....			.....RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	513.8	5.39	4,857.5	Soil Over HL (ab. water tbl)	1,142.8	3.58	4,095.0
HL Act Pres (be water tbl)	756.2	1.66	1,252.4	Soil Over HL (bel. water tbl)	291.7	3.58	4,095.0
Hydrostatic Force	382.2	1.17		Water Table	266.9	3.58	1,045.4
Buoyant Force =	327.6	2.25		Sloped Soil Over Heel =			
Surcharge over Heel =	466.7	4.58	2,138.9	Surcharge Over Heel =	320.8	3.58	1,149.7
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	550.0	1.00	550.0
=				Surcharge Over Toe =			
				Stem Weight(s) =	850.0	2.33	1,983.3
				Earth @ Stem Transitions =			
				Footing Weight =	787.5	2.25	1,771.9
				Key Weight =		1.83	
				Vert. Component =	624.5	4.50	2,810.2
Total	= 2,446.4	O.T.M. =	7,343.0	Total =	4,834.3	lbs R.M. =	14,362.0
Resisting/Overturning Ratio	= 1.96						
Vertical Loads used for Soil Pressure =	4,834.3		lbs				

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

*Includes water table effect

Vertical component of active lateral soil pressure IS considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS considered in the calculation of Overturning Resistance.

Tilt**Horizontal Deflection at Top of Wall due to settlement of soil**

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci

Horizontal Defl @ Top of Wall (approximate only) 0.092 in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retaining Wall W/O Seismic**Rebar Lap & Embedment Lengths Information**Stem Design Segment: 2nd

Stem Design Height: 2.50 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.3a) =

23.40 in

Development length for #5 bar specified in this stem design segment =

18.00 in

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.3a) =

23.40 in

Development length for #5 bar specified in this stem design segment =

18.00 in

Hooked embedment length into footing for #5 bar specified in this stem design segment =

10.50 in

As Provided =

0.4650 in²/ft

As Required =

0.3150 in²/ft

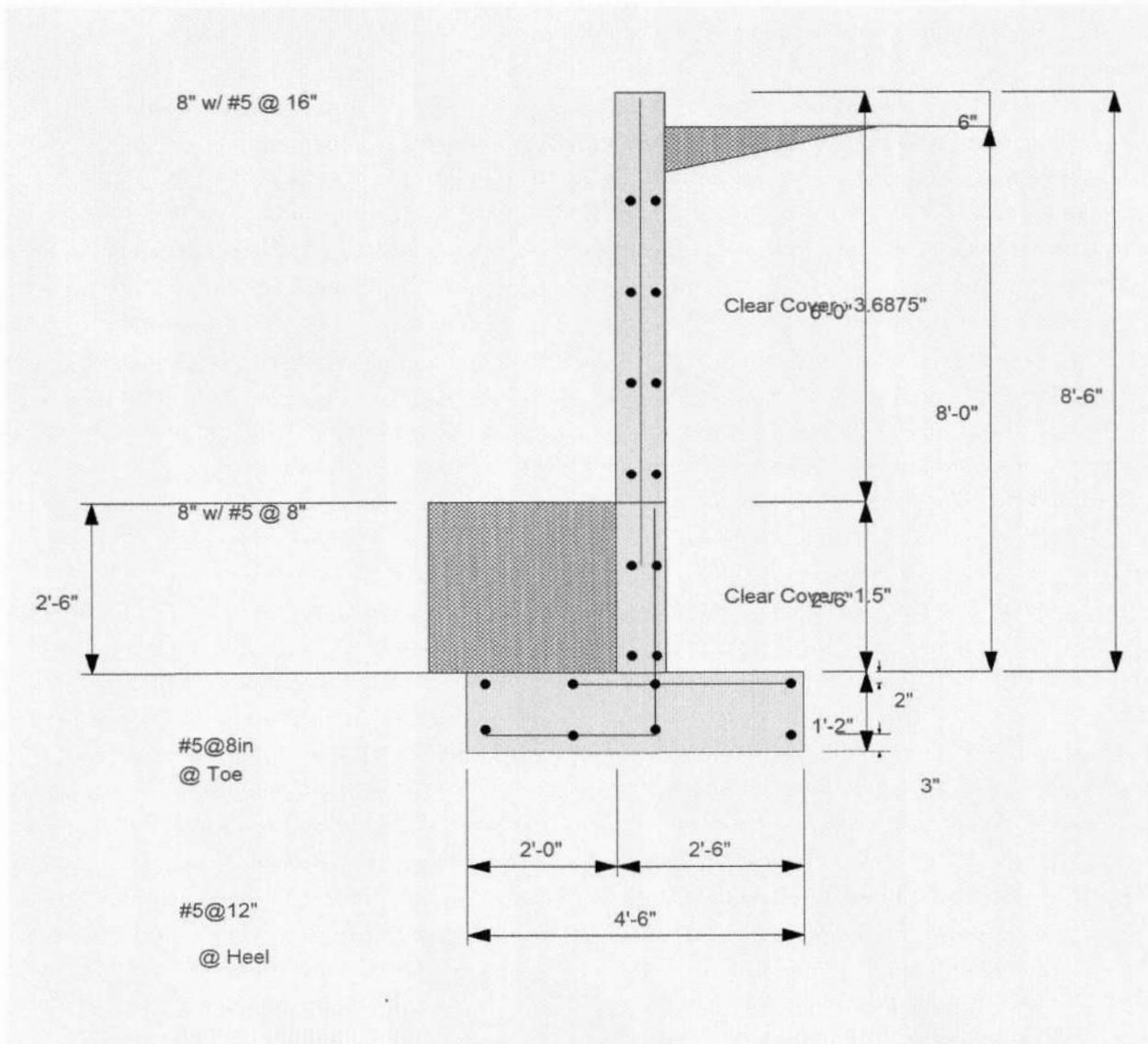
Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: 8' Retaining Wall W/O Seismic

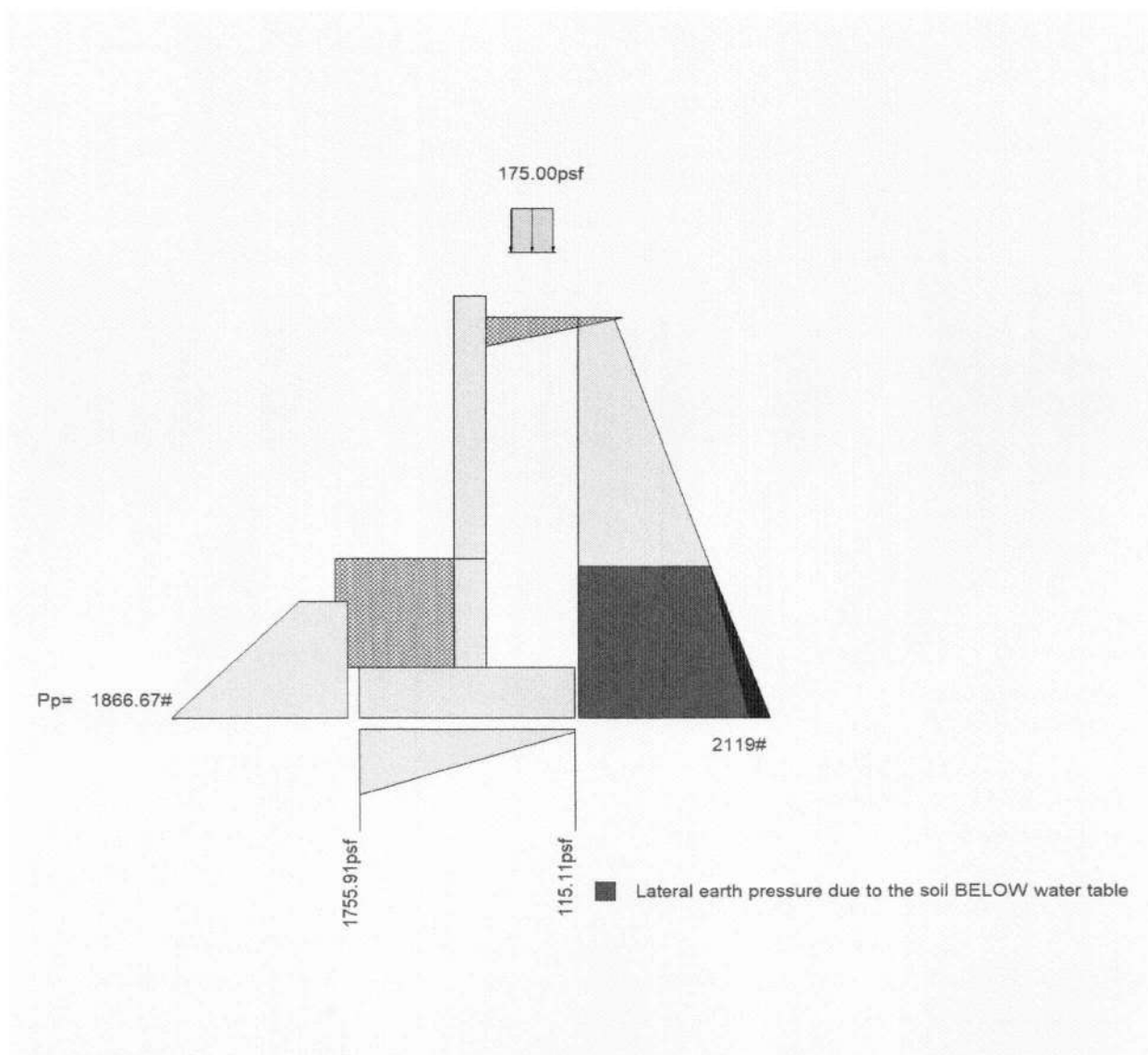
Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: 8' Retaining Wall W/O Seismic

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: 6' Retaining Wall W/ Seismic**Code Reference:**

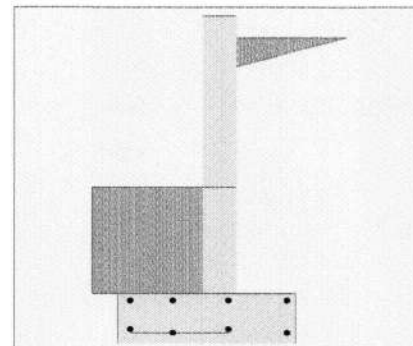
Calculations per IBC 2015 1807.3, CBC 2016, ASCE 7-10

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	30.00 in
Water table above bottom of footing	=	3.5 ft

Soil Data

Allow Soil Bearing	=	2,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	32.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.350
Soil height to ignore for passive pressure	=	30.00 in

**Surcharge Loads**

Surcharge Over Heel	=	175.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0 psf
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Mononobe-Okabe/Seed-Whitman
 Design Kh = 0.148 g

Using Mononobe-Okabe / Seed-Whitman procedure

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem	=	0.0 psf (Strength Level)

K _{ae} for seismic earth pressure	=	0.266
Difference: K _{ae} - K _a	=	0.210
K _a for static earth pressure	=	0.055

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type	=	Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Added seismic base force 156.5 lbs

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC# : KVV-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retaining Wall W/ Seismic

Design Summary			Stem Construction		2nd	Bottom		
			Design Height Above Ftg	ft =	Stem OK 2.50	Stem OK 0.00		
Wall Stability Ratios			Wall Material Above "Ht"	=	Concrete	Concrete		
Overturning	=	1.49 Ratio < 1.5!	Design Method	=	SD	SD	SD	SD
Sliding	=	1.32 Ratio < 1.5!	Thickness	=	8.00	8.00		
Global Stability	=	5.72	Rebar Size	=	# 5	# 5		
			Rebar Spacing	=	16.00	8.00		
			Rebar Placed at	=	Center	Edge		
Total Bearing Load	=	3,131 lbs	Design Data					
...resultant ecc.	=	11.48 in	fb/FB + fa/Fa	=	0.339	0.394		
Eccentricity outside middle third			Total Force @ Section					
Soil Pressure @ Toe	=	2,311 psf OK	Service Level	lbs =				
Soil Pressure @ Heel	=	0 psf OK	Strength Level	lbs =	699.7	1,773.0		
Allowable	=	2,500 psf	Moment.....Actual					
Soil Pressure Less Than Allowable			Service Level	ft-# =				
ACI Factored @ Toe	=	3,170 psf	Strength Level	ft-# =	1,324.7	4,659.9		
ACI Factored @ Heel	=	0 psf	Moment.....Allowable	ft-# =	3,898.0	11,799.2		
Footing Shear @ Toe	=	12.6 psi OK	Shear.....Actual					
Footing Shear @ Heel	=	15.2 psi OK	Service Level	psi =				
Allowable	=	75.0 psi	Strength Level	psi =	14.6	23.9		
Sliding Calcs			Shear.....Allowable	psi =	75.0	75.0		
Lateral Sliding Force	=	1,650.9 lbs	Anet (Masonry)	in2 =				
less 100% Passive Force	=	1,079.2 lbs	Wall Weight	psf =	100.0	100.0		
less 100% Friction Force	=	1,095.8 lbs	Rebar Depth 'd'	in =	4.00	6.19		
Added Force Req'd	=	0.0 lbs OK	Masonry Data					
....for 1.5 Stability	=	562.5 lbs NG	f'm	psi =				
Vertical component of active lateral soil pressure IS considered in the calculation of soil bearing pressures.			Fs	psi =				
			Solid Grouting	=				
			Modular Ratio 'n'	=				
			Equiv. Solid Thick.	=				
			Masonry Block Type	=				
			Masonry Design Method	=	ASD			
Load Factors			Concrete Data					
Building Code			f'c	psi =	2,500.0	2,500.0		
Dead Load		1.200	Fy	psi =	60,000.0	60,000.0		
Live Load		1.600						
Earth, H		1.600						
Wind, W		1.600						
Seismic, E		1.000						

Vertical component of active lateral soil pressure IS considered in the calculation of soil bearing pressures.

Load Factors

Building Code	
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.600
Seismic, E	1.000

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: 6' Retaining Wall W/ Seismic**Concrete Stem Rebar Area Details**

2nd Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>
As (based on applied moment) :	0.08 in2/ft	
(4/3) * As :	0.1066 in2/ft	Min Stem T&S Reinf Area 0.768 in2
200bd/fy : 200(12)(4)/60000 :	0.16 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
	=====	<u>One layer of :</u> <u>Two layers of :</u>
Required Area :	0.1728 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.2325 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.5419 in2/ft	#6@ 27.50 in #6@ 55.00 in

Bottom Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>
As (based on applied moment) :	0.1764 in2/ft	
(4/3) * As :	0.2353 in2/ft	Min Stem T&S Reinf Area 0.480 in2
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
	=====	<u>One layer of :</u> <u>Two layers of :</u>
Required Area :	0.2353 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.465 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8382 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	1.67 ft
Heel Width	=	1.83
Total Footing Width	=	3.50
Footing Thickness	=	14.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	1.42 ft
f'c =	2,500 psi	Fy = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm = 3.00 in

Footing Design Results

	<u>Toe</u>	<u>Heel</u>	
Factored Pressure	= 3,170		0 psf
Mu' : Upward	= 3,386		0 ft-#
Mu' : Downward	= 753		1,578 ft-#
Mu: Design	= 2,633 OK		1,578 ft-# OK
phiMn	= 21,219		15,795 ft-#
Actual 1-Way Shear	= 12.56		15.22 psi
Allow 1-Way Shear	= 75.00		75.00 psi
Toe Reinforcing	= # 5 @ 8.00 in		
Heel Reinforcing	= # 5 @ 12.00 in		
Key Reinforcing	= None Spec'd		
Footing Torsion, Tu	=		0.00 ft-lbs
Footing Allow. Torsion, phi Tu	=		0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Heel: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Key: No key defined

Min footing T&S reinf Area 1.06 in2
Min footing T&S reinf Area per foot 0.30 in2 /ft

If one layer of horizontal bars:

#4@ 7.94 in
#5@ 12.30 in
#6@ 17.46 in

If two layers of horizontal bars:

#4@ 15.87 in
#5@ 24.60 in
#6@ 34.92 in

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retaining Wall W/ Seismic**Summary of Overturning & Resisting Forces & Moments**

Item	.....OVERTURNING.....				.....RESISTING.....		
	Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	215.1	4.72	2,712.6	Soil Over HL (ab. water tbl)	469.2	2.92	1,369.3
HL Act Pres (be water tbl)	532.2	1.62	860.4	Soil Over HL (bel. water tbl)	185.1	2.92	1,369.3
Hydrostatic Force	382.2	1.17		Water Table	169.4	2.92	540.3
Buoyant Force =	254.8	1.75		Sloped Soil Over Heel =			
Surcharge over Heel =	364.8	3.58	1,307.4	Surcharge Over Heel =	203.6	2.92	594.1
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	459.3	0.84	383.5
Seismic Earth Load =	156.5	4.30	673.0	Surcharge Over Toe =			
=				Stem Weight(s) =	650.0	2.00	1,302.2
				Earth @ Stem Transitions =			
Total =	1,905.7	O.T.M. =	4,748.4	Footing Weight =	612.5	1.75	1,071.9
				Key Weight =		1.42	
				Vert. Component =	381.7	3.50	1,336.0
Resisting/Overturning Ratio		=	1.49	Total =	3,130.8	R.M. =	7,091.5
Vertical Loads used for Soil Pressure =		3,130.8	lbs				

* If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS considered in the calculation of Overturning Resistance.

Tilt**Horizontal Deflection at Top of Wall due to settlement of soil**

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci

Horizontal Defl @ Top of Wall (approximate only) 0.119 in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KIW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retaining Wall W/ Seismic**Rebar Lap & Embedment Lengths Information**Stem Design Segment: 2nd

Stem Design Height: 2.50 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.3a) =

23.40 in

Development length for #5 bar specified in this stem design segment =

18.00 in

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.3a) =

23.40 in

Development length for #5 bar specified in this stem design segment =

18.00 in

Hooked embedment length into footing for #5 bar specified in this stem design segment =

6.00 in

As Provided =

0.4650 in2/ft

As Required =

0.2353 in2/ft

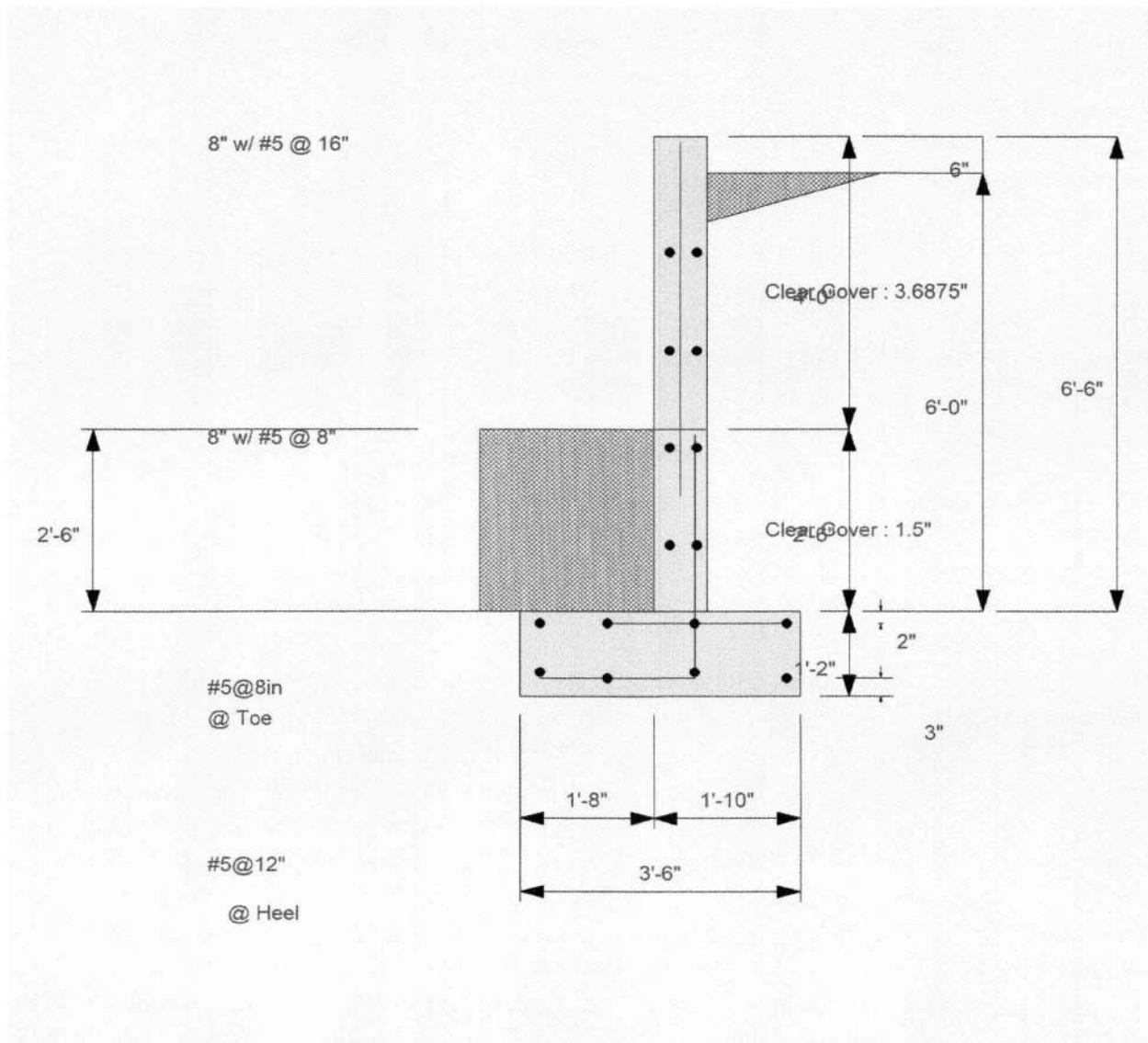
Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retaining Wall W/ Seismic

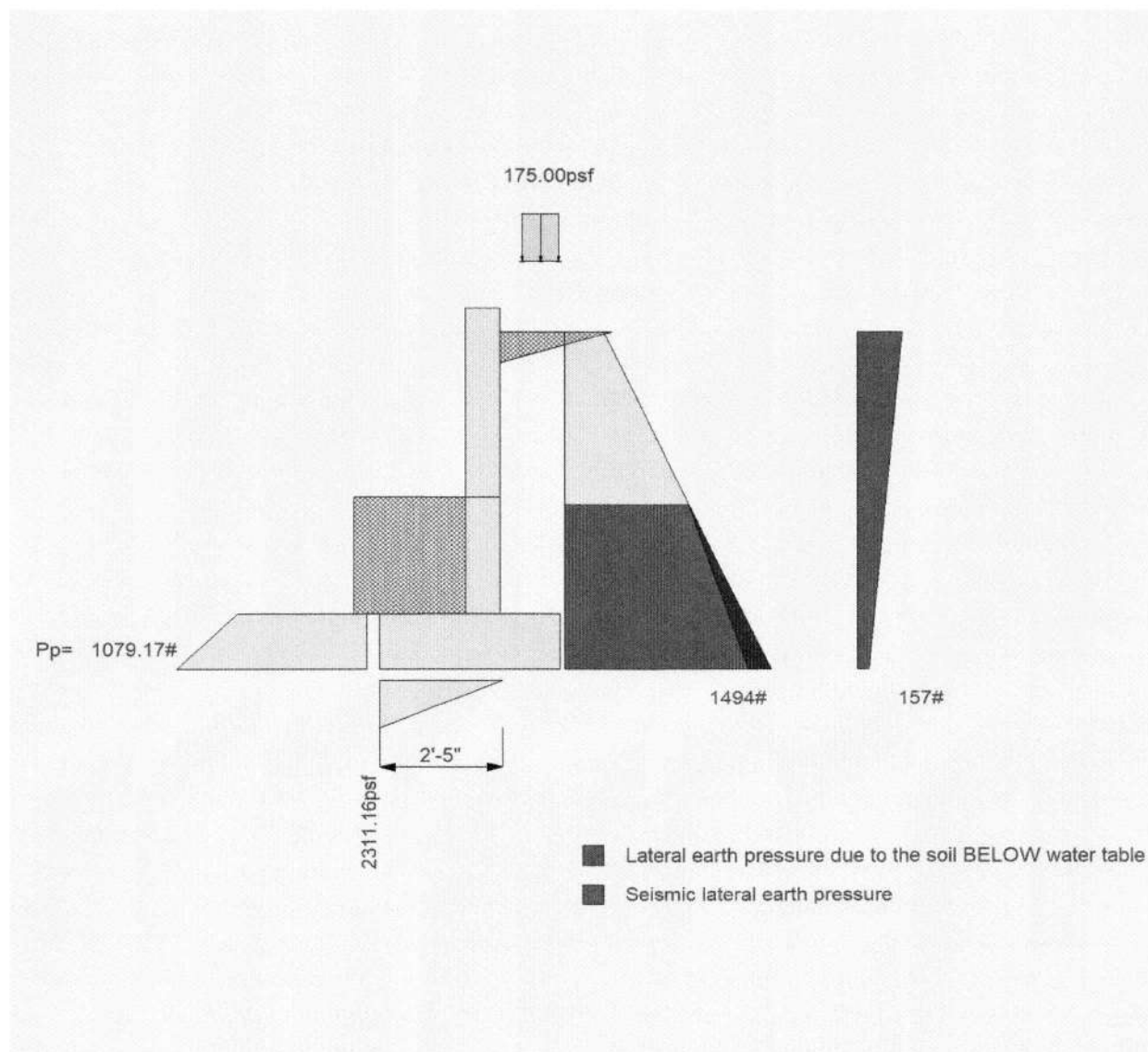
Cantilevered Retaining Wall

LIC# : KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

Project File: 22-0690.ec6

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DESCRIPTION: 6' Retaining Wall W/ Seismic

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retaining Wall W/O Seismic**Code Reference:**

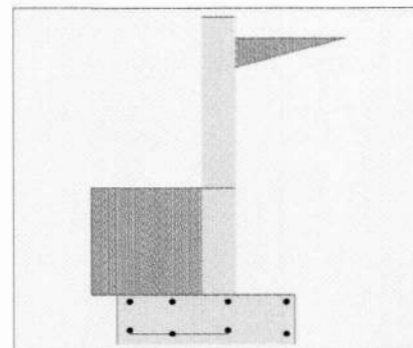
Calculations per IBC 2015 1807.3, CBC 2016, ASCE 7-10

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	30.00 in
Water table above bottom of footing	=	3.5 ft

Soil Data

Allow Soil Bearing	=	2,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	32.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.350
Soil height to ignore for passive pressure	=	0.00 in

**Surcharge Loads**

Surcharge Over Heel	=	175.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0 psf
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W)
		(Service Level)
Wind on Exposed Stem	=	0.0 psf
(Strength Level)		

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retaining Wall W/O Seismic

Design Summary			Stem Construction		2nd	Bottom		
Wall Stability Ratios			Design Height Above Ftg	ft =	Stem OK 2.50	Stem OK 0.00		
Overturning	=	1.74 OK	Wall Material Above "Ht"	=	Concrete	Concrete	SD	SD
Sliding	=	2.08 OK	Design Method	=	SD	SD		
Global Stability	=	5.72	Thickness	=	8.00	8.00		
			Rebar Size	=	# 5	# 5		
			Rebar Spacing	=	16.00	8.00		
			Rebar Placed at	=	Center	Edge		
Total Bearing Load			Design Data					
...resultant ecc.	=	3,131 lbs	fb/FB + fa/Fa	=	0.286	0.351		
	=	8.55 in	Total Force @ Section					
Eccentricity outside middle third			Service Level	lbs =				
Soil Pressure @ Toe	=	1,766 psf OK	Strength Level	lbs =	599.8	1,629.2		
Soil Pressure @ Heel	=	0 psf OK	Moment....Actual					
Allowable	=	2,500 psf	Service Level	ft-# =				
Soil Pressure Less Than Allowable			Strength Level	ft-# =	1,114.9	4,142.1		
ACI Factored @ Toe	=	2,422 psf	Moment.....Allowable	ft-# =	3,898.0	11,799.2		
ACI Factored @ Heel	=	0 psf	Shear.....Actual					
Footing Shear @ Toe	=	9.2 psi OK	Service Level	psi =				
Footing Shear @ Heel	=	13.5 psi OK	Strength Level	psi =	12.5	21.9		
Allowable	=	75.0 psi	Shear.....Allowable	psi =	75.0	75.0		
Sliding Calcs			Anet (Masonry)	in2 =				
Lateral Sliding Force	=	1,494.3 lbs	Wall Weight	psf =	100.0	100.0		
less 100% Passive Force	=	2,016.7 lbs	Rebar Depth 'd'	in =	4.00	6.19		
less 100% Friction Force	=	1,095.8 lbs	Masonry Data					
Added Force Req'd	=	0.0 lbs OK	f'm	psi =				
....for 1.5 Stability	=	0.0 lbs OK	Fs	psi =				
Vertical component of active lateral soil pressure IS considered in the calculation of soil bearing pressures.			Solid Grouting	=				
Load Factors			Modular Ratio 'n'	=				
Building Code			Equiv. Solid Thick.	=				
Dead Load		1.200	Masonry Block Type	=				
Live Load		1.600	Masonry Design Method	=	ASD			
Earth, H		1.600	Concrete Data					
Wind, W		1.600	f'c	psi =	2,500.0	2,500.0		
Seismic, E		1.000	Fy	psi =	60,000.0	60,000.0		

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC# : KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retaining Wall W/O Seismic**Concrete Stem Rebar Area Details**

2nd Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>
As (based on applied moment) :	0.0673 in ² /ft	
(4/3) * As :	0.0897 in ² /ft	Min Stem T&S Reinf Area 0.768 in ²
200bd/fy : 200(12)(4)/60000 :	0.16 in ² /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in ² /ft
0.0018bh : 0.0018(12)(8) :	0.1728 in ² /ft	Horizontal Reinforcing Options :
	=====	<u>One layer of :</u> <u>Two layers of :</u>
Required Area :	0.1728 in ² /ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.2325 in ² /ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.5419 in ² /ft	#6@ 27.50 in #6@ 55.00 in

Bottom Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>
As (based on applied moment) :	0.1568 in ² /ft	
(4/3) * As :	0.2091 in ² /ft	Min Stem T&S Reinf Area 0.480 in ²
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in ² /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in ² /ft
0.0018bh : 0.0018(12)(8) :	0.1728 in ² /ft	Horizontal Reinforcing Options :
	=====	<u>One layer of :</u> <u>Two layers of :</u>
Required Area :	0.2091 in ² /ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.465 in ² /ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8382 in ² /ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	1.67 ft
Heel Width	=	1.83
Total Footing Width	=	3.50
Footing Thickness	=	14.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	1.42 ft
f _c =	2,500 psi	F _y = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm = 3.00 in

Footing Design Results

	<u>Toe</u>	<u>Heel</u>	
Factored Pressure	= 2,422		0 psf
Mu' : Upward	= 2,774		61 ft-#
Mu' : Downward	= 753		1,578 ft-#
Mu : Design	= 2,021	OK	1,517 ft-# OK
phi Mn	= 21,219		15,795 ft-#
Actual 1-Way Shear	= 9.23		13.53 psi
Allow 1-Way Shear	= 75.00		75.00 psi
Toe Reinforcing	= # 5 @ 8.00 in		
Heel Reinforcing	= # 5 @ 12.00 in		
Key Reinforcing	= None Spec'd		
Footing Torsion, Tu	=		0.00 ft-lbs
Footing Allow. Torsion, phi Tu	=		0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Heel: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Key: No key defined

Min footing T&S reinf Area	1.06 in ²
Min footing T&S reinf Area per foot	0.30 in ² /ft
<u>If one layer of horizontal bars:</u>	<u>If two layers of horizontal bars:</u>
#4@ 7.94 in	#4@ 15.87 in
#5@ 12.30 in	#5@ 24.60 in
#6@ 17.46 in	#6@ 34.92 in

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retaining Wall W/O Seismic**Summary of Overturning & Resisting Forces & Moments**

Item	.....OVERTURNING.....				.....RESISTING.....		
	Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	215.1	4.72	2,712.6	Soil Over HL (ab. water tbl)	469.2	2.92	1,369.3
HL Act Pres (be water tbl)	532.2	1.62	860.4	Soil Over HL (bel. water tbl)	185.1	2.92	1,369.3
Hydrostatic Force	382.2	1.17		Water Table	169.4	2.92	540.3
Buoyant Force =	254.8	1.75		Sloped Soil Over Heel =			
Surcharge over Heel =	364.8	3.58	1,307.4	Surcharge Over Heel =	203.6	2.92	594.1
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	459.3	0.84	383.5
=				Surcharge Over Toe =			
				Stem Weight(s) =	650.0	2.00	1,302.2
				Earth @ Stem Transitions =			
				Footing Weight =	612.5	1.75	1,071.9
				Key Weight =		1.42	
				Vert. Component =	381.7	3.50	1,336.0
Total	= 1,749.1	O.T.M. =	4,075.4	Total =	3,130.8 lbs	R.M. =	7,091.5
Resisting/Overturning Ratio	= 1.74						
Vertical Loads used for Soil Pressure =	3,130.8 lbs						

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

*Includes water table effect

Vertical component of active lateral soil pressure IS considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS considered in the calculation of Overturning Resistance.

Tilt**Horizontal Deflection at Top of Wall due to settlement of soil**

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci

Horizontal Defl @ Top of Wall (approximate only) 0.091 in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe.

because the wall would then tend to rotate into the retained soil.

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retaining Wall W/O Seismic**Rebar Lap & Embedment Lengths Information**Stem Design Segment: 2nd

Stem Design Height: 2.50 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.3a) =

23.40 in

Development length for #5 bar specified in this stem design segment =

18.00 in

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.3a) =

23.40 in

Development length for #5 bar specified in this stem design segment =

18.00 in

Hooked embedment length into footing for #5 bar specified in this stem design segment =

6.00 in

As Provided =

0.4650 in²/ft

As Required =

0.2091 in²/ft

Cantilevered Retaining Wall

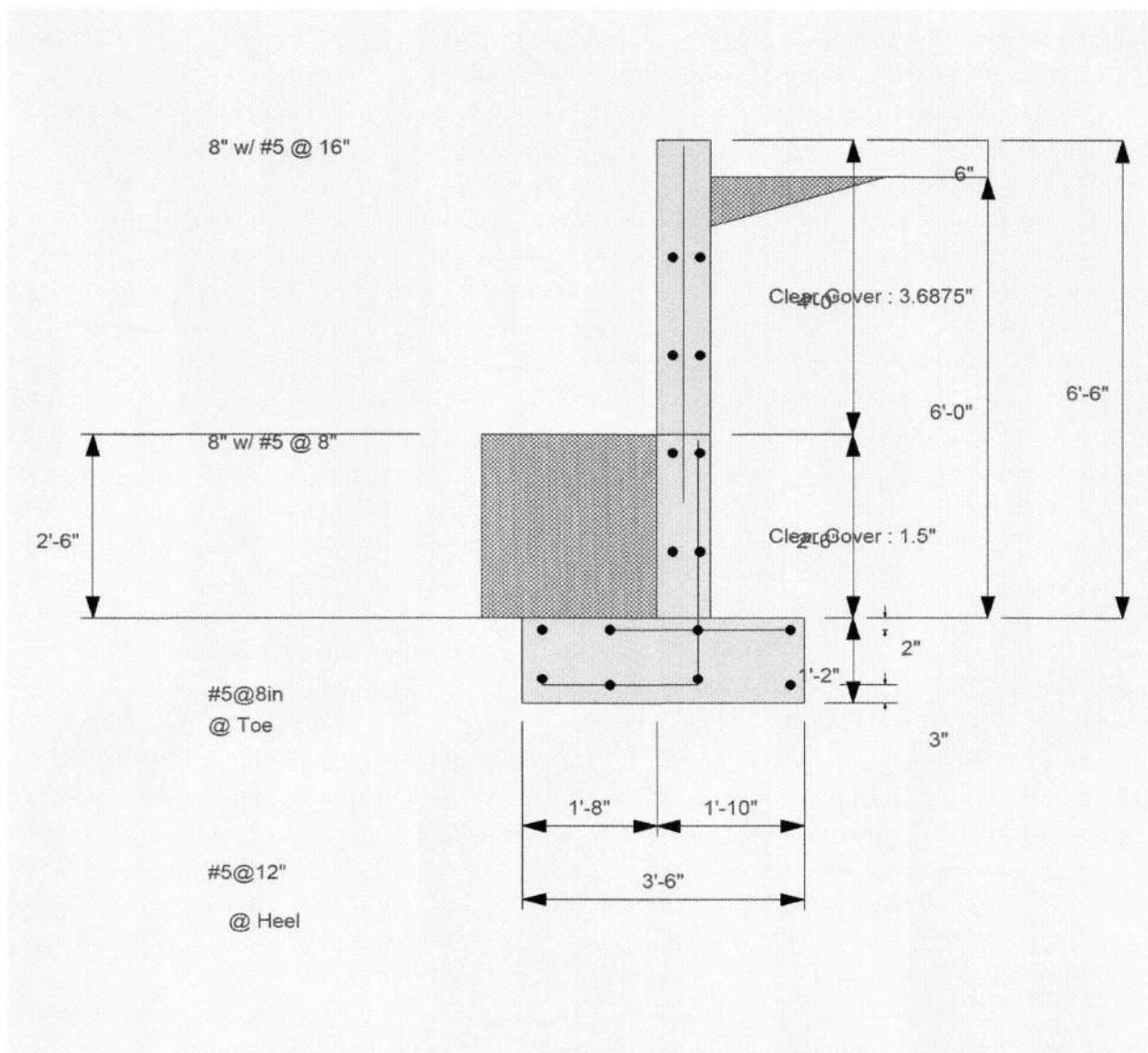
LIC#: KW-06014874, Build:20.23.05.01

Stability Engineering Inc.

Project File: 22-0690.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retaining Wall W/O Seismic



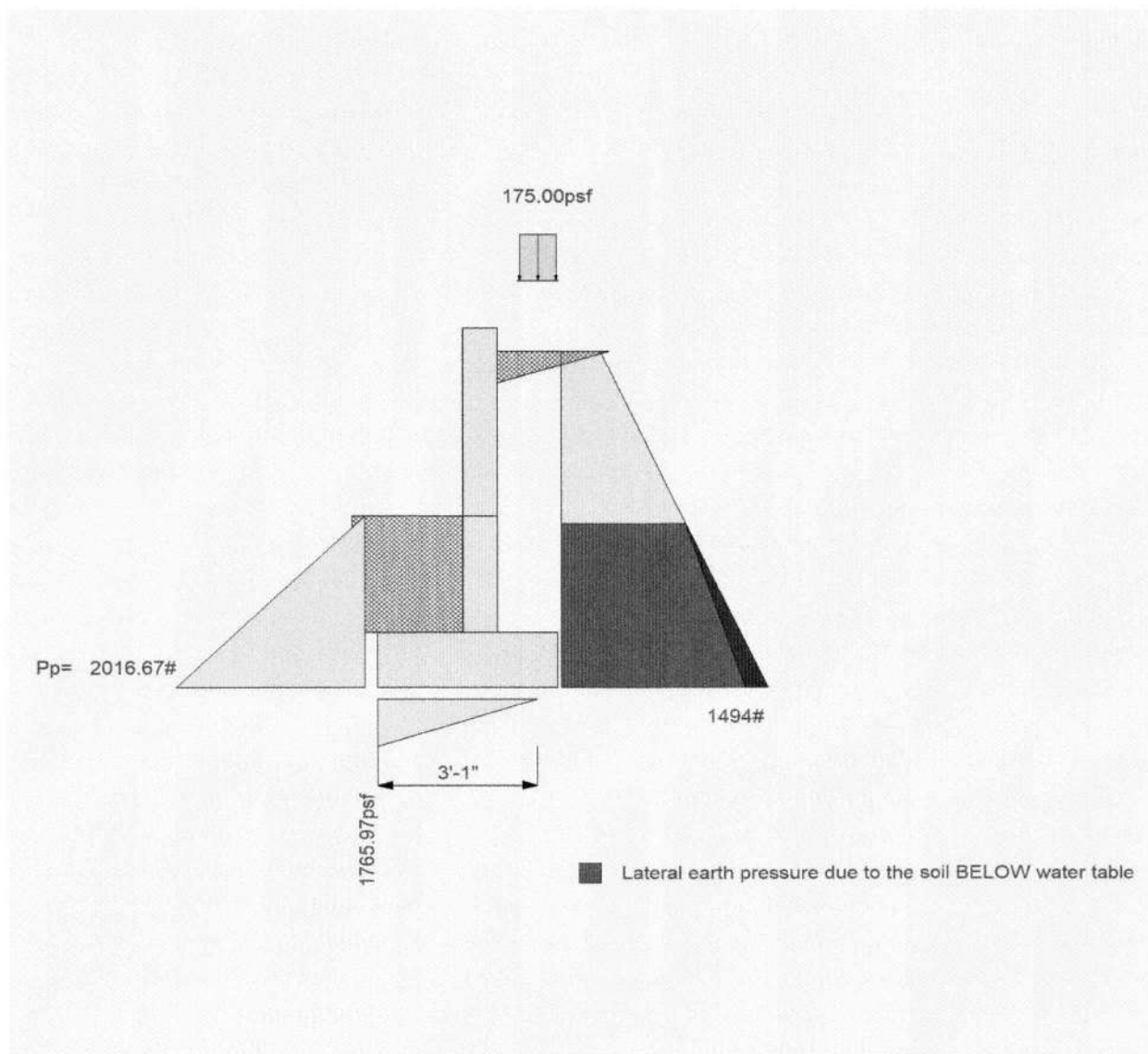
Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KVV-06014874, Build:20.23.05.01

Stability Engineering Inc.

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DESCRIPTION: 6' Retaining Wall W/O Seismic

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.22

Stability Engineering Inc.

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DESCRIPTION: 4' Retaining Wall W/O Seismic**Code Reference:**

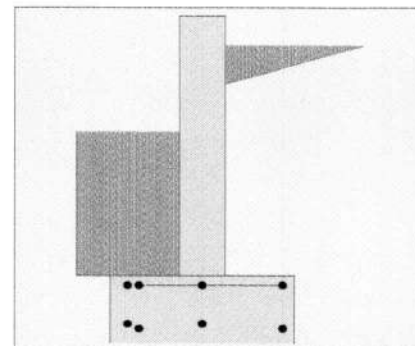
Calculations per IBC 2015 1807.3, CBC 2016, ASCE 7-10

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	30.00 in
Water table above bottom of footing	=	3.5 ft

Soil Data

Allow Soil Bearing	=	2,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	32.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.350
Soil height to ignore for passive pressure	=	0.00 in

**Surcharge Loads**

Surcharge Over Heel	=	175.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W)
		(Service Level)
Wind on Exposed Stem	=	0.0 psf
(Strength Level)		

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.22

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 4' Retaining Wall W/O Seismic**Design Summary****Wall Stability Ratios**

Overturning	=	1.64	OK
Sliding	=	2.74	OK
Global Stability	=	10.30	

Total Bearing Load	=	2,056 lbs	
...resultant ecc.	=	8.30 in	

Eccentricity outside middle third

Soil Pressure @ Toe	=	1,924 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	2,500 psf	
Soil Pressure Less Than Allowable			

ACI Factored @ Toe	=	2,624 psf	
ACI Factored @ Heel	=	0 psf	

Footing Shear @ Toe	=	1.9 psi	OK
Footing Shear @ Heel	=	9.4 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	997.9 lbs	
less 100% Passive Force	=	2,016.7 lbs	
less 100% Friction Force	=	719.6 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

Vertical component of active lateral soil pressure IS considered in the calculation of soil bearing pressures.

Load Factors

Building Code	
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.600
Seismic, E	1.000

Stem Construction

Design Height Above Ftc	ft =	Stem OK	
Wall Material Above "Ht"	=	Concrete	
Design Method	=	SD	SD
Thickness	=	8.00	
Rebar Size	=	# 5	
Rebar Spacing	=	16.00	
Rebar Placed at	=	Center	

Design Data

fb/FB + fa/Fa	=	0.430	
---------------	---	-------	--

Total Force @ Section

Service Level	lbs =		
Strength Level	lbs =	954.2	

Moment....Actual

Service Level	ft-# =		
Strength Level	ft-# =	1,678.7	

Moment.....Allowable	=	3,898.0	
----------------------	---	---------	--

Shear.....Actual

Service Level	psi =		
Strength Level	psi =	19.9	

Shear.....Allowable	psi =	75.0	
---------------------	-------	------	--

Anet (Masonry)	in2 =		
----------------	-------	--	--

Wall Weight	psf =	100.0	
-------------	-------	-------	--

Rebar Depth 'd'	in =	4.00	
-----------------	------	------	--

Masonry Data

f _m	psi =		
F _s	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=		
Masonry Design Method	=	ASD	

Concrete Data

f _c	psi =	2,500.0	
F _y	psi =	60,000.0	

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.22

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 4' Retaining Wall W/O Seismic**Concrete Stem Rebar Area Details**

Bottom Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>
As (based on applied moment) :	0.1013 in ² /ft	
(4/3) * As :	0.1351 in ² /ft	Min Stem T&S Reinf Area 0.864 in ²
200bd/fy : 200(12)(4)/60000 :	0.16 in ² /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in ² /ft
0.0018bh : 0.0018(12)(8) :	0.1728 in ² /ft	Horizontal Reinforcing Options :
	=====	<u>One layer of :</u> <u>Two layers of :</u>
Required Area :	0.1728 in ² /ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.2325 in ² /ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.5419 in ² /ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	1.67
Total Footing Width	=	2.67
Footing Thickness	=	14.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	1.00 ft
f _c =	2,500 psi	F _y = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm.= 3.00 in

Footing Design Results

	<u>Toe</u>	<u>Heel</u>	
Factored Pressure	= 2,624		0 psf
Mu' : Upward	= 1,086		4 ft-#
Mu' : Downward	= 270		831 ft-#
Mu: Design	= 816 OK		827 ft-# OK
phiMn	= 14,400		15,795 ft-#
Actual 1-Way Shear	= 1.87		9.36 psi
Allow 1-Way Shear	= 75.00		75.00 psi
Toe Reinforcing	= # 5 @ 12.00 in		
Heel Reinforcing	= # 5 @ 12.00 in		
Key Reinforcing	= None Spec'd		
Footing Torsion, Tu	=	0.00 ft-lbs	
Footing Allow. Torsion, phi Tu	=	0.00 ft-lbs	

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Heel: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Key: No key defined

Min footing T&S reinf Area 0.81 in²
 Min footing T&S reinf Area per foot 0.30 in²/ft

If one layer of horizontal bars:

#4@ 7.94 in
 #5@ 12.30 in
 #6@ 17.46 in

If two layers of horizontal bars:

#4@ 15.87 in
 #5@ 24.60 in
 #6@ 34.92 in

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.22

Stability Engineering Inc.

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DESCRIPTION: 4' Retaining Wall W/O Seismic**Summary of Overturning & Resisting Forces & Moments**

Item	.....OVERTURNING.....			.....RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	44.4	4.06	1,485.1	Soil Over HL (ab. water tbl)	183.9	2.17	398.9
HL Act Pres (be water tbl)	308.2	1.52	468.4	Soil Over HL (bel. water tbl)	159.7	2.17	398.9
Hydrostatic Force	382.2	1.17		Water Table	146.1	2.17	346.2
Buoyant Force =	194.4	1.34		Sloped Soil Over Heel =			
Surcharge over Heel =	263.0	2.58	679.5	Surcharge Over Heel =	175.6	2.17	380.7
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	275.0	0.50	137.5
=				Surcharge Over Toe =			
				Stem Weight(s) =	450.0	1.33	600.0
				Earth @ Stem Transitions =			
				Footing Weight =	467.3	1.34	623.8
				Key Weight =		1.00	
				Vert. Component =	198.4	2.67	529.7
				Total =	2,055.9 lbs	R.M. =	3,333.5
Total =	1,192.2	O.T.M. =	2,033.6				
Resisting/Overturning Ratio		=	1.64				
Vertical Loads used for Soil Pressure =		2,055.9 lbs					

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

*Includes water table effect

Vertical component of active lateral soil pressure IS considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS considered in the calculation of Overturning Resistance.

Tilt**Horizontal Deflection at Top of Wall due to settlement of soil**

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci

Horizontal Defl @ Top of Wall (approximate only) 0.090 in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.22

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: 4' Retaining Wall W/O Seismic**Rebar Lap & Embedment Lengths Information**Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.3a) =

23.40 in

Development length for #5 bar specified in this stem design segment =

18.00 in

Hooked embedment length into footing for #5 bar specified in this stem design segment =

7.80 in

As Provided =

0.2325 in²/ft

As Required =

0.1728 in²/ft

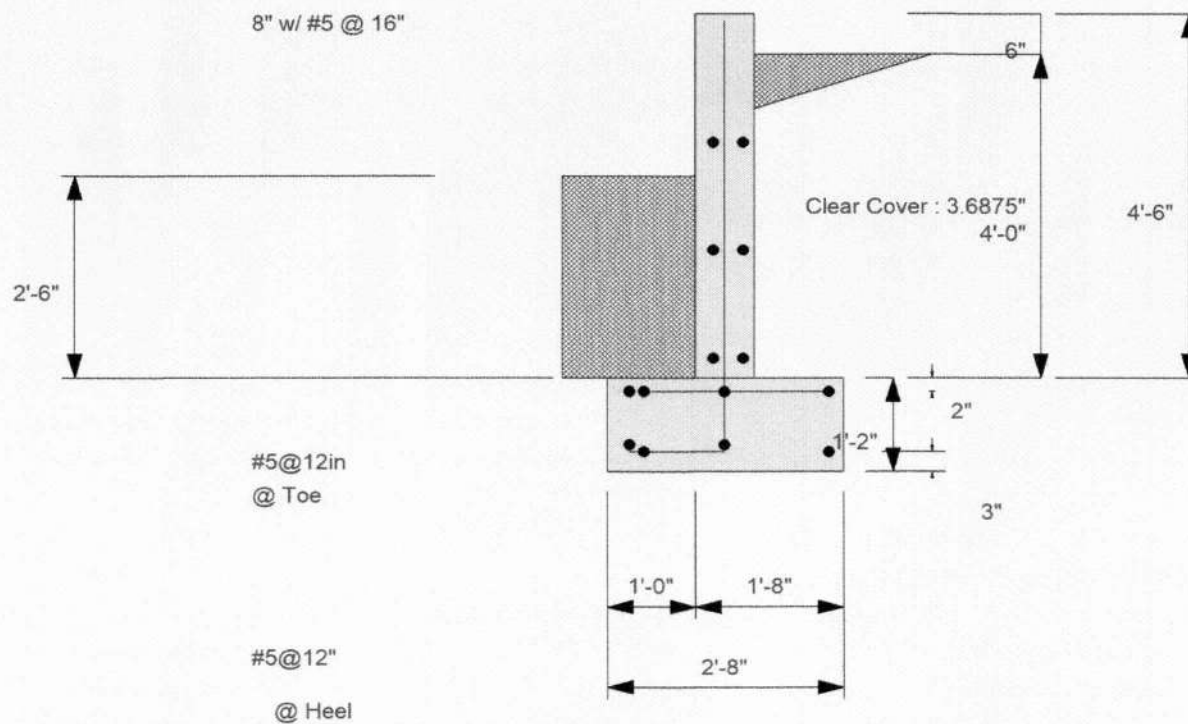
Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.22

Stability Engineering Inc.

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DESCRIPTION: 4' Retaining Wall W/O Seismic

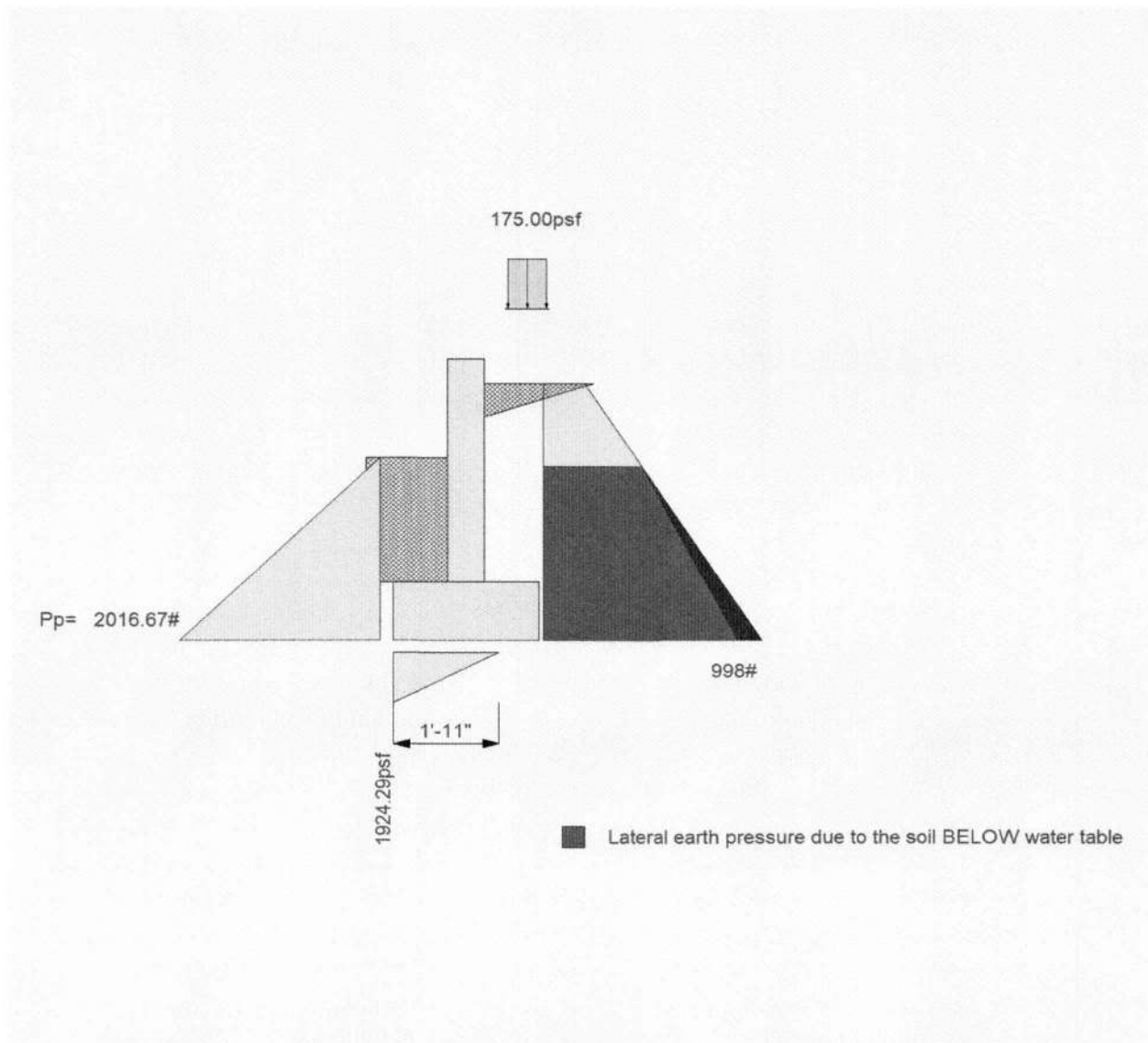
Cantilevered Retaining Wall

Project File: 22-0690.ec6

LIC#: KW-06014874, Build:20.23.05.22

Stability Engineering Inc.

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DESCRIPTION: 4' Retaining Wall W/O Seismic

Attachment of Propane Tank to Slab

$$F_p = 1585 \text{ lbs} \quad * (\text{see next pg of calcs})$$

$$F_a = 4897 \text{ lbs}$$

Try (4) PAB6 Anchor Bolts

$$\frac{F_p}{4} = \frac{396 \text{ lbs (ASD)}}{(0.7)} \left(\frac{2}{2.0} \right) = 1131 \text{ lbs (STR)}$$

\uparrow ASD Factor \uparrow 2.0

$$\frac{F_a}{2} = \frac{2448 \text{ lbs}}{(0.7)} = 3498 \text{ lbs (STR)}$$

\uparrow ASD Factor

* See next (6) pg's of calcs

5/24/2023

Project: 22-0690



By: Paul Schroeder

Mechanical Units: Propane Tank

HVAC Shear and Overturning Forces

ASCE 7-16; 13.3: Seismic Force

$$\begin{aligned} W_p &= 7560 & \text{lb} \\ a_p &= 2.5 \\ S_{DS} &= 0.599 & g \\ R_p &= 6 \\ I_p &= 1 \\ z &= 1 & \text{ft} \\ h &= 1 & \text{ft} \end{aligned}$$

ASCE 7-16; Table 13.6-1

ASCE 7-16; Table 13.6-1

ASCE 7-16; 13.1.3

$$F_p = 0.4a_p S_{DS} W_p (1+2z/h) / (R_p / I_p) (.7) = 1585 \text{ lb}$$

ASCE 7-16; Equation 13.3-1

$$\text{Maximum } F_p = 1.6S_{DS} I_p W_p (.7) = 5072 \text{ lb}$$

ASCE 7-16; Equation 13.3-2

$$\text{Minimum } F_p = 0.3S_{DS} I_p W_p (.7) = 951 \text{ lb}$$

ASCE 7-16; Equation 13.3-3

$$\text{Controlling } F_p = 1585 \text{ lb}$$

Max
Force

$$F_{pv} = 0.2S_{DS} W_p (.7) = 634 \text{ lb}$$

ASCE 7-16; 13.3.1

ASCE 7-16; 29.4: Wind Force

$$\begin{aligned} K_z &= 0.57 \\ K_{zt} &= 1 \\ K_d &= 1 \\ V &= 98 & \text{mph} \\ GC_r &= 1.9 \\ GC_{r(\text{uplift})} &= 1.5 \\ A_f &= 68.5 & \text{sf} \\ A_v &= 9.6 & \text{sf} \end{aligned}$$

ASCE 7-16; Table 26.10-1

ASCE 7-16; 26.8.2

ASCE 7-16; Table 26.6-1

ASCE 7-16; 29.4.1

ASCE 7-16; 29.4.1

Horizontal projected area of equipment

$$q_h = 0.00256 K_z K_{zt} K_d V^2 = 14.0 \text{ psf}$$

ASCE 7-16; Equation 26.10-1

$$F_w = (.6) q_h GC_r A_f = 1094 \text{ lb}$$

ASCE 7-16; Equation 29.4-2

$$F_{wv} = (.6) q_h GC_{r(\text{uplift})} A_v = 121 \text{ lb}$$

ASCE 7-16; Equation 29.4-3

Overturning Force: Seismic and Wind

$$\begin{aligned} X &= 30 & \text{in.} \\ Y_1 &= 24 & \text{in.} \\ Y_2 &= 211.25 & \text{in.} \end{aligned}$$

$$CW + \sum M_o = 0 = F_p(Y_1 + Y_2/2) + F_{pv}(X/2) - W_p(X/2) - F_a X$$

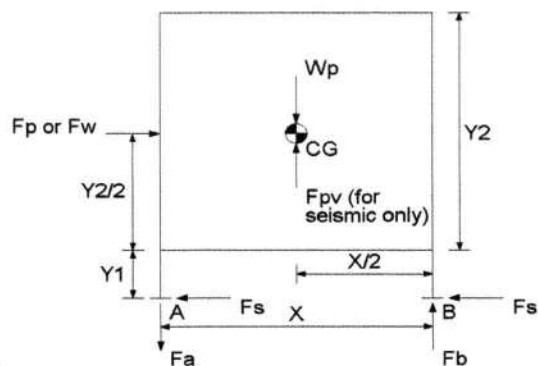
$$F_a = 4897 \text{ lb}$$

$$CW + \sum M_o = 0 = F_w(Y_1 + Y_2/2) + F_{wv}(X/2) - W_p(X/2) - F_a X$$

$$F_a = 2521 \text{ lb}$$

Seismic forces control

$$\text{Controlling } F_a = 4897 \text{ lb}$$

Max
uplift



Company:	STABILITY ENGINEERING INC.	Date:	2/28/2023
Engineer:	PAUL SCHROEDER	Page:	1/5
Project:	22-0690		
Address:			
Phone:			
E-mail:	PAUL@STABILITYENGINEERS.COM		

1. Project information

Customer company:
 Customer contact name:
 Customer e-mail:
 Comment:

Project description:
 Location:
 Fastening description:

2. Input Data & Anchor Parameters

General

Design method: ACI 318-14
 Units: Imperial units

Anchor Information:

Anchor type: Cast-in-place
 Material: AB
 Diameter (inch): 0.750
 Effective Embedment depth, h_{ef} (inch): 15.000
 Anchor category: -
 Anchor ductility: Yes
 h_{min} (inch): 17.25
 C_{min} (inch): 4.50
 S_{min} (inch): 4.50

Base Material

Concrete: Normal-weight
 Concrete thickness, h (inch): 18.00
 State: Cracked
 Compressive strength, f_c (psi): 2500
 $\Psi_{c,v}$: 1.0
 Reinforcement condition: B tension, B shear
 Supplemental reinforcement: Not applicable
 Reinforcement provided at corners: No
 Ignore concrete breakout in tension: No
 Ignore concrete breakout in shear: No
 Ignore 6do requirement: No
 Build-up grout pad: No

Recommended Anchor

Anchor Name: PAB Pre-Assembled Anchor Bolt - PAB6 (3/4"Ø)



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Load and Geometry

Load factor source: ACI 318 Section 5.3

Load combination: not set

Seismic design: Yes

Anchors subjected to sustained tension: Not applicable

Ductility section for tension: 17.2.3.4.2 not applicable

Ductility section for shear: 17.2.3.5.2 not applicable

Ω_0 factor: not set

Apply entire shear load at front row: No

Anchors only resisting wind and/or seismic loads: Yes

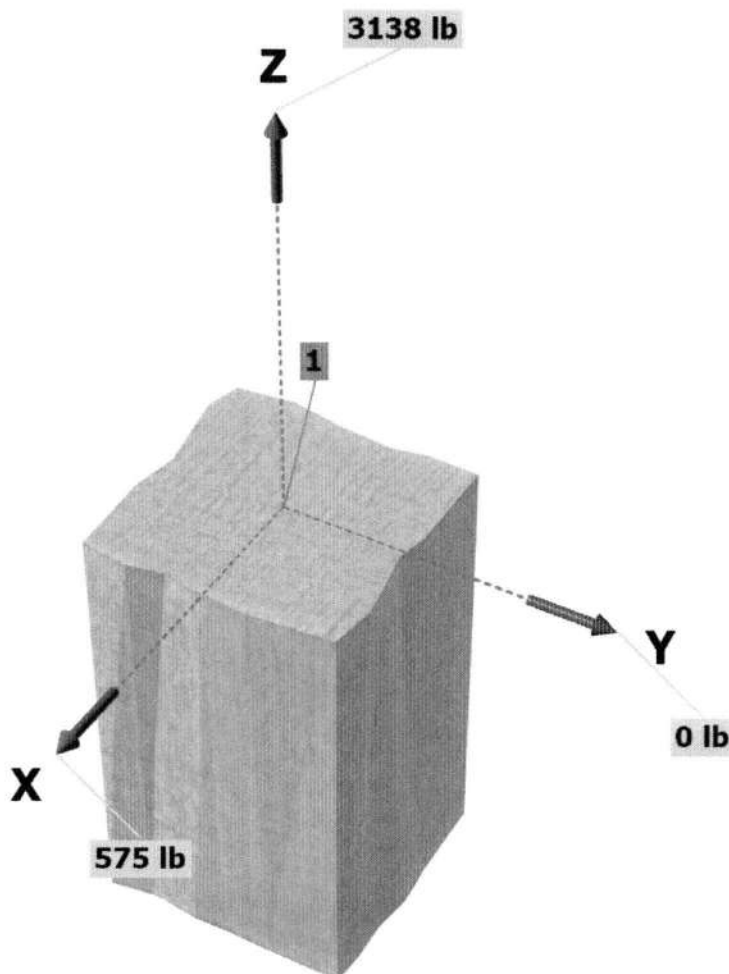
Strength level loads:

N_{ua} [lb]: 3138

V_{uax} [lb]: 575

V_{uay} [lb]: 0

<Figure 1>



Input data and results must be checked for agreement with the existing circumstances, the standards and guidelines must be checked for plausibility.

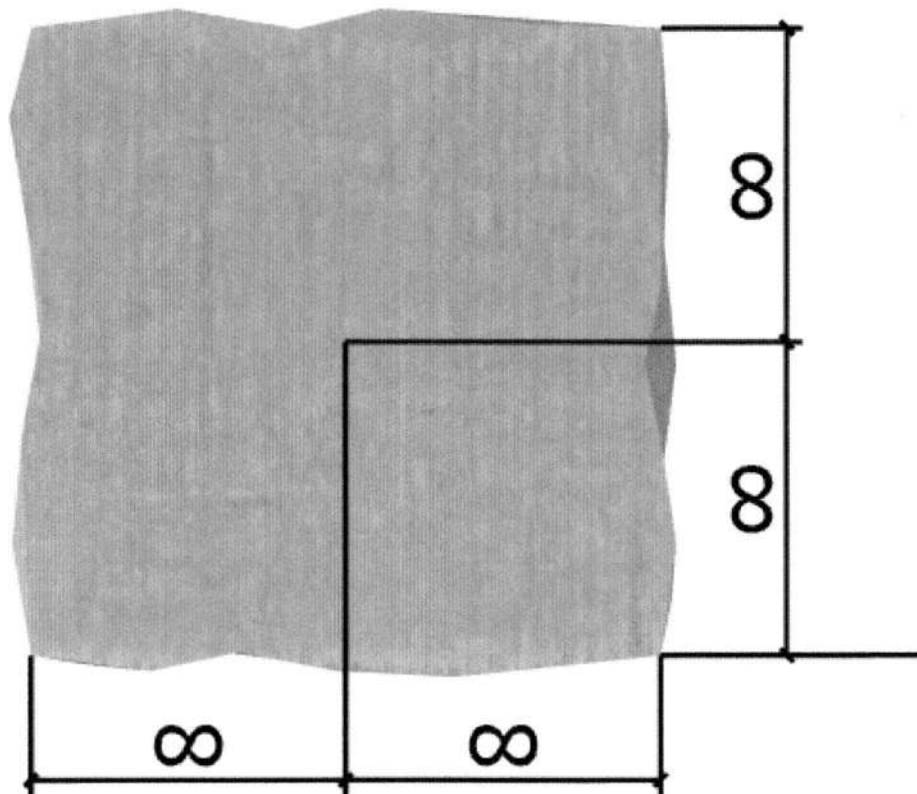
Simpson Strong-Tie Company Inc. 5956 W. Las Positas Boulevard Pleasanton, CA 94588 Phone: 925.560.9000 Fax: 925.847.3871 www.strongtie.com



Anchor Designer™
Software
Version 3.0.7947.0

Company:	STABILITY ENGINEERING INC.	Date:	2/28/2023
Engineer:	PAUL SCHROEDER	Page:	3/5
Project:	22-0690		
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<Figure 2>





Company:	STABILITY ENGINEERING INC.	Date:	2/28/2023
Engineer:	PAUL SCHROEDER	Page:	4/5
Project:	22-0690		
Address:			
Phone:			
E-mail:	PAUL@STABILITYENGINEERS.COM		

3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2 + (V_{uay})^2}$ (lb)
1	3138.0	575.0	0.0	575.0
Sum	3138.0	575.0	0.0	575.0

Maximum concrete compression strain (‰): 0.00

Maximum concrete compression stress (psi): 0

Resultant tension force (lb): 3138

Resultant compression force (lb): 0

Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00

Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00

Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00

Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

4. Steel Strength of Anchor in Tension (Sec. 17.4.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
19370	0.75	14528

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.4.2)

$N_b = 16\lambda_a \sqrt{f_c} h_{ef}^{5/3}$ (Eq. 17.4.2.2b)

λ_a	f_c (psi)	h_{ef} (in)	N_b (lb)
1.00	2500	15.000	72986

$0.75\phi N_{cb} = 0.75\phi (A_{Nc} / A_{Nco}) \psi'_{ed,N} \psi'_{c,N} \psi'_{cp,N} N_b$ (Sec. 17.3.1 & Eq. 17.4.2.1a)

A_{Nc} (in ²)	A_{Nco} (in ²)	$c_{s,min}$ (in)	$\psi'_{ed,N}$	$\psi'_{c,N}$	$\psi'_{cp,N}$	N_b (lb)	ϕ	$0.75\phi N_{cb}$ (lb)
2232.56	2025.00	-	1.000	1.00	1.000	72986	0.70	42245

6. Pullout Strength of Anchor in Tension (Sec. 17.4.3)

$0.75\phi N_{pn} = 0.75\phi \psi'_{c,P} N_p = 0.75\phi \psi'_{c,P} 8A_{brg} f_c$ (Sec. 17.3.1, Eq. 17.4.3.1 & 17.4.3.4)

$\psi'_{c,P}$	A_{brg} (in ²)	f_c (psi)	ϕ	$0.75\phi N_{pn}$ (lb)
1.0	3.53	2500	0.70	37107

Input data and results must be checked for agreement with the existing circumstances, the standards and guidelines must be checked for plausibility.

Simpson Strong-Tie Company Inc. 5956 W. Las Positas Boulevard Pleasanton, CA 94588 Phone: 925.560.9000 Fax: 925.847.3871 www.strongtie.com



Company:	STABILITY ENGINEERING INC.	Date:	2/28/2023
Engineer:	PAUL SCHROEDER	Page:	5/5
Project:	22-0690		
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8. Steel Strength of Anchor in Shear (Sec. 17.5.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
11625	1.0	0.65	7556

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.5.3)

$$\phi V_{cp} = \phi k_{cp} N_{cb} = \phi k_{cp} (A_{Nc} / A_{Nco}) \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \text{ (Sec. 17.3.1 \& Eq. 17.5.3.1a)}$$

k_{cp}	A_{Nc} (in ²)	A_{Nco} (in ²)	$\psi_{ed,N}$	$\psi_{c,N}$	$\psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cp} (lb)
2.0	2232.56	2025.00	1.000	1.000	1.000	72986	0.70	112655

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.6.)

Tension	Factored Load, N_{ua} (lb)	Design Strength, ϕN_n (lb)	Ratio	Status	
Steel	3138	14528	0.22	Pass (Governs)	
Concrete breakout	3138	42245	0.07	Pass	
Pullout	3138	37107	0.08	Pass	
Shear	Factored Load, V_{ua} (lb)	Design Strength, ϕV_n (lb)	Ratio	Status	
Steel	575	7556	0.08	Pass (Governs)	
Pryout	575	112655	0.01	Pass	
Interaction check	$N_{ua}/\phi N_n$	$V_{ua}/\phi V_n$	Combined Ratio	Permissible	Status
Sec. 17.6..1	0.22	0.00	21.6%	1.0	Pass

PAB6 (3/4"Ø) with hef = 15.000 inch meets the selected design criteria.

12. Warnings

- Per designer input, the tensile component of the strength-level earthquake force applied to anchors does not exceed 20 percent of the total factored anchor tensile force associated with the same load combination. Therefore the ductility requirements of ACI 318 17.2.3.4.2 for tension need not be satisfied – designer to verify.

- Per designer input, the shear component of the strength-level earthquake force applied to anchors does not exceed 20 percent of the total factored anchor shear force associated with the same load combination. Therefore the ductility requirements of ACI 318 17.2.3.5.2 for shear need not be satisfied – designer to verify.

- Designer must exercise own judgement to determine if this design is suitable.

General Footing

Project File: 22-0690 Propane Ftg.ec6

LIC#: KW-06014874, Build:20.23.05.22

Stability Engineering Inc.

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DESCRIPTION: Propane Footing

Code References

Calculations per ACI 318-14, IBC 2018, CBC 2019, ASCE 7-16

Load Combinations Used : IBC 2021

General Information

Material Properties

f_c : Concrete 28 day strength	=	2.50 ksi
f_y : Rebar Yield	=	60.0 ksi
E_c : Concrete Elastic Modulus	=	3,122.0 ksi
Concrete Density	=	145.0 pcf
ϕ Values Flexure	=	0.90
Shear	=	0.750

Analysis Settings

Min Steel % Bending Reinf.	=	
Min Allow % Temp Reinf.	=	0.00180
Min. Overturning Safety Factor	=	1.50 : 1
Min. Sliding Safety Factor	=	1.50 : 1
Add Ftg Wt for Soil Pressure	:	Yes
Use ftg wt for stability, moments & shears	:	Yes
Add Pedestal Wt for Soil Pressure	:	No
Use Pedestal wt for stability, mom & shear	:	No

Soil Design Values

Allowable Soil Bearing	=	1.50 ksf
Soil Density	=	110.0 pcf
Increase Bearing By Footing Weight	=	No
Soil Passive Resistance (for Sliding)	=	250.0 pcf
Soil/Concrete Friction Coeff.	=	0.350

Increases based on footing Depth

Footing base depth below soil surface	=	1.50 ft
Allow press. increase per foot of depth when footing base is below	=	0.10 ksf
	=	1.0 ft

Increases based on footing plan dimension

Allowable pressure increase per foot of depth		
when max. length or width is greater than	=	ksf
	=	ft

Dimensions

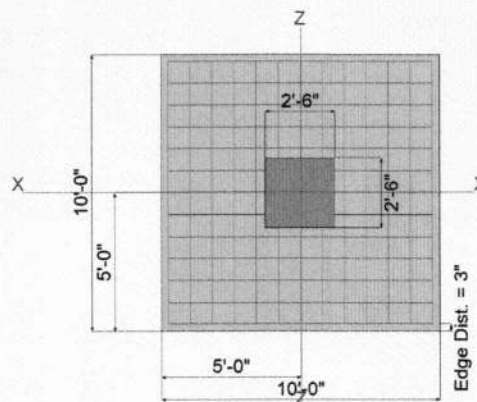
Width parallel to X-X Axis	=	10.0 ft
Length parallel to Z-Z Axis	=	10.0 ft
Footing Thickness	=	18.0 in

Pedestal dimensions...

px : parallel to X-X Axis	=	30.0 in
pz : parallel to Z-Z Axis	=	30.0 in
Height	=	130.0 in

Rebar Centerline to Edge of Concrete...

at Bottom of footing	=	3.0 in
----------------------	---	--------



Reinforcing

Bars parallel to X-X Axis	=	
Number of Bars	=	13
Reinforcing Bar Size	=	# 5

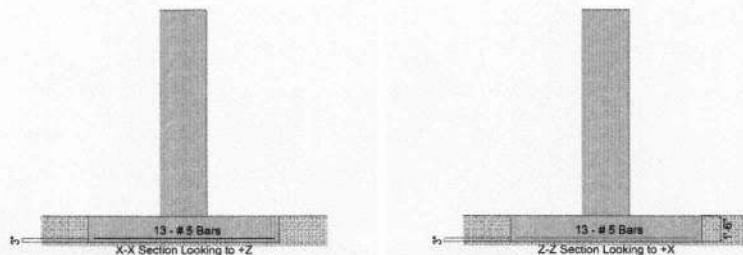
Bars parallel to Z-Z Axis	=	
Number of Bars	=	13
Reinforcing Bar Size	=	# 5

Bandwidth Distribution Check (ACI 15.4.4.2)

Direction Requiring Closer Separation

Bars required within zone n/a

Bars required on each side of zone n/a



Applied Loads

	D	Lr	L	S	W	E	H
P : Column Load	=	7.560					k
OB : Overburden	=						ksf
M-xx	=						k-ft
M-zz	=						k-ft
V-x	=				1.823	2.264	k
V-z	=						k

General Footing

Project File: 22-0690 Propane Ftg.ec6

LIC#: KKW-06014874, Build:20.23.05.22

Stability Engineering Inc.

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DESCRIPTION: Propane Footing**DESIGN SUMMARY****Design OK**

	Min. Ratio	Item	Applied	Capacity	Governing Load Combination
PASS	0.2640	Soil Bearing	0.4092 ksf	1.550 ksf	+D+0.70E about Z-Z axis
PASS	n/a	Overturning - X-X	0.0 k-ft	0.0 k-ft	No Overturning
PASS	5.998	Overturning - Z-Z	14.659 k-ft	87.930 k-ft	+0.60D+0.70E
PASS	5.659	Sliding - X-X	1.585 k	8.968 k	+0.60D+0.70E
PASS	n/a	Sliding - Z-Z	0.0 k	0.0 k	No Sliding
PASS	n/a	Uplift	0.0 k	0.0 k	No Uplift
PASS	0.05774	Z Flexure (+X)	1.521 k-ft/ft	26.343 k-ft/ft	+1.20D+E
PASS	0.02825	Z Flexure (-X)	0.7441 k-ft/ft	26.343 k-ft/ft	+1.40D
PASS	0.02825	X Flexure (+Z)	0.7441 k-ft/ft	26.343 k-ft/ft	+1.40D
PASS	0.02825	X Flexure (-Z)	0.7441 k-ft/ft	26.343 k-ft/ft	+1.40D
PASS	0.04007	1-way Shear (+X)	3.005 psi	75.0 psi	+1.20D+E
PASS	0.01960	1-way Shear (-X)	1.470 psi	75.0 psi	+1.40D
PASS	0.01960	1-way Shear (+Z)	1.470 psi	75.0 psi	+1.40D
PASS	0.01960	1-way Shear (-Z)	1.470 psi	75.0 psi	+1.40D
PASS	0.02236	2-way Punching	3.354 psi	150.0 psi	+1.40D



Top reinforcing mat required (see 'Bending' tab).

Hand check required for anchor pullout.